A User's Guide to

WINSTEPS®

MINISTEP

Rasch-Model Computer Programs

Program Manual 5.10.1 by

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1 Control Variables Index

Before your analysis, these control variables can be set in your Control file and at the Extra specifications prompt.
After your analysis, these control variables can be set in the Specification-menu dialog box and in other pull-down menus.
The current settings of these variables can be seen from the Output Files menu. Click on Control variables file.

Control variable	Use	Shortest
AGREEFILE=	paired-person agreement file	AG
AGREEGROUP=	compare with other groups in Table 35	AGREEG
ALPHANUM=	alphabetic numbering to exceed 9 with XWIDE=1	ALP
ANCESTIM=	Special alternative estimation method for anchored analyses	ANCE
ASCII=	output only ASCII characters	ASC
ASYMPTOTE=	report estimates of upper and lower asymptotes	ASY
BATCH=	set batch mode	BA
BOXSHOW=	draw boxes around Output Tables	BO
BYITEM=	show empirical curves for items	BY
CATREF=	reference category: Table 2	CATR
CFILE=	scored category label file	CF
CHART=	graphical plots of measures	CHA
CHISQUARE=	output Chi-square instead of Mean-square in IFILE= and PFILE=	CHI
CIMPUTE=	impute values for missing data in PCA analysis	CI
CLFILE=	codes label file	CL
CMATRIX=	category matrix in Table 3.2, etc.	CMA
CMLE=	Conditional Maximum Likelihood Estimation	CML
CODERANGE=	numerical range of data codes	CODER
CODES=	valid & missing data codes	COD
CONVERGE=	select convergence criteria	CON
CSV=	comma-separated values in output files	CS
CURVES=	probability curve selection: Tables 21, 2	CUR
CUTHI=	cut off responses with high expectations	CUTH
CUTLO=	cut off responses with low expectations	CUTL
DATA=	name of data file	DA or MS
DATESHOW=	display analysis date and Winsteps version number in Table headings	DATES
DELIMITER=	delimiter of input response data fields	DELI
DIF=	person label columns for DIF	DIF
DISCRIM=	display item discrimination estimates	DISC
DISFILE=	category/distractor/response option count file	DISF
DISOPTION=	distractor file reporting option	DISO
DISTRACTOR=	output category/distractor/option counts	DIST
DIVAUTO=	automatic changes to ESTMULT= when estimation diverges	DIVA
DPF=	item label columns for DPF	DPF
EDFILE=	edit data file	ED
EFILE=	expected scores on the items	EF
EQFILE=	code equivalences	EQ
ESTMULT=	estimate change multiplier	ES
ETYPE=	expected score file options	ET

EXCAT=	extreme-category adjustment	EXC
EXCELDECIMAL=	decimal separator for Excel spreadsheets	EXCELD
EXCELNUMBER=	Excel converts numeric labels into numbers = No	EXCELN
EXCELPLOT32=	Use 32-bit Excel Plot interface = Yes	EXCELP
EXTRSCORE=	extreme score adjustment	EXT or MM
FITHIGH=	lower bar in charts	FITH
FITITEM=	item misfit criterion	FITI or MFIT2
FITLOW=	lower bar in charts	FITL
FITPERSON=	person misfit criterion	FITP or MFIT1
FORMAT=	reformat data	FORMA
FORMFEED=	form-feed character	FORMF
FRANGE=	half-range of fit statistics on plots	FRA or Y
FREQUENT=	column heading in Tables 1, 12, 16	FRE
FSHOW=	show files created from control file	FS
G0ZONE=	percent of 0's within 0-zone among which all 1's are turned to 0's	G0 or GO
G1ZONE=	percent of 1's within 1-zone among which all 0's are turned to 1's	G1
GRFILE=	graphing file for probability curves	GRF
GROUPS=	assigns items to rating scale or partial credit groupings (same as ISGROUPS=)	GRO
GRPFROM=	location of ISGROUPS=	GRP
GUFILE=	Guttmanized file of responses	GU
HEADER=	display or suppress Sub-Table Headings after the first	HE
HIADJ=	correction for top categories	HI
HLINES=	heading lines in output files	HL
IADD=	add item difficulty to GRFILE= measure	IAD
IAFILE=	item anchor file	IAF or AF
IANCHQU=	anchor items interactively	IAN or ANCH
ICOLORFILE=	colors for item labels in PKMAPs	ICOL
ICORFILE=	inter-item residual correlations	ICOR
IDELETE=	one-line item deletion list	IDELE
IDELQU=	delete items interactively	IDELQ or DELQ
IDFILE=	item deletion file	IDF or DF
IDROPEXTR=	remove items with extreme scores	IDR
IFILE=	item output file	IF
ILFILE=	item label file	IL
IMAP=	item label for item maps	IMA
INDEXED=	summarize response strings for estimation	IND
INUMB=	label items by sequence number	IN or ISEQ
IOFSFIELDS=	field selection for IFILE=	IO
IPDECIMALS=	decimal places reported in IFILE= and PFILE=	IPD
IPEXTREME=	placement of extreme scores on maps	IPE
IPMATRIX=	response matrix	IPM
IPRFILE=	change codes for blocks of persons and items	IPR
IREFER=	identifying items for recoding	IR

ISELECT=	item selection criterion	ISE
ISFILE=	item-structure output file	ISF
ISGROUPS=	assigns items to rating scale or partial credit groupings (same as GROUPS=)	ISG
ISORT=	sort column in item label	ISO
ISRANGE=	category range of an item group	ISR or ICR
ISUBTOTAL=	subtotal items by specified columns	ISU
ITEM=	title for item labels	ITEM
ITEM1=	column number of first response	ITEM1
ITLEN=	maximum length of item label	ITL
IVALUEx=	recoding for items	IV
IWEIGHT=	item (variable) weighting	IW
KEYFORM=	keyform output file (backwards compatibility only)	KEYFO or KEYFI
KEYFROM=	location of KEYn=	KEYFR
KEYn=	scoring key	KEY
KEYSCR=	reassign scoring keys	KEYS
LCONV=	logit change at convergence	LC
LESS=	column heading in Tables 1, 12, 16	LE
LINELENGTH=	length of printed lines	LI
LOCAL=	locally restandardize fit statistics	LOC
LOGFILE=	accumulates control files	LOG
LOWADJ=	correction for bottom categories	LOW or LOA
MAKEKEY=	construct an MCQ scoring key	MAK
MATRIX=	correlation output format	MAT
MAXPAGE=	maximum number of lines per page	MAXP
MBOTTOM=	lowest measure in Table 1 etc.	MB
MCMLE=	maximum number of CMLE iterations = 0, no limit	MCM
MFORMS=	reformatting input records & multiple forms	MFO
MHSLICE=	size of Mantel or Mantel-Haenszel slice	MHS
MHZERO=	adjustment to zero cells in Mantel cross-tabulation	MHZ
MISSCORE=	scored value of missing data: not your missing-data code	MI
MJMLE=	maximum number of JMLE iterations	MJ
MNSQ=	show mean-square or t standardized fit	MN or ME
MODELS=	assigns model types to items	MODE
MODFROM=	location of MODELS=	MODF
MORE=	column heading in Tables 1, 12, 16	MOR
MPROX=	maximum number of PROX iterations	MP
MRANGE=	half-range of measures on plots in Tables	MR or XA
MTICK=	measure distance between tick-marks on plots in Tables	MTI
MTOP=	highest measure in Table 1 etc.	MTO
MUCON=	maximum number of JMLE iterations	MUC
MUNITS=	number of rows per measurement unit in Table 1 etc.	MUN
NAME1=	first column of person label	NAME1
NAMLEN=	length of person label	NAMELE or NAMLE

NAMLMP=	label length on maps	NAMELM or NAMLM or NAML6
NEWSCORE=	recoded data values	NE
NI=	number of items	NI
NOMEASURE=	value in IFILE= or PFILE= for no measure	NOM
NORMAL=	normal distribution for standardizing fit	NOR
OFILE=	report output file	OF
OSORT=	category/option/distractor sorted by score, count or measure	OS
OUTFIT=	sort misfits on outfit or infit	OU
PAFILE=	person anchor file	PAF
PAIRED=	correction for paired comparison data	PAI
PANCHQU=	anchor persons interactively	PAN
PCORFIL=	inter-person residual correlations	PC
PDELETE=	one-line person deletion list	PDELE
PDELQU=	delete persons interactively	PDELQ
PDFILE=	person deletion file	PDF
PDROPEXTR=	remove persons with extreme scores	PDR
PERSON=	title for person labels	PE
PFILE=	person output file	PF
PIVOT=	structure anchoring (backwards compatibility only)	PI
PKMAP=	customize Table 36 diagnostic maps	PK
PLFILE=	person label file	PL
PMAP=	person label for person maps	PM
POFSFIELDS=	field selection for PFILE=	PO
PRCOMP=	residual type for principal components/contrast analysis	PR
PSELECT=	person selection criterion	PSE
PSORT=	sort column in person label	PSO
PSUBTOTAL=	subtotal persons by specified columns	PSU
PTBISERIAL=	report point-biserial correlations	PT
PVALUE=	report item proportion-correct-values or average ratings	PV
PWEIGHT=	person (case) weighting	PW
QCMLE=	Quasi-Conditional Maximum Likelihood Estimates	QCM
QUOTED=	quote-marks around labels	Q
RARE=	column heading in Tables 1, 12, 16	RA
RCONV=	score residual at convergence	RC
REALSE=	inflate S.E. of measures for misfit	REA
RESCORE=	controls response recoding	RESC
RESFRM=	location of RESCORE=	RESF
RFILE=	scored response output file	RF
RMSR=	report root-mean-square residual in measure tables	RMSR
ROW1HEADING=	heading in first row of output file	RO
SAFILE=	structure anchor file	SAF
SAITEM=	multiple ISGROUPS= format in SFILE= & SAFILE=	SAI
SANCHQU=	anchor structure interactively	SAN
SCOREFILE=	score-to-measure file	SC

SCREENFILE=	screen log file	SCREEN
SDELQU=	delete structure interactively	SDELQ
SDFILE=	structure deletion file	SDF
SEPARATOR=	delimiter of input response data fields	SE
SFILE=	structure output file	SF
SFUNCTION=	function to model Andrich thresholds with polynomials	SFU
SICOMPLETE=	simulate complete data	SIC
SIEXTREME=	simulate extreme scores = Yes	SIE or SIX
SIFILE=	simulated data file	SIF
SIMEASURE=	measure or data = Yes	SIM
SINUMBER=	number of simulated data files = 1	SIN
SIRESAMPLE=	number of persons resampled	SIR
SISEED=	simulated data seed = 0 (clock)	SIS
SORTABLE=	webpages with sortable columns	SO
SPFILE=	supplemental control file	SP
SPSS32=	SPSS .sav output module (32-bit or 64-bit) = Yes (32-bit)	SPS
STBIAS=	correct for estimation bias	STB
STEPT3=	structure summary in Table 3.2 or 21	STEPT
STKEEP=	keep non-observed intermediate categories in structure	STEPK or STK or STR
SUBSETS=	perform subset detection	SU
SVDEPOCHS=	maximum epochs for SVD estimation	SVDE
SVDFACTORS=	singular-value decomposition factors	SVDFA
SVDFILE=	singular-value decomposition file	SVDFI
SVDMIN=	singular-value decomposition minimum improvement	SVDM
SVDTYPE=	singular-value decomposition residual type	SVDT
T1CAT=	show category number in subtables	T1C
T1ITEM#=	items per # in Table 1	T1I
T1MWE=	mean and S.D. with extreme measures in Tables 1, 12, 16	T1M
T1PPERSON#=	persons per # in Table 1	T1P
T1SCORE=	show raw score in Tables 1,12,16	T1S
T1WEIGHTED=	weighted items and persons shown once or by weight in Table 1	T1W
T2SELECT=	selects Table 2 subtables	T2
T30PAIRSMAX=	maximum pairs to display in Tables 30.1, 31.1	T30P
T45OPTIONS=	field choices for Table 45	T45
T7OPTIONS=	selects Table 7.1 and 11.1 detail lines	T7
TABLES=	output table selection	TAB
TARGET=	information-weighted estimation	TAR
TCCFILE=	Test Characteristic Curve (TCC) and Test Information Function (TIF)	TC
TCCHIGH=	highest value on TCC measurement scale	TCCH
TCCINCR=	increment on TCC measurement scale	TCCI
TCCLOW=	lowest value on TCC measurement scale	TCCL
TFILE=	input file of table numbers to be output	TF
TITLE=	title for output listing	TI
TOTALSCORE=	show total observed score and count	TO

TRPOFILE=	transposed file	TRPOF
TRPOTYPE=	transposed file type	TRPOT
UAMOVE=	amount to increase anchor values	UAM
UANCHOR=	user anchors (backward compatibility only)	UAN
UASCALE=	anchor user-scale value of 1 logit	UAS
UCOUNT=	most unexpected responses in Tables 6 and 10.	UC
UDECIMALS=	number of decimal places reported	UD
UEXTREME=	include extreme scores for UIMEAN= or UPMEAN= = No	UE
UIMEAN=	reported user-set mean of item measures	UI
UMEAN=	reported user-set mean of item measures	UM
UPMEAN=	reported user-set mean of person measures	UP
USCALE=	reported user-scaled value for 1 logit	US
UTF8ENC=	file is or is not encoded in UTF-8	UTF8E
UTF8SUB=	substitute character for multibyte UTF-8	UTF8S
W300=	produce IFILE= and PFILE= in 3.00 format	W3
WEBFONT=	font to display using ASCII=Webpage	WE
WHEXACT=	Wilson-Hilferty exact normalization	WH
WMLE=	Warm's Weighted Maximum Likelihood Estimates	WM or WA or WL
WRFIT=	Weighted-residual fit statistics = No	WR
XFILE=	analyzed response file	XF
XLRSSST32=	Excel/RSSST input conversion module: 32-bit or 64-bit = Yes (32-bit)	XLR
XWIDE=	columns per response	XW

&INST	start of control variables (optional)
&END	end of control variables, before item labels
END LABELS END NAMES	end of item labels or names, before data
@FIELD=	user-defined field locations
#1#=	user-defined replaceable tokens

2 Control Variables by function

Data file layout:	
DATA=	name of data file
DELIMITER=	delimiter of input response data fields
FORMAT=	reformat data
ILFILE=	item label file
INUMB=	label items by sequence number
ITEM1=	column number of first response
ITLEN=	maximum length of item label
MFORMS=	reformatting input records & multiple forms
NAME1=	first column of person label

NAMLEN=	length of person label
NI=	number of items
PLFILE=	person label file
SEPARATOR=	delimiter of input response data fields
XWIDE=	columns per response
@FIELD=	user-defined field locations
Data selection and recoding:	
ALPHANUM=	alphabetic numbering to exceed 9 with XWIDE=1
CODES=	valid & missing data codes
CUTHI=	cut off responses with high expectations
CUTLO=	cut off responses with low expectations
EDFILE=	edit data file
IREFER=	identifying items for recoding
IVALUEx=	recoding for items
IWEIGHT=	item (variable) weighting
KEYn=	scoring key
KEYFROM=	location of KEYn=
KEYSCR=	reassign scoring keys
MAKEKEY=	construct an MCQ scoring key
MISSCORE=	scored value of missing data: not your missing-data code
NEWSCORE=	recoding values
PWEIGHT=	person (case) weighting
RESCORE=	response recoding
RESFRM=	location of RESCORE=
Items: deleting, anchoring and selecting:	
IAFILE=	item anchor file
IANCHQU=	anchor items interactively
IDELETE=	one-line item deletion list
IDELQU=	delete items interactively
IDFILE=	item deletion file
IDROPEXTR=	remove items with extreme scores
ISELECT=	item selection criterion

Person: deleting, anchoring and selecting:	
PAFILE=	person anchor file
PANCHQU=	anchor persons interactively
PDELETE=	one-line person deletion list
PDELQU=	delete persons interactively
PDFILE=	person deletion file
PDROPEXTR=	remove persons with extreme scores
PSELECT=	person selection criterion
Rating scales, partial credit items and polytomous response structures:	
GROUPS=	assigns items to rating scale or partial credit groupings (same as ISGROUPS=)
GRPFROM=	location of ISGROUPS=
ISGROUPS=	assigns items to rating scale or partial credit groupings (same as GROUPS=)
MODELS=	assigns model types to items
MODFROM=	location of MODELS=
STKEEP=	keep non-observed categories in structure
Category structure: anchoring, labeling, deleting:	
CFILE=	scored category label file
CLFILE=	codes label file
SAFILE=	structure anchor file
SAITEM=	multiple ISGROUPS= format in SFILE= & SAFILE=
SANCHQU=	anchor structure interactively
SDELQU=	delete structure interactively
SDFILE=	structure deletion file
Measure origin, anchoring and user-scaling:	
UAMOVE=	amount to increase anchor values
UANCHOR=	anchor values in user-scaled units (only for backward compatibility)
UASCALE=	anchor user-scaled value for 1 logit
UDECIMALS=	number of decimal places reported
UEXTREME=	include extreme scores for UIMEAN= or UPMEAN= = No
UIMEAN=	reported user-set mean of item measures

UMEAN=	reported user-set mean of item measures
UPMEAN=	reported user-set mean of person measures
USCALE=	reported user-scaled value for 1 logit
Output table selection and format:	
ASCII=	output only ASCII characters
FORMFEED=	form-feed character
HEADER=	display or suppress Sub-Table Headings after the first
ITEM=	title for item labels
LINELENGTH=	length of printed lines
MAXPAGE=	maximum number of lines per page
PERSON=	title for person labels
TABLES=	output table selection
TFILE=	input file of table numbers to be output
TITLE=	title for output listing
TOTALSCORE=	show total observed score and count
WEBFONT=	font to display using ASCII=Webpage
Output tables, files and graphs: specific controls	
ASYMPTOTE=	report estimates of upper and lower asymptotes
BOXSHOW=	display border boxes around columns of numbers in tables
BYITEM=	show empirical curves for items
CATREF=	reference category: Table 2
CHART=	graphical plots of measures
CMATRIX=	category matrix in Table 3.2, etc.
CURVES=	probability curve selection: Tables 21, 2
DISCRIM=	display item discrimination estimates
DISTRT=	output category/distractor/option counts
EQFILE=	code equivalences
FITHIGH=	lower bar in charts
FITI=	item misfit criterion
FITLOW=	lower bar in charts
FITP=	person misfit criterion
FRANGE=	half-range of fit statistics on plots

HIADJ=	correction for top categories
IMAP=	item label for item maps
IPEXTREME=	placement of extreme scores on maps
ISORT=	sort column in item label
ISUBTOTAL=	subtotal items by specified columns
LOWADJ=	correction for bottom categories
MNSQ=	show mean-square or t standardized fit
MATRIX=	correlation output format
MRANGE=	half-range of measures on plots
MTICK=	measure distance between tick-marks on plots in Tables
NAMLMP=	label length on maps
OSORT=	category/option/distractor sorted by score, count or measure
OUTFIT=	sort misfits on outfit or infit
PMAP=	person label for person maps
PSORT=	sort column in person label
PSUBTOTAL=	subtotal persons by specified columns
PVALUE=	report item proportion-correct-values or average ratings
STEPT3=	structure summary in Table 3 or 21
T1I#=	items per # in Table 1
T1P#=	persons per # in Table 1
T7OPTIONS=	selects Table 7.1 and 11.1 detail lines
TRPOTYPE=	transposed file type
UCOUNT=	most unexpected responses in Tables 6 and 10.
W300=	produce IFILE= and PFILE= in 3.00 format
Output file format control:	
CSV=	comma-separated values in output files
HLINES=	heading lines in output files
QUOTED=	quote-marks around labels
Estimation, operation and convergence control:	
ANCESTIM=	Special alternative estimation method for anchored analyses
CONVERGE=	select convergence criteria
EXTRSCORE=	extreme score adjustment

LCONV=	logit change at convergence
LOCAL=	locally restandardize fit statistics
MJMLE=	maximum number of JMLE iterations
MPROX=	maximum number of PROX iterations
MUCON=	maximum number of JMLE iterations
NORMAL=	normal distribution for standardizing fit
PAIRED=	correction for paired comparison data
PTBISERIAL=	compute point-biserial correlations
RCONV=	score residual at convergence
REALSE=	inflate S.E. of measures for misfit
STBIAS=	correct for estimation bias
TARGET=	information-weighted estimation
WHEXACT=	Wilson-Hilferty exact normalization
Program operation:	
BATCH=	set batch mode
FSHOW=	show files created from control file
MAKEKEY=	construct an MCQ scoring key
SPFILE=	supplemental control file
&END	end of control variable list
&INST	start of control variable list (ignored)
END LABELS	end of item label list
Secondary (post-hoc) processing	
DIF=	person label columns for DIF
DPF=	item label columns for DPF
G0ZONE=	percent of 0's within 0-zone among which all 1's are turned to 0's
G1ZONE=	percent of 1's within 1-zone among which all 0's are turned to 1's
PRCOMP=	residual type for principal components/contrast analysis
SICOMPLETE=	simulate complete data
SIEXTREME=	simulate extreme scores = Yes
SINUMBER=	number of simulated data files = 1
SVDDEPTH=	singular-value decomposition levels
SVDMAX=	singular-value decomposition maximum change

SVDTYPE=	singular-value decomposition residual type

For the Output File control variables, please see Output Files Index

3 Input Files Index

These can be accessed from the Edit Menu. They are specified in your Control File or at Extra Specifications.

CFILE=	scored category label file
CLFILE=	codes label file
DATA=	name of data file
DIF=	person label columns for DIF
DPF=	item label columns for DPF
EDFILE=	edit data file
EQFILE=	code equivalences
GROUPS=	assigns items to rating scale or partial credit groupings (same as ISGROUPS=)
IAFILE=	item anchor file
ICOLORFILE=	colors for item labels in PKMAPs
IDFILE=	item deletion file
ILFILE=	item label file
IPRFILE=	change codes for blocks of persons and items
IREFER=	identifying items for recoding
ISRANGE=	category range of a rating scale
ISUBTOTAL=	subtotal items by specified columns
IWEIGHT=	item (variable) weighting
MFORMS=	reformatting input records & multiple forms
MODELS=	assigns model types to items
PAFILE=	person anchor file
PDFILE=	person deletion file
PIVOT=	structure anchoring (backwards compatibility only)
PLFILE=	person label file
PSUBTOTAL=	subtotal persons by specified columns
PWEIGHT=	person (case) weighting
RESCORE=	controls response recoding
SAFILE=	structure-threshold anchor file
SDFILE=	structure deletion file
SPFILE=	supplemental control file
TFILE=	input file of table numbers to be output

4 Output Tables Index

Click on the Table name to go to the Table description:

Output Tables | Output Files | Batch | Help | Specification | Plots | Excel/RSSST | Graphs | Data Setup

Request Subtables	1. Variable (Wright) maps	20. KID Score table
3.2+ Rating (partial credit) scale	2.2 General Keyform	21. Probability curves
2. Measure forms (all)	2.5 Category Averages	29. Empirical curves
Weight selection	3.1 Summary statistics	22. Scalograms
10. TAP (column): fit order	6. KID (row): fit order	40. KID Keyforms: fit order
13. TAP: measure	17. KID: measure	37. KID Keyforms: measure
14. TAP: entry	18. KID: entry	38. KID Keyforms: entry
15. TAP: alphabetical	19. KID: alphabetical	39. KID Keyforms: alphabetical
25. TAP: displacement	42. KID: displacement	41. KID Keyforms: unexpected
26. TAP: correlation	43. KID: correlation	36. KID diagnostic PKMAPs
11. TAP: responses	7. KID: responses	35. KID Paired Agreement
9. TAP: outfit plot	5. KID: outfit plot	45. KID Incremental Measures
8. TAP: infit plot	4. KID: infit plot	44. Global fit statistics
12. TAP: Wright map	16. KID: Wright map	34. Comparison of two statistics
23. TAP: dimensionality	24. KID: dimensionality	32. Control variable list
27. TAP: subtotals	28. KID: subtotals	20.3 TAP Score table
30. TAP: DIF, between/within	31. KID: DPF, between/within	33. KID-TAP: DGF: DIF & DPF

Table	*Description*
1	**Maps of person and item measures.** Show Rasch measures. 1.0 One page map with item and person labels. 1.1 Map of distributions - persons and items 1.2 Item labels with person distribution (squeezed onto one page) 1.3 Person labels with item distribution (squeezed onto one page) 1.4 (Polytomies) Rating scale or partial credit map of distributions: persons with items at high, mean, low 1.5 (Polytomies) Item map with expected score zones (Rasch-half-point thresholds) 1.6 (Polytomies) Item map with 50% cumulative probabilities (Rasch-Thurstonian thresholds) 1.7 (Polytomies) Item map with Andrich thresholds (modal categories if ordered) 1.8 (Polytomies) Item map with measures at category scores (maximum probability of categories) 1.9 (Polytomies) Item map of average person measure for each category score 1.10 One page map with person names by measure, item names by easiness. 1.11 Map of distributions - persons by ability and items by easiness 1.12 Map of item labels, by easiness, with person distribution 1.13 Map of person labels with item distribution by easiness
2	**Measures and responses plots.** Response categories for each item, listed in measure order, plotted against person measures, shown as modal categories, expected values and cumulative probabilities. Table 2 for dichotomous and multiple-choice items. Table 2 for polytomous, rating-scale, partial credit, items. *By scored categories (illustrated by an observed category code for each score)* 2.1 Modal categories (most probable) 2.2 Mean categories (average or expected: Rasch-half-point thresholds) 2.3 (Polytomies) Median categories (cumulative probabilities: Rasch-Thurstonian thresholds) 2.4 (Polytomies) Structure calibrations (Rasch model parameters: rating scale, partial credit, "restricted", "unrestricted": Rasch-Andrich thresholds) 2.5 Observed average measures of persons for scored categories (empirical averages) 2.7 Expected average measures of persons *By observed categories*

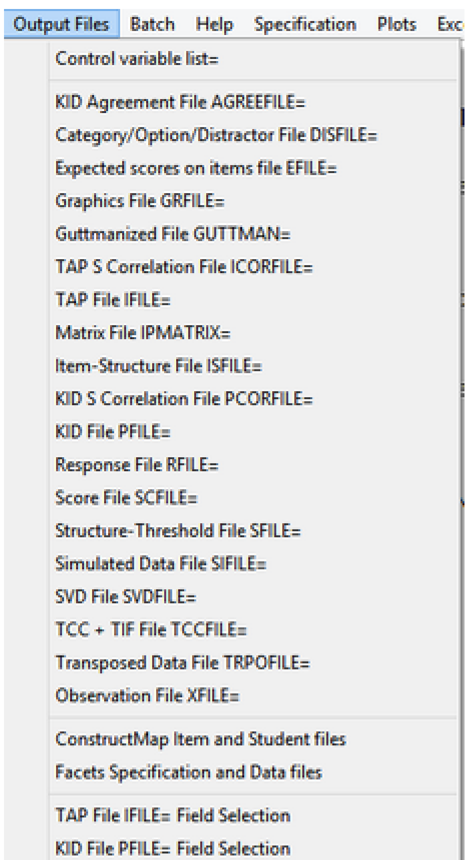
	2.6 Observed average measures of persons (empirical averages) *By category scores* 2.11 Modal categories (most probable) 2.12 Mean categories (average or expected: Rasch-half-point thresholds) 2.13 (Polytomies) Median categories (cumulative probabilities: Rasch-Thurstonian thresholds) 2.14 (Polytomies) Structure calibrations (Rasch model parameters: rating scale, partial credit, "restricted", "unrestricted") 2.15 Observed average measures of persons for scored categories (empirical averages) 2.16 Observed average measures of persons for observed categories (empirical averages) 2.17 Expected average measures of persons
3	**Summary statistics.** Person, item, and category measures and fit statistics. 3.1 Summaries of person and items: means, S.D.s, separation, reliability. 3.2 Summary of rating categories and probability curves. (STEPT3=Yes) 3.3-... Summary of rating categories and probability curves with ISGROUPS= (STEPT3=Yes)
4	**Person infit plot.** Person infit statistics plotted against person measures. 4.1 Person infit vs. person measure plot.
5	**Person outfit plot.** Person outfit statistics plotted against person measures. 5.1 Person outfit vs. person measure plot. 5.2 Person infit vs. person outfit plot.
6	**Person statistics - fit order.** Misfitting person list. Scalogram of unexpected responses. 6.1 Table of person measures in descending order of misfit. (Specify FITP=0 to list all persons) 6.2 Chart of person measures, infit mean-squares and outfit mean-squares. (Chart=Yes) 6.4 Scalogram of most misfitting person response strings. 6.5 Scalogram of most unexpected responses. 6.6 Most unexpected responses list.
7	**Misfitting Persons.** Lists response details for persons with *t* standardized fit greater than FITP=. 7.1 Response strings for most misfitting persons.
8	**Item infit plot.** Item infit plotted against item calibrations. 8.1 Item infit vs. item measure plot.
9	**Item outfit plot.** Item outfits plotted against item calibrations. 9.1 Item outfit vs. item measure plot. 9.2 Item infit vs. item outfit plot
10	**Item statistics - fit order.** Misfitting item list with option counts. Scalogram of unexpected responses. 10.1 Table of item measures in descending order of misfit. (Specify FITI=0 to list all persons) 10.2 Chart of item measures, infit mean-squares and outfit mean-squares. (Chart=Yes) 10.3 Item response-structure categories/options/distractors: counts and average abilities. (Distractors=Yes) 10.4 Scalogram of most misfitting item response strings. 10.5 Scalogram of most unexpected responses. 10.6 Most unexpected responses list.
11	**Misfitting Items.** Response details for items with t standardized fit greater than FITI=. 11.1 Response strings for most misfitting items.
12	**Item distribution map** with full labels for items and an person distribution. 12.2 Item labels with person distribution (same as 1.2) 12.5 (Polytomies) Item map with expected score zones (Rasch-half-point thresholds) (same as 1.5) 12.6 (Polytomies) Item map with 50% cumulative probabilities (Rasch-Thurstonian thresholds) (same as 1.6) 12.7 (Polytomies) Item map with Andrich thresholds (modal categories if ordered) (same as 1.7) 12.8 (Polytomies) Item map with measures at category scores (maximum probability of categories) (same as 1.8) 12.9 (Polytomies) Item map of average person measure for each category score (same as 1.9) 12.12 Item labels, by easiness, with person distribution (same as 1.12)
13	**Item statistics - measure order** list and graph with category/option/distractor counts. 13.1 Table of items in descending measure order. 13.2 Chart of item measures, infit mean-squares and outfit mean-squares. (Chart=Yes)

	13.3 Item response-structure categories/options/distractors: counts and average abilities. (Distractors=Yes)
14	**Item statistics - entry order** list and graph with category/option/distractor counts. 14.1 Table of items in entry number (sequence) order. 14.2 Chart of item measures, infit mean-squares and outfit mean-squares. (Chart=Yes) 14.3 Item response-structure categories/options/distractors: counts and average abilities. (Distractors=Yes)
15	**Item statistics - alphabetical order** list and graph with category/option/distractor counts. 15.1 Table of item measures in alphabetical order by label. (Specify ISORT= for sort column) 15.2 Chart of item measures, infit mean-squares and outfit mean-squares. (Chart=Yes) 15.3 Item response-structure categories/options/distractors: counts and average abilities. (Distractors=Yes)
16	**Person distribution map** with full labels for persons and an item distribution. 16.3 Person labels with item distribution (same as 1.3) 16.13 Person labels with item distribution by easiness (same as 1.13)
17	**Person statistics - measure order** list and chart. 17.1 Table of persons in descending measure order. 17.2 Chart of person measures, infit mean-squares and outfit mean-squares. (Chart=Yes)
18	**Person statistics - entry order** list and chart. 18.1 Table of persons in entry number (sequence) order. 18.2 Chart of person measures, infit mean-squares and outfit mean-squares. (Chart=Yes)
19	**Person statistics - alphabetical order** list and chart. 19.1 Table of person measures in alphabetical order by label. (Specify PSORT= for sort column) 19.2 Chart of person measures, infit mean-squares and outfit mean-squares. (Chart=Yes)
20	**Measures for all scores** on a test of all calibrated items, with percentiles. 20.1 Table of person measures for every score on complete test. (Specify ISELECT= for subtests). 20.2 Table of measures for every score, with sample percentiles and norm-referenced measures. 20.3 Table of item difficulty measures (calibrations) for every score (proportion-correct-values or average ratings) by complete sample.
21	**Category probability curves.** Category probabilities plotted against the difference between person and item measures, then the expected score and cumulative probability and expected score ogives. See also Graphs menu 21.1 Category probability curves (shows Rasch-Andrich thresholds). CURVES=1xx 21.2 Expected score ogive (model Item Characteristic Curve, model Item Response Function). CURVES=x1x 21.3 Cumulative category probability curves (shows Rasch-Thurstonian thresholds). CURVES=xx1
22	**Sorted observations.** Data sorted by person and item measures into scalogram patterns. 22.1 Guttman scalogram of sorted scored responses. 22.2 Guttman scalogram showing out-of-place responses. 22.3 Guttman scalogram showing original responses.
23	**Item principal components/contrasts.** Identifies structure and dimensionality in response residuals (BIGSTEPS Table: 10.3) 23.0 Scree plot of variance components 23.1, 23.11, ... Plot of loadings on first contrast in residuals vs. item measures. 23.2, 23.12, ... Items in contrast loading order. 23.3, 23.13, ... Persons exhibiting contrast. 23.4, 23.14, ... Items in measure order. 23.5, 23.15, ... Items in entry order. 23.6, 23.16, ... Person measures for item clusters. Matching scatterplot. 23.99 Tables of items with highly correlated residuals.
24	**Person principal components/contrasts**. Identifies structure in residuals (not in BIGSTEPS) 24.0 Scree plot of variance components. 24.1, 24.11,... Plot of loadings on first contrast in residuals vs. person measures. 24.2, 24.12,... Persons in contrast loading order. 24.3, 24.13,... Items exhibiting contrast. 24.4, 24.14, ... Persons in measure order. 24.5, 24.15,... Persons in entry order. 24.99 Tables of persons with highly correlated residuals.
25	**Item statistics - displacement order** list and graph with category/option/distractor counts.

	25.1 Table of items in descending displacement order. 25.2 Chart of item measures, infit mean-squares and outfit mean-squares. (Chart=Yes) 25.3 Item response-structure categories/options/distractors: counts and average abilities. (Distractors=Yes)
26	**Item statistics - correlation order** list and graph with category/option/distractor counts. 26.1 Table of items in ascending correlation order (Point-biserial, if PTBIS=Yes, else Point-measure). 26.2 Chart of item measures, infit mean-squares and outfit mean-squares. (Chart=Yes) 26.3 Item response-structure categories/options/distractors: counts and average abilities. (Distractors=Yes)
27	**Item subtotals**. 27.1 Measure sub-totals, controlled by ISUBTOT= 27.2 Measure sub-totals bar charts, controlled by ISUBTOT= 27.3.... Measure sub-totals summary statistics, controlled by ISUBTOT=
28	**Person subtotals**. 28.1 Measure sub-totals, controlled by PSUBTOT= 28.2 Measure sub-totals bar charts, controlled by PSUBTOT= 28.3.... Measure sub-totals summary statistics, controlled by PSUBTOT=
29	**Empirical item character curves and response frequency plots**. 29.1.... Expected and Empirical ICCs (see also Graph Menu) Empirical category code frequencies
30	**Differential Item Function across Person classifications** 30.1 DIF report (paired), controlled by DIF= 30.2 DIF report (measure list: person class within item) 30.3 DIF report (measure list: item within person class) 30.4 DIF report (item-by-person class chi-squares, between-class fit) 30.5 Within-class fit report (person class within item) 30.6 Within-class fit (report item within person class) 30.7 Item measure profiles for classes of persons
31	**Differential Person Function across Item classifications** 31.1 DPF report (paired), controlled by DPF= 31.2 DPF report (measure list: item class within person) 31.3 DPF report (measure list: person within item class) 31.4 DPF report (person by item-class chi-squares, between-class fit) 31.5 Within-class fit report (item class within person) 31.6 Within-class fit report person class within item) 31.7 Person measure profiles for classes of items
32	**Control Variable Listing** of the current settings of all Winsteps control variables - appears on the Output Files pull-down menu.
33	**Differential Group Function: Item Class vs. Person Class interaction/bias** 33.1 DGF report (paired person classes on each item class), controlled by DIF= and DPF= 33.2 DGF report (paired item classes on each person class) 33.3 DGF report (list of person classes within item class) 33.4 DPF report (list of item classes within person class) 33.7 Item group-Person group profiles 33.8 Item group-Person group profiles
34	**File Comparison** (Plot menu) 34.1 Column comparison of two statistics (and Excel scatterplot)
35	**Paired Comparison of Person Response Strings** 35.1, 35.11,... % Same (paired student) observed responses 35.2, 35.12,... % Same (paired student) scored responses 35.3, 35.13,... % Same (paired student) observed highest (right) responses 35.4, 35.14,... % Same (paired student) observed lowest (wrong) responses 35.5, 35.15,... % Same (paired student) missing responses
36	**Person PKMAP Plots** 36.1.... PKMAPS of persons
37	**Person KeyForms - Measure order.** 37.1-... Keyforms of responses of persons.

38	**KeyForms of Persons - Entry order.** 38.1-... Keyforms of responses of persons.
39	**KeyForms of Persons - Alphabetical order.** 39.1-... Keyforms of responses of persons.
40	**KeyForms of Persons - Misfit order.** 40.1-... Keyforms of responses of persons.
41	**KeyForms of Persons - Misfit order - only Unexpected Responses.** 41.1-... Keyforms of unexpected responses.
42	**Person statistics - displacement order** list and chart. 42.1 Table of persons in descending displacement order. 42.2 Chart of person measures, infit mean-squares and outfit mean-squares. (Chart=Yes)
43	**Person statistics - Correlation order** list and chart. 43.1 Table of persons in ascending correlation order (Point-biserial, if PTBIS=Yes, else Point-measure). 43.2 Chart of person measures, infit mean-squares and outfit mean-squares. (Chart=Yes)
44	**Global statistics** 44.1 Table of global counts and fit statistics
45	**Table 45** 45.1 Person measures after each item
0	**Control Variables and Convergence** report. Lists the control variables and shows estimation convergence. (Only appears at end of Output Report File). 0.1 Title page and Analysis identification 0.2 Convergence table 0.3 Control file 0.4 Subset details

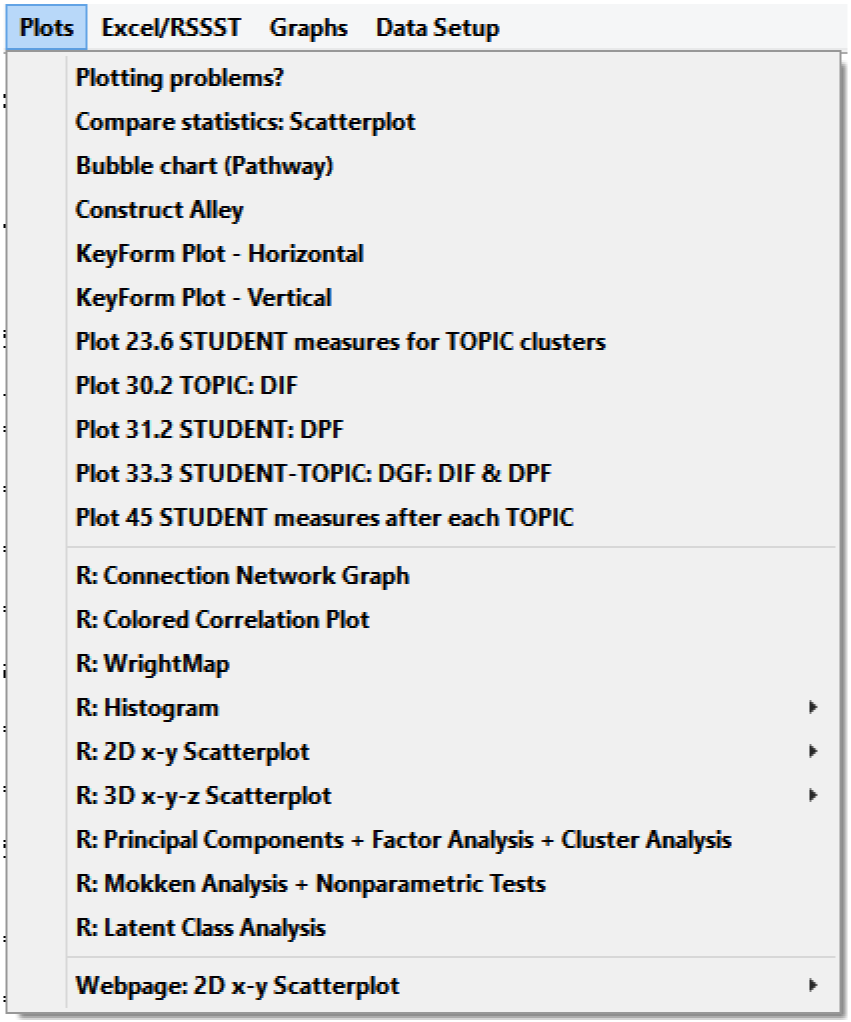
5 Output Files Index



These can be accessed from the Output Files pull-down menu. Once created, they can be accessed from the Edit Menu. The output files specified in the control file can be displayed immediately they are created with FSHOW=Yes.

Output files	
Control variable file	control variable listing (same as Table 32)
AGREEFILE=	paired-person agreement counts
DISFILE=	category/distractor/response option count file
EFILE=	expected scores on the items
GRFILE=	graphing file for probability curves
GUFILE=	Guttmanized file of responses
ICORFILE=	inter-item residual correlations
IFILE=	item output file
IPMATRIX=	response matrix
ISFILE=	item-structure output file (Do not use for anchoring)
MFORMS=	shows input responses as reformatted by MFORMS=
PCORFIL=	inter-person residual correlations
PFILE=	person output file
RFILE=	scored response output file
SCOREFILE=	score-to-measure file
SFILE=	structure-threshold output file (Use for anchoring)
SIFILE=	simulated data file
SVDFILE=	singular-value decomposition file
TCCFILE=	Test Characteristic Curve and Test Information Function
TRPOFILE=	transposed file
XFILE=	analyzed response file
ConstructMap	ConstructMap (formerly GradeMap) files - only from Output Files menu
Facets	create Facets Specification and Data files - only from Output Files menu
KEYFORM=	Keyform skeleton for Excel plot - see Plots menu
LOGFILE=	accumulates control files - only in the Control file
OFILE=	change report output file
IFILE= Field Selection	select fields to output to IFILE= file
PFILE= Field Selection	select fields to output to PFILE= file

6 Plots index



Here is the Plots menu:	
Plotting problems?	these are usually due to the Winsteps-Excel interface. See www.winsteps.com/problems.htm
These are plotted with Excel:	
Compare statistics: Scatterplot	enables you to draw scatter-plots (xy-plots) of Winsteps statistics within or between analyses. It also produces the tabular output of Table 34.
Bubble chart (pathway)	generates a Bond & Fox-style bubble chart.
Construct Alley	generates a Massof-style construct map with error bars
Keyform Plot - Horizontal	generates a horizontal Keyform layout.
Keyform Plot - Vertical	generates a vertical Keyform layout.
Plot 23.6 Person measures for Item clusters	scatterplots the person measures in Table 23.6 on the 3 clusters of items in Table 23.1
Plot 30.2. (Item): DIF	DIF plots the DIF values in Table 30.2.
Plot 31.2. (Person): DPF	DPF plots the DPF values in Table 31.2.
Plot 33.3. (Person-Item): DGF: DIF& DPF	DIF & DPF plots the DIF+DPF values in Table 33.3.
Plot 45. Person measures after each item	plots the values in Table 45
These are plotted with R Statistics:	

R: Connection Network Graph	draws the connections between the persons and items in the data
R: Colored Correlation Plot	plots a correlation matrix as colored cells
R: WrightMap	plots a WrightMap (Torres Irribarra & Freund)
R: Histogram	plots a histogram using 1 column of numbers for the x value and y count
R: 2D x-y Scatterplot	plots a 2-dimensional scatterplot using 2 columns of numbers for the x-y values.
R: 3D x-y-z Scatterplot	plots a 3-dimensional scatterplot using 3 columns of numbers for the x-y-z values.
R: Principal Components + Factor Analysis + Cluster Analysis	plots PCA and EFA eigenvalues and reports component/factor loadings, scores. Draw cluster analysis dendrogram
R: Mokken Analysis + Nonparametric Tests	reports summaries and provides links to plots
R: Latent Class Analysis	class probabilities for columns (items) and most probable class membership for rows (persons)
This is plotted with your webpage browset:	
Webpage 2D x-y Scatterplot	plots a 2-dimensional scatterplot using 2 columns of numbers for the x-y values.with interactive point labels

7 Introduction

7.1 Rasch analysis and WINSTEPS

Winsteps is Windows-based software which assists with many applications of the Rasch model, particularly in the areas of educational testing, attitude surveys and rating scale analysis. There is more information at: www.winsteps.com

Winsteps started from "Rating Scale Analysis" (Wright & Masters, 1982), available by free download at www.rasch.org (green book).

Rasch analysis is a method for obtaining objective, fundamental, additive measures (qualified by standard errors and quality-control fit statistics) from stochastic observations of ordered category responses. Georg Rasch, a Danish mathematician, formulated this approach in 1953 to analyze responses to a series of reading tests (Rasch G, *Probabilistic Models for Some Intelligence and Attainment Tests,* Chicago: MESA Press, 1992, with instructive Foreword and Afterword by B.D. Wright). Rasch is pronounced like the English word *rash* in Danish, and like the English sound *raa-sch* in German. The German pronunciation, *raa-sch*, is used to avoid misunderstandings.

The person and item total raw scores are used to estimate additive measures. Under Rasch model conditions, these measures are item-free (item-distribution-free) and person-free (person-distribution-free). So that the measures are statistically equivalent for the items regardless of which persons (from the same population) are analyzed, and for the items regardless of which items (from the same population) are analyzed. Analysis of the data at the response-level indicates to what extent these ideals are realized within any particular data set. Rasch analysis is "conjoint measurement". The person abilities and item difficulties are measured on the same scale. If you add something to the item difficulties then you add the same amount to the person abilities (thetas) in order to keep the relationship between the person and items the same.

The Rasch models implemented in Winsteps include the Georg Rasch dichotomous, Andrich "rating scale", Masters "partial credit", Bradley-Terry "paired comparison", Glas "success model", Linacre "failure model", Bradley-Massof "consecutive dichotomization" and most combinations of these models. Other models such as binomial trials and Poisson can also be analyzed by anchoring (fixing) the response structure to accord with the response model. (If you have a particular need, please let us know as Winsteps is continually being enhanced.)

The estimation methods are JMLE, "Joint Maximum Likelihood Estimation" and CMLE "Conditional Maximum Likelihod Estimation", with initial starting values provided by PROX, "Normal Approximation Algorithm".

Rasch Models implemented in Winsteps

The necessary and sufficient transformation of ordered qualitative observations into additive measures is a Rasch model. Rasch models are logit-linear models, which can also be expressed as log-linear models. Typical Rasch models operationalized with Winsteps are:

The dichotomous model:
loge(Pni1 / Pni0) = Bn - Di

The polytomous "Rating Scale" model:
log(Pnij/ Pni(j-1)) = Bn - Di - Fj

The polytomous "Partial Credit" model: ISGROUPS=0
log(Pnij/ Pni(j-1)) = Bn - Di - Fij = Bn - Dij

The polytomous "Grouped response-structure" model: ISGROUPS=11122333
log(Pnij/ Pni(j-1)) = Bn - Dig - Fgj

where
Pnij is the probability that person n encountering item i is observed in category j,
Bn is the "ability" (theta) measure of person n,
Di is the "difficulty" (delta) measure of item i, the point where the highest and lowest categories of the item are equally probable.
Fj is the "calibration" measure of category j relative to category j-1, the point where categories j-1 and j are equally probable relative to the measure of the item. No constraints are placed on the possible values of Fj.

Other Rasch models can be implemented by using anchored thresholds, SAFILE=. These include the Rasch Binomial Trials model and the Rasch Poisson Counts model.

Another useful model that can be implemented is the Rasch Paired Comparison (Bradley-Terry) model. Also a useful approximation to the Rasch Rank-Order model.

Also models with the form of "Continuation Ratio" models, such as the "Success" model and the "Failure" model.

For methods of estimation, see RSA, pp. 72-77.

Work-flow with Winsteps

Control + Data file or Control file and Data file(s)
↓
User-interaction → Winsteps ← Anchor Files
↓
Report Output File + Output Tables + Graphs + Output Files
↓
Word Processor, Spreadsheet, Statistical Package
↓
Actions

Winsteps is designed to construct Rasch measurement from the responses of a set of persons to a set of items. Responses may be recorded as letters or integers and each recorded response may be of one or two characters. Alphanumeric characters, not designated as legitimate responses, are treated as missing data. This causes these observations, but not the corresponding persons or items, to be omitted from the analysis. The responses to an item may be dichotomous ("right"/"wrong", "yes"/"no"), or may be on a rating scale ("good"/ "better"/"best", "disagree"/"neutral"/"agree"), or may have "partial credit" or other hierarchical structures. The items may all be grouped together as sharing the one response structure, or may be sub-groups of one or more items which share the same response structure.

Winsteps begins with a central estimate for each person measure, item calibration and response-structure calibration, unless pre-determined, "anchor" values are provided by the analyst. An iterative version of the PROX algorithm is used reach a rough convergence to the observed data pattern. The JMLE method is then iterated to obtain more exact estimates, standard errors and fit statistics.

Output consists of a variety of useful plots, graphs and tables suitable for import into written reports. The statistics can also be written to data files for import into other software. Measures are reported in Logits (log-odds units) unless user-rescaled. Fit statistics are reported as mean-square residuals, which have approximate chi-square distributions. These are also reported t standardized, N(0,1).

As computer speeds and available memory (and dataset sizes) increase, I improve the numerical precision and other aspects of the software. Winsteps recently moved to native 64-bit computations. It is now advancing from double-precision floating point to quad-precision. *An interesting example:* a large dataset that Winsteps needed one week to analyze in 2006 required only 2.5 hours in late 2021!

7.2 References

Please cite the current Winsteps computer program as:

Linacre, J. M. (2025). Winsteps® Rasch measurement computer program (Version 5.10.1). Portland, Oregon: Winsteps.com

For this User's Guide, the citation is:

Linacre, J. M. (2025). Winsteps® Rasch measurement computer program User's Guide. Version 5.10.1. Portland, Oregon: Winsteps.com

APA Style:
Linacre, J.M. (2025). Winsteps® (Version 5.10.1) [Computer Software]. Portland, Oregon: Winsteps.com. Available from https://www.winsteps.com/

For a webpage in Winsteps Help:
Linacre, J. M. (2025, June) Web page title, Retrieved on January 1, 2025 from www.winsteps.com/winman/webpage.htm

RSA means Wright B.D. & Masters G.N. Rating Scale Analysis, Chicago: MESA Press, 1982, especially p. 100: www.rasch.org - free
BTD means Wright B.D. & Stone M.H. Best Test Design, Chicago: MESA Press, 1979: www.rasch.org - free

Other recommended sources:
Rasch Measurement Transactions: www.rasch.org/rmt/
Journal of Applied Measurement: jampress.org
"Applying the Rasch Model: Fundamental Measurement in the Human Sciences", by Bond, Yan, Heene, 2020. Authors' website. Using Winsteps: Bond & Fox examples
"Introduction to Rasch Measurement", Everett V. Smith, Jr. & Richard M. Smith (Eds.) JAM Press, 2004 jampress.org
Rasch, G. (1960). Probabilistic Models for Some Intelligence and Attainment Tests (Reprint, with Foreword and Afterword by B. D. Wright, Chicago: University of Chicago Press, 1980). Copenhagen, Denmark: Danmarks Paedogogiske Institut. www.rasch.org/books.htm

Some Rasch papers available online:
For quick access to online papers, Google "+Winsteps +Rasch +Linacre filetype:pdf" - as of November 2009, this produced 2,290 hits.

https://www.science.gov/topicpages/m/many-facet+rasch+model.html#

https://worldwidescience.org/topicpages/m/many-faceted+rasch+model.html#

www.uky.edu/~kdbrad2/Rasch_Symposium.pdf Constructing and Evaluating Measures: Applications of the Rasch Measurement Model
scholarworks.umass.edu/pare/vol10/iss1/4/ Test Equating by Common Items and Common Subjects: Concepts and Applications

www.jalt.org/pansig/2005/HTML/Weaver.htm How entrance examination scores can inform more than just admission decisions (skip the short section in Japanese).

Other Winsteps references (please submit yours if you want it listed here):

Peeters M.J., Stone G.E. (2009). An instrument to objectively measure pharmacist professionalism as an outcome: a pilot study. Canadian Journal of Hospital Pharmacy, 62(3), 209-16.

Youtube channel of instructive **Rasch videos**.

7.3 About the Program Manual and Software

You don't need to know about every Winsteps option in order to use the program successfully. Glance through the examples and find one similar to yours. Adapt the example to match your requirements. Then "fine tune" your analysis as you become familiar with further options.

Most of this Guide is in proportionately-spaced type.

```
When it is important to be precise about blanks or
                              spaces, or about
                              column alignment,
                              fixed-space type is used.
```

When it is important to show everything that appears on a long line, small type is used.

Suggestions that we have found helpful are shown like this in italics.

Authors: please cite the current Winsteps computer program as shown in References.

Winsteps software was written in Absoft Pro Fortran and Microsoft Visual Basic 6.0. Itis is transitioning to Intel IFORT Fortran and Xojo Basic. The software installer is constructed by Setup Factory. Help files and PDFs are written using Help & Manual.

We acknowledge the kind permission granted by Chris Hanscom of ***Veign*** for the use of their **Jeweled Style Command Button.**

Thank you to the many Winsteps users who have reported bugs and sent us suggestions for improvements. Please keep up the good work!

An Ode from a user:

Winsteps

This is a program that's much alive,
With scores and maps, and curves Ogive,
Persons and items to separate,
Giving results that do relate.

Although we love what Winsteps does,
Some problems make us Yelp!
But if we give John Michael a buzz,
He is always there to help!

Jim Houston, Nov. 30, 2001

7.4 Getting further help

Common installation problems are solved at: www.winsteps.com/problems.htm

Winsteps is a powerful weapon in the struggle to wrest meaning from the chaos of empirical data. As you become skilled in using Winsteps, you will find that it helps you to conceptualize what you are measuring, and to diagnose measurement aberrations. The Special Topics section of this User's Guide contains a wealth of information and advice.

Rasch Measurement Transactions, contains instructive articles on the fundamentals of Rasch analysis as well as the latest ideas in theory and practice. There are other useful books and journals, including: Journal of Applied Measurement, Trevor Bond & Christine Fox: "Applying the Rasch Model", Lawrence Erlbaum Assoc.

You may also find that you can use a more personal word of advice on occasion. The author of Winsteps, Mike Linacre, is happy to answer e-mailed questions to do with the operation of Winsteps or the nature of Rasch analysis.

8 Installation and Execution

8.1 What is supplied

Winsteps is supplied in several forms:

1)	MinistepInstall.exe	To install Ministep, the student/evaluation version with maximum dataset size of 75 persons (rows) by 25 items (columns). This is freeware.
2)	WinstepsTimeLimitedInstall.exe	To install Winsteps. This full version of Winsteps expires in a few weeks. It is used for training.
3)	WinstepsPasswordInstall.exe	To install Winsteps with password-protected installation. This is the full licensed version.
4)	Bond&FoxStepsInstall.exe	To install Bond&FoxSteps, the reduced-capability version for use with "Applying the Rasch Model"

These create directory, C:\Winsteps, and install Winsteps or Ministep in it.

Sample control and data (.TXT) files are also installed in c:\Winsteps\EXAMPLES to help you get started:
KCT.TXT is the Knox Cube Test data (BTD p.31 - see Section 1.1) The results in BTD were obtained with more approximate algorithms and do not agree exactly with Winsteps results.
SF.TXT is the Liking For Science data (RSA p.18)
There are many more EXAMPLE files described later in this manual.

8.2 Installation instructions for WINSTEPS

Under Windows 11, 10, 8, 7, Vista:
Run WinstepsPasswordInstall.....exe from the downloaded file.
Type in your installation password
Accept the default file locations or type in your own
OK

If program hangs during "Constructing Winsteps.ini ..." then see Initialization Fails

To Run Winsteps:
Click on *Start* button (or use desktop Winsteps icon)
Point to *Programs*
Point to *Winsteps*
Click on *Winsteps* icon
Click No to Welcome dialog box
Type **SF.TXT or Files menu: Open File and select a Winsteps control file**
Press Enter key
Press Enter key
Press Enter key

Winsteps will run. Examine its output with the pull-down menus, particularly **Output Tables**

Additional Notes:

a) Winsteps is usually installed in the C:\Winsteps directory.
b) When Winsteps ends, pull down the **"Edit"** menu to edit control and output files.
c) All information on the screen is also in the Report output file.
d) Files in the C:\TEMP directory and with the suffix .TMP may be deleted.

Macintosh Computer: Winsteps users report successful operation under Fusion, Virtual PC and Soft PC.

8.3 Silent Installation of Winsteps from the Command Line

1. Download WinstepsPasswordInstall(version number).exe
or MinistepInstall.exe

Example: WinstepsPasswordInstall371.exe

2. Obtain your installation password.

3. Installing in folder c:\Winsteps

In the folder which contains WinstepsPasswordInstall(version number).exe
At a DOS prompt or in a batch file, type in:
WinstepsPasswordInstall(version number).exe /serial:"Installation Password"
Example: WinstepsPasswordInstall371.exe /serial:"abcd1234"

Press enter at the DOS prompt, or save and launch the batch file.
Winsteps or Ministep should install

or 3. Installing in a different folder:

Silent Install of Winsteps

1. Download WinstepsPasswordInstallxxx.exe to your work folder
2. In your work folder, create text file: setupvars.ini
3. The contents of setupvars.ini are:
   [SetupValues]
   %AppFolder%=C:\Winsteps (or your target folder)
   %AppShortcutFolderName%=Winsteps
4.
5. In your work folder, create text file: install.bat

6. The contents of install.bat are:
   `WinstepsPasswordInstallxxx.exe "/S:c:\(work folder path)\setupvars.ini" /serial:"123456789"`
   ← your installation password goes here

Example:
My installation password is: *my$password*
`WinstepsPasswordInstall3902.exe "/S:c:\myworkfolder\setupvars.ini" /serial:"my$password"`
If the password contains %, then it becomes %%

7. To install Winsteps silently, double-click on install.bat in the Explorer view of your work folder.
8. View c:\Winsteps (or your target folder) to verify that Winsteps.exe has installed correctly
9. Back up these files in your work folder, then delete them: WinstepsPasswordInstallxxx.exe, setupvars.ini, install.bat

Silent Install of Ministep

1. Download Ministep.exe to your work folder
2. In your work folder, create text file: setupvars.ini
3. The contents of setupvars.ini are:
   [SetupValues]

%AppFolder%=C:\Winsteps (or your target folder)
%AppShortcutFolderName%=Winsteps

4. In your work folder, create text file: install.bat
5. The contents of install.bat are:
MinistepInstall.exe "/S:c:\(full path name)\setupvars.ini"
6. To install Ministep silently, double-click on install.bat in the Explorer view of your work folder.
7. View c:\Winsteps (or your target folder) to verify that Ministep.exe has installed correctly
8. Back up these files in your work folder, then delete them: Ministep.exe, setupvars.ini, install.bat

8.4 Starting WINSTEPS in Windows

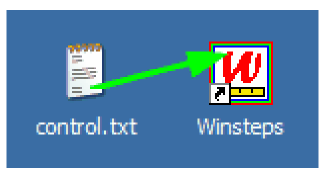
A typical analysis requires two components: control information and data. These can be in separate computer files or can be combined in one file. The results of the analysis are written to output files.

To launch your Winsteps analysis, here are several methods:

1) Double-click the Winsteps Icon on the Desktop. Winsteps launches. File menu: Open File.
To change the Winsteps starting folder,
right-click on the icon
highlight and click on properties
click the shortcut tab
change the "Start in" path to the path to the desired folder.

or 2) Click on Start button
Point to Programs
Point to Winsteps
Click on Winsteps icon

or 3) Drag your control file onto your Winsteps icon.



or 4) Add Winsteps to the Windows Sendto menu, and right-click on your control file.
To add Winsteps to Sendto:
1. Open an Explorer window. Enter the following into the address bar and press the Enter key:
shell:sendto
2. Copy the desktop shortcuts for Winsteps into the Send To folder.
3. To run an analysis, right click on the control file to open the Send To menu, select Winsteps.

If program hangs during "Constructing Winsteps.ini ..." then see Initialization Fails

---

Welcome to Winsteps!

Control + Data Setup Procedure: If you need help to set up a new control file, click this and go to control and data file set-up.

Import from Excel, R, SAS, SPSS, STATA, Tabbed Text: takes you to the Excel/RSSST dialog

Text-File Instructions: takes you to the do-it-yourself instructions

No: Winsteps asks you for the names of your input and report output files. There are example files already in the Winsteps\examples directory.

Don't ask again: makes "No" the standard option here. You can reset this using Edit Initial Settings

Help displays this page.

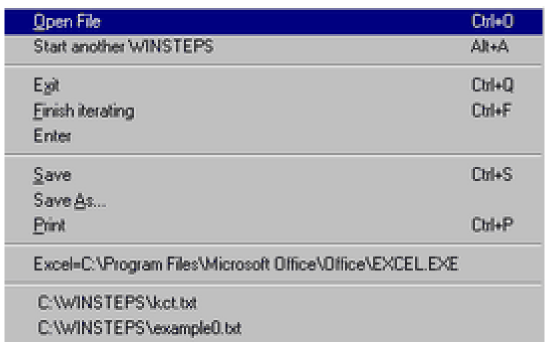
Does not work? Winsteps fails

To select your control file:

Winsteps asks: **Please enter name of Winsteps control file:**

(a) You can type it in ...
Please enter name of Winsteps control file: KCT.TXT(Enter)

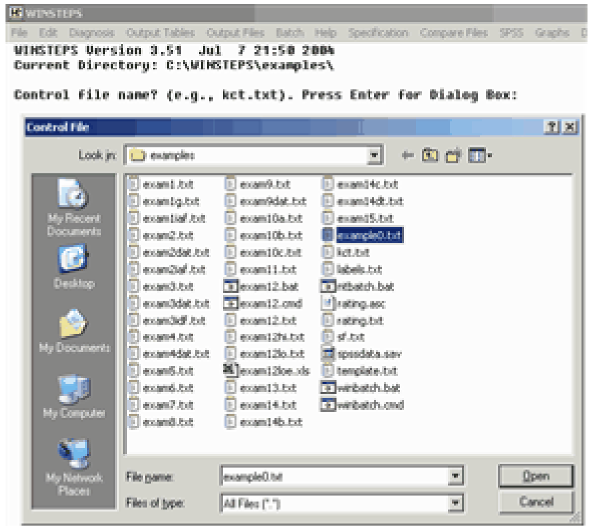
or (b) Click on the Files pull-down menu, "Open File", to get a file dialog box.



or (c) Click-on a file name from the bottom of the Files menu list.

or (d) Press your **Enter key**

This displays a standard Windows open dialog box - try it.



You can also edit files directly from the file dialog box by right-clicking on them and selecting "Edit".

Example Analysis:

Control file name? (e.g., kct.txt). Press Enter for Dialog Box: Example0.txt(Enter)

Please enter name of report output file: (Enter)
If you only press Enter, a temporary output file will be used.
If you type in a file name, that file will be created and used.
If you want the file dialog box, use 'Open File' on the File pull-down menu.

Extra specifications (if any). Press Enter to analyze):? (e.g., MJMLE=1), or press Enter: (Enter)
Usually you have none, so merely press Enter.
This is used for making just-in-time changes to your control file instructions, for this run only.

Winsteps will now construct measures (i.e., analyze) the Liking for Science data from RSA.

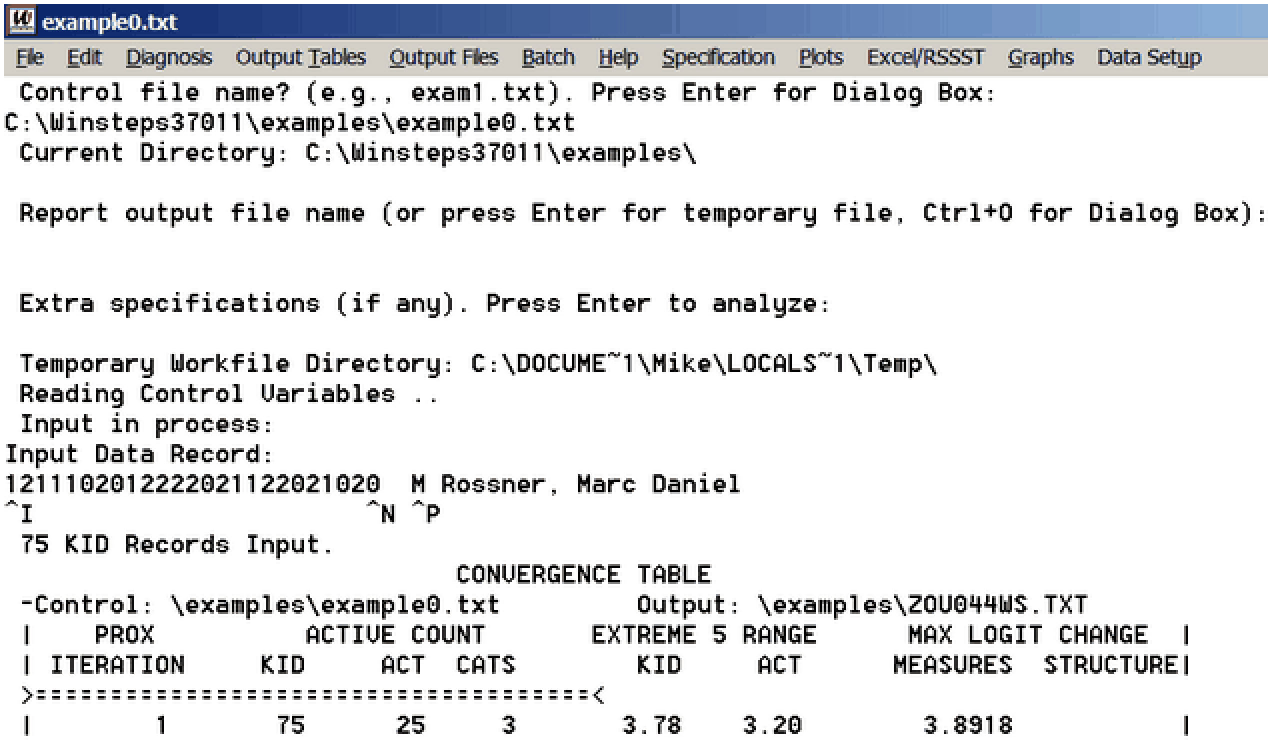
Use the Edit pull-down menu to simplify inspection and editing of the control, input and output files. This is done with Notepad or your own text editor.

At the end of the run, using the Output Tables pull-down menu you can request further output Tables to be produced interactively and displayed on the screen. If you want to save any of these, use the Save As option when they are displayed. If you omit to save them, they are written as "ws.txt" files, and can be recovered from the Recycle Bin.

At the end of the run, you can also use the Output Files pull down menu, to write out person and item measures to computer-readable PFILE= and IFILE= files.

If the Edit menu and Output Tables menu don't work properly, then see Changing your Word Processor setting.

8.5 Using Winsteps under Windows



```
example0.txt
File  Edit  Diagnosis  Output Tables  Output Files  Batch  Help  Specification  Plots  Excel/RSSST  Graphs  Data Setup
 Control file name? (e.g., exam1.txt). Press Enter for Dialog Box:
C:\Winsteps37011\examples\example0.txt
 Current Directory: C:\Winsteps37011\examples\

 Report output file name (or press Enter for temporary file, Ctrl+O for Dialog Box):


 Extra specifications (if any). Press Enter to analyze:

 Temporary Workfile Directory: C:\DOCUME~1\Mike\LOCALS~1\Temp\
 Reading Control Variables ..
 Input in process:
Input Data Record:
1211102012222021122021020  M Rossner, Marc Daniel
^I                        ^N ^P
 75 KID Records Input.
                              CONVERGENCE TABLE
 -Control: \examples\example0.txt          Output: \examples\ZOU044WS.TXT
 |    PROX          ACTIVE COUNT        EXTREME 5 RANGE      MAX LOGIT CHANGE  |
 | ITERATION     KID      ACT   CATS          KID      ACT      MEASURES  STRUCTURE|
 >=====================================<
 |        1        75       25      3        3.78     3.20        3.8918           |
```

Winsteps provides a familiar "pull-down" user interface, intended to provide the user with maximum speed and flexibility. There are three main ways that you direct Winsteps:

(a) You respond to prompts on the screen.

There are two frequent ones:

Name of control file:

This is the ASCII file where your control specifications reside.
You can press **Enter** to browse for it.

Report output file name:

Press Enter for a temporary output file, or
Type in an output file name or use the pull-down file menu
The report output file is always in text format.

Extra specifications (if any). Press Enter to analyze):

Press Enter
This is used for making just-in-time changes to your control file instructions, for this run only.

If these prompts do not appear, see Edit Initial Settings

(b) You use the pull-down menus.

A frequent choice is the first choice on both the File and Edit menus:

Edit Control File=

Select this to edit your Winsteps control file.

(c) You use the Notepad text editor.

All editing and display of Winsteps output is done using text files and Notepad or your own text editor.
This gives you great flexibility to:

modify control and anchor files
view, copy and paste output into Word (or other) files

8.6 Uninstalling WINSTEPS

Depending on the installation procedure:

(a) Select "Uninstall" from the Start menu: Winsteps
or
(b) Go to "Settings", "Control Panel", "Add/Remove Programs" and double-click on "Winsteps Uninstall"
or
(c) Delete Winsteps directory, and delete the Winsteps entries from "Windows\Start Menu\Programs"

Also:
(d) Use a Windows clean-up utility, such as CCleaner, to tidy up loose ends.

(e) Delete files in folder %temp% (or your own temporary folder) and files ending *.....ws.txt*

8.7 Stopping WINSTEPS

The Winsteps program ceases execution when
1) The program stops itself:
The estimation procedure has reached an acceptable level of convergence and all pre-specified output has been produced. This happens when:

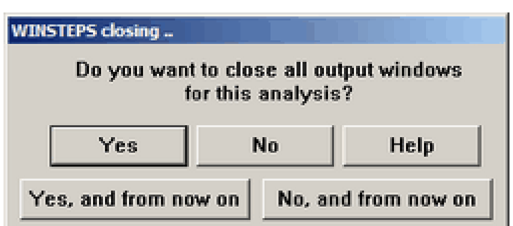
a) The estimates are within the convergence criteria (LCONV= and RCONV= as controlled by CONVERGE=)
b) The maximum number of iterations has been reached (MPROX= and then MJMLE=)
   To instruct Winsteps to run indefinitely (up to 2,000,000,000 iterations), set
   MJMLE=0
   LCONV=0
   RCONV=0
   CONVERGE=F
c) The estimates are not improving. This can occur when the limits of the computational precision of your computer have been reached.

2) You stop the iterative process:

a) If you press Ctrl with F (or use File menu) during PROX iterations:
   PROX iteration will cease as soon extreme scores have been identified and point-biserial correlations have been calculated. JMLE iterations then start.
b) If you press Ctrl with F during JMLE iterations:
   JMLE iteration will cease at the end of this iteration. Fit statistics will then be calculated and output tables written to disk.
c) If you press Ctrl with F during the output phase:
   Output will cease at the end of the current output operation.
   Acknowledgment of your Ctrl with F instruction is shown by the replacement of = by # in the horizontal bar drawn across you screen which indicates progress through the current phase of analysis.

3) You cancel Winsteps execution immediately:
From the Winsteps File menu, choose Exit.
No more analysis or output is performed.

When Winsteps exits ...
It deletes all temporary files it has created and releases memory. You may have output Tables, files or graphs open on your screen. Winsteps asks if you want these closed.

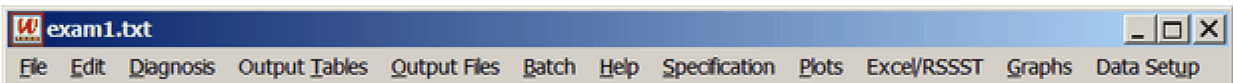


Yes: close all open windows. If some windows have been modified, but not saved, you may be asked if you want to save those.
No: leave all windows as they are, but close the Winsteps analysis window.
To make Yes or No the automatic standard, click "**and from now on**". This choice may be reset in Edit Initial Settings

9 Menus

9.1 Menu bar

Winsteps analysis window has a useful set of pull-down menus:

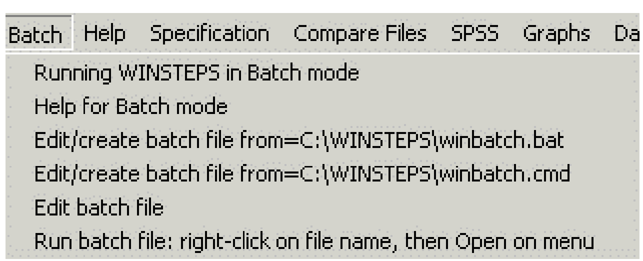


The top line shows the name of the file currently being analyzed. The name can be changed with Edit Task Bar caption. This is useful when you are copying the window (using, for instance, your PrintScreen key) to include in a document.

File	overall control of the analysis
Edit	display and editing of input and output files and Tables
Diagnosis	Tables for understanding, evaluating and improving your measurement system
Output Tables	produces all output Tables produced by Winsteps
Output Files	produces output primarily intended for input into other software
Batch	facilitates running Winsteps in batch mode
Help	displays Help file
Specification	allows entry of specifications after the analysis, one at a time, in the form of specification=value
Plots	uses Excel to display and compare analyses
Excel/RSSST	reformat Excel .xls, R .rda, SAS .sas7bdat, SPSS .sav, STATA .dta, and Tabbed-text .txt files into Winsteps control and data files
Graphs	computer-graphics for test, item and category display
Data Setup	provides a immediate means for setting up control and data files

9.2 Batch menu

This facilitates running Winsteps in batch mode.



Running Winsteps in Batch mode: Summary instructions for running Winsteps in batch mode.

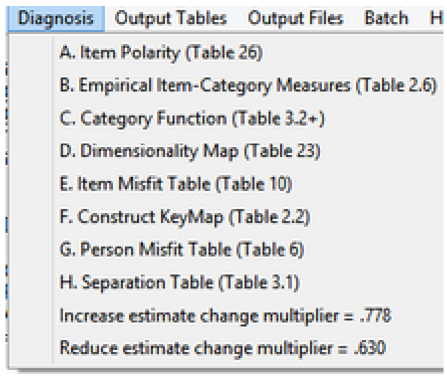
Help	Displays help information for batch mode
Edit	Edit batch file
Run	Run batch file: done by right-clicking on batch file name (.bat or .cmd), then clicking on **open** on the Windows **right-click menu**

9.3 Data Setup menu

This is described at Control and data file setup.

9.4 Diagnosis menu

The Diagnosis pull-down menu suggests a step-by-step procedure for investigating the results of your analysis.



A. Item Polarity: check that all items are aligned in the same direction on the latent variable, same as Table 26. Check that all items have positive correlations. Use IREFER= and IVALUE= to point all items in the same direction, or KEY1= to correct a multiple-choice key error. IDFILE= to delete (for the moment) uncooperative items.

B. Empirical Item-Category Measures: check that all categories for all items are aligned in the same direction, same as Table 2.6. For multiple-choice items, see Table 2 for MCQ. Check that correct answers, and higher category values corresponding to "more" of the variable, are to the right.

C. Category Function: check that all categorization functioned as intended, same as Table 3.2 onwards. Check that the "average measures" for the categories advance, and that no category is especially noisy. Use IREFER= and IVALUE= to collapse or remove discordant categories. Use ISGROUPS= to identify category functioning. If more details are required, look at the option/distractor analysis of the Item Tables.

D. Dimensionality: check that all items share the same dimension, same as Table 23. This identifies sub-structures, "secondary dimensions", in the data by performing a principal components/contrast decomposition of the observation residuals. If there are large sub-structures, then it may be wiser to divide the data into two measurement instruments.

E. Item Misfit: check that items cooperate to measure, same as Table 10. Are there misbehaving items? Look for large mean-squares, and also for contradictory use of responses in the option/distractor listing.

F. Construct KeyMap: check that the item hierarchy is as intended (construct validity), same as Table 2.2. This locates items, response categories and your sample in one picture. Does your item measure hierarchy make sense? What is the typical person in your sample saying?

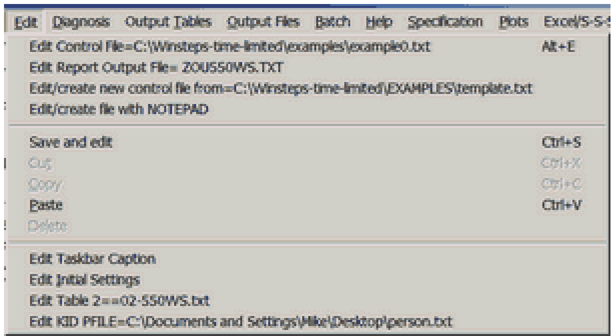
G. Person Misfit: check that persons cooperate to measure, same as Table 6. Are there misbehaving persons? Look for large mean-squares, and also look at the unexpected observations in the Most Unexpected Responses subtable.

H. Separation: check that the items discriminate different levels of person performance ("test" reliability), same as Table 3.1. Also that persons are able to discriminate differences in item calibration.

Increase estimate change multiplier =
Reduce estimate change multiplier =
The usual estimate change multiplier, ESTMULT=, is 0.7. Increasing this value increases the size of the changes in each iteration. If ESTMULT= is too big, then the estimates will diverge so that the maximum residuals will become larger.

9.5 Edit menu

Display and editing of input and output files and tables.



Edit Control File=	display and edit the current control file. Alters this analysis if no computation has been done, otherwise the next analysis done with this control file
Edit Report Output File=	display and edit the report output file written during the main analysis phase. This contains Table 0 and output specified with TABLES= and TFILE=
Edit/create new control file from= ....\template.txt	template.txt is a generic control file which can be edited and saved under another name to give you a flying start at setting up your own analysis. There is a control and data file setup procedure. It is easier!
Edit/create file with Notepad	launches Notepad or your own text editor
Save and edit	save the Winsteps analysis window to a disk file and open for editing
Cut	copy characters from an analysis window line to the Windows clipboard and delete them from the screen
Copy	copy characters from an analysis window line to the Windows clipboard
Paste	paste characters from the Windows clipboard to an analysis window line
Delete	delete character from an analysis window line
for more substantial editing, save the analysis screen using the File pull-down menu	
Edit Taskbar Caption	change the task name displayed on the Windows taskbar
Edit initial settings	change standard files and settings in Winsteps.ini
Edit Table ...	display and edit a Table produced from the Diagnosis, Output Tables or other pull-down menu
Edit ... File	display and edit a file produced from the Output Files or in other ways
Formatted data==	Formatted data after FORMAT=.

9.6 Excel/RSSST menu

Convert data files from proprietary formats into Winsteps files.

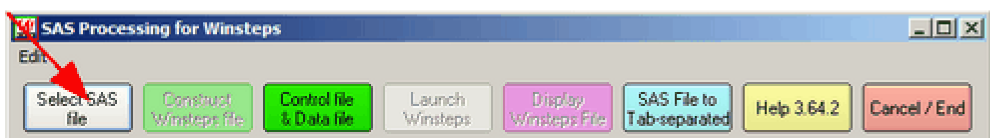
Excel: This is described in Data from Excel files
R: This is described in Data from R Statistics files
SAS: This is described in Data from SAS files
SPSS: This is described in Data from SPSS files
STATA (version 13 and earlier): This is described in Data from STATA files
Text-Tab: This is described in Data from Text files (with Tabs)

Winsteps does not function with every version of these programs.
Suggestion: Save your input file as a tab-separated DOS text file.
Then select Text-Tab input

The same procedure applies to all these file types. We will use Excel as the example.

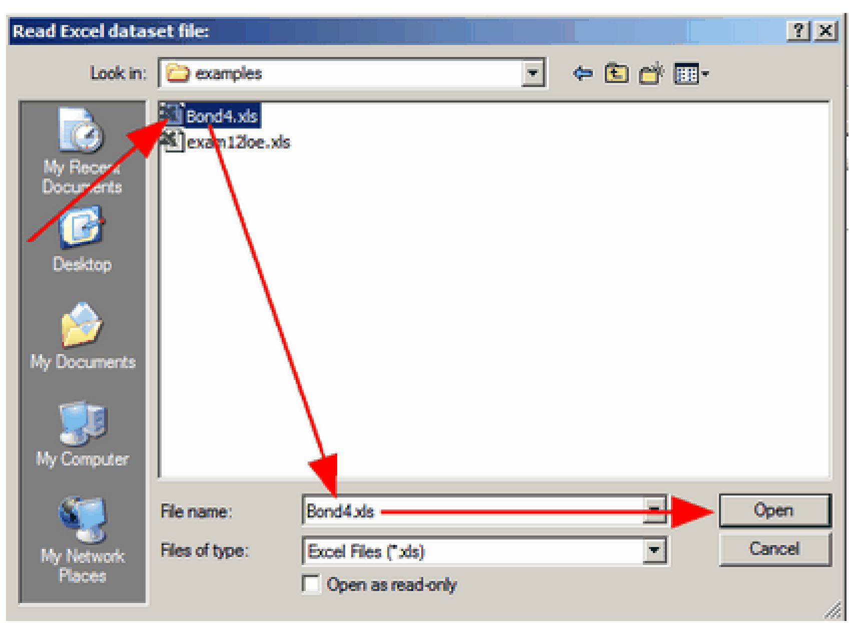
0. Use the Winsteps Excel/RSSST menu: Excel option:

1. Select the Input file to be converted:



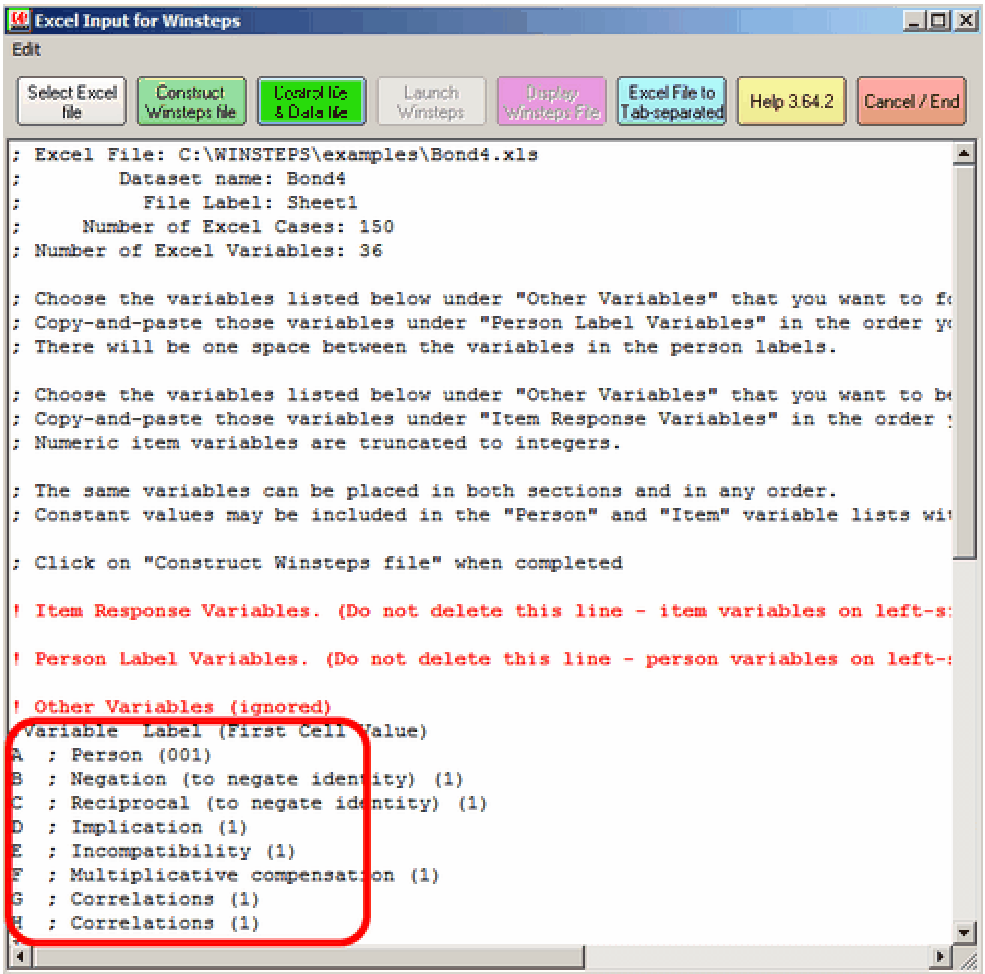
and more ....

2. Then select the desired input file and click "Open"

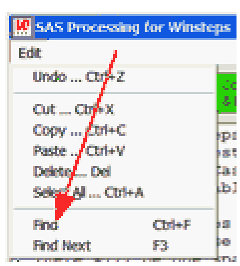


3. Look at your input variables.
In the Excel spreadsheet, the first row is the variable names. Then each row is one person (subject, case). Each column contains one variable: person name, item response, demographic variable.

A summary report about your input file, and some brief instructions are shown.
The input variables are listed in the selection window under "! Other Variables". They are identified by their column letters. You can also select "Case number" and "Row number" when available.



If your variable list is long, use "Edit", "Find" to locate the variables:



4. Copy-and-paste the Item Response Variables
Which are the variables the contain the responses, observations, ratings, etc. that are to be analyzed by Winsteps? Copy-and-Paste the variable names under "! Item Response Variables". You can change the order if you want to. In this example, I have alphabetized the item variables by what will be the Winsteps item labels.

```
; Click on "Construct Winsteps file" when c

! Item Response Variables. (Do not delete t
M  ; Affirmation of p (1)
J  ; Conjunction (1)
G  ; Correlations (1)
H  ; Correlations (1)
I  ; Correlations (1)
K  ; Disjunction (1)
D  ; Implication (1)
E  ; Incompatibility (1)
F  ; Multiplicative compensation (1)
B  ; Negation (to negate identity) ; Item 1
C  ; Reciprocal (to negate identity) (1)

! Person Label Variables. (Do not delete th
```

How to copy-and-paste:

a. Drag your mouse pointer over an SPSS variable name in the "Other Variables" list to highlight it.
b. Press your Ctrl key. Hold it down and press the C key. Release the keys. The variable name is copied to the Windows clipboard.
c. Position the mouse pointer on the line under "Item Response Variables"
d. Press your Ctrl key. Hold it down and press the V key. Release the keys. The variable name is pasted into the window.
e. Repeat the process for all the other variable names. You can also highlight a block of variable names at the same time.

5. Copy-and-paste the Person Label Variables

Which are the variables the contain the person identification, demographics, etc. that are to be reported by Winsteps? Copy-and-Paste the variable names under "! Person Label Variables". You can change the order if you want to. You can also reuse an Item Variable.

In this example, the person label includes, the "Person" column, one of the items "Disjunction" because I want Winsteps to report person sub-totals based on responses to that item, and also the Excel row number, in case I need to refer back to the original Excel spreadsheet.

```
B  ; Negation (to negate identity) ;
C  ; Reciprocal (to negate identity)

! Person Label Variables. (Do not de
A  ; Person (001)
K  ; Disjunction (1)
@Row number ; in Excel spreadsheet

! Other Variables (ignored)
;Variable  Label (First Cell Value)
A  ; Person (001)
```

6. Optional extras ....

A. In each Winsteps data line, the item responses are to the left and the person labels are to the right:

`111010011100111 Jose M`

If you prefer the person labels to the left, and the item responses to the right:

`Jose  M 111010011100111`

then cut-and-paste "!Person Label Variables" and its variables above "! Item Response Variables"

B. You can include constant values in the Item or Person sections. For instance, perhaps this dataset is from Region "B23" and you want this in every person label.

C. Item responses then person labels, or Person labels then item responses.

Item responses, then person labels:

```
; Click on "Construct Winsteps file" when completed

! Item Response Variables. (Do not delete this line -
wr1_writing_1 ; F8.0 First items on the test
wr2           ; F8.0
wr3           ; F8.0

! Person Label Variables. (Do not delete this line -
name          ; F8.0
```

Person labels, then item responses:

```
; Click on "Construct Winsteps file" when completed

! Person Label Variables. (Do not delete this line -
name          ; F8.0

! Item Response Variables. (Do not delete this line
wr1_writing_1 ; F8.0 First items on the test
wr2           ; F8.0
wr3           ; F8.0
```

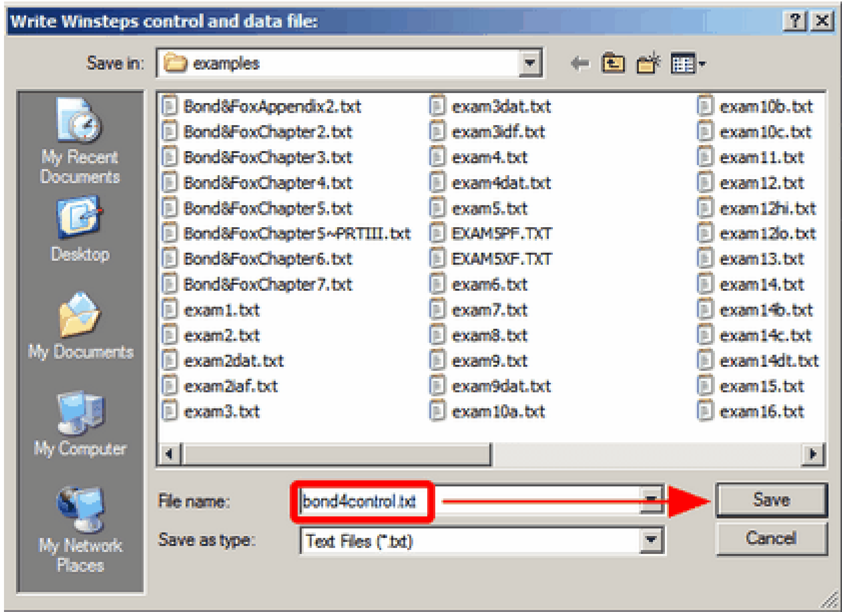
In this example, the Person Variables are moved before the Item Variables, so they will appear to the left in the Winsteps file. Constant "B23" is included.

```
; Click on "Construct Winsteps file" when comp
! Person Label Variables. (Do not delete this
A  ; Person (001)
K  ; Disjunction (1)
"B23"
@Row number ; in Excel spreadsheet

! Item Response Variables. (Do not delete this
M  ; Affirmation of p (1)
J  ; Conjunction (1)
G  ; Correlations (1)
H  ; Correlations (1)
I  ; Correlations (1)
K  ; Disjunction (1)
D  ; Implication (1)
E  ; Incompatibility (1)
F  ; Multiplicative compensation (1)
B  ; Negation (to negate identity) ; Item label
C  ; Reciprocal (to negate identity) (1)

! Other Variables (ignored)
;Variable  Label (First Cell Value)
A  ; Person (001)
```

To save this information for a later file conversion, Select All (ctrl+A), copy (ctrl+C) and paste (ctrl+V) into a convenient document.

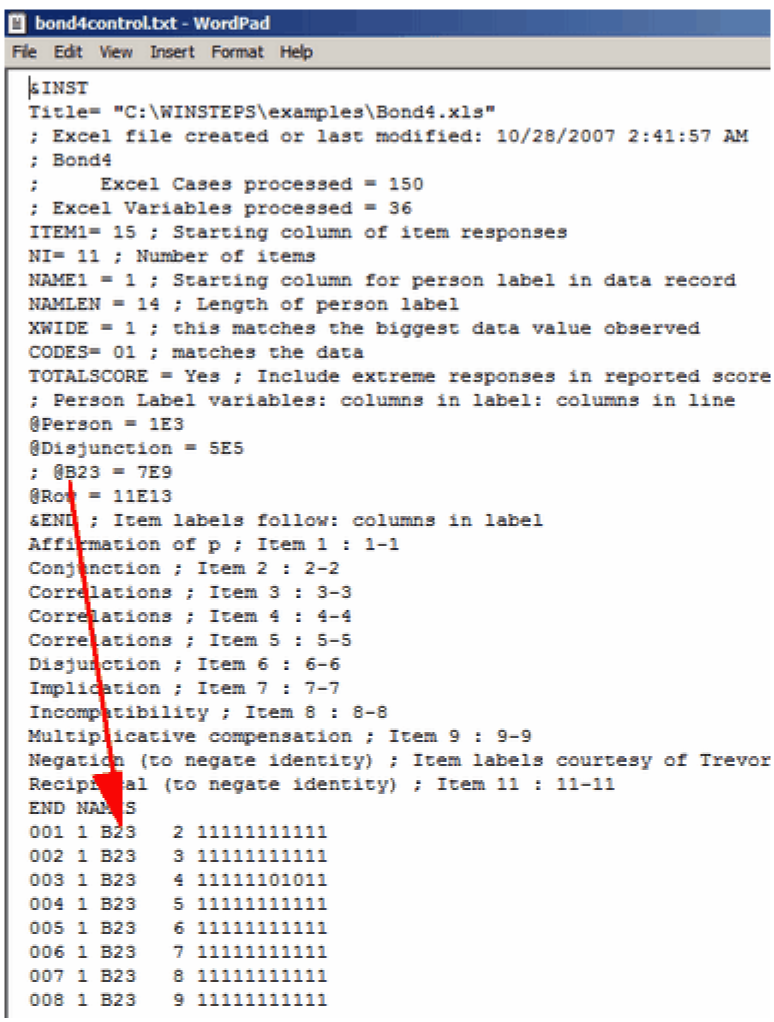
7. Construct the Output file, a Winsteps control and data file.
Click on "Construct Winsteps File":

Type in the name of the new Winsteps control and data file. "bond4control.txt" in this example.
Click on "Save".



If you want a separate Winsteps control file and a Winsteps data file, then click on "Control file & Data file", and enter the name of the control file into the first file dialog box, and the name of the data file into the second file dialog box.

The Winsteps control and data file displays in a text-editor window.




```
&INST
Title= "C:\WINSTEPS\examples\Bond4.xls"
; Excel file created or last modified: 10/28/2007 2:41:57 AM
; Bond4
;      Excel Cases processed = 150
; Excel Variables processed = 36
ITEM1= 15 ; Starting column of item responses
NI= 11 ; Number of items
NAME1 = 1 ; Starting column for person label in data record
NAMLEN = 14 ; Length of person label
XWIDE = 1 ; this matches the biggest data value observed
CODES= 01 ; matches the data
TOTALSCORE = Yes ; Include extreme responses in reported score
; Person Label variables: columns in label: columns in line
@Person = 1E3
@Disjunction = 5E5
; @B23 = 7E9
@Row = 11E13
&END ; Item labels follow: columns in label
Affirmation of p ; Item 1 : 1-1
Conjunction ; Item 2 : 2-2
Correlations ; Item 3 : 3-3
Correlations ; Item 4 : 4-4
Correlations ; Item 5 : 5-5
Disjunction ; Item 6 : 6-6
Implication ; Item 7 : 7-7
Incompatibility ; Item 8 : 8-8
Multiplicative compensation ; Item 9 : 9-9
Negation (to negate identity) ; Item labels courtesy of Trevor
Reciprocal (to negate identity) ; Item 11 : 11-11
END NAMES
001 1 B23   2 11111111111
002 1 B23   3 11111111111
003 1 B23   4 11111101011
004 1 B23   5 11111111111
005 1 B23   6 11111111111
006 1 B23   7 11111111111
007 1 B23   8 11111111111
008 1 B23   9 11111111111
```

Winsteps includes ISGROUPS=0 in the control file because Winsteps does not know the structure of your data. Please delete ISGROUPS=0 if your data are dichotomous or use the Andrich Rating-Scale model. If ISGROUPS=0 is in the Winsteps control file, the partial-credit model is used.

If one of your data lines is an answer-key then:
Cut-and-paste the answer-key data line.
Remove it from the data section.
Paste it before &END
Edit it to start:
KEY1= (answer-key)
Save the control and data file.

8. Click on "Launch Winsteps" to analyze this control and data file.

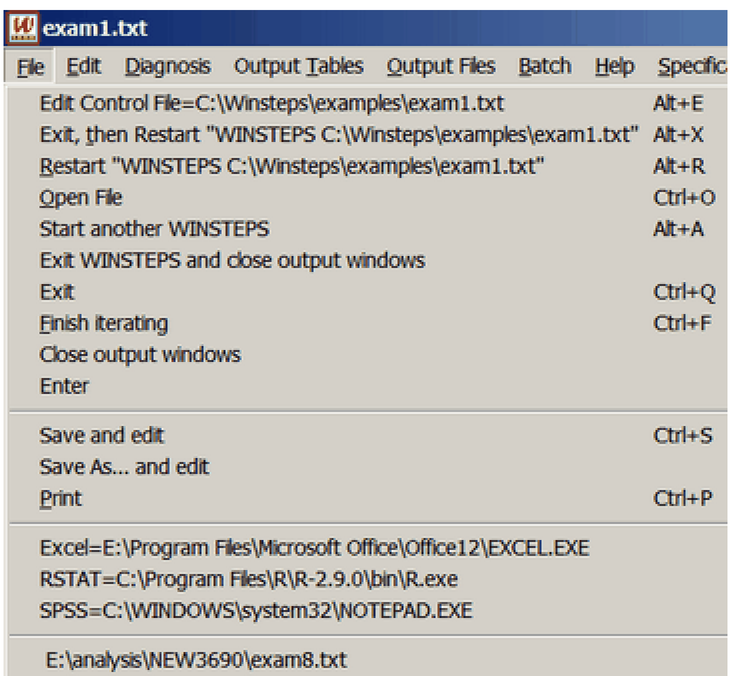
9. Click on "Display Winsteps File" to redisplay the Winsteps control and data file, if you need to see them again.

10. Click on "File to Tab-Separated" to display the contents of an input file in tab-separated format.
Tab-separated files can be conveniently pasted into Excel. The tab-separated values display in a temporary file. Copy and paste the contents, or **"Save as"** for a permanent copy.

11. Click on "Cancel / End" to conclude this dialog.

9.7 File menu

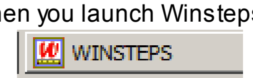
This menu launches and terminates Winsteps analysis.



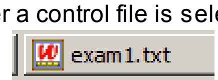
Edit Control File=	Edit the current control file. Alters this analysis if no computation has been done, otherwise the next analysis done with this control file.
Exit, then Restart "WINSTEPS ..."	Stop and then restart this analysis, usually after editing the control file.
Restart "WINSTEPS ..."	Restart this analysis, leaving the current one running.

Open File	Select control file for this analysis
Start another Winsteps	Launch a new copy of Winsteps. More than one copy of Winsteps can run at the same time.
Exit WINSTEPS and close output windows	Exit from Winsteps and close output windows without asking.
Exit	Exit from Winsteps
Finish iterating	Finish the current phase as quickly as possible.
Close open output windows	close any open windows for output tables, files or plots.
Enter	Acts as the Enter key
Save and edit	Save the information displayed on the processing screen to disk.
Save As... and edit	Save the screen output to a named disk file.
Print	Print the screen output
Excel=	Location of the Excel program (if installed on your computer): can be change in Edit Initial Settings
RSTAT=	Location of the R Statistics program (if installed on your computer): can be change in Edit Initial Settings
SPSS=	Location of the SPSS program (if installed on your computer): can be change in Edit Initial Settings
(file name)	Up to 30 must recently used Winsteps control files. Click on one of these to analyze it

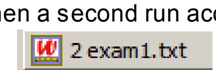
When you launch Winsteps, the Windows task bar shows:



After a control file is selected, the task bar indicates it:



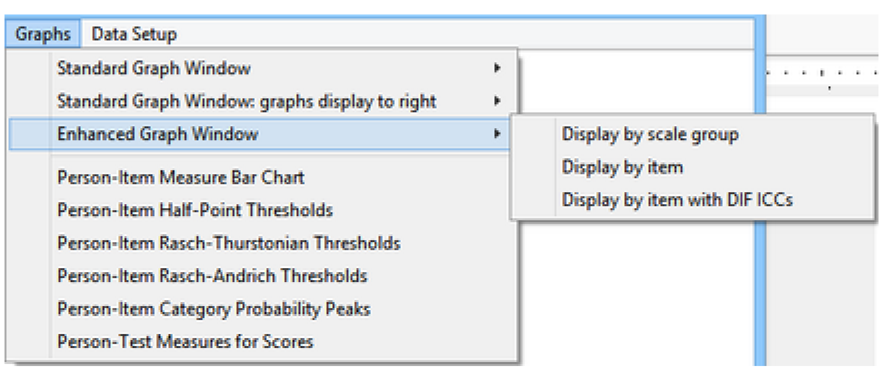
When a second run accesses the same control file:



and the number increments for further uses of the same control file.

9.8 Graphs menu

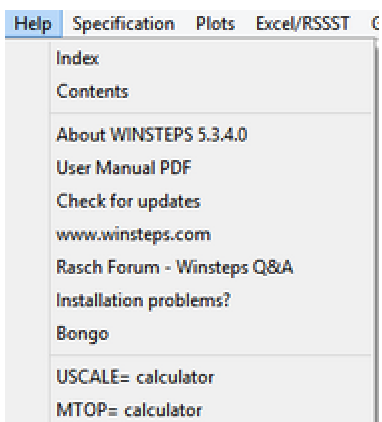
Winsteps produces bit-mapped images in the Graph window using the **Graphs** menu. Winsteps produces character-based graphs in Table 21



Initially, select which Graph window you want to see. When the Graph window displays, you can select the other options. Graphs are plotted relative to the central difficulty of each item or response structure unless "Absolute Scaling" is clicked in the Graphs window . Model-based curves (such as probability and information functions) are the same for all items which share the same model definition in ISGROUPS=. Empirical curves differ across items and rating scales.

Graph window options:	
Standard Graph Window	This is the Graph window implemented in Winsteps since 2002. It is module winvbexe.exe in 32-bit VB6.
Standard Graph Window: graphs display to the right	This is the Standard Graph Window with the graph displayed to the bottom right so it can be dragged larger. It is module winvbebr.exe in 32-bit VB6.
Enhanced Graph Window	This is the Graph window recently implemented in Winsteps. It is module winxojog.exe in 64-bit Xojo.
Display by scale group	for each ISGROUPS= code, a set of curves is shown. An example item number is also shown - all other items in the grouping are included in the one set of grouping plots.
Display by item	shows curves for individual items. Model-based output is the same for all items with the same ISGROUPS= designation.
Display by item with DIF ICCs	Same as "Display by Item", but non-uniform DIF curves are also shown for each item. *Enhanced:* Uniform DIF curve is also shown
Vertical histograms showing the distributions of the person abilities and ...	
Person-Item Measure Bar Chart	item difficulties
Person-Item Half-Point Thresholds	rating-scale half-point thresholds between categories: similar to Table 1.5
Person-Item Rasch-Thurstonian Thresholds	rating-scale Rasch-Thurstonian thresholds between categories: similar to Table 1.6
Person-Item Rasch-Andrich Thresholds	rating-scale Andrich thresholds between categories: similar to Table 1.7
Person-Item Category Probability Peaks	rating-scale category centers: similar to Table 1.8, where expected score on the item is the category number, and also the category has the highest probability of being observed.
Person-Test Measures for Scores	locations of the measures rescaled to approximate raw scores on the currently active set of items

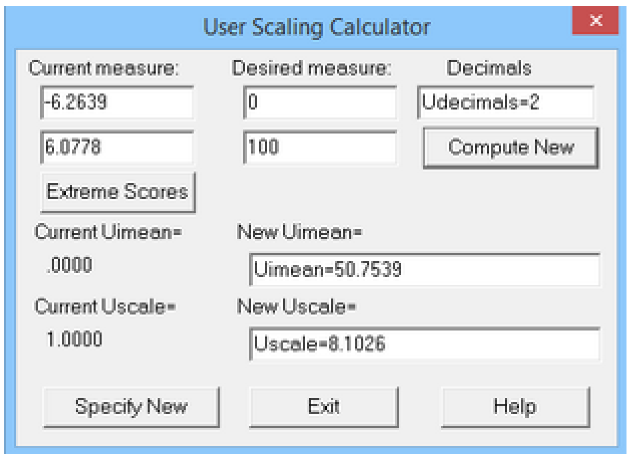
9.9 Help menu



Index	displays the Index of control variables in the Help file
Contents	displays the Table of Contents of the Help file.
About WINSTEPS	displays Winsteps version number and compile date. Please mention these when reporting problems.
User Manual PDF	displays the Winsteps Help file as a printable User Manual PDF.

Download latest User Manual PDF	shows webpage www.winsteps.com/manuals.htm	
Check for updates	shows webpage of Winsteps updates on www.winsteps.com/wingood.htm	
www.winsteps.com	takes you to our website: www.winsteps.com	
Rasch Forum - Winsteps Q&A	takes you to the Rasch Forum website: raschforum.boards.net	
Installation problems?	shows webpage of Winsteps installation problems and solutions on www.winsteps.com/problems.htm	
Bongo	is the Winsteps "Adjutant's Bugle Call" - play this when you are summoning the data in preparation for constructing measures!	梵語
USCALE= calculator	helps you linearly rescale your measures in the way most meaningful for your audience:	
MTOP= calculator	helps you size the Table 1, 12, 16 Wright Maps	

USCALE= Calculator



Under **Current measure:** enter two measures from your current analysis.
Under **Desired measure:** enter the values with which you want them to be reported.
Under **Decimals:** enter the number of decimal places for the measure Tables, Udecimals=.
Press **Compute New** to calculate the revised values of Uimean= and Uscale=.
The current values of Uimean= and Uscale= are displayed and also the revised **New** values. The New values can be altered if you wish.
Press **Extreme Scores** to place the measures for the minimum possible and maximum possible scores on the current set of items into the **Current Measure** boxes.
Press **Specify New** to action the **New** values. Or the values can be copied (Ctrl+c) and pasted into your Winsteps control file.
Also clicking on "Output Files", "Control Variable List" produces the full list of control variables including the new values of UIMEAN= and USCALE=

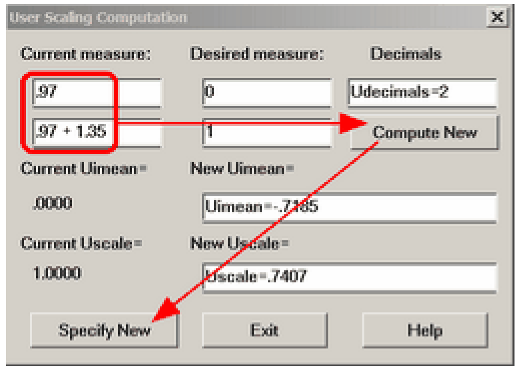
Example: We want the mean and S.D. of our sample to be 0 and 1.

Current Table 3.1

```
 ----------------------------------------
 |           RAW
 |          SCORE      COUNT      MEASURE
 |---------------------------------------
 | MEAN      31.7       25.0          .97
 | S.D.       8.7         .0         1.35
```

The current mean = .97
The current mean + 1 S.D. = .97 +1.35

The desired mean = 0
The desired mean + 1 S.D. = 0+1



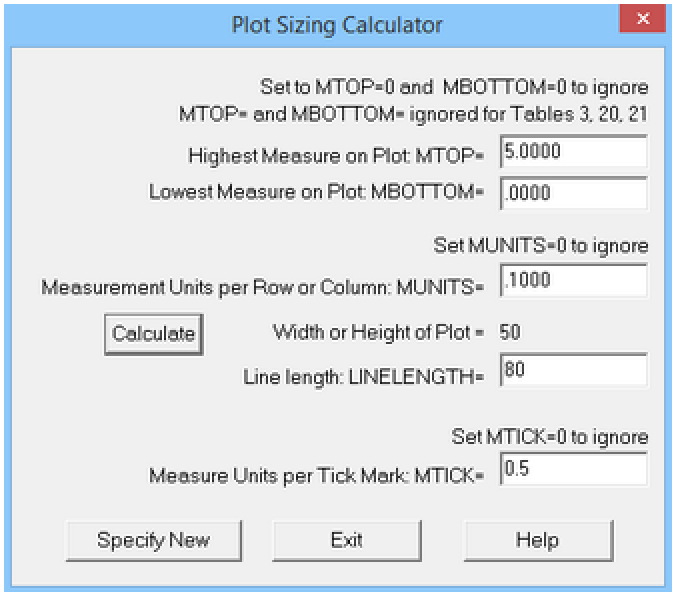
New Table 3.1

	RAW SCORE	COUNT	MEASURE
MEAN	31.7	25.0	.00
S.D.	8.7	.0	1.00

Example: If I use IAFILE= and SAFILE= for some items, how do I rescale the analysis to set the reported person measure range as 0-100?

1. Do your analysis with IAFILE= and SAFILE=. USCALE= in this analysis is the value of USCALE= in the analysis that output the SAFILE=
2. Output Tables menu: Table 20.1. Identify the measure you want tobe 0, and the measure you want to be 100
3. Help menu: Scaling calculator
   "Current Measure:" are the two measures from Table 20.1
   "Desired Measure:" are the two measures you want
   Click on "Compute New:" write down the value of Uscale= for your next analysis
   Click on "Specifiy New"
4. Output Tables menu: Table 20.1. The range should be 0-100.
5. Output IFILE=if.txt, SFILE=sf.txt
6. Do the analysis again: IAFILE=if.txt, SAFILE=sf.txt and USCALE= the value of Uscale= from 3.
7. Output Tables menu: Table 20.1. The range should be 0-100.

MTOP= Calculator



On Calculator:	***Action for Tables 1, 12, 16*** Set value to 0 to ignore the command.
Highest measure on Plot MTOP=	Sets MTOP=
Lowest measure on Plot MBOTTOM=	Sets MBOTTOM=
Measurement Units per Row or Column: MUNITS=	Sets MUNITS= also for Table 2 and similar Tables. *Example:* MUNITS=0.1 for 10 rows or columns for 1 logit or USCALE= unit.
Line length: LINELENGTH=	Sets LINELENGTH=. Make this long enough for the width of the plot.
Measure Units per Tick Mark MTICK=	Sets MTICK=. *Example:* MTICK=0.5 place a tick mark every 0.5 measurement units (logits) on the plot
Calculate button	Calculates how many rows for MTOP=, MBOTTOM= and MUNITS=
Width or Height of Plot	Using the values in the calculator, reports the current height or width of the plot part of Tables 1, Table 2, etc. Set LINELENGTH= at least 20 more than this value.
Specify New	the values are actioned and the calculator exits
Exit	the values are not actions and the calculator exits
Help	shows this page

9.10 Output Files menu

The Output Files menu produces output primarily intended for input into other software. When a selection is clicked on, the output file specifications dialog box is usually shown so that you can choose the output file format.

For details, please see Output Files Index

9.11 Output Tables menu

Output Tables are listed in the Output Table Index. They are written into temporary files if selected from the Output Tables menu. Output Tables are written into the Report Output File if specified using TABLES= or TFILE= in the control file. Table 0 is always written to the Report Output File.

Output Tables are always in text format (.txt). To export a Table in Excel format see Excel-formatted Output Tables.

For details of the Output Tables menu, please see Output Tables Index

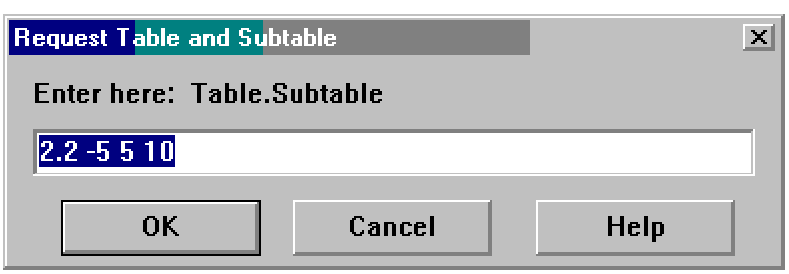
3.2 Rating (partial credit) response-structure *and most Tables shown*
Click on the Table to write it to a file and show it on the screen. Here is "3.2 Rating response-structure Structure". It is written into temporary file 03-859ws.txt. "03" refers to Table number 3. "859" is a unique number for this analysis. "ws.txt" means "Winsteps text file".

```
TABLE 3.2 LIKING FOR SCIENCE (Wright & Masters p. ZOU859ws.txt Oct  9 10:54 2002
INPUT: 76 PUPILS, 25 ACTS  REPORTED: 75 PUPILS, 12 ACTS, 3 CATS    WINSTEPS 3.36
--------------------------------------------------------------------------------

SUMMARY OF CATEGORY STRUCTURE.  Model="R"
+-------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------+
|  0   0     667  33| -1.30 -1.30|   .96   .95||  NONE   |( -2.04)| 00 dislike
|  1   1     757  37|  -.08  -.09|   .90   .78||   -.82  |    .00 | 01 neutral
|  2   2     609  30|  1.40  1.41|  1.09  1.33||    .82  |(  2.04)| 02 like
+-------------------------------------------------------------------
AVERAGE MEASURE is mean of measures in category.
```

Tables 27, 28, 30, 31, 33
These all allow the user to change the relevant control command on execution. ISUBTOTAL= controls the sub-total segments for Table 27 with a selection command so you are asked to confirm or change this value, before the Table is produced.

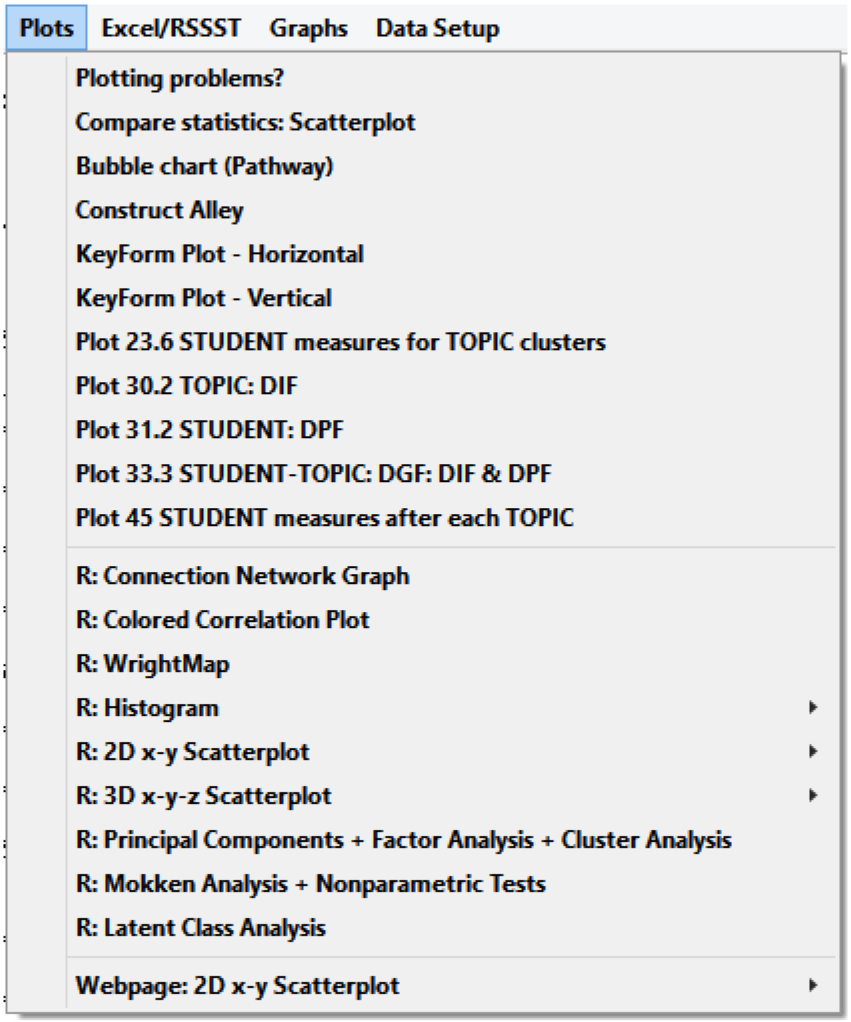
Tables 23, 30, 31, 33
These allow the user to produce Excel plots of parts of the Table.

Request Subtables
Any Table (except Table 0) can be displayed using this command. It also accepts the special fields available with TFILE=



Weight Selection. See weighting. When IWEIGHT= or PWEIGHT= are used in estimation, reports can be adjusted to reflect those weights or not. Weights of zero are useful for pilot items, variant items or persons with unusual characteristics. These can be reported exclusively or excluded from reports.

9.12 Plots menu



Here is the Plots menu:	
Plotting problems?	these are usually due to the Winsteps-Excel interface. See www.winsteps.com/problems.htm
These are plotted with Excel:	
Compare statistics: Scatterplot	enables you to draw scatter-plots (xy-plots) of Winsteps statistics within or between analyses. It also produces the tabular output of Table 34.
Bubble chart (pathway)	generates a Bond & Fox-style bubble chart.
Construct Alley	generates a Massof-style construct map with error bars
Keyform Plot - Horizontal	generates a horizontal Keyform layout.
Keyform Plot - Vertical	generates a vertical Keyform layout.
Plot 23.6 Person measures for Item clusters	scatterplots the person measures in Table 23.6 on the 3 clusters of items in Table 23.1
Plot 30.2. (Item): DIF	DIF plots the DIF values in Table 30.2.
Plot 31.2. (Person): DPF	DPF plots the DPF values in Table 31.2.

Plot 33.3. (Person-Item): DGF: DIF& DPF	DIF & DPF plots the DIF+DPF values in Table 33.3.
Plot 45. Person measures after each item	plots the values in Table 45
These are plotted with R Statistics:	
R: Connection Network Graph	draws the connections between the persons and items in the data
R: Colored Correlation Plot	plots a correlation matrix as colored cells
R: WrightMap	plots a WrightMap (Torres Irribarra & Freund)
R: Histogram	plots a histogram using 1 column of numbers for the x value and y count
R: 2D x-y Scatterplot	plots a 2-dimensional scatterplot using 2 columns of numbers for the x-y values.
R: 3D x-y-z Scatterplot	plots a 3-dimensional scatterplot using 3 columns of numbers for the x-y-z values.
R: Principal Components + Factor Analysis + Cluster Analysis	plots PCA and EFA eigenvalues and reports component/factor loadings, scores. Draw cluster analysis dendrogram
R: Mokken Analysis + Nonparametric Tests	reports summaries and provides links to plots
R: Latent Class Analysis	class probabilities for columns (items) and most probable class membership for rows (persons)
This is plotted with your webpage browset:	
Webpage 2D x-y Scatterplot	plots a 2-dimensional scatterplot using 2 columns of numbers for the x-y values.with interactive point labels

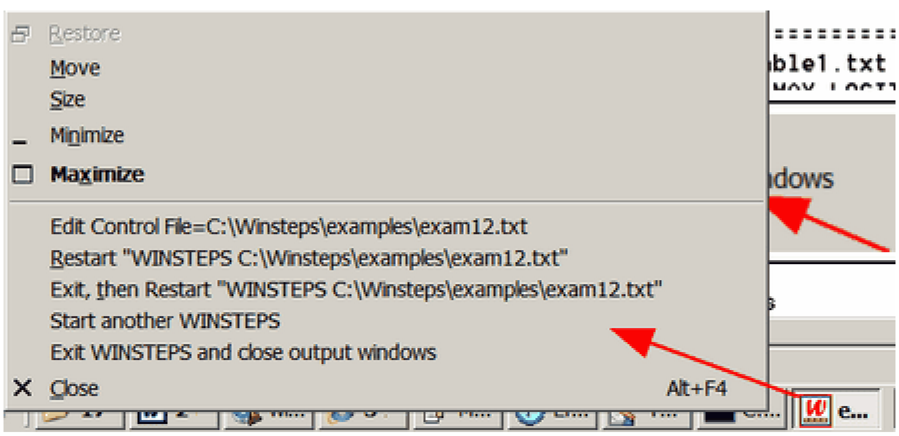
9.13 Right-click menus

Mouse Right-Click on the Winsteps screen

Right-click anywhere on the Winsteps screen, and a menu will be displayed.
During estimation: It is the File menu.
After estimation: It is the Output Tables menu.

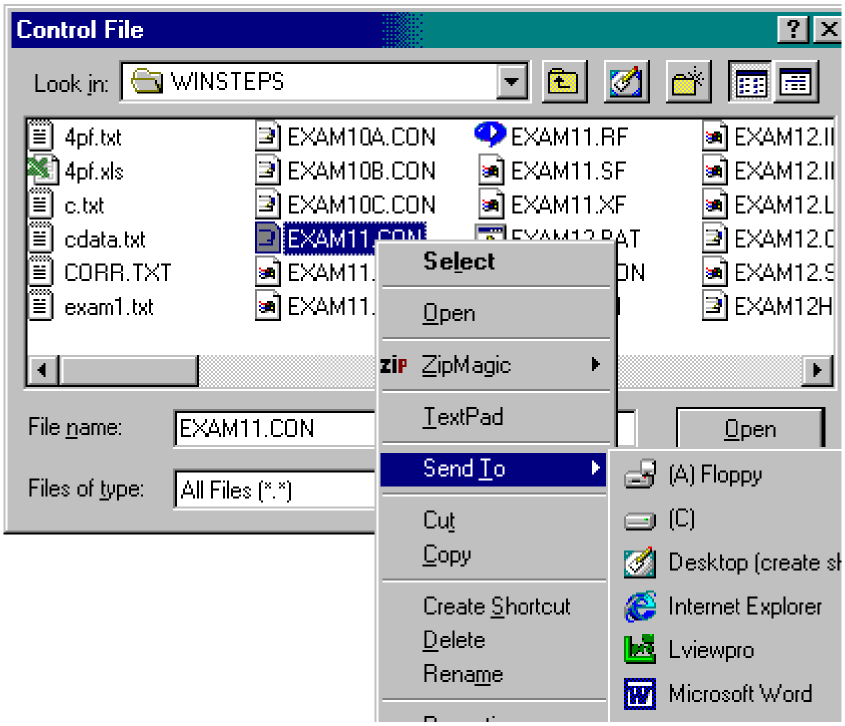
Mouse Right-Click on the Task Bar

Right-click on the task bar, to obtain the Winsteps system menu. This has much of the functionality of the File menu.



Mouse Right-Click on File Dialog Box:

Right-click a file name, and get the **Send To menu.**



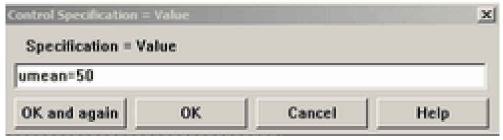
Add functionality to the **Send To menu** by copying short-cuts into **c:\windows\SendTo** (or the equivalent SendTo folder in your version of Windows) - a useful program to add is WordPad or [your own text editor](). To do this:

Start
Find
Files or Folders
Named: WordPad in C:
when Wordpad.exe appears, Right-click on it.
Send To: Desktop: Create shortcut
Exit from Find
On Desktop:
My Computer
C:
Windows (if this does not appear: then View: Folder Option: View: Show all files)
Send To
Drag WordPad shortcut from Desktop into SendTo folder.
WordPad is now in the Send To menu.

9.14 Specification menu

This allows entry of most specifications after the analysis, one at a time, in the form of *specification=value*. Click on "OK" to action the specification and return to the standard screen. *"OK and again"* to action the specification and redisplay this entry box.

In general:
Control variables in the control file or at the "Extra specification" prompts are applied during measure estimation.
Control variables from the pull-down variables only affect the output.
For instance, IDELETE=
In the control file or at the extra specifications prompt: these deleted items do no take part in the measure estimation.
From the "Specification" pull-down menu: these deleted items are not reported, but have taken part in measure estimation, fit statistics, etc.



[Most specifications](#) can be entered after the analysis has completed. They do not change the analysis but do alter the output. They are useful for making selections (e.g., PSELECT= and ISELECT=), setting output Table control values (e.g., MRANGE=) and changing user-scaling (e.g., USCALE=10).

"**not done**" in the Analysis window indicates that
1. a command that should be implemented before estimation (usually by inclusion in the control file) is being done after estimation (usually from the Specification dialog box). For instance, since anchor values (IAFILE=) is implemented before estimation, then UASCALE= (which tells Winsteps the scaling of the anchor values) must also be implemented before estimation.
2. a command has no effect or removes all the data

Multi-line specifications and the Specification pull-down menu:

Specifications with "file name only" do not support "*".
CFILE= scored category label file: file name only, blank deletes labels
CLFILE= codes label file: file name only, blank deletes labels
IDFILE= item deletion file: file name only: blank resets temporary deletions
ILFILE= item label file: file name only: blank not allowed
PDFILE= person deletion file: file name only: blank resets temporary deletions

So, instead of
CLFILE=*
1 strongly disagree
2 disagree
3 agree
4 strongly agree
*

use the Edit menu, "Create/Edit with Notepad",
then, in Notepad, type
1 strongly disagree
2 disagree
3 agree
4 strongly agree

save as "clfile.txt"
and in the Specification dialog box, enter:
CLFILE = clfile.txt

Example: We want score Table 20 for items 1-12, 14-20, 31
Specification dialog box: IDELETE=+1-20,13,+31
Output Tables menu: Table 20

Incremental commands

These commands add to the effect of previous commands: IDELETE=, PDELETE=, ISELECT=, PSELECT=

Example 1: In the Specification menu dialog box:
PDELETE= ; reinstates everyone who is temporarily deleted
PDELETE= 23 ; temporarily deletes person 23 and reinstates no one
PDELETE= +23 ; temporarily deletes everyone, then reinstates person 23 if temporarily deleted
PDELETE= 23 +23 ; temporarily deletes person 23 then reinstates person 23 and deletes no one
PDELETE= 23 +23 +5 ; temporarily deletes person 23 then reinstates persons 23 and 5 and deletes no one

Example 2: In the Specification menu dialog box:
ISELECT= ; reinstates everyone who is temporarily deselected
ISELECT= A ; deselects everyone whose person label does not start "A" and reinstates no one
ISELECT= ?B ; deselects everyone whose person label does not have "B" in its second column and reinstates no one
ISELECT= A then ISELECT= ?B is the same as ISELECT= AB

10 Control and Data Files

10.1 Control and Data File Setup Window

10.1.1 Control and data file setup window

This interface simplifies setting up Winsteps control and data files. It can be used for entering data with matching specifications or for constructing the specifications that match existing data. For instructions, see Winsteps Tutorials.

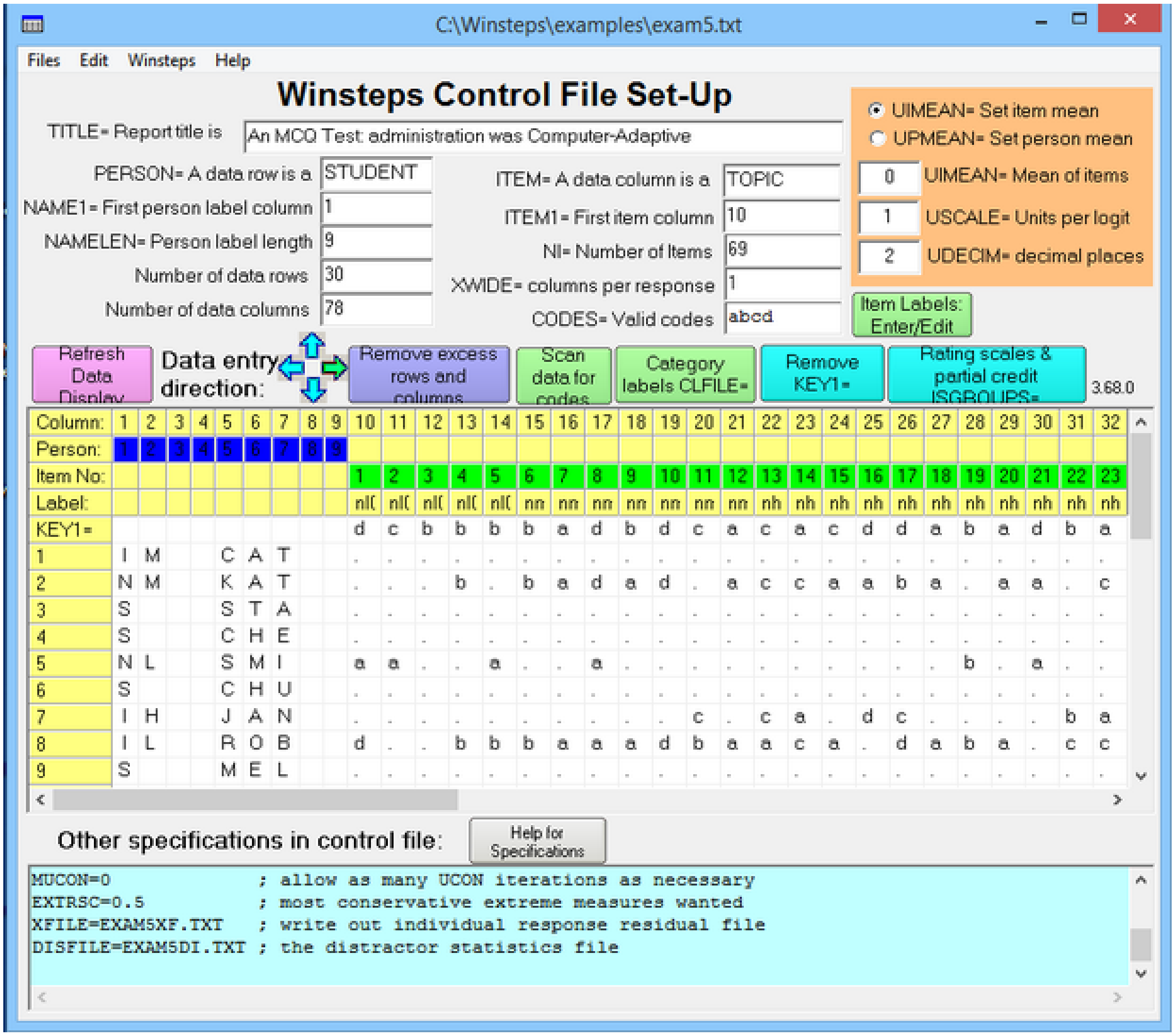
When you launch Winsteps, the Welcome dialog box displays, or use the Data Setup pull-down menu. Click on "Control + Data Setup Procedure" to launch the 32-bit version of Data Setup. If your computer does not support 32-bits, then the 64-bit version launches.

If this does not display, then go to Edit Initial Settings and check-mark "Show Data-setup dialog" and then click on OK. Restart Winsteps.

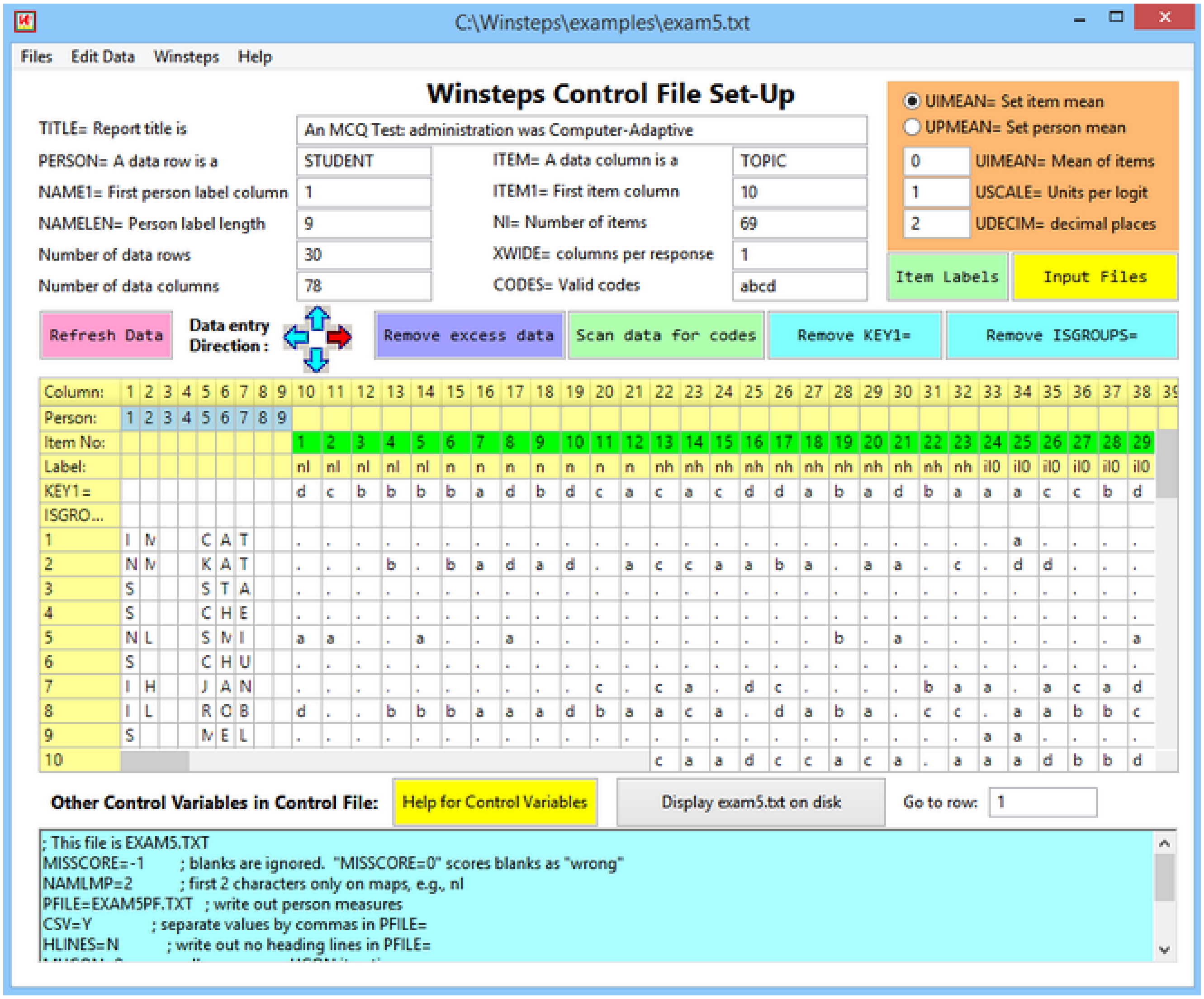
Control + Data Setup Procedure
If you are already in Winsteps, then on the menu bar:

32-bit and 64-bit options are available. Choose in Edit menu: Edit Initial Settings

32-bit Data Setup displays this Control File Set-Up screen.



64-bit Data Setup displays this Control File Set-Up screen:



A multiple-choice test key, KEY1=, can be specified, if desired.
Items can be clustered into similar response-structure groupings using ISGROUPS=, using a one character code for each grouping.

Use the *Files* menu to read in pre-existing control or data files. Use the boxes and the data grid to enter new control and data information. Use the *Files* or *Winsteps* menu to Save what you have done.

After performing the set-up, save the file and return to Winsteps using the *Winsteps* pull-down menu.

Import from Excel, R, SAS, SPSS, STATA, Tabbed Text
Click on this for the Excel/RSSST dialog box:

This constructs a Winsteps control and data file from a pre-existing Excel, R, SAS, SPSS, STATA, or Tabbed-Text data file.
This has the same functionality as the Excel/RSSST menu

Text-file Instructions.
Shows the Help page: Do-it-yourself control and data file construction
All Winsteps control and data files are in text format. These can be edited with Notepad and most other word processing and text editing software.

No.
Closes this dialog box. Use "Open File" to select a control file.

Don't ask again.
Click on this to make "No." the continuing option. To reinstate this dialog box, go to Edit Initial Settings and click on the "Welcome" option and then OK. Restart Winsteps.

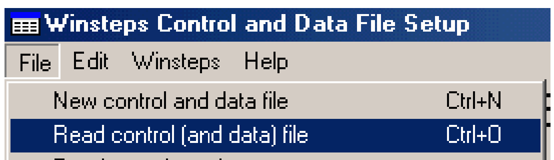
Help
Click on this for this Help page.

Next

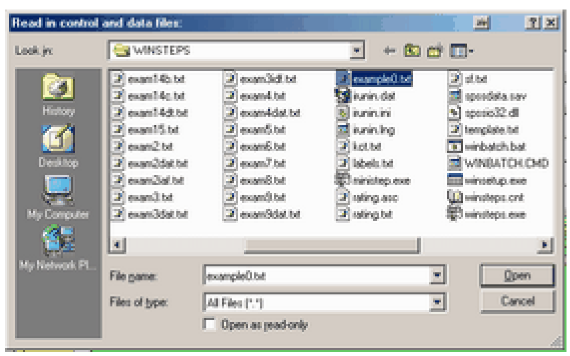
10.1.2 Reading in a pre-existent control file

Reading in a pre-existing control file is easy. You can add or change control specifications, and add or change the data.

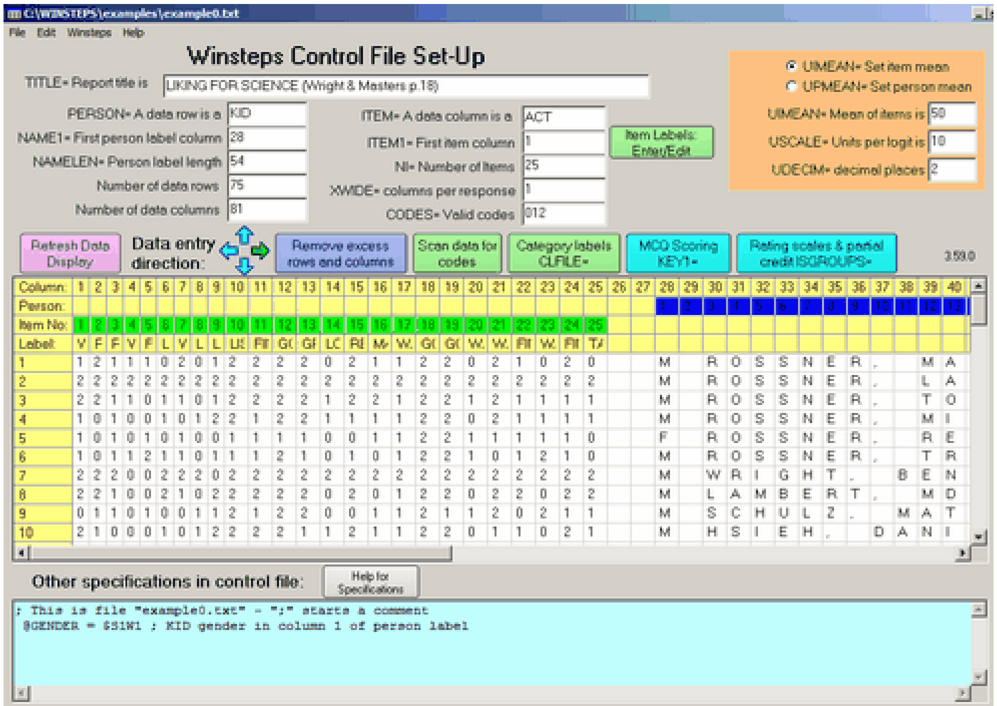
From the Setup screen, use the **File** pull-down menu:



Select your desired pre-existing control or data file:



This fills in the Setup screen:



The control specifications and data are those in the Control and Data file. Control values are filled in as far as possible. The data are filled in with one row per data record and one character per data column.

To see the item labels (between &End and END LABELS in the Control file) either drag the column wider or click on "Item Labels Enter/Edit"

Item deletion: type the specification:
IDELETE=(item number)
into the box at the bottom of the data setup screen.
This omits the item from your analysis

Next

10.1.3 Data display

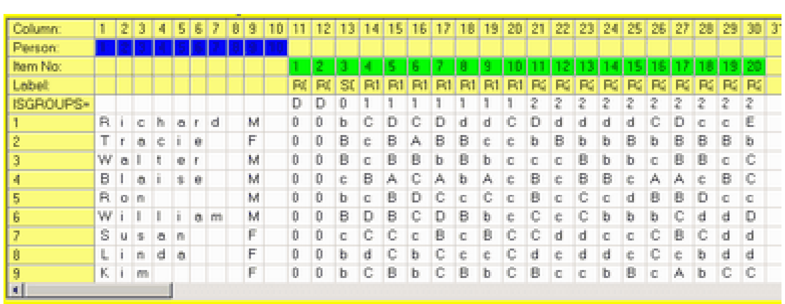
This grid displays the data file with one character per column.

During data entry, more columns are automatically added to the right, as needed.

Double-click the extreme row or column for an extra row or column.

Click on *"Refresh Data Display"* if the display does not show the current specification settings.

Press shift + left-click on the Person or Item No. row to dynamically select person label or item response columns.



You can copy-and-paste data into the data-display box. In this box there is one character per cell.

Note: FORMAT= is ignored in this display

Next

10.1.4 Item labels

Output reports and displays are much more useful and informative when the items are identified with short, clear identifying labels.

These are usually entered in the specification control file after &END and before END LABELS (or END NAMES). There is one item identifying label per line, so there should be as many lines of item identification as there are items on the test or instrument.

Blank lines and lines containing only comments starting with ; are ignored between &END and END LABELS. Items without labels are labeled with their item entry number.

In the Setup routine, they are entered in a special screen.

Next

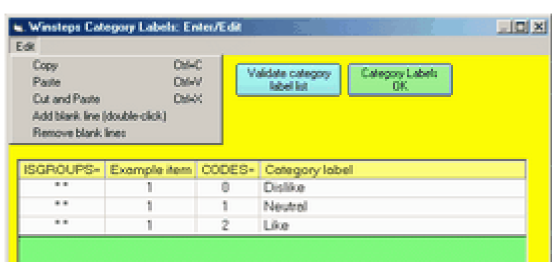
10.1.5 Category labels

Category labels describe the categories in a response structure, levels in a partial credit item, or such like.

Categories are identified in the data codes (CODES=). If there are different categories for different items, then use item grouping (ISGROUPS=) to identifier clusters of items which share the same category structures. Both of these can be entered on the main set-up screen.

Example grouping " " means that this is the standard common grouping.

Double-click on the bottom line for another blank line.



10.2 Do-it-yourself control and data file construction

There is a control and data file setup or Tabbed Text procedure. They are easier!

Here is a step-by-step guide to setting up and running Winsteps. It is a little tricky the first time, but you'll soon find it's a breeze!

The first stage is to set up your data in a rectangular data file in "MS-DOS text with line breaks" format.

1. Obtain your data

You'll need to be a little organized. Think of your data as a wall of pigeon-holes.

(a) Each column corresponds to one item, probe, prompt, task, agent, ...

For each column, you will need an item name or label. Make these short, only one or two words long. Make a list of these in a document file. Put the label of the first item on the first line, etc.
Put END LABELS on the line after the last item.
Your list will look like this:

Eating
Dressing
....
Walking
Stair climbing
END LABELS

You can use Notepad or your own text editor or pull-down the Winsteps "Edit" menu, and select "Create/Edit file with Notepad"

(b) Each row of pigeon-holes corresponds to one person, subject, case, object, ...

You will need some useful identifying codes for each row such as age, gender, demographics, diagnosis, time-point. Winsteps doesn't require these. but its is much more useful when they appear. Give each of these identifiers one or two letter codes, e.g., F=Female, M=Male, and give each identifier a column of pigeon-holes.

(c) The Data must be carefully lined up.
It is simpler if each data point, observation, response, rating can be squeezed into one character - numeric or alphabetic.

Now create the data file. It will look like something this:

```
M 29 B 001 210212110200102
F 27 W 002 122121010201020
F 32 H 003 222210102112100
M 31 W 004 002010021000210
```

or, less conveniently,

```
M29B001210212110200102
F27W002122121010201020
F32H003222210102112100
M31W004002010021000210
```

After the END LABELS line, or in a separate file,
on each line enter the person identifying codes. Line them up so that each column has a meaning. This is easier if you set the font to Courier.

Then enter the responses, starting with the first item and continuing to the last.
Do not place spaces or tabs between the responses.
If the lines start to wrap-around, reduce the font size, or increase the page size.

Excel, SPSS, SAS, ACCESS
Your data may already be entered in a spread-sheet, statistics program or database.

"Copy and Paste", Save As, Export or Print to disk the data from that program into "DOS-text with line breaks" or ASCII file.

If the program puts in extra blanks or separators (e.g., Tabs or commas), remove them with a "global replace" in your text editor or word processor.

To replace a Tab with nothing, highlight the space where a Tab is. Then Ctrl+c to copy. Global replace. Ctrl+V put a Tab into "From". Put nothing in "To". Action Global Replace.

In Excel, reduce the column width to one column, then
"Save As" Formatted Text (Spaced delimited) (*.prn)

In SPSS, see SPSS pull-down menu.

2. Set up your Winsteps Control and Data file

(a) Edit Template.txt
Pull-down the Edit menu, select "Create new control file from= ....\Template.txt"

The Template.txt will be displayed on your screen by Notepad or your own text editor.

(b) Template.txt is a Winsteps Control and Data file
Find the three sections:

top: down to &END are Control Specifications
we will edit this in a moment

middle: between &END and END LABELS are the Item Labels
copy and paste the item labels from your list into this area.
one item label per line, in the order of the labels.

bottom: below END LABELS are the data
copy and paste the person labels and responses into this area.
one person per line (row).

(c) Edit the Control Specifications

Find the line "Title="
Replace Put your page heading here with your own page heading.

Look at a data line, and count across:

In which column does the person identifying label start, the first position of the person name?	
This is the Name1= value	e.g., if it is column 4, then Name1=-4
How long is the person identifying label, the name length?	
This is the Namlen= value	e.g., if it is 10 columns, then Namlen=10
In which column is the response to the first item?	
This is the Item1= value	e.g., if the first response is in column 12, then Item1=12
How many items are there, the number of items?	
This is the NI= value	e.g., if the number of items is 50, then NI=50
What are the valid item response codes in the data file?	
This is the Codes= value	e.g., if the codes are 1,2,3,4, then Codes=1234

If your codes are not numeric, then you will need to rescore them.
See Data recoding

This is usually enough for your first Winsteps run.

(d) "Save As" the Template.txt file with your own file name.
Winsteps accepts any valid file name.

3. Run Winsteps

To the prompt:
Control file name? (e.g., KCT.txt). Press Enter for Dialog Box:
Press the Enter key
Select your control file from the dialog box
Press the Enter key

Report output file name (or press Enter for temporary file):
Press the Enter key

Extra specifications (if any). Press Enter to analyze):
Press the Enter key
This is used for making just-in-time changes to your control file instructions, for this run only.

4. Your analysis commences

5. Your analysis concludes.

If there is an error message:
select "Edit Control File=" from the Winsteps Edit menu
correct the control file
save it
select "Exit, then Restart Winsteps" from the File menu

If "Measures constructed" -
use the Output Tables pull-down menus to look at the Output Tables
here is the list of output tables.

6. Exit Winsteps using the X in the top right corner.

10.3 Control file and template.txt

The control file tells what analysis you want to do. The template file, TEMPLATE.TXT. gives you an outline to start from. The easiest way to start is to look at one of the examples in the next section of this manual, or on the program disk. The control file contains control variables. These are listed in the index of this manual. Only two control variables must have values assigned for every analysis: NI= and ITEM1=. Almost all others can be left at their automatic standard values, which means that you can defer learning how to use most of the control variables until you know you need to use them.

When in doubt, don't specify control variables, then they keep their standard values.

Here is a version of TEMPLATE.TXT. Copy and paste this, if your TEMPLATE.TXT is corrupted.

```
; this is a WINSTEPS specification control file template.
; Save it with your own name, e.g., control.txt

; a semi-colon means a comment: remove semi-colons as needed.

&INST ; optional
```

```
 TITLE = "Put your page heading here"

;Input Data Format
 NAME1 = 1       ; column of start of person information
NAMLEN = 30       ; maximum length of person information
 ITEM1 = ?        ; column of first item-level response
    NI = ??       ; number of items = test length
 XWIDE = 1        ; number of columns per response
PERSON = Person   ; Persons are called ...
  ITEM = Item     ; Items are called ...

; DATA =          ; data after control specifications

; For rescoring
;       0        1         2         3         4         5         6         7
;       1234567890123456789012345678901234567890123456789012345678901234567890
;ISGROUPS=0        ; specify that each item has its own response structure (partial credit)
;IREFER=AABBCC....

; Data Scoring
  CODES = "01"    ; valid response codes
;IVALUEA= "01"    ; for rescoring for item type A
;IVALUEB= "10"    ; for rescoring for item type B
;IVALUEC= "  "    ; for rescoring for item type C
;                 ; Codes in IREFER with no IVALUE are not changed

CLFILE = *          ; label the categories in Table 3.2
0 Strongly Disagree ; 0 in the data means "Strongly Disagree"
1 Strongly Agree    ; 1 in the data means "Strongly Agree"
*

;NEWSCORE = "10"    ; use to rescore all items
;    KEY1 =         ; key for MCQ items

; XWIDE = 2   ; for all codes 00 to 99
; CODES = "00010203040506070809101112131415161718192021222324252627282 9+
;         +30313233343536373839404142434445464748495051525354555657585 9+
;         +60616263646566676869707172737475767778798081828384858687888 9+
;         +90919293949596979899"

; codes reversed, in case needed
; NEWSCR= "99989796959493929190898887868584838281807978777675747372717 0+
;         +69686766656463626160595857565554535251504948474645444342414 0+
;         +39383736353433323130292827262524232221201918171615141312111 0+
;         +09080706050403020100"

; MISSCORE = -1     ; -1 = missing data treated as not administered

;User Scaling
UMEAN  = 50             ; user-set item mean - standard is 0.00
USCALE = 10             ; user-scaled measure units - standard is 1.00
UDECIM = 1              ; reported decimal places - standard is 2
MRANGE = 50             ; half-range on maps - standard is 0 (auto-scaled)

&END

;Put item labels here for NI= lines

END LABELS

;Put data here - and delete this comment to prevent it being processed as a data line.
```

10.4 Data file

If your data file is small, it is easiest merely to have it at the end of your control file. If your data is extensive, keep it in a separate data file.
Your data file is expected to contain a record for each person containing a person-id field and a string of responses to some items. Your data can be placed either at the end of your control file or in a separate disk file.

Winsteps reads up to 30 columns of person-id information as standard. Normally the person-id is assumed to end when the response data begin or when the end of your data record is reached. However, an explicit length of up to 300 characters can be given using the NAMLEN= control variable.

By the term "response" is meant a data value which can be a category label or value, score on an item or a multiple-choice option code. The responses can be one or two characters wide. Every record must contain responses (or missing data codes) to the same items. The response (or missing data code) for a particular item must be in the same position in the same format in every record. If every person was not administered every item then mark the missing responses blank or make them some otherwise unused code, so that the alignment of item responses from record to record is maintained.

A table of valid responses is entered using the CODES= character string. Any other response found in your data is treated as missing. By using the CODES=, KEYn=, NEWSCORE= and IVALUE= options, virtually any type of response, e.g. "01", "1234", " 1 2 3 4", "abcd", " a b c d", can be scored and analyzed. Missing responses are usually ignored, but the MISSCORE= control variable allows such responses to be treated as, say, "wrong".

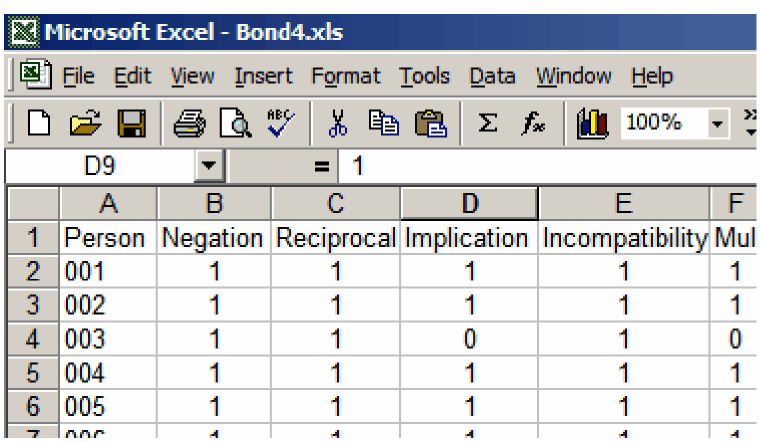
When writing a file from **SPSS,** the syntax is:
FORMATS ITEM1 ITEM2 ITEM3 (F1). i.e., FORMATS varlist (format) [varlist..]
The procedure is FORMATS and then the variable list. Enclosed in parentheses is the format type. F signifies numeric while 1 signifies the width. (F2) would signify a numeric with a width of 2 columns for XWIDE=2. See pages 216 and 217 of the SPSS Reference Guide (1990). See also the SPSS pull-down menu.

10.5 Data from Excel files

Winsteps control and data files can easily be constructed from Excel .xls files. Use the Excel/RSSST menu: Excel option:

In the Excel spreadsheet, the first row is the variable names. Then each row is one person (subject, case). Each column contains one variable: person name, item response, demographic variable.

Here is Bond4.xls - the example from Bond & Fox, "Applying the Rasch Model", chapter 4:



	A	B	C	D	E	F
1	Person	Negation	Reciprocal	Implication	Incompatibility	Mul
2	001	1	1	1	1	1
3	002	1	1	1	1	1
4	003	1	1	0	1	0
5	004	1	1	1	1	1
6	005	1	1	1	1	1

Each Excel column is an "Excel Variable". The first row contains the variable name.
"Person" is the person identification - we want this to go into the Winsteps Person Label.

"Negation", "Reciprocal", ... are items on the test instrument. The responses, 1 or 0, are in each column for each person - we want these to be the Winsteps Items.

Now follow the procedure at Excel/RSSST menu

For another conversion technique see Data from Excel and other spreadsheets

Winsteps-Excel interface modules: XLRSSST=	**Imported Excel file types**	
XLRSSST= Yes wininput.exe (32-bit) Excel VBA	.xls, .xlsx	Installation of Excel is required
XLRSSST= No wininput64.exe (64-bit)	.xls, .xlsx, .xlsm	Installation of Excel is not required Installation of R Statistics is required. Package "readxl" is automatically installed by Winsteps.

10.6 Data from R Statistics files

Winsteps control and data files can easily be constructed from R Statistics ***.rda*** and ***.rdata*** files. Use the Excel/RSSST menu: R option:

Now follow the procedure at Excel/RSSST menu.

Winsteps-R Statistics interface modules	**Imported R Statistics file types**	**Installation of R Statistics is required**
XLRSSST= Yes wininput.exe (32-bit) R Statistics	.rda, .rdata	Installation of R Statistics is required
XLRSSST= No wininput64.exe (64-bit)	.rda, .rdata	Installation of R Statistics is required

10.7 Data from SAS files

Winsteps control and data files can easily be constructed from SAS ***.sas7bdat*** files. Use the Excel/RSSST menu: SAS option:

Now follow the procedure at Excel/RSSST menu

Winsteps-SAS interface modules	**Imported SAS file types**	**Installation of SAS is not required**
XLRSSST= Yes	.sas7bdat (version 9.3 or earlier)	SAS local provider is required

wininput.exe (32-bit) SAS local provider (see above)		
XLRSSST= No wininput64.exe (64-bit)	.sas7bdat, .xpt	Installation of R Statistics is required. Package "haven" is automatically installed by Winsteps.

32-bit module only:
SAS file conversion requires the "SAS Local Provider", downloadable free (after free registration) from https://www.sas.com/ - more precisely from
https://support.sas.com/downloads/package.htm?pid=648

.sas7bdat files from SAS 9.4 or later may not be compatible with the SAS Local Provider. Please create SAS files with the SAS option:

```
options ExtendObsCounter=no;
```

see Usage Note 49496: The option EXTENDOBSCOUNTER=YES might cause the error
An alternative is to export your SAS file in .CSV format or to Excel.

SAS conversion problems may also be due to lack of Microsoft Data Access Components (MDAC) support in Windows, available by download free from Microsoft.

---

2. SAS provides an environment within which Winsteps can run. Kazuaki Uekawa suggests:

Sample instructions:

```
/*type the location where Winsteps is installed*/
%let win= C:\Winsteps\Winsteps;
....
option xwait xsync;
/*This run uses the whole sample*/
x "start &win &WD&scale..con &WD&scale._whole.out ifile=&WD&scale._whole.ifile
        pfile=&WD&scale._whole.pfile ";
....
 /*item files produced by Winsteps are now read by SAS*/
.....
```

10.8 Data from SPSS files

Winsteps control and data files can easily be constructed from SPSS **.sav, .zsav, .por** files (but not from PASW .spv files or other SPSS formats).

The Winsteps version of spssio32.dll only extracts 8-character variable names. If your variable names are longer, then convert your SPSS file into an Excel file, and use the Excel routine to create your Winsteps file.

Here is a summary of the procedure to convert an SPSS file into a Winsteps file:

1. Launch Winsteps

2. If you see a button label "Import from ... SPSS", please click on it with your mouse.
If you don't, please click on "Excel/RSSST" on the menu bar at the top of the Ministep window.

3. The "Select data" buttons display.

4. Click on the SPSS button.

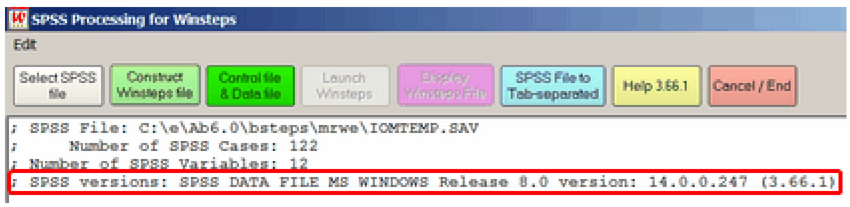
5. A window opens "Select SPSS processing for Winsteps"

6. Click on "Select SPSS file"

7. A window opens "Read SPSS dataset file"

8. Navigate to your .sav file, click on its name, then click on the OPEN button.

9. The SPSS variable list displays.



SPSS File:	Name of the SPSS .sav data file
Number of SPSS Cases:	Number of cases (person records) found in the SPSS file.
Number of SPSS Variables:	Number of SPSS variables (items, person labels, demographic indicators, etc.)
SPSS versions:	
SPSS DATA FILE	SPSS version which created the SPSS .sav file
version:	spssio32.dll version number (10.0 is the minimal interface supplied with Winsteps). Your version of SPSS has a copy of spssio32.dll with a higher version number. If it is not active, please copy it into the Windows System folder, and delete spssio32.dll in the Winsteps folder.
(5.10.1)	Winsteps interface routine (wininput.exe) performing the conversion. This is usually the same as your Winsteps version number.

10. Now please follow the file-conversion procedure from Step 3 in Excel/RSSST menu

Example dataset spssdata.sav is courtesy of Parisa Daftarifard.

Winsteps-SPSS interface modules	Imported SPSS file types	Installation of SPSS is not required
XLRSSST= Yes wininput.exe (32-bit) spssio32.dll	.sav	spssio32.dll is installed with your copy of SPSS, or is in your SPSS software package (often in an obscure folder). If this is not present, Winsteps installs a minimal spssio32.dll
XLRSSST= No wininput64.exe (64-bit)	.sav, .zsav, .por	Installation of R Statistics is required. Package "haven" is automatically installed by Winsteps.

10.9 Data from STATA files

STATA have changed the internal format of their .dta files in STATA version 14. To **read a STATA 14 or later file with Winsteps, first in STATA,**
. saveold filename13, version(13)
Check that filename13.dta is in **binary** format, not XML, by opening it with your text editor.
Then filename13.dta can be processed by Winsteps,

if this does not work correctly, output to a tab-delimited text file instead of a Stata 13 file:
export delimited filename.txt, delimiters(tab)
then filename.txt can be processed by Winsteps Excel/RSSST menu data with tabs.

Winsteps control and data files can easily be constructed from STATA ***.dta*** files. Use the Excel/RSSST menu: STATA option:

Now follow the procedure at Excel/RSSST menu

You can simplify some of the variable selection if you construct your person variable in STATA using STATA instructions similar to:
Gen pname newvar = string(var1,"%05.0f") + string(var2,"%01.0f") + string(var1,"%01.0f") + string(var1,"%01.0f")
This becomes the person-name variable for Winsteps.

Winsteps-STATA interface modules	Imported STATA file types	Installation of STATA is not required
XLRSSST= Yes wininput.exe (32-bit)	.dta (version 13 or earlier: see above)	
XLRSSST= No wininput64.exe (64-bit)	.dta	Installation of R Statistics is required. Package "haven" is automatically installed by Winsteps.

Alan Acock writes: Fred Wolfe has provided a Stata module which produces Winsteps control and data files. It is a Stata command that does two things:
1. It converts the data you want to analyze using Winsteps to a dataset that Winsteps can read.
2. It generates the Winsteps command file to do the analysis in Winsteps.

To install this command go to the command window in Stata and enter the following command:

```
ssc install raschcvt
```

This will find the command on the internet and install the command. You only need to run this once. Here is an example of how you would use the command. From an open session of Stata enter the following command in your command window:

```
raschcvt var1 var2 var3 var4 id , outfile(c:\Winsteps\testme) id(id) max(4)
```

This will generate a dataset for Winsteps and put it in the directory where Winsteps is located. The file will be called

```
testme.dat
```

This will also generate a command file called

```
testme.con
```

and put it in the same directory as the data. This file may have a couple lines at the top and bottom that need to be edited out. The Rasch analysis will be performed on the variables that you list. In this example the variables are var1, var2, var3, and var4. The identification variable should be at the end of this list and happens to be called id in this example. It is important that each variable has a variable label in the Stata dataset as Wolfe's command assumes this when generating the command file. The outfile(c:\Winsteps\testme) after the comma determines the name and location of the two files created, the id(id) gives the name you select for the identification variable, and the max(4) gives the maximum score, in this case the variables have a maximum value of 4.

Use your editor to remove any lines at the top or bottom in the testme.con file that are superfluous. When you run Winsteps simply click on enter or file open, and then browse to find *testme.con.* When prompted for the output file name enter an appropriate name. When asked for special features simply press enter. This will run your data in Winsteps.

10.10 Data from Text files (with Tabs, Commas, Semicolons)

Winsteps control and data files can easily be constructed from Text files with Tabs, commas or semicolons, usually ***.txt*** files. Use the Excel/RSSST menu: Text-Tab option:

Now follow the procedure at Excel/RSSST menu.

The Text files (with Tabs) must be in standard Windows .txt file format, with one row for each person and one column for each item (variable). The columns are separated by tab characters. Additional columns can contain person identification and demographics.

The first row contains the names (labels) for the columns, also tab-separated.

Here is a typical file. The white spaces are tab characters.

Person	Item1	Item2	Item3	Item4	Item5
001	1	1	1	1	1
002	1	1	1	1	1
003	1	1	0	1	0
004	1	1	1	1	1
005	1	1	1	1	1

The 64-bit option allows for more file formats: see Edt Initial Settings

10.11 Data from Excel and other spreadsheets

When possible, use the technique described at Data from Excel files. But it is straight-forward to copy data from an Excel spreadsheet into a Winsteps data file.

(i) Organize your data.
    Transform all item responses into columns one or two columns wide, e.g., "1" or "23"
    Transform all demographics into columns, one column wide, e.g., "M" and "F" for male and female.

(ii) Organize your Excel spread sheet.
    Put all item responses (one item per column) into one block to the left of your spreadsheet.
    Put all person identifiers (one item per column) into one block, immediately to the right of the last item column.

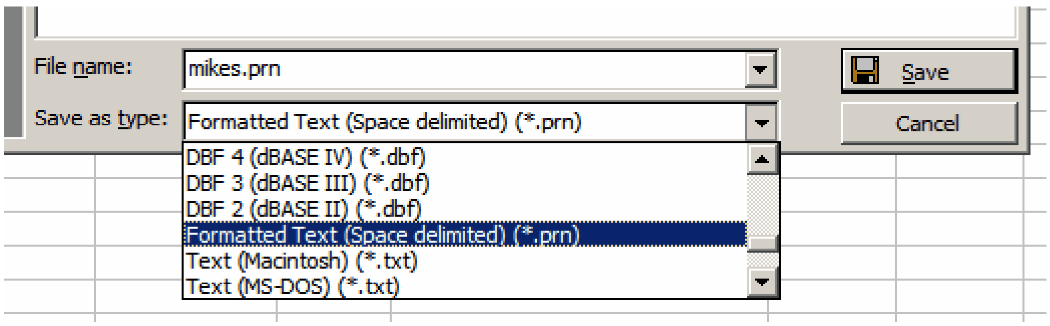
(iii) Organize your column widths.
    Make all item column widths the same (usually one or two columns).
    Person identifier widths can match the identifiers, but these are best at one column wide.

(iv) Replace missing data with "*" or "." or "-"
    Global replace nothing in a cell with a convenient clear missing data indicator, which is **not a number**.

(v) Use the Excel format function to inset leading zeroes etc.
Select the item columns, then
Format - Cells - Custom
and enter 0 for 1 character wide columns, 00 for 2 character-wide columns, etc.

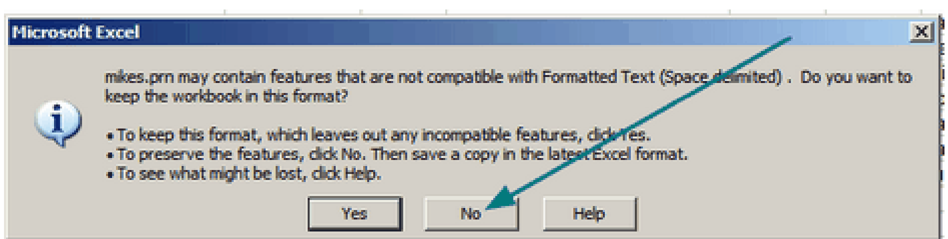
(vi) Select all cells.

(vii) Copy into clipboard (Ctrl+C), or write to a tab-delimited file
or **"Save as" a "Formatted Text (space delimited) (*.prn)" file (respond No to next dialog box)**

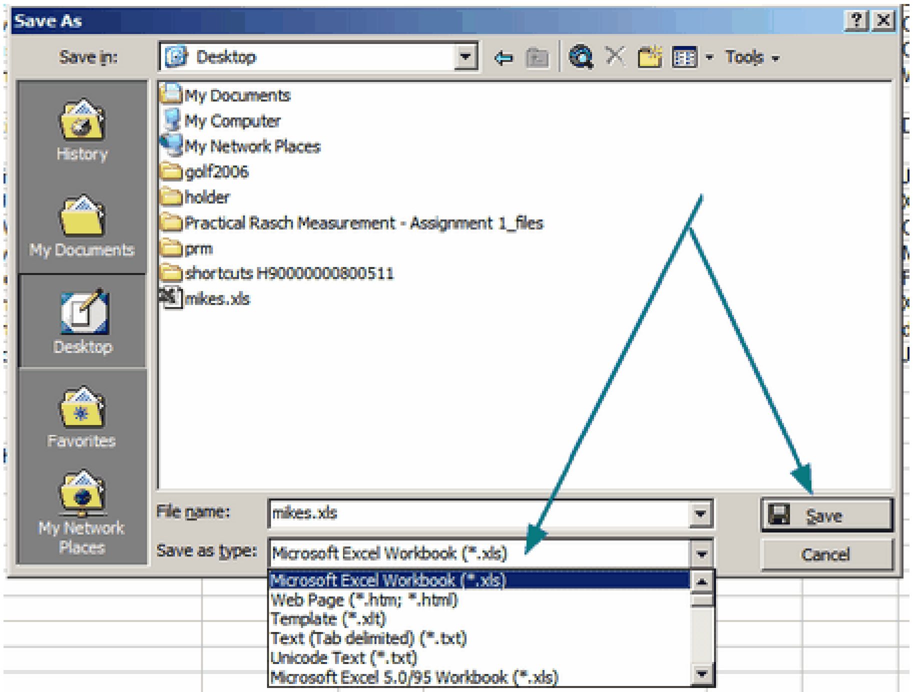


The data has been saved in the .prn format. This is a txt file.

To the "Keep" question: respond No:



To the "Save As" question, respond "Microsoft Excel Workbook", "Save"



(viii) Open Notepad or your own text editor.
Paste (Ctrl+V) or open the tab-delimited file.

(ix) Removing tabs
Highlight a tab (area between two columns)
Copy (Ctrl+C)
Replace all tabs: (Ctrl+V) tab if necessary with nothing.

(x) The file should now look like a standard Winsteps rectangular data file.
Save as a text file.

To obtain a data matrix like this from Excel:

```
110101010
001011001
```

1. Set the Excel column widths so that the Excel matrix looks like this.
2. "Save As" the matrix as "Formatted Text (Space delimited) (*.prn)"

10.12 Data file with other delimiters

Global replace the delimiters with tabs and use the Excel/RSSST menu: Data as Text with Tabs option.

It is often convenient to organize your data with delimiters, such as commas, semi-colons or spaces, rather than in fixed column positions. However, often the delimiter (a Tab, space or comma) only takes one column position. In which case, it may be easier to include it in the CODES= or use MFORMS= or FORMAT=. See also DELIMITER=.

11 * Control Variables

11.1 #1#= user-defined replaceable token

#1#= to #9#= are 9 user-defined tokens that can be used to replace values in other control specifications. Each can be up to 32 characters long. Tokens can reference tokens that are already defined. Undefined tokens are removed from control specifications.

Example 1:

&INST
#1# = myfile
#2# = 3
IFILE=#1##2#.txt ; this is processed as IFILE=myfile3.txt

Example 2:
Extra Specifications? #3#=analysis2
Control file:
PFILE = #3#pf.txt ; this is processed as PFILE = analysis2pf.txt

Example 3:
At the DOS prompt, or in a Batch file:
c:\myfolder>c:\Winsteps\Winsteps.exe mycontrol.txt #3#=analysis2
Control file:
OUTFILE = #3#out.txt ; this is processed as PFILE = analysis2out.txt
PFILE = #3#pf.txt ; this is processed as PFILE = analysis2pf.txt

11.2 &END end of control variables

The first section in a control file contains the control variables, one per line. Its end is indicated by &END.

TITLE = "Example control file"
ITEM1 = 1
NI = 10
NAME1 = 12
&END
...... ; Item labels here
END LABELS

11.3 &INST start of control instructions

&INST is ignored by current versions of Winsteps. It is maintained for backward compatibility with earlier versions, where it was required to be the first control instruction. It is still present in some example files, again for backwards compatibility.

&INST ; this is allowed for compatibility
TITLE = "Old control file"
....

11.4 ; starts a comment

; starts comment for control variables or item labels. A different character can be substituted using Edit Initial Settings

Example:
NI = 24 ; this test has 24 items
&END
2+2 ; the first item tests simple addition
....
END LABELS

11.5 @Field= name for location in label

@Fieldname= allows for user-defined names for locations with the person or item labels to be specified with the column selection rules.
@Fieldname = value

Field name: a user-specified name which can include letters and numbers, but not = signs. Field names are converted to capital letters, and must be referenced in full. Fieldname is 1 to 9 characters, e.g., @X or @123456789 or @FIRSTNAME

Value: a user-specified values which must accord with the column selection rules.

@ILABEL= is the length of the longest item label
@PLABEL= is the length of the longest person label

Example 1: The gender of persons is in column 14 of the person label. A DIF report on gender is wanted.

```
@GENDER = 14 ; gender indicator in column 14 of the person label
DIF = @GENDER ; DIF classification is by Gender column
or
DIF = @gender  ; lower case letters in field names are allowed
but not
DIF = @GEN  ; abbreviations of field names are not allowed
TFILE=*
30   ; produce the DIF Table
*
```

This can also be done by the pull-down menus
Specification menu box: @GENDER = 14
Output Tables menu: 30. Items: DIF
Right-click on DIF selection box: @GENDER
Click on OK box

Example: DIF for ethnicity in the pre- and post- treatment group:

In the person label, a column for pre-post code, say column 7
@PREPOST=7
a column for an ethnicity code, say column 3
@ETHNIC=3
DIF for pre-post and ethnicity:
DIF=@PREPOST+@ETHNIC
Produce Table 30

One way: in your Winsteps control file:

```
TFILE=*
@PREPOST=7
@ETHNIC=3
DIF=@PREPOST+@ETHNIC
30
*
```

11.6 AGREEFILE= paired-person agreement counts

(controlled by PSELECT=, ISELECT=, PSUBTOTAL=)

AGREEFILE= reports the paired-person information underlying Table 35. Use PSELECT= and ISELECT= to choose subsets to compare for agreement. Sub-samples (groups of persons) can be specified with PSUBTOTAL=. Only pairs in the same groups are shown if AGREEGROUP=Yes.

AGREEFILE=? opens a Browse window.

When AGREEFILE= is launched from the Output Files menu, the AGREEFILE= dialog box displays.

Contents of AGREEFILE=

```
; AGREEMENT FILE FOR An MCQ Test: administration was Computer-Adaptive ISELECT=* PSELECT=* AGREEGROUP=Y
```

```
 TWOOBS TWOSAME TWOSCOR ONEHIGH TWOHIGH  ONELOW  TWOLOW ONEMISS TWOMISS MEASURE MEASURE AVERAGE T35.1 T35.2 T35.3 T35.4 T35.5 STUDEN1
    STUDEN2 P-LABEL P-LABEL2
      9       7       8       5       4       5       3      60      33     .40     .44     .42  77.8  88.9  80.0  60.0  55.0       1
          7 IM  CAT IH  JAN
      9       7       7       6       4       5       3      60      24     .40    -.96    -.28  77.8  77.8  66.7  60.0  40.0       1
          8 IM  CAT IL  ROB
      7       3       4       5       2       5       1      62      35     .40    -.05     .18  42.9  57.1  40.0  20.0  56.5       1
         14 IM  CAT IL  TAK
```

Field	Columns	Description
TWOOBS	1-8	count of items for which both persons have non-missing observations
TWOSAME	9-16	count of items for which both persons have the same non-missing observations
TWOSCORE	17-24	count of items for which both persons have non-missing observations scored the same
ONEHIGH	25-32	count of items for which one or both persons have non-missing observations scored in the highest (correct) category
TWOHIGH	33-40	count of items for which both persons have the same non-missing observations scored in the highest (correct) category
ONELOW	41-48	count of items for which one or both persons have non-missing observations scored in the lowest (wrong) category
TWOLOW	49-56	count of items for which both persons have the same non-missing observations scored in the lowest (wrong) category
ONEMISS	57-64	count of items for which one or both persons have a missing observation
TWOMISS	65-72	count of items for which both persons have missing observations
MEASURE(1)	73-80	person ability measure for first person
MEASURE(2)	81-88	person ability measure for second person
AVERAGE	89-96	average person ability of the two persons: Table 35 x-axis measure
T35.1	97-102	Table 35.1 y-axis percent = % Same (Paired Kid) Observed Responses
T35.2	103-108	Table 35.2 y-axis percent = % Same (Paired Kid) Scored Responses
T35.3	109-114	Table 35.3 y-axis percent = % Same (Paired Kid) Observed Highest (Right) Responses
T35.4	115-120	Table 35.4 y-axis percent = % Same (Paired Kid) Observed Lowest (Wrong) Responses
T35.5	121-126	Table 35.5 y-axis percent = % Same (Paired Kid) Missing Responses when either person has a Missing Response
PERSON(1)	127-134	person entry number for first person
PERSON(2)	135-142	person entry number for second person
P-LABEL(1)	143-....(length of longest person label)	person label for first person
P-LABEL(2)	(one blank, then) ...-....	person label for second person

Example 1: an MCQ test with 60 questions, scored 1, 0. One person answered questions 1-40 and the other answered 10-50. They were scored 1-1 on 10 items, 1-0 on 8 items, 0-1 on 5 items, 0-0 on 8 items = 31 items.

TWOOBS: both students must be observed on the item. They were both observed on items 10-40, so that 31 will appear here.

TWOSAME: counts of items to which both students made the same response. There was only one correct response to each item, so SAME = 10 (1-1) correct answers + 2 (out of 8 0-0) incorrect same choice of distractors = 12.

TWOSCORE: the count of items on which they scored the same (for a dichotomy, both correct or both incorrect). They made the SAME score on 10 (1-1) + 8 (0-0) = 18.

ONEHIGH: one or both persons scored in the highest category, "1", in 10+8+5 = 23 items. The "highest" category is the highest score possible on each item, for dichotomies usually scored 1. For Likert rating scales, the high category is usually scored 5.

TWOHIGH: 10 pairs of responses are in the highest category (1-1).

ONELOW: one or both persons score in the lowest category, "0", in 8+5+8 = 21 items. The "lowest" category is the lowest score possible on each item, for dichotomies usually scored 0. For Likert rating scales, the low category is usually scored 1.

TWOLOW: 8 pairs of responses are in the lowest category (0-0).

ONEMISS: there are 60 questions, the both responded to 31, so one or other or both students had missing data on ONEMISS = 60 - 31 = 29 items.

TWOMISS: items 51-60 were missing for both students. TWOMISS = 10.

11.7 AGREEGROUP= compare with other groups in Table 35 = Yes

AGREEGROUP = Yes

For the overall plots in Table 35, and AGREEFILE=, AGREEGROUP=Yes if persons are to be compared only with others in their own classification groups.

AGREEGROUP = Yes

For the overall plots in Table 35, and AGREEFILE=, AGREEGROUP=No if persons are to be compared with all other persons.

11.8 ALPHANUM= alphabetic numbering

Normally XWIDE=1 limits the numerical score range to 0-9, but with ALPHANUM= this can be extended much further.

ALPHANUM= is followed by a string of characters that represent the cardinal numbers in order starting with 0, 1, 2, 3, ...

Example: Represent the numbers 0-20 using XWIDE=1

```
ALPHANUM = 0123456789ABCDEFGHIJK ; then A=10, B=11, .., K=20
XWIDE = 1
CODES = 0123456789ABCDEFGHIJK
NI = 5
ITEM1 = 1
&END
21BF3 Mary ; Mary's responses are 2, 1, 11, 15, 3
K432A Mark ; Mark's responses are 20, 4, 3, 2, 10
```

11.9 ANCESTIM= alternative method for anchored analyses

ANCESTIM = No (the default)	Not done. Estimation with anchors is done using standard procedure.
ANCESTIM = YES	When there are IAIFLE= or PAFILE= anchor values, MJMLE is done with an alternative estimation method.

The standard Winsteps anchoring procedure, ANCESTIM=No, is usually successful, but sometimes reports convergence when the Displacements for the anchor values (set by IAFILE=, PAFILE=) and/or freely estimated persons and items are unnecessarily large.

The special alternative anchoring estimation method, ANCESTIM=YES, attempts to minimize the Displacements from the anchor values by global shifting of the estimates of the unanchored persons (PAFILE=) or items (IAFILE=) or both (PAFILE= and IAFILE= together).

Advice: if ANCESTIM=No (the default) produces unsatisfactory Displacements, please try ANCESTIM=YES, and *vice-versa.*

11.10 ASCII= characters

Encoded drawing characters can produce prettier-looking output tables.

ASCII=Yes	use ASCII characters (the standard) for drawing table boxes.
ASCII=Webpage	use HTML characters for drawing table boxes, output to web browser.
ASCII=Doc	use HTML characters for drawing table boxes, output to Microsoft Word (or equivalent).
ASCII=No	use MS-DOS box characters for drawing table boxes.

BOXSHOW=No removes the lines around the table boxes.

ASCII=Yes (displays in your text editor)

```
ASCII=Yes ; Letter Gothic Line
+-----------------------------------------------------+
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT| COHERENCE|ESTIM|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ| M->C C->M|DISCR|
|-------------------+------------+------------+----------+-----|
|  0    0     203  50| -3.29 -3.27|   .98   .76|  90%  90%|     | 0 Wrong
|  1    1     203  50|  2.99  2.97|   .94   .70|  90%  90%| 1.04| 1 Right
+-----------------------------------------------------+
ASCII=Yes ; Lucida Console
+-----------------------------------------------------+
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT| COHERENCE|ESTIM|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ| M->C C->M|DISCR|
|-------------------+------------+------------+----------+-----|
|  0    0     203  50| -3.29 -3.27|   .98   .76|  90%  90%|     | 0 Wrong
|  1    1     203  50|  2.99  2.97|   .94   .70|  90%  90%| 1.04| 1 Right
+-----------------------------------------------------+
```

Fonts: Letter Gothic Line, Lucida Console, Consolas, Courier New, SImPL, SimSUN, Bitstream Vera Sans Mono, Crystal, Onuava, Andale Mono.

ASCII=Webpage (displays in your web browser)

ASCII=Webpage ; Courier New

CATEGORY LABEL	SCORE	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	COHERENCE M->C	C->M	ESTIM DISCR	
0	0	203	50	-3.29	-3.27	.98	.76	90%	90%		0 Wrong
1	1	203	50	2.99	2.97	.94	.70	90%	90%	1.04	1 Right

ASCII=Webpage ; Lucida Console

CATEGORY LABEL	SCORE	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	COHERENCE M->C	C->M	ESTIM DISCR	
0	0	203	50	-3.29	-3.27	.98	.76	90%	90%		0 Wrong
1	1	203	50	2.99	2.97	.94	.70	90%	90%	1.04	1 Right

Fonts: Courier New, Lucida Console, Andale Mono, DejaVu Sans Mono
WEBFONT= sets the font priority.

ASCII=Doc (displays in Microsoft Word or equivalent)

ASCII=Webpage ; Courier New

CATEGORY LABEL	SCORE	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	COHERENCE M->C	C->M	ESTIM DISCR	
0	0	203	50	-3.29	-3.27	.98	.76	90%	90%		0 Wrong
1	1	203	50	2.99	2.97	.94	.70	90%	90%	1.04	1 Right

ASCII=Webpage ; Lucida Console

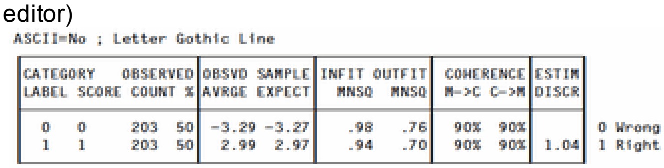
CATEGORY LABEL	SCORE	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	COHERENCE M->C	C->M	ESTIM DISCR	
0	0	203	50	-3.29	-3.27	.98	.76	90%	90%		0 Wrong
1	1	203	50	2.99	2.97	.94	.70	90%	90%	1.04	1 Right

Fonts: Courier New, Lucida Console, Andale Mono, DejaVu Sans Mono

WEBFONT= sets the font priority.

Example: Output a Table to Microsoft Word:
1. Do the Winsteps analysis
2. Specification Menu box: ASCII=Doc
3. Output Tables menu: select Table or enter Sub-Table
4. Table is output to Microsoft Word
5. In Winsteps, Specification Menu box: ASCII=Yes

ASCII=No (displays in your text editor)



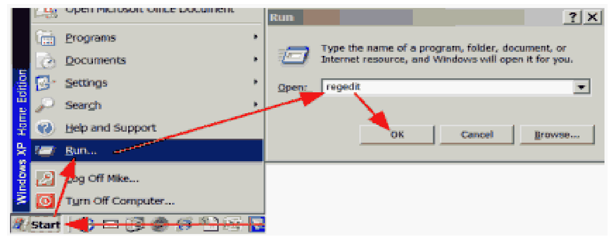
ASCII=No ; Letter Gothic Line

CATEGORY LABEL	SCORE	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	COHERENCE M->C	C->M	ESTIM DISCR	
0	0	203	50	-3.29	-3.27	.98	.76	90%	90%		0 Wrong
1	1	203	50	2.99	2.97	.94	.70	90%	90%	1.04	1 Right

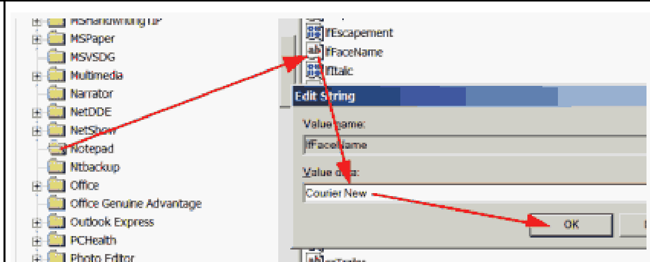
Fonts: Letter Gothic Line, MS Line Draw.

To make permanent (default) changes in Notepad font face and/or size:

Windows "Start"
Click on "Run"
Type in "regedit"
Click on "OK"



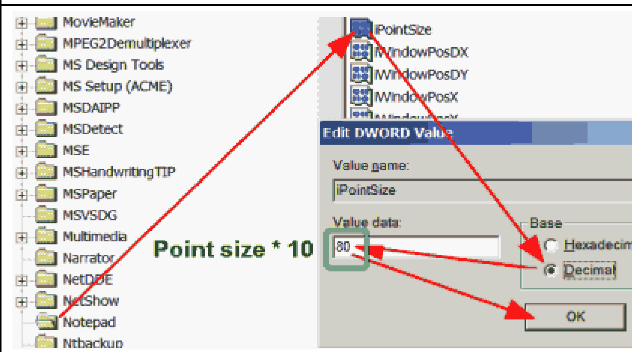
Registry Editor:
Click on the + in front of "HKEY_CURRENT_USER"
Click on the + in front of "Software"
Click on the + in front of "Microsoft"
Click on "Notepad"
For the type face:
Double-click on "lfFaceName"
Type in "Courier New" (or "Letter Gothic Line")
Click on "OK"



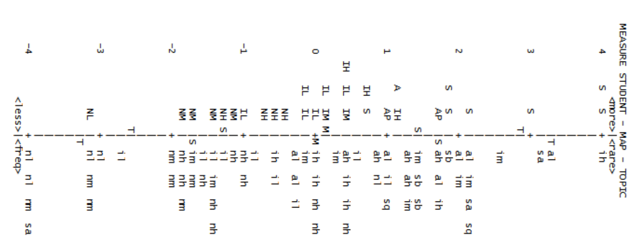
For the font size:
Double-click on "iPointSize"
Click on "Decimal"
Type in 80 (for point-size 8 multiplied by 10)
Click on "OK"

Close registry

Click on top right



Example 4. A horizontal Wright map.
1) Output Table 1.0
2) Copy-and-Paste into a Word document
3) Document "New Section" before and after map
4) Highlight the map:
5) Fixed space font: Consolas, Lucida Console
6) Small font size
7) Alt-F11 to launch VBA
8) in Immediate Window:
   Selection.Orientation = wdTextOrientationVerticalFarEast
9) Press Enter



Text is rotated!	

11.11 ASYMPTOTE= item upper and lower asymptotes

Persons responding to multiple-choice questions (MCQ) can exhibit guessing and carelessness. In the three-parameter IRT model (3-PL), guessing is parameterized as a lower asymptote to the item's logistic ogive of the probability of a correct answer. In the four-parameter IRT model (4-PL), carelessness is parameterized as an upper asymptote. Winsteps reports a first approximation to these parameter values, but does not use the estimates to alter the Rasch measures. The literature suggests that when the lower asymptote is .10 or greater, it is "substantial" (How Many IRT Parameters Does It Take to Model Psychopathology Items? Steven P. Reise, Niels G. Waller, Psychological Methods, 2003, 8, 2, 164-184).

ASYMPTOTE=Y	report the values of the Upper and Lower asymptotes in the Item Tables and IFILE=
ASYMPTOTE=N	do not report values for the Upper and Lower asymptotes.

Example 1: Estimate the 4-PL IRT parameters for the Knox Cube Test data:
  Run Exam1.txt
  After the analysis completes, use the "Specification" pull-down menu:
  Enter: DISCRIM = Yes to report the Item Discrimination
  Enter: ASYMP = Yes to report the asymptotes
  On the "Output Tables" menu, select an item table, e.g., Table 14.

```
+-----------------------------------------------------------------------------------------------+
|ENTRY    RAW                          |   INFIT  |  OUTFIT  |PTMEA|ESTIM| ASYMPTOTE |              |
|NUMBER  SCORE  COUNT  MEASURE   ERROR|MNSQ  ZSTD|MNSQ  ZSTD|CORR.|DISCR|LOWER UPPER| TAP          |
|------------------------------------+----------+----------+-----+-----+-----------+--------------|
|     4     32     34    -4.40     .81| .90    .0| .35    .8|  .55| 1.09|  .00  1.00| 1-3-4        |
|     6     30     34    -3.38     .64|1.17    .6| .96    .6|  .53|  .87|  .10  1.00| 3-4-1        |
|     7     31     34    -3.83     .70|1.33    .9|2.21   1.2|  .40|  .54|  .09   .98| 1-4-3-2      |
```

Example 2: Polytomous data: Liking for Science
  Run Example0.txt
  After the analysis completes, use the "Specification" pull-down menu:
  Enter: DISCRIM = Yes to report the Item Discrimination
  Enter: ASYMP = Yes to report the asymptotes
  On the "Output Tables" menu, select an item table, e.g., Table 14.

```
--------------------------------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL          |   INFIT  |  OUTFIT  |PTMEASURE-A|ESTIM| ASYMPTOTE |                      |
|NUMBER  SCORE  COUNT  MEASURE |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.|DISCR|LOWER UPPER| ACT                  |
|------------------------------+----------+----------+-----------+-----+-----------+----------------------|
|     1    109     75    -.40  | .55  -3.5| .49  -2.5|  .64   .49| 1.52|  .00  2.00| WATCH BIRDS          |
|     5     37     75    2.42  |2.30   5.6|3.62   7.3|  .05   .61| -.54|  .49  2.00| FIND BOTTLES AND CANS |
|    23     42     75    2.18  |2.41   6.3|4.11   9.0|  .00   .61| -.90|  .56  1.64| WATCH A RAT          |
```

Estimation
Item Response Theory (IRT) three-parameter and four-parameter (3-PL, 4-PL) models estimate lower-asymptote parameters ("guessability", "pseudo-guessing") and upper-asymptote parameters ("mistake-ability") and use these estimates to modify the item difficulty and person ability estimates. Rasch measurement models guessability and mistake-ability as misfit, and does not attempt to make adjustments for item difficulties and person abilities. But initial approximations for the values of the asymptotes can be made, and output by Winsteps with ASYMPTOTE=Yes.

The algebraic representation of the discrimination and lower asymptote estimate by Winsteps are similar to 3-PL IRT, but the estimation method is different, because Winsteps does not change the difficulties and abilities from their 1-PL values. Consequently, in Winsteps, discrimination and asymptotes are indexes, not parameters as they are in 3-PL.

A lower-asymptote model for dichotomies or polytomies is:

$$T_{ni} = c_i + (m_i - c_i)\,(E_{ni}/m_i)$$

where T_{ni} is the expected observation for person *n* on item *i*, c_i is the lower asymptote for item *i*, m_i is the highest category for item *i* (counting up from 0), and E_{ni} is the Rasch expected value (without asymptotes). Rewriting:

$$c_i = m_i\,(T_{ni} - E_{ni}) / (m_i - E_n i)$$

This provides the basis for a model for estimating c_i. Since we are concerned about the lower asymptote, let us construct a weight, W_{ni} ,
$B_i = B(E_{ni}=0.5)$ as the ability of a person who scores 0.5 on the item,
then $B_{ni} = B_n - D_i$ and $W_{ni} = B_{ni} - B_i$ for all $B_n < B_i$ otherwise $W_{ni} = 0$, for each observation X_{ni} with expectation E_{ni},

$$c_i \approx \Sigma(W_{ni}\, m_i\, (X_{ni} - E_{ni})) / \Sigma(W_{ni}\, (m_i - E_{ni}))$$

Similarly, for d_i, the upper asymptote,

$$d_i \approx \Sigma(W_{ni}\, m_i\, X_{ni}) / \Sigma(W_{ni}\, E_{ni})) \text{ for } B_{ni}>B(E_{ni}=m_i-0.5)$$

The lower asymptote is the lower of c_i or the item p-value. The upper asymptote is the higher of d_i or the item p-value. If the data are sparse in the asymptotic region, the estimates may not be good. This is a known problem in 3-PL estimation, leading many analysts to impute, rather than estimate, asymptotic values.

Birnbaum A. (1968) Some latent trait models and their uses in inferring an examinee's ability. In F.M. Lord & M.R. Novick, Statistical theories of mental test scores (pp. 395-479). Reading, MA: Addison-Wesley.
Barton M.A. & Lord F.M. (1981) An upper asymptote for the three-parameter logistic item-response model. Princeton, N.J.: Educational Testing Service.

11.12 BATCH= Batch/script mode analysis

1. In standard mode: If you want Winsteps to close itself after performing an analysis and writing out any output specified in the control file, e.g., by TABLES=, then specify BATCH=YES in the control file. You can launch batch files from the Batch menu.

If you want to run Winsteps so that it is visible, but automatically closes then:
Winsteps.exe inputfile.txt outputfile.txt
and include the command "batch=yes" in the inputfile.txt

2. In Batch/Script mode: If you want Winsteps to run in "background" with the minimum user interaction, then specify BATCH=YES in the Shortcut, DOS or Shell command which invokes Winsteps.

If you want to run Winsteps "hidden" then call it from the MS-DOS prompt:
Winsteps.exe batch=yes inputfile.txt outputfile.txt

If you want to run many Winsteps analyses consecutively, then use BATCH=Yes. Here is an example using Winsteps to simulate multiple datasets and analyze them.

Running Winsteps in Batch mode: *If this won't work for you, see **Difficulty** below.*

In most versions of Windows, .bat and .cmd function in the same way.

Please use whatever works in your version of Windows. First, test what works on your computer:

Create a simple text file on your Desktop with Notepad
contents are:

```
START /WAIT NOTEPAD
START /WAIT NOTEPAD
```

Name it "test.bat"

Double-click on it. Does Notepad launch? Close Notepad. Does another Notepad launch. If so, all is OK. Use a .bat batch file with START

If not, rename "test.bat" to "test.cmd".
Double-click on it. Does Notepad launch? Close Notepad. Does another Notepad launch. If so, all is OK. Use a .cmd batch file with START

If not,
rename "test.cmd" to "test.bat"
change the contents of "test.bat" to

NOTEPAD
NOTEPAD

Double-click on it. Does Notepad launch? Close Notepad. Does another Notepad launch. If so, all is OK. Use a .bat batch file without START.

If none of these work for you, then your version of Windows may not support batch files. Please contact www.winsteps.com.

Example: Blanks act like new lines in a control file. Commas act like blanks:

```
START /WAIT ..\Winsteps BATCH=YES SF.txt SF.OUT TFILE=* 1 *  PERSON=CASE IDELETE=3,4,24
```

It is often useful to run multiple Winsteps tasks, one after the other, without keyboard intervention. This can be accomplished by running Winsteps in **CMD batch mode**.

i) On the main Winsteps screen, click on the "Batch" menu item.
ii) On the pull-down menu, select "Edit batch file".
iii) In the dialog box, select **Winbatchcmd.cmd** and click on "Open"
iv) The following batch file is available to edit:

```
echo  This is the version for Windows-NT, 2000
echo  This is a batch file to run Winsteps in batch mode
echo  Edit the next lines and add more.
echo  Format of lines is:
echo  START /WAIT c:\Winsteps\Winsteps BATCH=YES c:\folder\Control-file c:\folder\Output-file
Extra=specifications
START /WAIT ..\Winsteps BATCH=YES EXAMPLE0.txt EXAMPLE0.OUT TABLES=111
START /WAIT ..\Winsteps BATCH=YES SF.txt SF.OUT TFILE=* 1 *  PERSON=CASE
START /WAIT ..\Winsteps BATCH=YES KCT.txt KCT.OUT TFILE=* 3 20 * MRANGE=4
```

These characters have special meanings in batch files: **@ & ^ ( )**

v) The lines starting with "echo" are comments.
v) Lines starting "`START /WAIT c:\Winsteps\Winsteps BATCH=YES`" execute Winsteps from the Winsteps folder
vi) The format is `START /WAIT Winsteps BATCH=YES control-file output-file extra-specifications`
vii) Each new Winsteps line is an additional run of the Winsteps program
viii) Edit and save this file. You can save it with any name ending ".cmd"

ix) From the "Batch" pull-down menu, select "Run batch file".
x) Right-click on the desired batch file
xi) **In the right-click menu, left-click on "open"**
x) The batch file will run - if nothing happens, the batch file is incorrect.
xi) Exit from the Winsteps dialog by clicking on "Cancel".
xii) You can minimize the batch screen by clicking on the underline in the top right corner.
xiii) You can cancel the batch run by right clicking on the Batch icon in the Task bar, usually at the bottom of the screen.

Example: I want to automatically run multiple DIF reports for the same set of data.
Since Winsteps can only perform one DIF analysis at a time in batch mode, you can use anchor files:
First line in batch file, produce measure files

```
Winsteps BATCH=YES infile outfile dif=$s1w1 ifile=ifile.txt pfile=pfile.txt sfile=sfile.txt
```

Later lines in batch file, use measure files as anchor files

```
Winsteps BATCH=YES infile outfile2 dif=$s2w1 ifile=iafile.txt pfile=pafile.txt safile=sfile.txt
tfile=* 30 *
Winsteps BATCH=YES infile outfile3 dif=$s3w1 ifile=iafile.txt pfile=pafile.txt safile=sfile.txt
tfile=* 30 *
```

A Winsteps batch processor for Windows

Batch files under Windows are used to test out new features in Winsteps. Here is what is done:

a) Create a new subfolder of c:\Winsteps, called c:\Winsteps\test

b) Copy into folder "test" all the control and data files to be analyzed. For instance all the Winsteps example control and data files, which are found in c:\Winsteps\examples

c) Use Notepad to create a file in c:\Winsteps\test to do the analysis. This file is "saved as" test.bat
This file contains, for instance:

```
start /w c:\Winsteps\Winsteps batch=yes exam1.txt exam1.out DISC=YES TABLES=111
start /w c:\Winsteps\Winsteps batch=yes exam9.txt exam9.out DISC=YES TABLES=111
start /w c:\Winsteps\Winsteps batch=yes sf.txt sf.out DISC=YES TABLES=111
```

You can replace ..\Winsteps with the pathname to your copy of Winsteps.exe
d) double-click on test.bat in c:\Winsteps\test to run this batch file.
e) Winsteps "flashes" on the task bar several times, and progress through the batch file is shown in a DOS-style window.
e) the .out files are written into c:\Winsteps\test

Example 1. Windows file: test.cmd to do 10 analyses from the same control and data files

rem - change the directory to the control and data files
```
chdir c:\Winsteps\examples
chdir
echo check that the change directory worked
pause
START /Wait c:\Winsteps\Winsteps.exe exam1.txt SCReadDIFg2.out.txt pselect=$2*
Title=READING_DIF_grade_2
echo check that Winsteps was called as expected: add BATCH=Y to the line above when it works
correctly
pause
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam1.txt exam1g3.out.txt pselect=$3*
Title=READING_DIF_grade_3
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam1.txt exam1g4.out.txt pselect=$4*
Title=READING_DIF_grade_4
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam1.txt exam1g5.out.txt pselect=$5*
Title=READING_DIF_grade_5
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam1.txt exam1g6.out.txt pselect=$6*
Title=READING_DIF_grade_6
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam1.txt exam1g7.out.txt pselect=$7*
Title=READING_DIF_grade_7
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam1.txt exam1g8.out.txt pselect=$8*
Title=READING_DIF_grade_8
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam1.txt exam1g10.out.txt pselect=$10*
Title=READING_DIF_grade_10
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam2.txt exam2g2.out.txt pselect=$2*
Title=MATH_DIF_grade_2
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam2.txt exam2g3.out.txt pselect=$3*
Title=MATH_DIF_grade_3
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam2.txt exam2g4.out.txt pselect=$4*
Title=MATH_DIF_grade_4
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam2.txt exam2g5.out.txt pselect=$5*
Title=MATH_DIF_grade_5
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam2.txt exam2g6.out.txt pselect=$6*
Title=MATH_DIF_grade_6
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam2.txt exam2g7.out.txt pselect=$7*
Title=MATH_DIF_grade_7
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam2.txt exam2g8.out.txt pselect=$8*
Title=MATH_DIF_grade_8
```

```
START /Wait c:\Winsteps\Winsteps.exe BATCH=Y exam2.txt exam2g10.out.txt pselect=$10*
Title=MATH_DIF_grade_10
```

If you want to combine all the output files into one file:

```
copy /Y *.out.txt all.txt
```

Example 2. To estimate the expected values of the eigenvalues in Table 23.0 by simulation
Your files are in folder: D:\rasch_simulation
Winsteps.exe is in folder C:\Winsteps
The output is Table 23.0
The batch file is:

```
D:
MKDIR \rasch_simulation
CD \rasch_simulation
REM
START /WAIT C:\Winsteps\winsteps.exe BATCH=YES marlon0.txt marlon0.out.txt PFILE=pf.txt IFILE=if.txt SFILE=sf.txt
REM
set /a test=1
:loop
REM
START /WAIT C:\Winsteps\winsteps.exe BATCH=YES marlon0.txt marlon0%loop%.out.txt PAFILE=pf.txt IAFILE=if.txt SAFILE=sf.txt
SIFILE=SIFILE%test%.txt SISEED=0
REM
START /WAIT C:\Winsteps\winsteps.exe BATCH=YES marlon0.txt data=SIFILE%test%.txt SIFILE%test%.out.txt TFILE=* 23.0 *
REM
set /a test=%test%+1
if not "%test%"=="11" goto loop
PAUSE
```

Performing multiple simulations in Batch mode

1. Use NotePad to create a text file called "Simulate.bat"
2. In this file:

```
REM - produce the generating values: this example uses example0.txt:
START /WAIT c:\Winsteps\Winsteps.exe BATCH=YES  example0.txt example0.out.txt PFILE=pf.txt
   IFILE=if.txt SFILE=sf.txt

REM - simulate 101 datasets - use anchor values to speed up processing
START /WAIT c:\Winsteps\Winsteps.exe  BATCH=YES example0.txt example0%test%.out.txt
   PAFILE=pf.txt IAFILE=if.txt SAFILE=sf.txt SIFILE=SIFILE.txt SISEED=0 SINUMBER=101

REM - initialize the loop counter: go from 2 to 101 for numbered SIFILE2.txt to SIFILE101.txt
set /a test=2
:loop

REM - estimate from the simulated dataset
START /WAIT c:\Winsteps\Winsteps.exe BATCH=YES example0.txt data=SIFILE%test%.txt SIFILE%test
   %.out.txt pfile=pf%test%.txt ifile=if%test%.txt sfile=sf%test%.txt TFILE=* 3.1 *
REM - do 100 times
set /a test=%test%+1
if not "%test%"=="102" goto loop
PAUSE
```

3. Save "Simulate.bat", then double-click on it to launch it.
4. The simulate files and their estimates are numbered 1 to 100.

5. The files of estimates can be combined and sorted using MS-DOS commands, e.g.,
Copy SIFILE*.out.txt combined.txt

Rem Sort brings similar lines together
Sort /+(sort column) <combined.txt >sorted.txt

```
Rem Find extracts lines with specific words
Find "CRONBACH ALPHA" <combined.txt  >found.txt
```

6. Individual lines from the output files can be written to one file using MS-DOS batch commands. For instance, using an MS-DOS batch routine (.bat or .cmd), the same text line can be extracted from many text files and output into a new text file. The new text file can be be pasted into Excel. Save these MS-DOS commands as *extract.bat* in the folder that has the files of statistics. Double click on *extract.bat* to execute it.

```
rem replace 2 with the number of lines to skip before the line you want
@echo off
setlocal EnableDelayedExpansion
if exist result.csv del result.csv
for %%f in (*.txt) do (
  echo %%f
  set i=a
  for /F "skip=2 delims=" %%l in (%%f) do (
    if "!i!" == "a" echo %%f, %%l >> result.csv
    set i=b
  )
)
notepad result.csv
```

Example: to verify degrees of freedom for global statistics in Table 44:

```
REM - produce the generating values: this example uses example0.txt:
START /WAIT c:\Winsteps\Winsteps.exe BATCH=YES  example0.txt example0.out.txt PFILE=pf.txt IFILE=if.txt SFILE=sf.txt
tfile=* 44 *

REM - initialize the loop counter
set /a test=1
:loop

REM - simulate a dataset - use anchor values to speed up processing (or use SINUMBER= to avoid this step)
START /WAIT c:\Winsteps\Winsteps.exe  BATCH=YES example0.txt example0%test%.out.txt PAFILE=pf.txt IAFILE=if.txt
SAFILE=sf.txt SIFILE=SIFILE%test%.txt SISEED=0

REM - estimate from the simulated dataset
START /WAIT c:\Winsteps\Winsteps.exe BATCH=YES example0.txt data=SIFILE%test%.txt SIFILE%test%.out.txt pfile=pf
%test%.txt ifile=if%test%.txt sfile=sf%test%.txt TFILE=* 44 *
REM - do 100 times
set /a test=%test%+1
if not "%test%"=="101" goto loop
PAUSE
REM combine all the output files
Copy SIFILE*.out.txt combinedif.txt
REM sort the output files together
Sort /+1 <combinedif.txt  >sortedif.txt
REM copy-and-paste the Log-Likelihood lines into Excel to average them and compare with d.f. in the original Table 44.
```

Difficulty running Batch or Command files?

Microsoft Windows is designed to run interactively, not in batch mode. Microsoft are not consistent with the way they implement batch files in different versions of Windows. So our challenge is to discover a method of running batch files that works for the version of Windows we happen to have. Since Windows is very bad at running batch or command files. You need to validate your instructions one step at a time:

First make sure that your batch file runs *without* "BATCH=YES" so that you can see Winsteps in operation.

Paths with blanks? Put in quotes:

```
START /WAIT "e:\my folder\Winsteps folder\Winsteps.exe" BATCH=YES ....
```

i) Run Winsteps in standard mode from the DOS command prompt.

ii) Have the full paths to everything in your batch or command file, e.g., called mybatch.cmd,
START /WAIT c:\Winsteps\Winsteps BATCH=YES c:\Winsteps\examples\example0.txt c:\Winsteps\examples\example0.out.txt
also have full paths to everything in your Winsteps control file, e.g.,
DATA = c:\Winsteps\examples\mydata.txt

Note: In this Batch command:
START /WAIT c:\Winsteps\Winsteps BATCH=YES c:\Winsteps\examples\controlfile.txt outputfile.txt
file "outputfile.txt" will be placed in directory "c:\Winsteps\examples\"

iii) Windows "Start" menu. "Run". Copy and paste the following line into the Windows Run box on the Windows Start menu. Click OK:
c:\Winsteps\Winsteps c:\Winsteps\examples\example0.txt c:\Winsteps\examples\example0.out.txt table=1

Does Winsteps start in the ordinary way? This tests the Windows command line interface.

iv) Windows "Start" menu. "Run". Copy and paste the following line into the Run box. Click OK:
c:\Winsteps\Winsteps BATCH=YES c:\Winsteps\examples\exam15.txt c:\Winsteps\examples\exam15.out.txt table=1

Does the Winsteps icon appear on the Task bar and then disappear? This tests Winsteps background processing.

v) On your desktop, right-click, "New", "Text document". Double-click on icon. Paste in:
START /WAIT c:\Winsteps\Winsteps c:\Winsteps\examples\example0.txt c:\Winsteps\examples\example0.out.txt table=1

"Save as" Test.cmd. Double-click on Test.cmd

Does Winsteps run in the ordinary way? This test the Windows START function. If this fails, "Save as" Test.bat instead of Test.cmd.

vi) On your desktop, right-click, "New", "Text document". Double-click on icon. Paste in:
START /WAIT c:\Winsteps\Winsteps BATCH=YES c:\Winsteps\examples\exam15.txt c:\Winsteps\examples\exam15.out.txt table=1

"Save as" Test2.cmd. Double-click on Test2.cmd (or "Save as" Test2.bat if that works better on your computer.)

Does the Winsteps icon flash on the task bar line, and then disappear? Winsteps has run in background.

vii) Now build your own .cmd batch file, using lines like:
START /WAIT c:\Winsteps\Winsteps BATCH=YES c:\Winsteps\examples\example0.txt c:\Winsteps\examples\example0.out.txt

viii) If your command line contains sub-lists, indicate those with commas, e.g.,
IWEIGHT=* 23,2.5 47,1.3 *

Running Winsteps within other Software

Automating the standard version of Winsteps is straightforward using the control instruction BATCH=YES. Winsteps will run under Windows in background.

Let's assume your software is written in Visual Basic (or any other programming, database or statistical language)

(a) write out a Winsteps control file as a .txt file
(b) write out a Winsteps data file as a .txt file
(c) "shell" out to
"START /WAIT Winsteps BATCH=YES controlfile.txt outputfile.txt data=datafile.txt ifile=ifile.txt pfile=pfile.txt"

(d) read in the ifile.txt, pfile.txt or whatever Winsteps output you need to process.

This is being done routinely by users of SAS.

Running Winsteps within R

Use the R "system" command. To test that Winsteps runs correctly, specify:

try(system("c:/Winsteps/Winsteps.exe BATCH=NO yourcontrolfile youroutputfile", intern = TRUE, ignore.stderr = TRUE))

or, if the file names contain spaces, then use single quotes and double quotes:

try(system('c:/Winsteps/Winsteps.exe BATCH=NO "your control file" "your output file" ', intern = TRUE, ignore.stderr = TRUE))

For regular use:

try(system("START /WAIT c:/Winsteps/Winsteps.exe BATCH=YES yourcontrolfile youroutputfile", intern = TRUE, ignore.stderr = TRUE))

or

try(system('START /WAIT c:/Winsteps/Winsteps.exe BATCH=YES "your control file" "your output file" ', intern = TRUE, ignore.stderr = TRUE))

or

shell("c:/Winsteps/winsteps.exe control.txt output.txt")
this automatically waits for Winsteps to complete before returning to an R prompt

See also r2Winsteps

11.13 BOXSHOW= draw boxes around Output Tables

Output Tables can be output with or without box borders. Here is an example with Table 13. Excel "Data", "Text to columns" is easier with BOXSHOW=No.

BOXSHOW= Yes

```
-------------------------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL           MODEL|   INFIT  |  OUTFIT  |PT-MEASURE |EXACT MATCH|             |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%| TAP         |
|------------------------------------+----------+----------+-----------+-----------+-------------|
|    18      0     35     6.13   1.84|      MAXIMUM MEASURE|  .00   .00|100.0 100.0| 4-1-3-4-2-1-4|
|    15      1     35     4.80   1.07| .74   -.1| .11   -.6|  .32   .24| 97.1  97.0| 1-3-2-4-1-3  |
|    16      1     35     4.80   1.07| .74   -.1| .11   -.6|  .32   .24| 97.1  97.0| 1-4-2-3-1-4  |
|    17      1     35     4.80   1.07| .74   -.1| .11   -.6|  .32   .24| 97.1  97.0| 1-4-3-1-2-4  |
|    14      3     35     3.37    .70|1.56   1.2|1.49    .8|  .22   .38| 85.3  92.0| 1-4-2-3-4-1  |
```

BOXSHOW= No

```
 ENTRY   TOTAL  TOTAL           MODEL    INFIT      OUTFIT    PT-MEASURE  EXACT MATCH
 NUMBER  SCORE  COUNT  MEASURE  S.E.  MNSQ  ZSTD MNSQ  ZSTD CORR.  EXP.  OBS%  EXP%  TAP

     18      0     35     6.13   1.84       MAXIMUM MEASURE   .00   .00 100.0 100.0  4-1-3-4-2-1-4
     15      1     35     4.80   1.07  .74   -.1  .11   -.6   .32   .24  97.1  97.0  1-3-2-4-1-3
     16      1     35     4.80   1.07  .74   -.1  .11   -.6   .32   .24  97.1  97.0  1-4-2-3-1-4
     17      1     35     4.80   1.07  .74   -.1  .11   -.6   .32   .24  97.1  97.0  1-4-3-1-2-4
     14      3     35     3.37    .70 1.56   1.2 1.49    .8   .22   .38  85.3  92.0  1-4-2-3-4-1
```

BOXSHOW= No and HEADER=No

```
18       0       35      6.13      1.84        MAXIMUM MEASURE    .00     .00 100.0 100.0  4-1-3-4-2-1-4
15       1       35      4.80      1.07  .74    -.1   .11    -.6   .32     .24  97.1  97.0  1-3-2-4-1-3
16       1       35      4.80      1.07  .74    -.1   .11    -.6   .32     .24  97.1  97.0  1-4-2-3-1-4
17       1       35      4.80      1.07  .74    -.1   .11    -.6   .32     .24  97.1  97.0  1-4-3-1-2-4
14       3       35      3.37       .70 1.56    1.2 1.49     .8   .22     .38  85.3  92.0  1-4-2-3-4-1
```

*Example with **Excel**:*

1. In your Winsteps control file, or in the "Specification" menu dialog box:
   BOXSHOW=NO
2. Output the Winsteps Table
3. Copy and paste the relevant lines from your Winsteps Output Table into an Excel worksheet
4. In Excel, "Data", "Text to columns"
5. Excel: Delimited with spaces, or Fixed Width
6. Excel: Click to add or remove field separators
7. Using the Table above, in Excel:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	NUMBER	SCORE	COUNT	MEASURE	S.E. MNS	ZSTD	MNSQ	ZSTD	CORR.	EXP.	OBS%	EXP%	TAP	
2														
3	18	0	35	6.13	1.84	MAXI	MUM M	EASURE	0	0	100	100	4-1-3-4-2-1-4	
4	15	1	35	4.8	1.07 .74	-0.1	0.11	-0.6	0.32	0.24	97.1	97	1-3-2-4-1-3	
5	16	1	35	4.8	1.07 .74	-0.1	0.11	-0.6	0.32	0.24	97.1	97	1-4-2-3-1-4	
6	17	1	35	4.8	1.07 .74	-0.1	0.11	-0.6	0.32	0.24	97.1	97	1-4-3-1-2-4	
7	14	3	35	3.37	.70 1.56	1.2	1.49	0.8	0.22	0.38	85.3	92	1-4-2-3-4-1	

11.14 BYITEM= display graphs for items

In the bit-mapped graphs produced by the Graphs pull-down menu, the empirical item characteristic curves can be produced at the grouping level or the item level. When ISGROUPS=0, the item-level and grouping-level curves are the same.

BYITEM = Yes show empirical curves at the item level.

BYITEM = No show empirical curves at the grouping level.

11.15 CATREF= reference category for Table 2

If a particular category corresponds to a criterion level of performance, choose that category for CATREF=.

Table 2, "most probable responses/scores", maps the items vertically and the most probable responses, expected scores, and Rasch-Thurstonian thresholds (50% cumulative probabilities) horizontally. Generally, the vertical ordering is item difficulty measure. If, instead, a particular category is to be used as the reference for sorting, give its value as scored and recoded.

Special uses of CATREF= are:
CATREF=-3 for item entry order
CATREF=-2 for item measure order
CATREF=-1 for items measure order with ISGROUPS=
CATREF=0 for item measure order
CATREF=1 ... 32767 for item measure order based on this category.

Example 1: You have 4-point partial-credit items, entered in your data as A,B,C,D, and then scored as 1,2,3,4. You wish to list them based on the challenge of category C, rescored as 3,

```
CODES =ABCD  ; original responses
NEWSCORE=1234 ; rescored values
RESCORE=2  ; rescore all

CATREF=3  ; Table 2 reference category
ISGROUPS=0  ; partial credit: one item per grouping
```

If, for an item, the category value "3" is eliminated from the analysis or is the bottom category, the nearest higher category is used for that item.

Example 2: You have 6 3-category items in Grouping 1, and 8 4-category items in Grouping 2. You wish to list them in Table 2.2 by measure within grouping, and then by measure overall.

```
CODES=1234
NI= 14
ISGROUPS= 11111122222222
TFILE=*
2.2 0 0 0 -1  -1 ; means CATREF=-1
2.2 0 0 0 0  ; last 0 means CATREF=0
*
```

11.16 CFILE= scored category label file

Rating (or partial credit) scale output is easier to understand when the categories are shown with their substantive meanings. Use CFILE= to label categories using their scored values, i.e., after rescoring. Use CLFILE= to label categories using their original codes, i.e., before any rescoring.

Labels for categories, after they have been scored, can be specified using CFILE= and a file name, or CFILE=* and placing the labels in the control file. Each category number is listed (one per line), followed by its descriptive label. If the observations have been rescored (NEWSCORE=) or keyed (KEYn=), then use the recoded category value in the CFILE= specification. When there are different category labels for different ISGROUPS= of items, specify an example item from the grouping, followed immediately by "+" and the category number. Blanks or commas can be used a separators between category numbers and labels.

CFILE= file name	file containing details
CFILE = *	in-line list
CFILE = ?	opens a Browser window to find the file

Example 1: Identify the three LFS categories, 0=Dislike, 1=Don't know, 2=Like.

```
CODES=012
CFILE=*
0 Dislike
1 Don't know
2 Like
*
```

The labels are shown in Table 3.2 as:

```
-------------------------------------------------------
 CATEGORY OBSERVED AVGE  INFIT OUTFIT  STRUCTURE
  LABEL    COUNT   MEASURE MNSQ  MNSQ  MEASURE
-------------------------------------------------------
    0        378     -.87  1.08  1.19   NONE      Dislike
    1        620      .13   .85   .69     -.85    Don't know
    2        852     2.23  1.00  1.46      .85    Like
-------------------------------------------------------
```

Example 2: Items 1-10 (Grouping 1) are "Strong Disagree, Disagree, Agree, Strongly Agree". Items 11-20 (Grouping 2) are "Never, Sometimes, Often, Always".

```
NI=20
CODES=1234
ISGROUPS=11111111112222222222
CFILE=*
7+1 Strongly Disagree ; We could use any item number in Grouping 1, i.e., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
7+2 Disagree  ; item 7 has been chosen
7+3 Agree
7+4 Strong Agree
13+1 Never  ; We could use any item number in Grouping 2, i.e., 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
13+2 Sometimes ; item 13 has been chosen
13+3 Often
13+4 Always
```

*

Example 3: To enter CFILE= information on the DOS Prompt or Extra Specifications lines, using commas instead of blanks as separators:
C:>Winsteps SF.TXT SFO.TXT CFILE=* 1,Dislike 2,Don't-know 3,Like *

Example 4: Some items have one rating scale definition, but most items have another rating scale definition. But each item is calibrated with its own structure: ISGROUPS=0
NI=20
CODES=1234
ISGROUPS=0
CFILE=*
1 Strongly Disagree This scale is used by most items
2 Disagree
3 Agree
4 Strong Agree
16+1 Never 16 is one item using the other scale
16+2 Sometimes
16+3 Often
16+4 Always
17+1 Never 17 is another item using the other scale
17+2 Sometimes
17+3 Often
17+4 Always
.... for all the other items using the other scale
*

Example 5: Several categories are collapsed into one category. The original codes are A-H. After rescoring there is only a dichotomy: 0, 1.
NI=30
CODES =ABCDEFGH
NEWSCORE=00011110
CFILE=*
0 Fail Specify the categories as recoded
1 Pass
*

11.17 CHART= graphical plots in Tables 10, 13-15

The measures and fit statistics in the Tables can be displayed as graphical plots in subtables 6.2, 10.2, 13.2, 14.2, 15.2, 17.2, 18.2, 19.2, 25.2, 26.2.

CHART=N Omit the graphical plots.

CHART=Y Include graphical plots

```
         PUPIL FIT GRAPH:  OUTFIT ORDER
+----------------------------------------------------------------------------------+
|ENTRY| MEASURE |  INFIT MEAN-SQUARE  | OUTFIT MEAN-SQUARE  |                      |
|NUMBR| -      + |0      0.7 1 1.3    2|0      0.7 1 1.3    2| PUPIL                |
|-----+---------+---------------------+---------------------+----------------------|
|   72|*        |        :  .  :     * |A       :  .  :     *| JACKSON, SOLOMON     |
|   47|  *      |        :  . *:       |J       :  .  :   *  | VAN DAM, ANDY        |
|   53|*        |        : *.  :       |K       :  .  :     * | SABOL, ANDREW        |
|   32|  *      |       *:  .  :       |w       *  .  :      | ROSSNER, JACK        |
|   21|  *      |  *     :  .  :       |a *     :  .  :      | EISEN, NORM L.       |
+----------------------------------------------------------------------------------+
```

The fit information is shown in graphical format to aid the eye in identifying patterns and outliers. The fit bars are positioned by FITLOW= and FITHIGH=. They may also be repositioned using TFILE=.

11.18 CHISQUARE= in IFILE= and PFILE=

	In IFILE= and PFILE=, report Infit and Outfit fit statistics as
CHISQUARE=No	Mean-square fit statistics = Chi-square statistics divided by their degrees of freedom.
CHISQUARE=Yes	Chi-square fit statistics
	The chi-square degrees of freedom are reported in IFILE=, PFILE= columns INDF and OUTDF. The two-sided chi-square probabilities are reported adjacent to the chi-squares when LOCAL=Prob More at Chi-squares, d.f., probabilities and Mean-squares

Computation: Winsteps and Facets usually report mean-square statistics. These are chi-squares divided by their degrees of freedom. Now the chi-squares and their d.f. are also reported. For the computation of the mean-squares and d.f., see www.rasch.org/rmt/rmt34e.htm together with www.rasch.org/rmt/rmt162g.htm

So that $q_i^2 = 2$ / d.f.

And chi-square = mean-square * d.f.

Example:
LOCAL=Prob
CHISQUARE=Yes
IFILE=if.txt

Then, in file: if.txt:

```
;ENTRY MEASURE ST    COUNT     SCORE MODLSE IN.CHI  IN.PRO OUT.MS OUT.PR    INDF OUTDF G M R NAME
     4   -4.40  1     35.0      32.0    .81   6.77  .9809    .35  .9103   7.52  1.00 1 R . 4= 1-3-4
```

Infit Chi-square is 6.77 with 7.52 d.f., 2-sided probability = .9809

11.19 CIMPUTE= impute values for missing data

PCA Analysis is done for Table 23 and Table 24, When there are missing values in the data, there are two options:

Data type: PRCOMP=	**CIMPUTE=Yes** missing data becomes	**CIMPUTE=No**
S or Y: Standardized residuals	value: 0.00	missing data skipped
R: Raw score residuals. Yen's Q3	value: 0.00	missing data skipped
L: Logit residuals	value: 0.00	missing data skipped
O: Scored observations	missing data skipped	
K: Observation probability	missing data skipped	
H: Observation log-probability	missing data skipped	
G: Observation logit-probability	missing data skipped	

For more about PCA with missing data, see Principal component analysis of incomplete data – A simple solution to an old problem

Example: Using Exam5.txt (computer-adaptive test)

11.20 CLFILE= codes label file

Rating (or partial credit) scale output is easier to understand when the categories are shown with their substantive meanings. Use CFILE= to label categories using their scored values, i.e., after rescoring. Use CLFILE= to label categories using their original codes, i.e., before any rescoring. Labels for the original categories in the data can be specified using CLFILE= and a file name, or CLFILE=* and placing the labels in the control file. Each category number is listed (one per line), followed by its descriptive label. Original category values are used. There are several options:

CLFILE= file name	file containing details
CLFILE = *	in-line list
CLFILE = ?	opens a Browser window to find the file

Its format is:

```
CLFILE=*
item entry number + category code   category label
%item label + category code  category label
*

XWIDE=2 ;observations are two columns wide
CODES = " 0 1 299"      ; codes are 0, 1 , 2, 99
CLFILE=*
99   Strongly Agree ; original code of 99 has the label "Strongly Agree"
2  Agree  ; original code of blank+2 (or 2+blank) has the label "Agree"
2+99 Heartily Agree ; for item 2, code 99 has the label "Heartily Agree"
3+0 Disagree  ; for item 3, code 0 means "Disagree"
*
```

Example 1: Identify the three LFS categories, D=Dislike, N=Don't know, L=Like.

```
CODES      =DNL
NEWSCORE=012
CLFILE=*
D Dislike
N Neutral
L Like
*
```

The labels are shown in Table 3.2 as:

```
-------------------------------------------------------
 CATEGORY OBSERVED AVGE  INFIT OUTFIT  STRUCTURE
  LABEL    COUNT   MEASURE MNSQ  MNSQ  MEASURE
-------------------------------------------------------
    0        378     -.87  1.08  1.19   NONE     Dislike
    1        620      .13   .85   .69     -.85   Don't know
    2        852     2.23  1.00  1.46      .85   Like
-------------------------------------------------------
```

Example 2: Items 1-10 (Grouping 1) are "Strong Disagree, Disagree, Agree, Strongly Agree". Items 11-20 (Grouping 2) are "Never, Sometimes, Often, Always".

```
NI=20
CODES      =ABCD
NEWSCORE=1234
ISGROUPS=11111111112222222222
CLFILE=*
7+A Strongly Disagree ; 7 is any item in Grouping 1
7+B Disagree
7+C Agree
7+D Strong Agree
13+A Never  ; 13 is any item in Grouping 2
13+B Sometimes
13+C Often
13+D Always
*
```

Example 3: To enter CLFILE= information on the DOS Prompt or Extra Specifications lines, using commas instead of blanks as separators:

```
C:>Winsteps SF.TXT SFO.TXT  CLFILE=* D,Dislike N,Don't-know L,Like *
```

Example 4: One grouping of items has a unique response format, but the other groupings all have the same format. Here, each grouping has only one item, i.e., ISGROUPS=0

```
NI=20
CODES=1234
ISGROUPS=0
CLFILE=*
1 Strongly Disagree ; This rating scale is used by most items
2 Disagree
3 Agree
4 Strong Agree
16+1 Never  ; 16 is the one item using this rating scale
16+2 Sometimes
16+3 Often
16+4 Always
*
```

Example 5: Several categories are collapsed into one category. The original codes are A-H. After rescoring there is only a dichotomy: 0, 1.

```
NI=30
CODES = ABCDEFGH
NEWSCORE=00011110
CFILE=*
0 Fail  Specify the categories as recoded
1 Pass
*
; or
CLFILE=*
A Fail
B Fail
C Fail
D Pass
E Pass
F Pass
G Pass
H Pass
*
```

Example 6: Identifying the distractors for a multiple-choice MCQ item.

Here is item 5:

5. The shape of the relationship between raw score and measures on the latent variable is

```
CODES = abcd

CLFILE=*
5+a diatonic
5+b harmonic
5+c monotonic
5+d synchronic
*
```

Example 7: Using the item labels

```
CLFILE=*
%APMED+1 Attentive
%APMED+2 Interested
%APMED+3 Residual
%APMED+9 NOT ASKED THAT YEAR
*
```

11.21 CMATRIX= category matrix = Yes

A category matrix (confusion matrix, matching matrix) compares the observed categorization (classification) of observations with the predicted categorization (classification). One matrix is produced in Table 3.2, etc., for each rating-scale group defined in ISGROUPS=.

CMATRIX = N Do not output the category matrix.

CMATRIX = Y Output the category matrix. For interpretation, see Table 3.2

```
---------------------------------------------------------------------
| Category Matrix : Confusion Matrix : Matching Matrix              |
|             Predicted Scored-Category Frequency                   |
|Obs Cat Freq|          0           1           2 |          TOTAL |
|------------+------------------------------------+----------------|
|          0 |        .50        2.06         .44 |           3.00 |
|          1 |       2.03       20.83       12.15 |          35.00 |
|          2 |        .47       12.12       24.41 |          37.00 |
|------------+------------------------------------+----------------|
|      TOTAL |       3.00       35.00       36.99 |          75.00 |
---------------------------------------------------------------------
```

11.22 CMLE= Conditional Maximum Likelihood Estimation = No

CMLE is considered statistically superior to other estimation methods, such as JMLE, MMLE, PMLE and Minimum Chi-square. CMLE has advantages, but also practical drawbacks.

Option	Supported / Allowed	Not Supported / Not allowed
MODELS= model types	"R" (the default) - dichotomies and rating scales	CMLE analysis is not performed with "S", "F" - Success and Failure models
ISGROUPS= rating scale models	Dichotomous, Rating Scale Model, Partial Credit Model and Grouped Rating Scale Model	All = ISGROUPS= options are supported
Data structure, DATA= and EDFILE=	Complete and Incomplete (missing data) datasets (rectangles)	All Winsteps data structures supported
Anchoring: PAFILE=, IAFILE=, SAFILE=	Item anchoring IAFILE= and threshold (step) anchoring SAFILE= and person anchoring PAFILE= allowed.	
Weighting: IWEIGHT=, PWEIGHT=	Person (row) weighting with PWEIGHT= supported for item and person estimation. CMLE item and threshold estimation analysis is done ignoring IWEIGHT=, except for computing the item mean difficulty. Person estimates are made with IWEIGHT=	
Extreme scores (maximum and minimum possible)	Allowed for persons (rows)	Items with extreme scores are omitted from CMLE, but included in JMLE.
Targeting (information weighting) : TARGET=	No	Not allowed
Analysis of transposed data: TRPOFILE=	Persons become columns ("items"), and items become rows ("persons"). ISGROUPS= applies to the columns (persons), not the rows (items). *Andrich (2010)*	(supported)
Unobserved intermediate categories in a rating scale	Allowed with STKEEP=Yes. Reported as "NULL" in Table 3.2 and adjusted values in SFILE=	

Option	What happens	Notes
CMLE=Yes	CMLE estimation is performed along with JMLE estimation.	Exact CMLE is performed using the Summation algorithm (Gustafsson, 1980).
	CMLE output is displayed in the measure tables (Tables 14, 18, etc.)	CMLE WMLE controlled by WMLE=
	CMLE output is included in the measure output files, IFILE=, PFILE= SFILE=	Choose the CMLE fields to include in IFILE= and PFILE= using the IFILE=/PFILE= field selection dialog box.
	CMLE item statistics estimated from the data	item measures, standard errors, infit and outfit statistics, Warm MLE measures
	AMLE person measures are estimated from the items anchored at their CMLE measures and the data	AMLE person measures, standard errors, Warm MLE measures.
	CMLE person infit and outfit statistics,	Person fit statistics are computed from the CMLE item response probabilities, not from the AMLE person response probabilities
	CMLE Andrich thresholds for polytomous (rating scale) items	Thresholds output in SFILE= and Table3.2
	JMLE estimation and output are unchanged	
	Most of the Winsteps output continues to be based on the JMLE estimates.	*Suggestion:* from the CMLE analysis, output SFILE=, IFILE= PFILE=. These contain both JMLE and CMLE values. Remove the JMLE values and use SAFILE= etc. to anchor the step estimates at the CMLE values. Then rerun Winsteps. The fit statistics will not make sense, but the graphical output will match CMLE.
CMLE=No	CMLE estimation is not done.	There is no CMLE output.

Technical notes:
1. The "Summation algorithm" CMLE estimation accommodates missing data and ISGROUPS=, but is slow for large datasets. It loses precision with large numbers of items, usually about 200.
2. CMLE estimation builds a table of response probabilities matching the observed data. These probabilities are used to obtain:
(a) the item estimates, their standard errors, and their Warm's Weighted Maximum Likelihood estimates
(b) the item INFIT and OUTFIT statistics
(c) the person INFIT and OUTFIT statistics.
3. The CMLE item estimates (anchored) and the data are used to obtain:
(a) the person AMLE (Anchored Maximum Likelihood Estimates) and their standard errors.
(b) AMLE response probabilities. These are not used because they are biased relative to the CMLE response probabilities.
4. CMLE estimates are "consistent" and "unbiased' under most conditions. AMLE estimates are slightly biased. Absolute distances between person and item estimates change slightly when the dataset is transposed. (They are not changed under transposition with JMLE).

Andrich, D. (2010) Sufficiency and conditional estimation of person parameters in the polytomous Rasch model. Psychometrika. 75, 2, 292–308.

Gustafsson, J.-E. (1980). A solution of the conditional estimation problem for long tests in the Rasch model for dichotomous items. Educational and Psychological Measurement, 40(2), 377–385.

11.23 CODERANGE = numerical range of data codes

Says what characters to recognize as valid codes in your data file, together with CODES=. Characters in your data not included in CODES= or CODERANGE= are given the MISSCORE= value. The highest category number 32767. CODERANGE= can be up to 4,000 characters long. If CODES= and CODERANGE= are both specified, then the data are matched to CODES= first. CODES= can be rescored. CODERANGE= cannot be rescored or keyed. Do **not** use CODERANGE= with KEY=, IVALUE=

CODERANGE= lowest category number - highest category number	lowest and highest category numbers are in the range 0-32767. Highest number must be higher or equal to lowest number

Examples from CODES= rewritten for CODERANGE=.

Example 1: A test has four response choices. These are "1", "2", "3", and "4". All other codes in the data file are to be treated as "item not administered". Each response uses 1 column in your data file. Data look like: **134212342132.3212343221**

```
XWIDE=1  one character wide (the standard)
CODERANGE=1-4
```

Example 2: There are four response choices. Each response takes up 2 columns in your data file and has leading 0's, so the codes are "01", "02", "03" and "04". Data look like: 0302040103020104040301

```
XWIDE=2  two characters wide
CODERANGE=1-4  ; 01 is 1, 02 is 2, 03 is 3, 04 is 4.
```

Example 3: There are four response choices entered on the file with leading blanks, so that codes are " 1", " 2", " 3", and " 4". Data look like: 3 2 4 2 1 3 2

```
XWIDE=2  two characters wide
CODERANGE=1-4  ; 1 is 1, 2 is 2, 3 is 3, 4 is 4.
```

Example 4: Your data is a mixture of both leading blanks and leading 0's in the code field, e.g. "01", " 1", " 2", "02" etc. The numerical value of a response is calculated, where possible, so that both "01" and " 1" are analyzed as 1.
Data look like: **02 1 20102 1 2 01**

```
XWIDE=2  two characters wide
CODERANGE=1-4
```

Example 5: Your valid data are 1,2,3,4,5 and your missing data codes are 7,8,9 which you want reported separately on the distractor tables.

```
CODES = 789
NEWSCORE = XXX ; missing values scored with non-numeric values
CODERANGE= 1-5 ; data matched to CODERANGE= cannot be rescored
```

Example 6-8 must use CODES= (non-numeric codes)

Example 9: The valid responses are percentages in the range 00 to 99.

```
 XWIDE = 2  two columns each percent
 CODERANGE= 0-99
also recommended:
 ISRANGE = *
 1 0 99 ; defines the full range of the rating scale, regardless of the data
 *
 SFUNCTION=4 ; defines a smooth function for the Rasch-Andrich thresholds
```

Example 10: Codes are in the range 0-254.

```
XWIDE=3 ; 3 characters per response:
```

```
 CODERANGE= 0-254
also recommended:
 ISRANGE = *
 1 0 254 ; defines the full range of the rating scale, regardless of the data
 *
 SFUNCTION=4 ; defines a smooth function for the Rasch-Andrich thresholds
```

Example 11 must use CODES= (numeric codes are rescored)

Example 12: Codes in the range 0 - 1000.

```
 XWIDE=4 ; 4 characters per response
 CODERANGE= 0-1000
also recommended:
 ISRANGE = *
 1 0 1000 ; defines the full range of the rating scale, regardless of the data
 *
 SFUNCTION=4 ; defines a smooth function for the Rasch-Andrich thresholds
```

11.24 CODES= valid data codes

Says what characters to recognize as valid codes in your data file, together with CODERANGE=. If XWIDE=1 (the standard), use one column/character per legitimate code. If XWIDE=2, use two columns/characters per valid code. Characters in your data not included in CODES= or CODERANGE= are given the MISSCORE= value. The highest category number 32767. CODES= can be up to 4,000 characters long. If CODES= and CODERANGE= are both specified, then the data are matched to CODES= first. CODES= can be rescored. CODERANGE= cannot be rescored.

Initially, Winsteps assumes that all items share the same response structure.
If there are 2 response codes in CODES=, then this is the Rasch dichotomous model
If there are 3 or more response codes in CODES=, then this the Andrich rating-scale model.
To override those,
If ISGROUPS=0, then this is the Masters partial-credit model. Each item is modeled to have its own rating-scale structure.
If ISGROUPS = AABBACDDCAADEEA, then the items are grouped to share rating scales.
The "A" group are items 1,2,5, 10,11,15 - they share the same rating scale.
The "B" group are items 3,4 - they share the same rating scale.
The "C" group ....

See also these Examples written with CODERANGE=

Example 1: A test has four response choices. These are "1", "2", "3", and "4". All other codes in the data file are to be treated as "item not administered". Each response uses 1 column in your data file. Data look like: `134212342132.3212343221`

```
   XWIDE=1  one character wide (the standard)
   CODES=1234 four valid 1-character response codes
```

Example 2: There are four response choices. Each response takes up 2 columns in your data file and has leading 0's, so the codes are "01", "02", "03" and "04". Data look like: 0302040103020104040301

```
   XWIDE=2  two characters wide
   CODES=01020304 four valid 2-character response codes
```

Example 3: There are four response choices entered on the file with leading blanks, so that codes are " 1", " 2", " 3", and " 4". Data look like: 3 2 4 2 1 3 2

```
      XWIDE=2  two characters wide
      CODES=" 1 2 3 4" " required: blanks in 2-character responses
```

Note: when XWIDE=2 or more, both CODES= and the data value are left-aligned before matching, so both " 1" and "1 " in CODES= match both " 1" and "1 "in your data file.

Example 4: Your data is a mixture of both leading blanks and leading 0's in the code field, e.g. "01", " 1", " 2", "02" etc. The numerical value of a response is calculated, where possible, so that both "01" and " 1" are analyzed as 1.
Data look like: `02 1 20102 1 2 01`

```
      XWIDE=2  two characters wide
      CODES=" 1 2 3 401020304" two characters per response
```

Example 5: Your valid data are 1,2,3,4,5 and your missing data codes are 7,8,9 which you want reported separately on the distractor tables.

```
 CODES = 12345789
 NEWSCORE = 12345XXX ; missing values scored with non-numeric values
```

Example 6: The valid responses to an attitude survey are "a", "b", "c" and "d". These responses are to be recoded "1", "2", "3" and "4". Data look like: adbdabcd

```
 CODES   =abcd four valid response codes
 NEWSCORE=1234 new values for codes
 RESCORE=2  rescore all items
```

Typically, "abcd" data implies a multiple choice test. Then KEY1= is used to specify the correct response. But, in this example, "abcd" always mean "1234", so that the RESCORE= and NEWSCORE= options are easier to use.

Example 7: Five items of 1-character width, "abcd", then ten items of 2-character width "AA", "BB", "CC", "DD". These are preceded by person-id of 30 characters. Data look like:
George Washington Carver III dabcdBBAACCAADDBBCCDDBBAA

```
 FORMAT=(30A1,5A1,10A2) Name 30 characters, 5 1-chars, 10 2-chars
 XWIDE =2   all converted to 2 columns
 CODES ="a b c d AABBCCDD" "a" becomes "a "
 NEWSCORE="1 2 3 4 1 2 3 4 " response values
 RES EDFILE= edit data file CORE=2   rescore all items
 NAME1=1   name starts column 1 of reformatted record
 ITEM1=31   items start in column 31
 NI=15   15 items, all XWIDE=2
```

Example 8: Items are to rescored according to Type A and Type B. Other items to keep original scoring.

```
 IREFER = AAAAAAAABBBBBBBBCCCCCCC ; 3 item types
 CODES   = 1234 Original codes in the data file
 IVALUEA = 1223 Recode Type A items
 IVALUEB = 1123 Recode Type B items
 IVALUEC = 1234 Recode Type * item. Can be omitted
```

Example 9: The valid responses are percentages in the range 00 to 99.

```
 XWIDE = 2  two columns each percent
 ; for data with leading zeroes,
 CODES = 0001020304050607080910111213141516171819+
  +2021222324252627282930313233343536373839+
  +4041424344454647484950515253545556575859+
  +6061626364656667686970717273747576777879+
  +8081828384858687888990919293949596979899
or, for data with blanks,
 CODES =" 0 1 2 3 4 5 6 7 8 910111213141516171819+
  +2021222324252627282930313233343536373839+
  +4041424344454647484950515253545556575859+
  +6061626364656667686970717273747576777879+
  +8081828384858687888990919293949596979899"

also recommended:
 ISRANGE = *
 1 0 99 ; defines the full range of the rating scale, regardless of the data
 *
 SFUNCTION=4 ; defines a smooth function for the Rasch-Andrich thresholds
```

Example 10: Codes are in the range 0-254.

```
XWIDE=3 ; 3 characters per response:
 ; for data with leading zeroes,
CODES="000001002003004005006007008009010011012013014015016017018019020021022023+
      +024025026027028029030031032033034035036037038039040041042043044045046047+
      +048049050051052053054055056057058059060061062063064065066067068069070071+
      +072073074075076077078079080081082083084085086087088089090091092093094095+
```

```
      +0960970980991001011021031041051061071081091101111121131141151161171181119+
      +1201211221231241251261271281291301311321331341351361371381391401411421143+
      +1441451461471481491501511521531541551561571581591601611621631641651661167+
      +1681691701711721731741751761771781791801811821831841851861871881891901191+
      +1921931941951961971981992002012022032042052062072082092102112122132142215+
      +2162172182192202212222232242252262272282292302312322332342352362372382239+
      +240241242243244245246247248249250251252253254"
;or for data with blanks
CODES="  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23+
      + 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47+
      + 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71+
      + 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95+
      + 96 97 98 991001011021031041051061071081091101111121131141151161171181119+
      +1201211221231241251261271281291301311321331341351361371381391401411421143+
      +1441451461471481491501511521531541551561571581591601611621631641651661167+
      +1681691701711721731741751761771781791801811821831841851861871881891901191+
      +1921931941951961971981992002012022032042052062072082092102112122132142215+
      +2162172182192202212222232242252262272282292302312322332342352362372382239+
      +240241242243244245246247248249250251252253254"

also recommended:
 ISRANGE = *
 1 0 254 ; defines the full range of the rating scale, regardless of the data
 *
 SFUNCTION=4 ; defines a smooth function for the Rasch-Andrich thresholds
```

Example 11: The data include negative values, -10, -9, through to positive codes 9, 10. Winsteps can only analyze data that are positive integers, so the data would need to be rescored:

```
XWIDE=3 ; each observation is 3 characters wide in the data file
; the next line is so that I can be sure that each code is 3 characters wide
;          123123123123123123123123123123123123123123123123123123123123123
CODES   ="-10-9 -8 -7 -6 -5 -4 -3 -2 -1 0  1  2  3  4  5  6  7  8  9  10 "
NEWSCORE="0  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16 17 18 19 20 "
also recommended:
 ISRANGE = *
 1 0 20 ; defines the ful range of the rating scale, regardless of the data
 *
 SFUNCTION=4 ; defines a smooth function for the Rasch-Andrich thresholds
```

Example 12: Codes in the range 0 - 1000.

```
 ; CODES= is impractical. Use CODERANGE= 0-1000
```

11.25 CONVERGE= select convergence criteria

This selects which of LCONV= and RCONV= set the convergence criterion. See convergence considerations.

CONVERGE=L	LCONV= for "Logit change size" controls convergence. Iteration stops when the biggest logit change is less or equal to LCONV=, or when the biggest logit change size increases (divergence).
CONVERGE=R	RCONV= for "Residual size" controls convergence. Iteration stops when the biggest residual score is less or equal to RCONV=, or when the biggest residual size increases (divergence).
CONVERGE=E	Either LCONV= for "Logit change size" or RCONV= for "Residual size" controls convergence. Iteration stops when the biggest logit change is less or equal to LCONV=, or when the biggest residual score is less or equal to RCONV=, or when both the biggest logit change size increases and the biggest residual size increases (divergence).
CONVERGE=B	Both LCONV= for "Logit change size" and RCONV= for "Residual size" controls convergence. Iteration stops when both the biggest logit change is less or equal to LCONV= and the biggest residual score is less or equal to RCONV=, or when both the biggest logit change size increases and the biggest residual size increases (divergence).

CONVERGE=F	Force both LCONV= for "Logit change size" and RCONV= for "Residual size" to control convergence. Iteration stops when both the biggest logit change is less or equal to LCONV= and the biggest residual score is less or equal to RCONV=.

Example 1: We want to be take a conservative position about convergence, requiring both small logit changes and small residual sizes when iteration ceases.

CONVERGE=Both

Example 2: We need very high precision, then specify:

CONVERGE=BOTH ; both score-residual and logit-change criteria
RCONV=.001 ; at most, one tenth of the smallest score residual needed.
LCONV=.00001 ; at most, one tenth of the highest precision to be reported.
These values are much, much smaller than the natural precision of the data, which is .5 raw score points, or the logit precision (S.E.) of the ability measures.

Example 3: We want to set the convergence criteria to match BIGSTEPS version 2.59

CONVERGE=B ; the criteria were LCONV= and RCONV=
RCONV= 0.5 ; the BIGSTEPS standards or whatever value you used
LCONV= .01

Example 4: We want to set the convergence criteria to match Winsteps version 3.20

CONVERGE=E ; the criterion was LCONV or RCONV
RCONV= 0.5 ; the 3.20 standards or whatever value you used
LCONV= .01

Example 5: We want the convergence criteria to match Winsteps version 2.85

CONVERGE= F ; force both LCONV and RCONV to be met
RCONV= 0.5 ; the 2.85 standards or whatever value you used
LCONV= .01
You may also want:
WHEXACT=NO ; centralized Wilson-Hilferty was the default

Example 6: *Question:* With anchored analyses, iterations never stop!

```
|----------------------------------------------------------------------------|
|    JMLE     MAX SCORE   MAX LOGIT    LEAST CONVERGED     CATEGORY    STEP  |
| ITERATION   RESIDUAL*    CHANGE    EXID   BYCASE   CAT   RESIDUAL   CHANGE |
|----------------------------------------------------------------------------|
|       1      -239.04       .5562    1993    392*      6      85.70   -.5960|
|       2      -105.65      -.1513    1993    392*      4     -28.92    .2745|
.....
|      18        -5.35      -.0027    2228    352*      3       2.35    .0146|
|      19        -5.16       .0029    2228    352*      3       2.31    .0106|
|      20        -5.05       .0025    2228    352*      3       2.28    .0055|
|      21        -5.00       .0010    2228    352*      3       2.26    .0075|
|      22        -4.99      -.0008    2228    352*      3       2.25    .0025|
.....
|     170        -5.00      -.0011    1377    352*      3       1.96    .0109|
|     171        -5.00       .0018     187    352*      3       1.96    .0019|
.....
```

The standard convergence criteria in Winsteps are preset for "free" analyses. With anchored analyses, convergence is effectively reached when the logit estimates stop changing in a substantively meaningful way. This has effectively happened by iteration 20. Note that the logit changes are less than .01 logits - i.e., even the biggest change would make no difference to the printed output (which is usually reported to 2 decimal places)

To have the current Winsteps do this automatically, set

CONVERGE=L
LCONV=.005 ; set to stop at iteration 22 - to be on the safe side.

11.26 CSV= comma-separated values in output files

To facilitate importing the IFILE=, ISFILE=, PFILE=, SFILE= and XFILE= files into spreadsheet and database programs, the fields can be separated by commas, and the character values placed inside " " marks.

CSV=No or Fixed	Use fixed field length format (the standard) (.txt)
CSV=Yes or CSV=,	Separate values by commas (or their international replacements). If QUOTES=Yes, character fields in " " marks
CSV=Tab or CSV=	Separate values by tab characters. If QUOTES=Yes, character fields in " " marks
CSV=SPSS	SPSS format (.sav)
CSV=Excel or XL	Excel format (.xls, .xlsx)
CSV=Rstat	R-statistics format (.rda)
CSV=Webpage	Webpage format (.htm, .html)

Examples:

Fixed space:
```
; MATCH  Chess Matches at the Venice Tournament, 1971  Feb 11  0:47 2004
;ENTRY MEASURE STTS COUNT    SCORE  ERROR IN.MSQ IN.ZSTD OUT.MS OUT.ZSTD DISPL PTME WEIGHT
DISCR G M NAME
     1     .87  1     2.0      2.0    .69   1.17    .47   1.17    .47    .01   1.00   1.00
1.97 1 R I0001
```

Tab-delimited:
```
"MATCH  Chess Matches at the Venice Tournament, 1971  Feb 11  0:47 2004"
";" "ENTRY" "MEASURE" "STATUS" "COUNT" "SCORE" "ERROR" "IN.MSQ" "IN.ZSTD" .....
" " 1 .87 1 2.0 2.0 .69 1.17 .47 1.17 .47 .01 1.00 1.00 1.97 "1" "R" "I0001"
```

Comma-separated:
```
"MATCH  Chess Matches at the Venice Tournament, 1971  Feb 11  0:47 2004"
";","ENTRY","MEASURE","STATUS","COUNT","SCORE","ERROR","IN.MSQ","IN.ZSTD",....
" ",1,.87,1,2.0,2.0,.69,1.17,.47,1.17,.47,.01,1.00,1.00,1.97,"1","R","I0001"
```

SPSS format: This is the SPSS .sav file format.

11.27 CURVES= probability curves for Table 21

CURVES= specifies which curves in Table 21 are to display. "1" to display the curves. "0" to omit the curve. Formerly also controlled Table 2, now done with T2SELECT=.

CURVES=000 indicates no curves are to be drawn - Table 21 will be skipped, unless STEPT3=N, in which case only the structure summaries are output.

CURVES=101 displays subtables 21.1, 21.3 (and 21.4, 21.6, ...) when Table 21 is selected.

CURVES=	Table 21 displays ...	
100	21.1, 21.4, ...	Category probability curves (modes, structure calibrations)
010	21.2, 21.5, ...	Expected score ogive (means. model Item Characteristic Curve).
001	21.3, 21.6, ...	Cumulative category probability curves (medians, shows Rasch-Thurstonian thresholds = 50% cumulative probabilities)

11.28 CUTHI= cut off responses with high expectations

Use this if careless responses are evident. CUTHI= cuts off the top left-hand corner of the Scalogram in Table 22.

Eliminates (cuts off) observations where examinee ability measure is **CUTHI= logits or more higher** than item difficulty measure, so the examinee has a high probability of success. Removing off-target responses takes place after PROX has converged. After elimination, PROX is restarted, followed by JMLE estimation and fit calculation using only the reduced set of responses. This may mean that the original score-based ordering is changed.

Usually with CUTLO= and CUTHI=, misfitting items aren't deleted - but miskeys etc. must be corrected first. Setting CUTLO= and CUTHI= is a compromise between fit and missing data. If you loose too much data, then increase the values. If there is still considerable misfit or skewing of equating, then decrease the values.

Here are the usual effects of CUTLO= and CUTHI=
1. Fit to the Rasch model improves.
2. The count of observations for each person and item decreases.
3. The variance in the data explained by the measures decreases.

Polytomous items: CUTLO= and CUTHI= trim the data relative to the item difficulty, so they tend to remove data in high and low categories. You can adjust the item difficulty relative to the response structure using SAFILE=.

Example 1: Eliminate responses where examinee measure is 3 or more logits higher than item measure, to eliminate their worst careless wrong responses:
CUTHI= 3

This produces a scalogram with eliminated responses blanked out:: Table 22

```
RESPONSES SORTED BY MEASURE:
KID    TAP
              111111111
     123745698013245678
------------------------
 15  111        11100000 observations for extreme scores remain
 14  111      1110000000
 28  111    111010000000
 30  1111 1111000000000
 27  111111100000000000
```

Example 2. At www.rasch.org/rmt/rmt62a.htm the originator of this approach suggests CUTLO= -1 and CUTHI=2

11.29 CUTLO= cut off responses with low expectations

Use this if guessing or response sets are evident. CUTLO= cuts off the bottom right-hand corner of the Scalogram in Table 22.

Eliminates (cuts off) observations where examinee ability measure is **CUTLO= - logits or more lower** than item difficulty measure, so that the examinee has a low probability of success. The elimination of off-target responses takes place after PROX has converged. After elimination, PROX is restarted, followed by JMLE estimation and point-measure and fit calculation using only the reduced set of responses. This may mean that the original score-based ordering is changed.

CUTLO= is equivalent to Waller's procedure in Waller, M.I. (1976) "Estimating Parameters in the Rasch Model: Removing the Effects of Random Guessing", Report No. ETS-RB-76-0, Educational Testing Service, Princeton, N.J. https://files.eric.ed.gov/fulltext/ED120261.pdf

Usually with CUTLO= and CUTHI=, misfitting items aren't deleted - but miskeys etc. must be corrected first. Setting CUTLO= and CUTHI= is a compromise between fit and missing data. If you loose too much data, then increase the values. If there is still considerable misfit or skewing of equating, then decrease the values.

Here are the usual effects of CUTLO= and CUTHI=
1. Fit to the Rasch model improves.
2. The count of observations for each person and item decreases.
3. The variance in the data explained by the measures decreases.

CUTLO= is equivalent to the procedure outlined in in Waller, M.I. (1976) "*Estimating Parameters in the Rasch Model: Removing the Effects of Random Guessing*", Report No. ETS-RB-76-0, Educational Testing Service, Princeton, N.J., https://files.eric.ed.gov/fulltext/ED120261.pdf, also Bruce Choppin. (1983). *A two-parameter latent trait model. (CSE Report No. 197).* Los Angeles, CA: University of. California, Center for the Study of Evaluation, and David Andrich, Ida Marais, and Stephen Humphry (2012) *Using a Theorem by Andersen and the Dichotomous Rasch Model to Assess the Presence of Random Guessing in Multiple Choice Items*. Journal of Educational and Behavioral Statistics, 37, 417-442.

Polytomous items: CUTLO= and CUTHI= trim the data relative to the item difficulty, so they tend to remove data in high and low categories. You can adjust the item difficulty relative to the response structure using SAFILE=.

Example 1: Disregard responses where examinees are faced with too great a challenge, and so might guess wildly, i.e., where examinee measure is 2 or more logits lower than item measure:

```
 CUTLO= -2  ; 12% success
```

This is equivalent to a "Optimum Appropriateness Measurement" (OAM) model in which it is assumed that persons might guess on all the items, so all responses in guessing situations are eliminated.

```
GUTTMAN SCALOGRAM OF RESPONSES:Table 22
PERSON |ITEM
       | 12 22  1 3231311  1322112 2 113322
       |62257012473946508491143795368350281
       |-----------------------------------
   147 +0001111110011010100111111000001000   154
   130 +1100101111001110110101000000010100   135
    93 +011110010100111010000001101000010    098
   129 +1111101110110110000000000000001010   134
   134 +000110101110010001110010001000010    139
   133 +100100111110000000101010011000000    138
   137 +100000011110100101101000010000000    143
   141 +110100010011100001100000000001010    147
   138 +1010010101110100000000000010010       144
   113 +101100100010111100000000000000010     118
   144 +10000010100010001000010001             151
   114 +1000010010000100                       119
       |-----------------------------------
       | 12 22  1 3231311  1322112 2 113322
       |62257012473946508491143795368350281
```

Example 2: Richard Gershon applied this technique in Guessing and Measurement with CUTLO=-1 ; 27% success

Example 3: We have some misbehaving children in our sample, but don't want their behavior to distort our final report.

An effective approach is in two stages:
Stage 1. calibrate the items using the good responses
Stage 2. anchor the items and measure the students using all the responses.

In Stage 1, we trim the test. We want to remove the responses by children that are so off-target that successes are probably due to chance or other off-dimensional behavior. These responses will contain most of the misfit. For this we analyze the data using
CUTLO= -2 (choose a suitable value by experimenting)
CUTLO= -1.39 ; 20% success
CUTLO= -1.10 ; 25% success
write an item file from this analysis:
IFILE=if.txt

In Stage 2. Anchor all the items at their good calibrations:
IAFILE=if.txt
Include all the responses (omit CUTLO=)
We can now report all the children without obvious child mis-behavior distorting the item measures.

11.30 DATA= name of data file

Your data can be the last thing in the control file (which is convenient if you only have a small amount of data), but if you have a large amount of data, you can place it in a separate file, and then use DATA= to say where it is. FORMAT= reformats these records. MFORMS= enables multiple reformatting.

DATA= file name	file containing details
DATA = file name + file name+ ...	multiple data files
DATA = ?	opens a Browser window to find the file

Example 1: Read the observations from file "A:\PROJECT\RESPONSE.TXT".
DATA=A:\PROJECT\RESPONSE.TXT

Example 2: Read scanned MCQ data from file DATAFILE.txt in the current directory.
DATA=DATAFILE.txt

You may specify that several data files be analyzed together in one run, by listing their file names, separated by "+" signs. The list, e.g., FILE1.TXT+MORE.TXT+YOURS.D, can be up to 200 characters long. The layout of all data files must be identical.

Example 3: A math test has been scanned in three batches into files "BATCH.1", "BATCH.2" and "BATCH.3". They are to be analyzed together.
DATA=BATCH.1+BATCH.2+BATCH.3

11.31 DATESHOW= show date in Table headings

The date of the analysis is usually reported in Winsteps table headings. The date can be removed with DATESHOW=No

DATESHOW=Yes

```
TABLE 23.16 KNOX CUBE TEST                    EXAM1-PLUS.OUT  Jul 30  2:06 2013
INPUT: 35 KID  18 TAP  REPORTED: 35 KID  18 TAP  2 CATS         WINSTEPS 3.80.0
--------------------------------------------------------------------------------
```

DATESHOW=No

```
TABLE 23.16 KNOX CUBE TEST                                       EXAM1-PLUS.OUT
INPUT: 35 KID  18 TAP  REPORTED: 35 KID  18 TAP  2 CATS         WINSTEPS 3.80.0
--------------------------------------------------------------------------------
```

11.32 DELIMITER= or SEPARATOR= data field delimiters

It is often convenient to organize your data with delimiters, such as commas, semi-colons or spaces, rather than in fixed column positions. However, often the delimiter (a Tab, space or comma) only takes one column position. In which case, it may be easier to include it in the CODES= or use MFORMS= or FORMAT=.

To check that your data file has decoded properly, look at RFILE=

To do this, specify the following command DELIMITER= value (or SEPARATOR= value). This value is the separator.

Examples: DELIMITER= " " fixed-field values
DELIMITER= "," comma-separated values CSV. **The , must be ","**
DELIMITER=BLANK blank-separated values
or DELIMITER=SPACE space-separated values
DELIMITER=TAB tab-separated values
DELIMITER=";" semi-colon separated values. **The ; must be ";"** otherwise it is treated as a comment.

Examples: SEPARATOR= " " fixed-field values
SEPARATOR= "," comma-separated values CSV. **The , must be ","**

SEPARATOR=BLANK blank-separated values
or SEPARATOR=SPACE space-separated values
SEPARATOR=TAB tab-separated values
SEPARATOR=";" semi-colon separated values. **The ; must be ";"** otherwise it is treated as a comment.

When decoding delimited values, leading and trailing blanks, and leading and trailing quotation marks, " " and ' ' in each value field are ignored. Responses are left-aligned, and sized according to XWIDE=.

For NAME1= and ITEM1=, specify the value number in the data line, starting with 1 as the leftmost value. FORMAT= does not apply to this data design.

Combine your person name and demographic information into one field that is to be referenced by NAME1=.

Example 1 of a data line:

; the following is ONE data line:

```
"01"; 02; "01"; "01"; "01"; 00; 02; 00; "01"; 02; 02; 02; 02; 00; 02; "01"; "01"; 02; 02 ; 00; 02; "01"; 00; 02; 00; ROSSNER, MARC
    DANIEL
```

;which decodes as:

```
01020101010002000102020202000201010202000201000200ROSSNER, MARC DANIEL
```

```
ITEM1=1      ; item responses start in first field
NI=25        ; there are 25 responses, i.e., 25 response fields
NAME1=26     ; the person name is in the 26th field
DELIMITER = ";" ; the field delimiters are semi-colons
XWIDE=2      ; values are right-aligned, 2 characters wide.
CODES=000102 ; the valid codes.
NAMLEN=20    ; override standard person name length of 30 characters.
```

Example 2 of a data line:

; the following is ONE data line:

```
ROSSNER - MARC DANIEL, "01", 02 , "01", "01", "01", 00, 02, 00, "01", 02, 02, 02, 02, 00, 02, "01", "01", 02, 02, 00, 02, "01", 00,
    02, 00
```

;which decodes as:

```
01020101010002000102020202000201010202000201000200ROSSNER - MARC DANIEL
```

```
ITEM1=2      ; item responses start in second field
NI=25        ; there are 25 responses, i.e., 25 response fields
NAME1=1      ; the person name is in the 1st field
DELIMITER = "," ; the field delimiters are commas (so no commas in names)
XWIDE=2      ; values are right-aligned, 2 characters wide.
CODES=000102 ; the valid codes
NAMLEN=20    ; override standard person name length of 30 characters.
```

Example: Here is the data file, "Book1.txt"

```
fred,1,0,1,0
george,0,1,0,1
```

Here is the control file:

```
name1=1 ; first field
item1=2 ; second field
ni=4  ; 4 fields
data=book1.txt
codes=01
delimiter = ","
&END
```

```
looking
viewing
peeking
seeking
END LABELS
```

Here is the reformatted file from the Edit Pull-Down menu: *View Delimiter File:*

```
1010fred
0101george
```

Suggestion:
If you data file can be conveniently organized in columns:

```
fred  ,1,0,1,0
george,0,1,0,1
```

then process the data file as fixed width fields

```
NAME1 = 1 ; start of person label "fred"
NAMELENGTH = 6 ; up to first comma
ITEM1 = 8  ; first column of numbers
XWIDE = 2 ; number + comma
CODES = "0,1,0 1 " ; the data codes "0 1 " are for the last codes on the line.
```

this will then analyze the data as a standard fixed-column rectangular data matrix.

11.33 DIF= columns within person label for Table 30

DIF= specifies the part of the person label which is to be used for classifying persons in order to identify Differential Item Function (DIF) - uniform or non-uniform - using the column selection rules. See also DIF Table and DIF and DPF considerations.

DIF= *file name	file containing details
DIF= *	in-line list
DIF= $S1W1	field in person label. DIF fields **must** be inside the person label defined by NAME1= and NAMELENGTH=
DIF= MA2	person ability levels for non-uniform DIF: MA2 splits at the middle of the value value.range
DIF= $S1W1 + MA2	person classes or groups
DIF= ?	open browser for file

DIF= location is usually column number **within person label** field. DIF=1 means "DIF selection character is first character of person label."

Example 1: Columns 18-20 of the person label (in columns 118-120 of the data record) contain a district code:
NAME1=101 ; person label starts in column 101
NAMELENGTH = 20 ; person label must include all the DIF codes
DIF = $S18W3 ; district starts in column 18 of person label with a width of 3
or
@district = 18W3 ; district starts in column 18 of person label with a width of 3
DIF = @district ; DIF classifier
tfile=*
30 Table 30 for the DIF report (or use Output Tables menu)
*

Example 2: DIF by Gender+Grade: Column 1 of the person labels contains gender (M or F) and Columns 7-8 contain grade level (K-12).
DIF = 1W1 + 7W2

Example 3: I have tab-separated data and my DIF indicator is in a separate field from the Person label.
Solution: for the DIF analysis, do a separate run of Winsteps. At the "Extra Specifications" prompt:
NAME1=(location of DIF indicator)
DIF=$S1W1

Example 4: Columns 18-20 of the person label (in columns 118-120 of the data record) contain a district code. Column 21 of the person label (in column 121 of the data record) has a gender code. Three independent DIF analyses are needed: district, gender, district+gender

```
NAME1=101  ; person label starts in column 101
NAMELENGTH = 21 ; person label must include all the DIF codes
DIF = *
$S18W3  ; start in person label column 18 with a width of 3 - district
$S21W1  ; start in person label column 21 with a width of 1 - gender
$S18W3+ $S21W1  ; DIF by district+gender
*
tfile=*
30   Table 30 for the DIF report (or use Output Tables menu)
*
```

Example 5: An investigation of non-uniform DIF with high-low ability classification for the KCT data.

```
; action the following with the Specification pull-down menu
@SEX = $S9W1 ; the sex of participants is in column 9 of the person label
DIF = @SEX + MA2 ; look for non-uniform DIF (gender + two ability strata): MA2
PSUBTOT = @SEX + MA2 ; summary statistics by gender and ability strata
Tfile=*   ; This is more easily actioned through the Output Tables Menu
30   ; Table 30 - DIF report
28   ; Table 28 - Person subtotals for DIF classifications
*
```

```
Table 30: DIF specification is: DIF=@SEX+MA2
+-----------------------------------------------------------------------------------------+
| KID      DIF   DIF   KID      DIF   DIF      DIF     JOINT           TAP                |
| CLASS MEASURE S.E.  CLASS MEASURE S.E.   CONTRAST  S.E.    t  d.f. Number   Name        |
|-----------------------------------------------------------------------------------------|
| F1      -1.86  1.09  M1      -4.54  1.15       2.68  1.59  1.69    8       6  6= 3-4-1  |
```

```
Table 28: Subtotal specification is: PSUBTOTAL=@SEX+MA2
+---------------------------------------------------------+
| KID      MEAN     S.E.  OBSERVED  MEDIAN   REAL         |
| COUNT  MEASURE   MEAN     P.SD          SEPARATION  CODE |
|---------------------------------------------------------|
|       4   -2.08      .90      .89              .00      F1    | <- Non-extreme
|       6   -2.82      .41      .91   -2.86      .32      M1    |
```

Example 6: With Example0.txt (the Liking for Science rating scale data) you want to see if any items were biased against names starting with any letter of the alphabet, then:

run example0.txt
request the DIF Table (Table 30) from the Output Tables menu
specify: $S1W1
a DIF table is produced.

The equivalent DIF specification is: DIF=$S1W1

```
Positive DIF size is higher ACT difficulty measure
+------------------------------------------------------------------------------------+
| KID      DIF   DIF   KID      DIF   DIF      DIF     JOINT           ACT           |
| CLASS MEASURE S.E.  CLASS MEASURE S.E.   CONTRAST  S.E.    t  d.f. Number   Name   |
|------------------------------------------------------------------------------------|
| R        -.06    .54  W          .89> 2.05       -.95  2.12  -.45    8      1 WATCH BIRDS |
```

```
| R        -.06   .54  L       -.65   .75       .59   .92   .64  12      1 WATCH BIRDS |
| R        -.06   .54  S       -.42   .57       .36   .78   .46  18      1 WATCH BIRDS |
| R        -.06   .54  H      -1.63  1.13      1.57  1.25  1.26  11      1 WATCH BIRDS |
| R        -.06   .54  D        .12   .86      -.18  1.01  -.18  11      1 WATCH BIRDS |
.......
```

Example 7: The DIF demographic column is not part of the person label. Use the FORMAT= instruction to rearrange the record.
Was:

```
 0        1         2         3
 1234567890123456789012345678901
 AxxxxxxxxxxxxxxxxxxxBCyyyyyyyy ; original record layout
 ITEM1=2
 NI=19  ; the x's
 NAME1=21 ; starts with B
```

To move column 1 after column 21 with XWIDE=1:

```
 xxxxxxxxxxxxxxxxxxxBACyyyyyyyy ; after internal reformatting
 FORMAT = (T2,20A,T1,1A,T22,100A)
 ITEM1 = 1 ; references position in the reformatted record.
 NI = 19 ; the x's
 NAME1 = 20 ; starts with B - references position in the reformatted record.
 DIF = S2W1 ; code A
```

The first reformatted record is shown on your screen so you can check that it is how you want it.

Example 8: We only want DIF between person classification groups A and B, not the other person groups. Classification group code is in column 3 of the person label.
In the Specification pull down menu
PSELECT=??{AB}
Output Table menu: Table 30.

11.34 DISCRIMINATION= item discrimination

Rasch models assert that items exhibit the model-specified item discrimination. Empirically, however, item discriminations vary. During the estimation phase of Winsteps, all item discriminations are asserted to be equal, of value 1.0, and to fit the Rasch model. But empirical item discriminations never are exactly equal, so Winsteps can also report an estimate of those discriminations post-hoc (as a type of fit statistic). The amount of the departure of a discrimination from 1.0 is an indication of the degree to which that item misfits the Rasch model.

DISCRIM=NO Do not report an estimate of the empirical item discrimination.

DISCRIM=YES Report an estimate of the empirical item discrimination in the IFILE= and Tables 6.1, 10.1, etc.

An estimated discrimination of 1.0 accords with Rasch model expectations for an item of this difficulty. A value greater than 1 means that the item discriminates between high and low performers more than expected for an item of this difficulty. A value less than 1 means that the item discriminates between high and low performers less than expected for an item of this difficulty. In general, the geometric mean of the estimated discriminations approximates 1.0, the Rasch item discrimination.

Rasch analysis requires items which provide indication of relative performance along the latent variable. It is this information which is used to construct measures. From a Rasch perspective, over-discriminating items are tending to act like switches, not measuring devices. Under-discriminating items are tending neither to stratify nor to measure.

Over-discrimination is thought to be beneficial in many raw-score and IRT item analyses. High discrimination usually corresponds to low MNSQ values, and low discrimination with high MNSQ values. In Classical Test Theory, Guttman Analysis and much of Item Response Theory, the ideal item acts like a switch. High performers pass, low performers fail. This is perfect discrimination, and is ideal for sample stratification, but such an item provides no information about the relative performance of low performers, or the relative performers of high performers.

Winsteps reports an approximation to what the discrimination parameter value would have been in a 2-PL IRT program, e.g., BILOG for MCQ, or PARSCALE for partial credit items. IRT programs artificially constrain discrimination values in order to make them estimable, so Winsteps discrimination estimates tend to be wider than 2-PL estimates. For the lower asymptote, see ASYMPTOTE=.

The algebraic representation of the discrimination and lower asymptote estimate by Winsteps are similar to 2-PL/3-PL IRT, but the estimation method is different, because Winsteps does not change the difficulties and abilities from their 1-PL values. Consequently, in Winsteps, discrimination and asymptotes are indexes, not parameters as they are in 2-PL/3-PL.

A Rasch-Andrich threshold discrimination is also reported, see Table 3.2.

With DISCRIM=YES,

```
+-----------------------------------------------------------------------------------------+
|ENTRY    RAW                               |   INFIT   |  OUTFIT   |SCORE|ESTIM|                        |
|NUMBER  SCORE  COUNT  MEASURE  ERROR|MNSQ  ZSTD|MNSQ  ZSTD|CORR.|DISCR| ACTS                   |
|-----------------------------------+----------+----------+-----+-----+------------------------|
|    23     40     74     2.19     .21|2.42   6.3|4.13   8.9|  .00|  .09| WATCH A RAT            |
|    17     93     74      .16     .19| .65  -2.7| .59  -2.5|  .70| 1.20| WATCH WHAT ANIMALS EAT |
```

11.35 DISFILE= category/distractor/option count file

DISFILE=filename produces an output file containing the counts for each distractor or option or category of each item, similar to Table 10.3. See also Distractor Analysis

DISFILE=? opens a Browse window

DISOPTION= Code or DISOPTION= Score summary. These control the contents of the output fields.

With DISOPTION= Code

```
 ITEM CODE      VALUE  SCORE     UNWTD    UNWTD %        WTD      WTD % AVGE MEAS P.SD MEAS S.E. MEAS INFT MNSQ OUTF MNSQ         PTMA
LABEL
    13 *           -1     -1        17      56.67       17.0      56.67       1.14       1.99        .50        .00        .00        .46
nh01  supermarket
    13 a            0      0         2      15.38        2.0      15.38      -1.07        .12        .12        .68        .61       -.31
nh01  supermarket
    13 b            0      0         1       7.69        1.0       7.69       -.13        .00        .00       1.73       1.55        .14
nh01  supermarket
    13 c            1      1         8      61.54        8.0      61.54       -.58        .82        .31       1.35       1.40       -.11
nh01  supermarket
    13 d            0      0         2      15.38        2.0      15.38        .14        .60        .60       2.26       2.43        .36
nh01  supermarket
```

With DISOPTION= Score

```
 ITEM CODE      VALUE  SCORE     UNWTD    UNWTD %        WTD      WTD % AVGE MEAS P.SD MEAS S.E. MEAS INFT MNSQ OUTF MNSQ         PTMA
LABEL
    13                    -1        17      56.67       17.0      56.67       1.14       1.99        .50        .00        .00        .46
nh01  supermarket
    13                     0         5      38.46        5.0      38.46       -.40        .68        .34       1.41       1.53        .11
nh01  supermarket
    13                     1         8      61.54        8.0      61.54       -.58        .82        .31       1.35       1.40       -.11
nh01  supermarket
```

This file contains 1 heading lines (unless HLINES=N), followed by one line for each CODES= of each item (whether the code is observed for the item or not) containing:

Columns:			
Start:	*End:*	*Heading*	*Description*
1	10	ITEM	Item entry number
11	20	CODE (blank for DISOPTION= S)	Response code in CODES= or *** = missing (not subtotal)

21	25	VALUE (blank for DISOPTION= S)	Numerical value of the response code (directly or with KEYn=, NEWSCORE=, IVALUEx=, MISSCORE= etc.). -1 means "response is ignored"
27	30	SCORE	Score for category (DISOPTION=C) or summed across categories (DISOPTION=S) used for estimating the Rasch item measure (after recounting, weighting, etc.). -1 means "response is ignored"
31	40	UNWTD	Count of all valid response codes in data set (excludes missing except for "MISSING" lines)
41	50	UNWTD %	Percent of UNWTD responses to this item.
51	60	WTD	Count of all valid response codes (weighted with PWEIGHT=) in data set (excludes missing except for "MISSING" lines)
61	70	WTD %	% of WTD responses to this item
71	80	AVGE MEAS	Average person measure for WTD responses
81	90	P.SD MEAS	P.SD is the population standard deviation of the person measures for WTD responses
91	100	S.E. MEAS	Standard Error of average person measure for WTD responses = sqrt (P.SD (AVGE MEAS) / (WTD - 1))
101	101	INFT MNSQ	Infit Mean-square of weighted responses, omitting responses in extreme scores
111	120	OUTF MNSQ	Outfit Mean-square of weighted responses, omitting responses in extreme scores
121	130	PTMA	PTMA is the point-correlation between this code or summary score, scored 1, or its non-occurrence, scored 0, and the person raw scores or measures chosen by PTBISERIAL=. The computation is described in Correlations.
132	-	LABEL	Item label

DISOPTION=Code - Since the DISFILE= has the same number of CODES= and MISSING "***" entries for every item, the repeated fields are filled out with "0" for any unobserved response codes.

DISOPTION=Score - Only observed scores are reported.

Percentages for non-missing response-scores are computed based on total count of non-missing response scores. Percentages for missing response-scores are computed based on total count of all response scores.

When CSV=Y, commas separate the values with quotation marks around the "Item label", response in CODES=, and ***. When CSV=T, the commas are replaced by tab characters.

Example 1: You wish to write a file on disk called "DISCOUNT.TXT" containing the item distractor counts from Table 14.3, for use in constructing your own tables:

```
DISFILE=DISCOUNT.TXT
```

Example 2: You want to see if some distractors are more attractive for boys or girls.

1. Do your usual Winsteps analysis. Output the DISFILE= to Excel: this has counts for all persons for all distractors. PFILE=pf.txt
2. Put PSELECT=girls in your Winsteps control file. Do your usual Winsteps analysis. Output the DISFILE= to Excel: this has counts for girls. PAFILE=pf.txt to make the measures in the different analyses comparable.
3. Put PSELECT=boys in your Winsteps control file. Do your usual Winsteps analysis. Output the DISFILE= to Excel: this has counts for girls. PAFILE=pf.txt
4. Combine the DISFILE= Excel worksheets to compute percentages for each distractor. The DISFILE= also shows which option is correct.

11.36 DISOPTION= distractor file option = C

DISOPTION= Code	The distractor file DISFILE= reports by item response code

	in CODES=
DISOPTION= Score	The distractor file DISFILE= reports by item response score values of codes

11.37 DISTRACTOR= output option counts in Tables 10, 13-15

This variable controls the reporting of counts of option, distractor or category usage in Table 10.3 etc. The standard is DISTRACTOR=YES, if more than two values are specified in CODES=.

DISTRACTOR=No	Omit the option or distractor Table 10.3 etc.
DISTRACTOR=Yes	Include Table 10.3 etc, i.e., counts, for each item, for each of the values in CODES=, and for the number of responses counted as MISSCORE=

Distractor Analysis - Multiple-Choice (MCQ) Distractors

The distractor table reports what happened to the original observations after they were scored dichotomously.
Item writers often intend the MCQ options to be something like:
A. Correct option (scored 1) - high-ability respondents - highest positive point-biserial
B. Almost correct distractor (scored 0) - almost-competent respondents - somewhat positive point-biserial
C. Mostly wrong distractor (scored 0) - slightly competent respondents - zero to negative point-biserial
D. Completely wrong distractor (scored 0) - ignorant respondents - highly negative point-biserial
The distractor table reports whether this happened.

Example of a good set of distractors:

ITEM	CODE	SCORE	AVGE MEAS	PTMEA	
1	D	0	-1.59	-0.76	Most incorrect choice
1	C	0	-0.44	-0.15	
1	B	0	0.22	0.10	
1	A	1	2.37	0.45	Most correct choice

You will obtain exactly the same Rasch measures if you score your MCQ items in advance and submit a 0-1 dataset to Winsteps.

11.38 DIVAUTO= automatic changes to ESTMULT= when estimation diverges

During JMLE estimation, estimates may not converge for anchored or sparse data. Reducing the estimation multiplier, ESTMULT=, makes estimate changes smaller, assisting convergence.

DIVAUTO=Yes (default)	If JMLE estimates are not converging, allow automatic changes to the estimation multiplier ESTMULT= during JMLE estimation. Changes to ESTMULT= can also be made with the Diagnosis menu. This is compatible with Winsteps 4.5 and similar versions.
DIVAUTO=No	Do not allow automatic changes to the estimation multiplier ESTMULT= during JMLE estimation. Changes to ESTMULT= can be made with the Diagnosis menu.This is compatible with Winsteps 5.9 and similar versions.This is compatible with Winsteps 5.0 - 5.9 versions.

Example:

In the control file: DIVAUTO=Yes ; with automatic divergence control (default) In the Analysis window:

```
|    JMLE     MAX SCORE   MAX LOGIT      LEAST CONVERGED    CATEGORY STRUCTURE|
| ITERATION   RESIDUAL*      CHANGE  PERSON     ITEM    CAT   RESIDUAL   CHANGE|
.....
>===============================================================================<
|      28           -.11        .0001     187      70*                         |
>===============================================================================<
|      29            .13       -.0002     187      70*                         |
>===============================================================================<
|      30           -.15        .0002     187      70*  <- diverging           |
Estimation may have diverged. Reducing ESTMULT=.600 <- automatic divergence control
>===============================================================================<
|      31            .13       -.0001     187      70*                         |
```

In the control file:
DIVAUTO=No ; no divergence control

In the Analysis window:

```
|    JMLE     MAX SCORE   MAX LOGIT      LEAST CONVERGED    CATEGORY STRUCTURE|
| ITERATION   RESIDUAL*      CHANGE  PERSON     ITEM    CAT   RESIDUAL   CHANGE|
.....
>===============================================================================<
|      53            .12       -.0002   11765      70*                         |
>===============================================================================<
|      54           -.15        .0002   11765      70*                         |
>===============================================================================<
|      55            .13       -.0002    1617      70*  <- diverging           |
Estimation may have diverged. Press Ctrl-F to stop iterations
or Diagnosis menu: Reduce ESTMULT=  <- manual divergence control
>===============================================================================<
|      56           -.11        .0001     187      70*                         |
>===============================================================================<
```
..

11.39 DPF= columns within item label for Table 31

DPF= specifies the part of the item label which is to be used for classifying items in order to identify Differential Person Function (DPF) - uniform or non-uniform - using the column selection rules. See also DPF Table and DIF and DPF considerations.

DPF= *file name	file containing details
DPF= *	in-line list
DPF= $S1W1	field in item label
DPF= MA2	item difficulty levels for non-uniform DPF
DPF= $S1W1 + MA2	item groups
DPF= ?	open browser for file

See ISUBTOTAL for format.

See DPF Table 31.

Example 1: Columns 3 and 4 of the item label (between &END and END LABELS) contains content-area code:
DPF = $S3E4 ; start in column 3 and end in column 4 of item label
tfile=*

```
31  ; Table 31 is DPF Table (or use Output Tables menu)
*
```

Example 2: Columns 3 of the item label contains a content code. Column 5-6 have a complexity code. Two independent DIF analyses are needed:

```
DPF = *
$S3W1  ; content analysis
$S5W2  ; complexity
*
tfile=*
31  ; Table 31 is DPF Table (or use Output Tables menu)
*
```

11.40 EDFILE= edit data file

This permits the replacement of data values in your data file with other values, without altering the data file. Data values are in the original data file format, specified in CODES=. If specified as decimals, they are rounded to the nearest integers. Lines can be in EDFILE= in any order, and item numbers and person numbers can be skipped.Additional persons can be entered beyond those in DATA= or after END LABELS. Values can be in any order, but are more speedily processed when sorted in person-entry order. Person labels can be inserted or changed using PLFILE=.

The first line of the EDFILE= is shown in the Analysis window so that it can be checked:

```
 Processing EDFILE= data edit from: C:\Users\ADMINI~1\AppData\Local\Temp\ZED967WS.TXT
 Processing first active EDFILE= observation: 1-35         19       0
 Processing as: 1 (Adam    M) 19 (00019) 0
.................................................. 50000  (each dot is 1,000 observations)
.................................................. 150000  (each dot is 2,000 observations)
.................................................. 300000  (each dot is 3,000 observations, and
    so on)
```

with totals at the end:

```
 OBSERVATIONS IN EDFILE=: 123
    OBSERVATIONS UPDATED: 103
  OBSERVATIONS UNCHANGED: 20
```

EDFILE= file name	file containing details
EDFILE= file name + file name + ...	multiple files
EDFILE = *	in-line list
EDFILE = ?	opens a Browser window to find the file

EDFILE=* ; format is:		
person entry number or "person selection"	item entry number or "item selection"	insertion or replacement data value:
		insertion or replacement data string. Ranges are permitted for entry numbers: first-last.
*		

Selection rules. Person and item selections must be in quotation marks " " if they contain blanks or tabs, and follow the selection rules:	
Control characters match label or name. They start at the first column of the label or name.	
?	matches any character
*	matches any string of characters - must be last selection character. If * is in the first column, then every available person or item is selected.
A	matches A in the person label, and similarly all other characters except these: { }"

{..}	braces characters which can match a single character: {ABC} matches A or B or C.
{.. - ..}	matches single characters in a range. {0-9} matches digits in the range 0 to 9.
{.. --..}	matches a single "-" {AB--} matches A or B or "-".
{~ABX}	omits persons or items which match A or B or X
{" "}	matches a blank in the label
@fieldname=	positions the next selection character at the start of the specified field

Example 0. You want to merge, "rack", the data from two tests: To "stack" the data, use DATA=file1.txt+file2.txt
Use EDFILE= format, and combine file1.txt and file2.txt into one EDFILE= file. Person entry numbers must match but can be in any order. If items have the same number, then the second occurrence overwrites the first.

For instance:
file data in EDFILE= format , or input file1.txt as a standard DATA= file:
23 1-17 0100100100100111 ; person 23, items 1-17, responses: *Note:* **no spaces in 1-17. 1 - 17 fails.**
.....
file2 data in the same or only EDFILE=
23 18-30 1010110001101 ; person 23, items 18-30, responses
.....

For person labels not in DATA=, use PLFILE=

Example 1: In your MCQ test, you wish to correct a data-entry error. Person 23 responded to item 17 with a D and item 18 with an A, not whatever is in the data file.

```
EDFILE=*
23 17 D      ; person 23, item 17, data value of D
23 18 A      ; person 23, item 18, data value of A
*
```

or

```
EDFILE=*
23 17-18 DA     ; person 23, item 17 and 18, data values of D and A
*
```

Example 2: Person 43 failed to read the attitude survey instructions correctly for items 32-56. Mark these missing.

```
EDFILE=*
43 32-56 " " ; person 43, items 32 to 56, blanks are missing data.
*
```

Example 3: Persons 47-84 are to be given a rating of 4 on item 16.

```
EDFILE=*
47-84 16 4 ; persons 47 to 84, item 16, data value of 4
*
```

Example 4: Items 1-10 are all to be assigned a datum of 1 for the control sub-sample, persons 345-682.

```
EDFILE=*
345-682 1-10 1 ; persons 345-682, items 1 to 10, data value 1.
*
```

Example 5: Missing data values are to be imputed with the values nearest to their expectations.

a. Produce PFILE=, IFILE= and SFILE= from the original data (with missing).
b. Use those as PAFILE=, IAFILE=, SAFILE= anchor files with a data set in which all the original non-missing data are made missing, and vice-versa - it doesn't matter what non-missing value is used.
c. Produce XFILE= to obtain a list of the expected values of the originally missing data.

d. Use the EDFILE= command to impute those values back into the data file. It will round expected values to the nearest integer, for us as a category value.

```
EDFILE=*
17 6 2.6 ; persons 17, item 6, expected value 2.6, imputed as category "3".
*
```

Example 6: All responses to item 6 for males "M" in column 6 of person label are to be coded as "missing", character ".":

```
EDFILE=*
"?????M" 6 .
*
```

Example 7: We want to do Examples 1, 2, 3, 4, 5, 6 all at once to our dataset:

```
EDFILE=*
23 17 D     ; person 23, item 17, data value of D
43 32-56 " " ; person 43, items 32 to 56, blanks are missing data.
47-84 16 4 ; persons 47 to 84, item 16, data value of 4
345-682 1-10 1 ; persons 345-682, items 1 to 10, data value 1.
17 6 2.6 ; persons 17, item 6, expected value 2.6, imputed as category "3".
"?????M" 6 .
*
```

Example 8: We want person group X (in column 4 of the person label) except for subgroups 11, 24 (in columns 6, 7 of the person label):

```
    PSELECT = "???X?{12}{14}"   ; this selects X and 11, 14, 21, 24
EDFILE=*
    "?????14" "?" . ; convert 14 to missing data
    "?????21" "?" . ; convert 21 to missing data
    *
```

Example 9: Exceedingly unexpected responses are to be coded "missing". (It is easier, but not as exact, to use CUTLO= and CUTHI= to trim the observations).

Either

Extract into Excel the list of unexpected observations from Table 6.6 or Table 10.6.

Or

Output the XFILE= to Excel
Sort by unexpectedness (standardized residual)
Delete all rows except for the responses you want to code missing

Then

Rearrange the columns: Person Item
In the third column put the desired missing data code.
Copy-and-paste the three columns into a text file.
In your Winsteps control file:
EDFILE = (text file name)
Rerun the analysis

Example 9: All data in a separate EDFILE= data file.

NAME1 = 1 ITEM1 = 31 NI = (number of items) CODES = ABCD EDFILE= * 1 1 A 1 5 B 2 3 A 2 10 C	NAME1 = 1 ITEM1 = 31 NI = (number of items) CODES = ABCD EDFILE= eddata.txt DATA = personlabels.txt ; list of person labels .... &END ....

..... * &END .... END LABELS (list of person labels or nothing)	END LABELS and in another file, eddata.txt, 1 1 A 1 5 B 2 3 A 2 10 C .....

Example 10: Item bank recalibration for computer-adaptive tests (CAT) or similar.

Here is a method is that maintains the accuracy of previously-reported person measures as much as possible:

1. collect up all the relevant data and format the data into a rectangular dataset or equivalent. EDFILE= is useful for this.
2. anchor all the persons at their report measures
3. anchor all items at their item-bank difficulties, and rating-scale structures (if polytomies) SAFILE=
4. analyze the dataset
5. the item displacements tell us which items have drifted by how much.
6. items with displacements of more than 0.5 logits, that are also bigger than the item S.E.s, are candidates for recalibration.
7. unanchor all the displaced items. Keep everything else anchored
8. reanalyze the dataset. The displaced items will now have revised difficulties in the context of the anchored persons.

11.41 EFILE= expected scores on items

EFILE=filename produces an output file containing the Rasch-model expected score on each item for the measures in the operational range of the set of items. Adjust the reported range of measures with MRANGE=. Please set UDECIMALS=4, so that you see the decimals.

Subsets of items can be reported by using IDELETE= or ISELECT= from the Specification menu.

Options using ETYPE=

ETYPE=E	Expected score on the item for the ability measure according to the Rasch model. For dichotomous items scored 0/1, this is the probability of success.
ETYPE=P	Most probable category on the item for the ability measure according to the Rasch model. If more than one category, then middle or immediately higher category is shown.
ETYPE=T	Thurstonian category on the item for the ability measure according to the Rasch model. If more than one category, then middle or immediately higher category is shown.

Example 1: ETYPE=E with dichotomous 0-1 items.

```
; EXPECTED SCORES FOR Knox Cube Test (Best Test Design p.31)
MEASURE  SCORE      4      5     14     15     16     17
  -7.00    .11    .07    .04    .00    .00    .00    .00
  -6.85    .12    .08    .04    .00    .00    .00    .00
  -6.70    .14    .09    .05    .00    .00    .00    .00
  -6.55    .16    .10    .06    .00    .00    .00    .00
.....
   7.70   5.74   1.00   1.00    .98    .92    .92    .92
   7.85   5.78   1.00   1.00    .98    .93    .93    .93
   8.00   5.81   1.00   1.00    .99    .94    .94    .94
```

MEASURE -7.00	ability measure in logits or user-scaled units (UIMEAN=, USCALE=)
SCORE .11	expected raw score = sum of expected scores on the items with item weighting if IWEIGHT=
4, 5, 14, 15, ...	item entry numbers

.07, .04, .00, ...	Rasch-model expected score or category on the item for the MEASURE

Example 2: Reckase Chart of Expected Scores on All Items for All Measures.
Reckase, M. D. (2001). Innovative methods for helping standard-setting participants to perform their task: The role of feedback regarding consistency, accuracy, and impact. In: Gregory J. Cizek (Ed.), Setting performance standards: Concepts methods and perspectives (pp. 159-173). Mahwah, NJ: Erlbaum.
MacCann & Stanley, "Rasch Standard Setting", Practical Assessment Research & Evaluation, 11, 2, 2, Table 1.

Example 3: Angoff standard-setting ratings to measures to cut-scores
In https://scholarworks.umas.edu/cgi/viewcontent.cgi?article=1188&context=par "The Use of Rasch Modeling To Improve Standard Setting", their Table 1 is the EFILE= output
Their Table 2 is deduced from the EFILE= output

Expected Score using Excel

Example of 5-category rating scale:

Column A: item difficulty
Column B: 1
Column C: exp(-item difficulty - threshold 1)
Column D: Column C * exp(-item difficulty - threshold 2)
Column E: Column D * exp(-item difficulty - threshold 3)
Column F: Column E * exp(-item difficulty - threshold 4)
Column G: Column B + C + D + E + F
Column H: (Column C + 2 * Column D + 3 * Column E + 4 * Column F) / Column G = Expected score

11.42 END LABELS or END NAMES

The first section of a control file contains control variables, one per line, and ends with &END. This is followed by the second section of item labels, one per line, matching the items in the analysis. This sections ends with END LABELS or END NAMES, which mean the same thing. The data can follow as a third section, or the data can be in a separate file specified by the control variable DATA=.

```
TITLE = "5 item test"
ITEM1 = 1
NI = 5
.....
&END
Addition  ; label for item 1
Subtraction ; label for item 2
Multiplication ; label for item 3
Division  ; label for item 4
Geometry ; label for item 5
END LABELS
.....  ; data here
```

11.43 EQFILE= code equivalences

This specifies that different demographic or item-type codes are to be reported as one code. This is useful for Tables 27, 28, 30, 31, 33 and Use EQFILE=filename or EQFILE=*, followed by a list, followed by a *. These values can be overwritten from the equivalence boxes in the DIF specifications dialog box (and similar) when invoking the Tables from the Output Tables menu.

EQFILE= file name	file containing details
EQFILE = *	in-line list
EQFILE = ?	opens a Browser window to find the file

The format is
@Field name = $S1W1   ; user defined field name and location, see selection rules.
EQFILE=* ; start of list
@Field name ; field to be referred to
Base Code Code Code Code ..... ; code list
Base Code Code Code Code .....
Base Code Code Code .....
@Field name ; field to be referred to
Base Code Code Code Code ..... ; code list
Base Code Code Code Code .....
Base Code Code Code Code .....
* ; end of list

where @Field name is the name of field in the person or item label, such as
@GENDER = $S1W1 ; M or F
@STRAND = $S10W2   ; 01 to 99

Base is the demographic or item-type code to be reported. It need not be present in a label
Code is a demographic or item-type code to be included with the Base code.

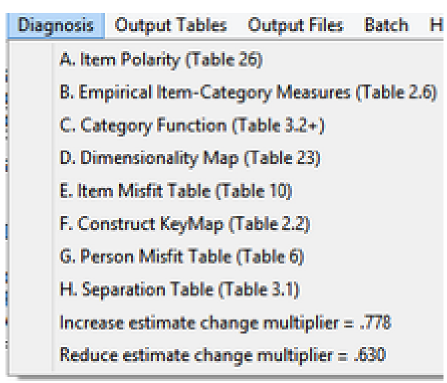
Example: gender in the data file is coded 1=Male, 2=Female, but to be reported as M or F

@GENDER = $S1W1 ; or wherever it is in the person label
EQFILE=*
@GENDER
M 1
F 2
*

11.44 ESTMULT= estimate change multiplier

During the JMLE estimation procedure, the measure estimates are improved each traversal of the data. The changes to the item and person estimates are computed by comparing the observed scores against the expected scores based on the current estimates. The changes are computed by curve-fitting. This process is not exact, so the changes are reduced by a factor of 0.7, the default value of ESTMULT=. This is to prevent changes becoming too big. But, if convergence (agreement between observed and expected scores) is happening too slowly, then higher values of ESTMULT= may be helpful.

During JMLE iterations, ESTMULT= can be increased or reduced using the Diagnosis Menu. When DIVAUTO=Yes, changes to ESTMULT= are made automaitcally



ESTMULT = 0.7	the default estimation-change multiplier
ESTMULT = 0.1 - 0.6	changes to estimates are smaller. More iterations to convergence
ESTMULT = 0.8 - 1.0	changes to estimates are bigger. Perhaps fewer iterations to convergence, but may diverge

ESTMULT = 1.1 - 2.0	changes to estimates are so big that estimates may overshoot so that estimates become worse and convergence is never reached. Reduce ESTMULT= in the Diagnosis Menu.when near to convergence

Example with large dataset:

Default control variable	`DIVAUTO=No ; do not allow automatic changes to ESTMULT=`	
In the Estimation window on change:	`>=== ESTMULT = .778` `=====================================================<`	
ESTMULT= value	`JMLE ITERATION  MAX SCORE RESIDUAL*  MAX LOGIT CHANGE`	Comment

ESTMULT= 0.7 (default)	`7  -2507.00  .0008`
	`8  -2488.50  .0007`
	`9  -2450.00  .0007`
	`10  -2419.00  .0007`
	`11  -2386.00  .0007`
		Slow, but safe

ESTMULT= 1.064	`31  -1757.50  .0008`
	`32  -1563.50  .0008`
	`33  -1704.00  .0007`
	`34  -1474.00  .0007`
	`35  -1657.50  .0007`
	`36  -1384.00  .0007`
		Faster, but unstable

ESTMULT= 0.960	`47  -1214.00  .0005`
	`48  -1192.50  .0005`
	`49  -1167.00  .0005`
	`50  -1146.50  .0005`
	`51  -1123.00  .0004`
	`52  -1102.50  .0004`
		Slow, safe (but see below)

ESTMULT= 1.185	`83  -773.00  .0004`
	`84  -250.00  .0004`
	`85  -927.00  .0004`
	`86  21.00  .0005`
	`87  -1232.00  .0006`
	`88  490.00  .0007`
	`89  -1809.00  .0009`
	`90  1326.50  .0011`
	`91  -2884.50  .0014`
	`.....`
	`104  119828.00  .0584`
		Very fast, but diverges
		← Diverging: Reduce estimation change multiplier ESTMULT= in the Diagnosis Menu.

ESTMULT= 0.960	`106  159415.00  .0718`
	`107  -144812.50  -.0567`
	`108  129760.50  .0513`
	`109  -117978.50  -.0460`
	`110  105562.00  .0418`
	`111  -96084.50  -.0374`
	`112  85834.50  .0340`
		Fast, unstable, usually converges

11.45 ETYPE= option for EFILE=

See EFILE=

11.46 EXCAT= extreme category adjustment

When using Rasch measures for prediction, slightly better results have been obtained when the measure estimates are based on adjusted data. A productive adjustment makes observations in extreme categories slightly less extreme.

EXCAT= 0	observations in the top and bottom categories of a rating scale or dichotomy are not adjusted
EXCAT= 0.25 (or any value between 0 and 1)	observations in the top and bottom categories are made more central by EXCAT= score points

Example: EXCAT=0.25

Dichotomies: 0,1 data are analyzed as 0.25,0.75 data. The observed raw scores are the sums of these values. The category frequencies are: 0 becomes 0.75*0 and 0.25*1, 1 becomes, 0.25*0, 0.75*1.

Rating scale: 1,2,3,4 data are analyzed as 1.25,2,3,3.75 data. The observed raw scores are the sums of these values. The category frequencies are: 1 becomes 0.75*1 and 0.25*2, 4 becomes, 0.25*3, 0.75*4.

11.47 EXCELDECIMAL= decimal separator for Excel spreadsheets

The default decimal separator for numbers on Excel spreadsheets is the decimal point ".".

If your Excel spreadsheets use decimal commas, then include in your Winsteps control file:

EXCELDECIMAL=Comma or EXCELDECIMAL=, or EXCELDECIMAL=","
or
At the Extra Specifications prompt: EXCELDECIMAL=Comma or EXCELDECIMAL=","
or
At "Edit Initial Settings": click on Decimal Comma
or
In the "Output Files" dialog box, click on Decimal Comma

11.48 EXCELNUMBER= Excel converts numeric labels into numbers

When person and items labels are output to Excel using IFILE= and PFILE=, numerical labels can be stored as characters or numerical values.

EXCELNUMBER = No (default)	Person and items labels become Excel text. An underline _ may be appended to the label to prevent Excel converting long numbers into numerical values. Excel is allowed to convert short numbers into numerical values. 1234 becomes a numerical value 0123 becomes 0123_ 123456 becomes 123456_ You can "replace all" in Excel to remove the _
EXCELNUMBER = Yes	Allows Excel to convert labels that look like numbers into numerical values.

11.49 EXTRSC= extreme score correction for extreme measures

EXTRSCORE= is the fractional score point value to subtract from perfect (maximum possible) scores, and to add to zero (minimum possible) scores, in order to estimate finite values for extreme scores (formerly MMADJ=). Look at the location of the E's in the tails of the test ogive in Table 20. If they look too far away, increase EXTRSC= by 0.1. If they look too bunched up, reduce EXTRSCORE= by 0.1.

The measure corresponding to an extreme (maximum or minimum) score is not estimable, but the measure corresponding to a score a little less than maximum, or a little more than minimum, is estimable, and is often a useful measure to report.

Persons with extreme scores are omitted from estimating item difficulties and item fit statistics. Items with extreme score are omitted from estimating person abilities and person fit statistics. This is because persons with extreme scores are uninformative about the relative difficulty of the items, and items with extreme scores are uninformative about the relative difficulty of the ites.

This is how Winsteps handles extreme scores. In Rasch theory, an extreme score (maximum possible score or minimum possible score) on a set of items corresponds to an infinite ability measure (theta). This is impractical and also misleading in most situations. So Winsteps takes the following action:

If the score is maximum possible, then Winsteps estimates the ability measure for the score (maximum possible - EXTRSCORE) where EXTRSCORE is a small adjustment to the score. Usually EXTRSCORE = 0.3 score-points. The reasonable range of EXTRSCORE is 0.1 to 0.5.

If the score is minimum possible, then Winsteps estimates the ability measure for the score (minimum possible + EXTRSC)

So in one line, this becomes:
Score for estimation = Maximum (Minimum(observed score, maximum possible score - EXTRSCORE) , minimum possible score + EXTRSCORE)

The actual ability measure corresponding to an adjusted extreme score or any other score depends on the spread of the items, but it is at least Ln((score for estimation - minimum possible score)/(maximum possible score - score for estimation)) away from the mean item difficulty.

Rasch programs differ in the way they estimate measures for extreme scores. Adjustment to the value of EXTRSC= can enable a close match to be made to the results produced by other programs.

There is no "correct" answer to the question: "How large should extreme score adjustments be?" The most conservative value, and that recommended by Joseph Berkson, is 0.5. Some work by John Tukey indicates that 0.167 is a reasonable value. The smaller you set EXTRSC=, the further away measures corresponding to extreme scores will be located from the other measures and the larger the S.E.s. The technique used here is Strategy 1 in *www.rasch.org/rmt/rmt122h.htm*. The default value in Bigsteps was 0.5.

Weighted items or persons: the extreme score adjustment is multiplied by the smallest non-zero item weight for items with extreme scores, and the smallest non-zero person weight for persons with extreme scores.

See also: G.H. Fischer , On the existence and uniqueness of maximum-likelihood estimates in the Rasch model. Psychometrika 46 (1981), pp. 59–77

Treatment of Extreme Scores	Tables	Output files
Placed at extremes of map	1, 12, 16	
Reported by estimated measure	2, 3, 13, 14, 15, 17, 18, 19, 20, 22, 25, 28, 29, 30, 31, 33, 34, 35, 36	IFILE=, ISFILE=, PFILE=, RFILE=, XFILE=
Omitted	4, 5, 6, 7, 8, 9, 10, 11, 21, 23, 24, 26	SFILE=

Example 1: You wish to estimate conservative finite measures for extreme scores by subtracting 0.4 score points from each perfect score and adding 0.4 score points to each zero person score.
EXTRSCORE=0.4

Example 2: With the standard value of EXTRSCORE=, this Table is produced:

```
+-------------------------------------------------------------------------+
|ENTRY    RAW                           |   INFIT  |  OUTFIT  |PTBSE|        |
|NUMBER  SCORE  COUNT  MEASURE   ERROR|MNSQ  ZSTD|MNSQ  ZSTD|CORR.| PERSON |
|------------------------------------+----------+----------+-----+--------|
|    46     60     20     7.23    1.88| MAXIMUM ESTIMATED MEASURE | XPQ003 |
|    94     62     21     5.83    1.12| .44   -.9| .08   -.6|  .62| XPQ011 |
|    86     18      6     5.11    1.90| MAXIMUM ESTIMATED MEASURE | XPQ009 |
|    64     50     17     4.94    1.09| .53   -.7| .13   -.6|  .60| XPQ006 |
```

Here, the 5.11 corresponds to a perfect score on 6 easier items. The 5.83 was obtained on 21 harder items (perhaps including the 6 easier items.) To adjust the "MAXIMUM ESTIMATED" to higher measures, lower the value of EXTRSCORE=, e.g., to EXTRSCORE=0.2

Example 3. EXTRSCORE= is applied to the response string as observed. So, imagine that Mary is administered 5 dichotomous items out of a pool of 100 items and scores R on the 5 items. Her estimate will be based on:
Score for estimation = Maximum (Minimum(R, 5 - EXTRSCORE) , 0 + EXTRSCORE)

11.50 FITHIGH= higher bar in charts

Use FITHIGH= to position the higher acceptance bars in Tables like 6.2. Use FITLOW= to position the lower bar.

FITHIGH=0 cancels the instruction.

Example: We want the lower mean-square acceptance bar to be shown at 1.4
FITHIGH=1.4 ; show higher fit bar
CHART=YES ; produce Tables like 6.2

```
        ACTS FIT GRAPH:  MISFIT ORDER
+----------------------------------------------------------------------------------------+
|ENTRY | MEASURE |  INFIT MEAN-SQUARE  | OUTFIT MEAN-SQUARE  |                           |
|NUMBER| -     + |0.0       1  1.4    2|0.0       1  1.4    2| ACTS                    G |
|------+---------+---------------------+---------------------+---------------------------|
|    23|        *|:         .   :     *|:         .   :     *| WATCH A RAT             0 |
|     5|        *|:         .   :     *|:         .   :     *| FIND BOTTLES AND CANS   0 |
|    20|       * |:         .  *:      |:         .   :  *   | WATCH BUGS              0 |
|    18|*        |:         . * :      |:         .*  :      | GO ON PICNIC            0 |
|     8|       * |:         .*  :      |:         . * :      | LOOK IN SIDEWALK CRACKS 0 |
```

11.51 FITI= item misfit criterion

Specifies the minimum *t* standardized fit value at which items are selected for reporting as misfits. For Table 10, the table of item calibrations in fit order, an item is omitted only if the absolute values of both *t* standardized fit statistics are less than FITI=, and both mean-square statistics are closer to 1 than (FITI=)/10, and the item point-biserial correlation is positive. The 26 most underfitting items (high mean-squares) and 26 most overfitting items (low mean-squares) are always reported.

For Table 11, the diagnosis of misfitting items, all items with a *t* standardized fit greater than FITI= are reported. Selection is based on the OUTFIT statistic, unless you set OUTFIT=N in which case the INFIT statistic is used. If MNSQ=YES, then selection is based on the mean-square value: 1 + FITI=/10.

Example 1: You wish to focus on grossly "noisy" items in Tables 10 and 11.
FITI=4 an extreme positive value

Example 2: You wish to include all items in Tables 10 and 11.
FITI= 0

11.52 FITLOW= lower bar in charts

Use FITLOW= to position the lower acceptance bars in Tables like 6.2. Use FITHIGH= to position the higher bar.

FITLOW=0 cancels the instruction.

Example: We want the lower mean-square acceptance bar to be shown at 0.6
FITLOW=0.6 ; show lower fit bar
CHART=YES ; produce Tables like 6.2

```
         PUPIL FIT GRAPH:  MISFIT ORDER
+------------------------------------------------------------------------------------------+
|ENTRY | MEASURE |  INFIT MEAN-SQUARE  | OUTFIT MEAN-SQUARE  |                             |
|NUMBER| -     + | .0  0.6  1        :2| .0  0.6  1        :2| PUPIL                       |
|------+---------+---------------------+---------------------+-----------------------------|
```

```
|     46|   *       |         :    .    *         |T       :     .*           | MULLER, JEFF                  |
|     26|   *       |         :*   .              |U       :     .  *         | NEIMAN, RAYMOND               |
|     30| *         |         :    *              |V       :     .  *         | NORDGREN, JAN SWEDE           |
|     23|     *     |      * :    .              |c   *   :     .            | VROOM, JEFF                   |
|     22|    *      |    *  :    .               |b *     :     .            | HOGAN, Kathleen               |
|     21|   *       |  *    :    .               |a *     :     .            | RISEN, NORM L.                |
```

11.53 FITP= person misfit criterion

Specifies the minimum *t* standardized fit value at which persons are selected for reporting as misfits. For Table 6, person measures in fit order, a person is omitted only if the absolute values of both *t* standardized fit statistics are less than FITP=, and both mean-square statistics are closer to 1 than (FITP=)/10, and the person point-biserial correlation is positive. The 26 most underfitting persons(high mean-squares) and 26 most overfitting persons (low mean-squares) are always reported.

For Table 7, the diagnosis of misfitting persons, with a *t* standardized fit greater than FITP= are reported. Selection is based on the OUTFIT statistic, unless you set OUTFIT=N in which case the INFIT statistic is used. If MNSQ=YES, then selection is based on the mean-square value: 1 + FITP=/10.

Example 1: You wish to examine wildly guessing persons in Tables 6 and 7.
  FITP= 3 an extreme positive value

Example 2: You wish to include all persons in Tables 6 and 7.
  FITP= 0

11.54 FORMAT= reformat data

Enables you to process awkwardly formatted data! ***But MFORMS= is easier***

FORMAT= is rarely needed when there is one data line per person.

Place the data in a separate DATA= file, then the Winsteps screen file will show the first record before and after FORMAT=. The formatted data records are also shown from the Edit menu, Formatted Data=.

Control instructions to pick out every other character for 25 two-character responses, then a blank, and then the person label:

```
 XWIDE=1
 data=datafile.txt
 format=(T2,25(1A,1X),T90,1A,T11,30A)
```

This displays on the Winsteps screen:

```
Opening: datafile.txt
Input Data Record before FORMAT=:
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890
----------------------------------------------------------------------
01xx 1x1 10002000102020202000201010202000201000200ROSSNER, MARC DANIEL
Input Data Record after FORMAT=:
1x11102012222021122021020 L
^I                      ^N^P
```

^I is Item1= column
^N is the last item according to NI=
^P is Name1= column

FORMAT= enables you to reformat one or more data record lines into one new line in which all the component parts of the person information are in one person-id field, and all the responses are put together into one continuous item-response string. A FORMAT= statement is required if
1) each person's responses take up several lines in your data file.
2) if the length of a single line in your data file is more than 10000 characters.

3) the person-id field or the item responses are not in one continuous string of characters.
4) you want to rearrange the order of your items in your data record, to pick out sub-tests, or to move a set of connected forms into one complete matrix.
5) you only want to analyze the responses of every second, or nth, person.

FORMAT= contains up to 512 characters of reformatting instructions, contained within (..), which follow special rules. Instructions are:

nA	read in n characters starting with the current column, and then advance to the next column after them. Processing starts from column 1 of the first line, so that 5A reads in 5 characters and advances to the sixth column.
nX	means skip over n columns. E.g. 5X means bypass this column and the next 4 columns.
Tc	go to column c. T20 means get the next character from column 20. T55 means "tab" to column 55, not "tab" passed 55 columns (which is TR55).
TLc	go c columns to the left. TL20 means get the next character the column which is 20 columns to the left of the current position.
TRc	go c columns to the right. TR20 means get the next character the column which is 20 columns to the right of the current position.
/	means go to column 1 of the next line in your data file.
n(..)	repeat the string of instructions within the () exactly n times.
,	a comma is used to separate the instructions.
	Set XWIDE=2 and you can reformat your data from original 1 or 2 column entries. Your data will all be analyzed as XWIDE=2. Then:
nA2	read in n pairs of characters starting with the current column into n 2-character fields of the formatted record. (For responses with a width of 2 columns.)
A1	read in n 1-character columns, starting with the current column, into n 2-character fields of the formatted record.

Always use nA1 for person-id information. Use nA1 for responses entered with a width of 1-character when there are also 2-character responses to be analyzed. When responses in 1-character format are converted into 2-character field format (compatible with XWIDE=2), the 1-character response is placed in the first, left, character position of the 2-character field, and the second, right, character position of the field is left blank. For example, the 1-character code of "A" becomes the 2-character field "A ". Valid 1-character responses of "A", "B", "C", "D" must be indicated by CODES="A B C D " with a blank following each letter.

ITEM1= must be the column number of the first item response in the formatted record created by the FORMAT= statement. NAME1= must be the column number of the first character of the person-id in the formatted record.

Example 1: Each person's data record file is 80 characters long and takes up one line in your data file. The person-id is in columns 61-80. The 56 item responses are in columns 5-60. Codes are "A", "B", "C", "D". No FORMAT= is needed. Data look like:

```
xxxxDCBDABCADCDBACDADABDADCDADDCCDADDCAABCADCCBBDADCACDBBADCZarathrustra-Xerxes
```

Without FORMAT=

```
XWIDE=1 response width (the standard)
ITEM1=5 start of item responses
NI=56  number of items
NAME1=61 start of name
NAMLEN=20 length of name
CODES=ABCD valid response codes
```

With FORMAT=
Reformatted record will look like:

```
DCBDABCADCDBACDADABDADCDADDCCDADDCAABCADCCBBDADCACDBBADCZarathrustra-Xerxes
   XWIDE=1 response width (the standard)
   FORMAT=(4X,56A,20A) skip unused characters
   ITEM1=1 start of item responses
   NI=56  number of items
   NAME1=57 start of name
```

```
   NAMLEN=20 length of name
   CODES=ABCD valid response codes
```

Example 2: Each data record is one line of 80 characters. The person-id is in columns 61-80. The 28 item responses are in columns 5-60, each 2 characters wide. Codes are " A", " B", " C", " D". No FORMAT= is necessary. Data look like:

```
xxxx C D B A C B C A A D D D D C D D C A C D C B A C C B A CZarathrustra-Xerxes
```

Without FORMAT=

```
   XWIDE=2 response width
   ITEM1=5 start of item responses
   NI=28  number of items
   NAME1=61 start of name
   NAMLEN=20 length of name
   CODES=" A B C D" valid response codes
```

With FORMAT=

Columns of reformatted record:

```
1-2-3-4-5-6-7-8-9-0-1-2-3-4-5-6-7-8-9-0-1-2-3-4-5-6-7-8-90123456789012345678
 C D B A C B C A A D D D D C D D C A C D C B A C C B A CZarathrustra-Xerxes
   XWIDE=2 response width
   FORMAT=(4X,28A2,20A1) skip unused characters
   ITEM1=1 start of item responses in formatted record
   NI=28  number of items
   NAME1=29 start of name in "columns"
   NAMLEN=20 length of name
   CODES=" A B C D" valid response codes
```

Example 3: Each person's data record is 80 characters long and takes one line in your data file. Person-id is in columns 61-80. 30 1-character item responses, "A", "B", "C" or "D", are in columns 5-34, 13 2-character item responses, "01", "02" or "99", are in 35-60.

```
xxxxDCBDABCADCDBACDADABDADCDADDCCA019902010199020101990202O1Zarathrustra-Xerxes.
```

becomes on reformatting:

Columns:

```
1234567890123456789012345678901-2-3-4-5-6-7-8-9-0-1-2-3-4567890123456789O123
DCBDABCADCDBACDADABDADCDADDCCA01990201019902010199020201Zarathrustra-Xerxes


   XWIDE=2 analyzed response width
   FORMAT=(4X,30A1,13A2,20A1) skip unused
   ITEM1=1 start of item responses in formatted record
   NI=43  number of items
   NAME1=44 start of name
   NAMLEN=20 length of name
   CODES="A B C D 010299" valid responses
     ^ 1-character code followed by blank
```

Example 4: The person-id is 10 columns wide in columns 15-24 and the 50 1-column item responses, "A", "B", "C", "D", are in columns 4000-4019, then in 4021-50. Data look like:

```
xxxxxxxxxxxxxxJohn-Smithxxxx....xxxDCBACDADABCADCBCDABDxBDCBDADCBDABDCDDADCDADBBDCDABB
```

becomes on reformatting:

```
John-SmithDCBACDADABCADCBCDABDBDCBDADCBDABDCDDADCDADBBDCDABB
   FORMAT=(T15,10A,T4000,20A,1X,30A)
   NAME1=1 start of person name in formatted record
   NAMLEN=10 length of name (automatic)
   ITEM1=11 start of items in formatted record
   NI=50  50 item responses
   CODES=ABCD valid response codes
```

Example 5: There are five records or lines in your data file per person. There are 100 items. Items 1-20 are in columns 25-44 of first record; items 21-40 are in columns 25-44 of second record, etc. The 10 character person-id is in columns 51-60 of the last (fifth) record. Codes are "A", "B", "C", "D". Data look like:

```
xxxxxxxxxxxxxxxxxxxxxxxxACDBACDBACDCABACDACD
xxxxxxxxxxxxxxxxxxxxxxxxDABCDBACDBACDCABACDA
xxxxxxxxxxxxxxxxxxxxxxxxACDBACDBACDCABACDACD
```

```
xxxxxxxxxxxxxxxxxxxxxxxxDABCDBACDBACDCABACDA
xxxxxxxxxxxxxxxxxxxxxxxxABCDBACDBACDCABACDADxxxxxxMary-Jones
```

becomes:

```
ACDBACDBACDCABACDACDDABCDBACDBACDCABACDAACDBACDBACDCABACDACDDABCDBACDBACDCABACDAABCDBACDBACDCABACDADMary-Jones
```

```
FORMAT=(4(T25,20A,/),T25,20A,T51,10A)
ITEM1=1 start of item responses
NI=100  number of item responses
NAME1=101 start of person name in formatted record
NAMLEN=10 length of person name
CODES=ABCD valid response codes
```

Example 6: There are three lines per person. In the first line from columns 31 to 50 are 10 item responses, each 2 columns wide. Person-id is in the second line in columns 5 to 17. The third line is to be skipped. Codes are "A ", "B ", "C ", "D ". Data look like:

```
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx A C B D A D C B A Dxxxxxxxx
xxxxJoseph-Carlosxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
```

becomes:

Columns:

```
1-2-3-4-5-6-7-8-9-0-1234567890123
 A C B D A D C B A DJoseph-Carlos
```

```
FORMAT=(T31,10A2,/,T5,13A1,/)
ITEM1=1 start of item responses
NI=10  number of items
XWIDE=2 2 columns per response
NAME1=11 starting "A" of person name
NAMLEN=13 length of person name
CODES='A B C D ' valid response codes
```

If the third line isn't skipped, format a redundant extra column in the skipped last line. Replace the first control variable in this with:

```
FORMAT=(T31,10A2,/,T5,13A1,/,A1) last A1 unused
```

Example 7: **Pseudo-random data selection**

To skip every other record, use (for most situations):

```
FORMAT=(500A, /) ; skips every second record of two
```

or

```
FORMAT=(/, 500A) ; skips every first record of two
```

You have a file with 1,000 person records. This time you want to analyze every 10th record, beginning with the 3rd person in the file, i.e., skip two records, analyze one record, skip seven records, and so on. The data records are 500 characters long.

```
   XWIDE = 1
   FORMAT = (/,/,500A,/,/,/,/,/,/,/)
 or
   XWIDE = 2
   FORMAT = (/,/,100A2,300A1,/,/,/,/,/,/,/) ; 100 2-character responses, 300 other columns
```

Example 8: Test A, in file EXAM10A.TXT, and TEST B, in EXAM10B.TXT, are both 20 item tests. They have 5 items in common, but the distractors are not necessarily in the same order. The responses must be scored on an individual test basis. Also the validity of each test is to be examined separately. Then one combined analysis is wanted to equate the tests and obtain bankable item difficulties. For each file of original test responses, the person information is in columns 1-25, the item responses in 41-60.

The combined data file specified in EXAM10C.TXT, is to be in RFILE= format. It contains

Person information 30 characters (always)
Item responses Columns 31-64

The identification of the common items is:

Test Item Number (=Location in item string)							
Bank	1	2	3	4	5	6-20	21-35
A:	3	1	7	8	9	2, 4-6, 10-20	
B:	4	5	6	2	11		1, 3, 7-10, 12-20

I. From Test A, make a response (RFILE=) file rearranging the items with FORMAT=.

```
; This file is EXAM10A.TXT
&INST
TITLE="Analysis of Test A"
RFILE=EXAM10AR.TXT ; The constructed response file for Test A
NI=20
FORMAT=(25A,T43,A,T41,A,T47,3A,T42,A,T44,3A,T50,11A)
ITEM1=26  ; Items start in column 26 of reformatted record
CODES=ABCD#  ; Beware of blanks meaning wrong!
; Use your editor to convert all "wrong" blanks into another code,
; e.g., #, so that they will be scored wrong and not ignored as missing.
KEYFRM=1  ; Key in data record format
&END
Key 1 Record                            CCBDACABDADCBDCABBCA
BANK 1   TEST A 3 ; first item name
 .
BANK 20  TEST A 20
END NAMES
Person 01 A                             BDABCDBDDACDBCACBDBA
 .
Person 12 A                             BADCACADCDABDDDCBACA
```

The RFILE= file, EXAM10AR.TXT, is:

```
Person 01 A                   00001000010010001001
Person 02 A                   00000100001110100111
   .
Person 12 A                   00100001100001001011
```

II. From Test B, make a response (RFILE=) file rearranging the items with FORMAT=. Responses unique to Test A are filled with 15 blank responses to dummy items.

```
; This file is EXAM10B.TXT
&INST
TITLE="Analysis of Test B"
RFILE=EXAM10BR.TXT ; The constructed response file for Test B
NI=35
FORMAT=(25A,T44,3A,T42,A,T51,A,T100,15A,T41,A,T43,A,T47,4A,T52,9A)
   ; Blanks are imported from an unused part of the data record to the right!
   ; T100 means "go beyond the end of the data record"
   ; 15A means "get 15 blank spaces"
ITEM1=26  ; Items start in column 26 of reformatted record
CODES=ABCD#  ; Beware of blanks meaning wrong!
KEYFRM=1  ; Key in data record format
&END
Key 1 Record                            CDABCDBDABCADCBDBCAD
BANK 1   TEST B 4
  .
BANK 5   TEST B 11
BANK 6   TEST A 2
  .
BANK 20  TEST A 20
```

```
BANK 21  TEST B 1
  .
BANK 35  TEST B 20
END NAMES
Person 01 B                        BDABDDCDBBCCCCDAACBC
  .
Person 12 B                        BADABBADCBADBDBBBBBB
```

The RFILE= file, EXAM10BR.TXT, is:

```
Person 01 B               10111               010101001000100
Person 02 B               00000               010000000001000
  .
Person 11 B               00010               001000000000100
Person 12 B               00000               000101000101000
```

III. Analyze Test A's and Test B's RFILE='s together:

```
; This file is EXAM10C.TXT
&INST
TITLE="Analysis of Tests A & B (already scored)"
NI=35
ITEM1=31  ; Items start in column 31 of RFILE=
CODES=01  ; Blanks mean "not in this test"
DATA=EXAM10AR.TXT+EXAM10BR.TXT ; Combine data files

; or, first, at the DOS prompt,
;  C:> COPY EXAM10AR.TXT+EXAM10BR.TXT EXAM10AB.TXT(Enter)
; then, in EXAM10C.TXT,
;  DATA=EXAM10AB.TXT

PFILE=EXAM10CP.TXT ; Person measures for combined tests
IFILE=EXAM10CI.TXT ; Item calibrations for combined tests
tfile=*  ; List of desired tables
3   ; Table 3.1 for summary statistics, 3.2, ...
10   ; Table 10 for item structure
*
PRCOMP=S  ; Principal components/contrast analysis with standardized residuals
&END
BANK 1   TEST A 3 B 4
  .
BANK 35  TEST B 20
END NAMES
```

Shortening FORMAT= statements

If the required FORMAT= statement exceeds 512 characters, consider using this technique:

Relocate an entire item response string, but use an IDFILE= to delete the duplicate items, i.e., replace them by blanks. E.g., for Test B, instead of

```
 FORMAT=(25A, T44,3A,T42,A,T51,A, T100,15A, 41,A,T43,A,T47,4A,T52,9A)
 NI=35
```

Put Test 2 as items 21-40 in columns 51 through 70:

```
 FORMAT=(25A, T44,3A,T42,A,T51,A, T100,15A, T41,20A)
 NI=40
```

Blank out (delete) the 5 duplicated items with an IDFILE= containing:

```
 24-26
 22
 31
```

11.55 FORMFEED= the form feed character

Do not change FORMFEED= unless you have problems printing the tables or importing them into some other program.

The form feed character indicates the start of a new page of print-out. The DOS standard is Ctrl+L (ASCII 12) which is what represented by ^ (Shift+6). The DOS standard is understood by most word-processing software and PC printers as the instruction to skip to the top of a new page, i.e., form feed. The ASA (FORTRAN) form feed character is 1.

Notepad does not have a "form feed" or page advance feature. You must put extra blank lines in the output files.

Example 1: You want your EPSON LQ-500 printer to form feed automatically at each new page of output. (You have already set the printer to use compressed print, at 15 cpi, because output lines contain up to 132 characters):
FORMFEED=^ (the standard)

Example 2: Your main-frame software understands a "1" in the first position of a line of print-out to indicate the top of a new page:
FORMFEED=1

Example 3: You do not want a form-feed character:
FORMFEED=

11.56 FRANGE= half-range of fit statistics on plots

Specifies the t standardized fit Y-axis half-range, (i.e. range away from the origin), for the t standardized fit plots. FRANGE= is in units of t standardized fit (i.e., expected mean = 0, standard deviation = 1).

Example: You want the fit plots to display from -3 to +3 units of t standardized fit:
FRANGE=3

11.57 FREQUENT= heading in Tables 1, 12, 16

Please see MORE=

11.58 FSHOW= show files created from control file

When files are created from a control variable in the control file are not immediately displayed in a window unless FSHOW=Yes.

Files can be displayed from the Edit Menu.

Example: The PFILE= is specified in the control file, and is to be displayed as soon as it is created:

PFILE= examineelist.txt
FSHOW=Yes ; display immediately

11.59 GRFILE= probability curve coordinate output file

If GRFILE=filename is specified, a file is output which contains a list of measures relative to item difficulty (x-axis coordinates) and corresponding expected scores and category probabilities (y-axis coordinates) to enable you to use your own plotting program to produce item-category plots like those in the Graphs menu.

GRFILE=? opens a Browse window

Column Heading	Column Contents	Fixed Columns
ITEM (or ITEM= value)	Item number	6

MEAS (Measure without item difficulty added) MEAS+ (Measure with item difficulty added)	IADD=No (default): The measure relative to item difficulty (user-rescaled by USCALE=) with UDECIMALS= decimal places. The plotted range is at least MRANGE= away from its center. **IADD=Yes adds the item difficulty** to MEAS for absolute measure relative to the latent variable.	7
SCOR (Score)	Expected score for the Modeled Item Characteristic Curve (ICC) or Item Response Function (IRF).	7
INFO (Information)	Statistical information for Item Information Function. Sum these for all items for the Test Information Function (TIF).	7
0 (Category number)	Probability of observing lowest category	7
1, 2, etc. (Category numbers)	Probability of observing higher categories	7
If CSV=Y, values are separated by commas. When CSV=T, values are separated by tab characters.		

For the numbers plotted for empirical ICCs, see the "Empirical ICC" plot, "Copy data to Clipboard"

Example 1: You wish to write a file on disk called "MYDATAGR.txt" containing x- and y-**coordinates for plotting** a generic item's category response curves and its item information function. Item difficulty is not added.

```
IADD=No
GRFILE=MYDATAGR.txt
```

With CSV=Y

```
"PROBABILITY CURVES FOR LIKING FOR SCIENCE (Wright & Masters p.18) Aug 13 2023 12:40"
"ITEM","MEASURE","SCORE","INFORMATION",0,1,2
1,-4.00,.0420,.0409,.9583,.0414,.0003
1,-3.99,.0423,.0412,.9580,.0417,.0003
1,-3.98,.0427,.0415,.9577,.0420,.0003
1,-3.98,.0430,.0418,.9573,.0423,.0003
1,-3.97,.0433,.0421,.9570,.0427,.0003
```

With CSV=N (fixed spacing)

```
; PROBABILITY CURVES FOR LIKING FOR SCIENCE (Wright & Masters p.18) Aug 13 2023 12:40
   ACT    MEAS    SCOR    INFO       0       1       2
     1   -4.00   .0420   .0409   .9583   .0414   .0003
     1   -3.99   .0423   .0412   .9580   .0417   .0003
     1   -3.98   .0427   .0415   .9577   .0420   .0003
     1   -3.98   .0430   .0418   .9573   .0423   .0003
     1   -3.97   .0433   .0421   .9570   .0427   .0003
```

Example 2: I want the **information function for every item** in my test relative to the latent variable (absolute x-axis).

```
IADD=Yes  ; item difficulty is added
GRFILE=MYDATAGR.txt
```

Columns: ITEM, MEAS, INFO

```
; PROBABILITY CURVES FOR LIKING FOR SCIENCE (Wright & Masters p.18) Aug 13 2023 12:40
   ACT   MEAS+    SCOR    INFO       0       1       2
     1   -7.40   .0021   .0021   .9979   .0021   .0000
     1   -7.38   .0022   .0022   .9978   .0022   .0000
     1   -7.37   .0022   .0022   .9978   .0022   .0000
     1   -7.36   .0022   .0022   .9978   .0022   .0000
     1   -7.34   .0023   .0023   .9977   .0023   .0000
```

Example 3:The **Category Information Functions** are the item information function multiplied by the category probability for each category for each measure. Use Excel for the calculation.

IADD=Yes
GRFILE=MYDATAGR.xls

11.60 GROUPS= or ISGROUPS= assigns items to rating scale groupings

See ISGROUPS=

11.61 GRPFROM= location of ISGROUPS

Only use this if you have too many items to put conveniently on one line of the ISGROUPS= control variable.

Instructs where to find the ISGROUPS= information.
GRPFROM=N
ISGROUPS= is a control variable before &END (the standard).

GRPFROM=Y
ISGROUPS= information follows just after &END, but before the item names. It is formatted exactly like a data record. It is helpful to enter "ISGROUPS=", for reference, where the person name would go.

Example: An attitude survey of 10 items with 3 rating scale definitions. Items 1 through 3 on Rating Scale 1, items 4 through 6 on Rating Scale 2 and items 7 through 10 on Rating Scale 3. The ISGROUPS= information is formatted like a data record and entered after &END and before the item names. The responses are in columns 1-10, and the person-id in column 11 onwards.

```
NAME1=11  start of person-id
ITEM1=1  start of responses
NI=10   number of items
CODES=12345  valid responses
GRPFRM=Y  ISGROUPS= formatted like data
&END
1112223333  ISGROUPS= information
Item name 1  item names
|
Item name 10
END NAMES
2213243223 John Smith first data record
|
```

11.62 GUFILE= (G0ZONE=, G1ZONE=) Guttmanized response file

This writes out the response file edited to more closely match an ideal Guttman scalogram. It is in a format close to the original data file, with items and person in entry order.

For counts of Guttman errors.

GUFILE=? opens a Browse window

Outlying 1's are converted to 0's according to G0ZONE=
Outlying 0's are converted to 1's according to G1ZONE=

This removes unlikely 1's in the G0ZONE (e.g., lucky guesses)
and unlikely 0's in the G1ZONE (e.g. careless mistakes)

It is also useful for imputing theories about item hierarchies.

G0ZONE= sets the % of observed 0's, starting from the "difficult" side of the Guttman scalogram, among which all 1's are turned to 0's. (The item hierarchy is constructed with the current data, but can be enforced through anchoring.) Standard value is 50.

G1ZONE= sets the % of observed 1's, starting from the "easy" side of the Guttman scalogram, among which all 0's are turned to 1's. Standard value is 50.

Example:
GUFILE= guttman.txt
G0ZONE = 20%
G1ZONE = 40%

Original data (Guttman ordered)
```
11100110011001001010
```
becomes
```
11111110011001001000
```

The file format matches the input data file if both are in fixed-field format.
When GUFILE= is written with CSV=Y, comma-separated or CSV=T, tab-separated, the item responses precede the person label.

Example: KCT.txt Guttmanized with fixed field format:
```
Richard M 111111100000000000
Tracie  F 111111111100000000
Walter  M 111111111001000000
```

KCT.txt Guttmanized with comma-separated, CSV=Y, format:
```
1,1,1,1,1,1,1,0,0,0,0,0,0,0,0,0,0,0,Richard M
1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0,0,Tracie  F
1,1,1,1,1,1,1,1,1,0,0,1,0,0,0,0,0,0,Walter  M
```

11.63 HEADER= display or suppress subtable headings

Subtables are usually displayed with two heading lines, showing Table number, Title, date, etc.

To display these (the standard), specify HEADER=YES.
To suppress these, specify HEADER=NO. The heading lines are replaced by 2 blank lines.

Example: In Table 7.2, the person misfits. Heading lines are not wanted between persons.
HEADER=NO

11.64 HIADJ= correction for top rating scale categories

The Rasch model models the measure corresponding to a top rating (or partial credit) scale category as infinite. This is difficult to think about and impossible to plot. Consequently, graphically in Table 2.2 and numerically in Table 3.1 a measure is reported corresponding to a top category. This is the measure corresponding to an imaginary rating HIADJ= rating points below the top category. The corresponding instruction for the bottom category is LOWADJ=. For choice of value, see EXTRSCORE=

Example: The standard spread in Table 2.2 is based on HIADJ=0.25. You wish the top category number to be printed more to the right, further away from the other categories.
HIADJ=0.1

11.65 HLINES= heading lines in output files

To facilitate importing the IFILE=, PFILE=, SFILE= and XFILE= files into spreadsheet and database programs, the heading lines can be omitted from the output files.

HLINES=Y Include heading lines in the output files (the standard)
In IFILE= and PFILE=, specifying HLINES=Y also puts ";" at the start of missing, deleted and extreme lines.
For simulated data files, SIFILE=, HLINES=Y puts the person generating value in each data line.
HLINES=N Omit heading lines.

Example: I want a tab-separated score-to-measure file, without the column headings:
SCOREFILE=mysc.txt
HLINES=NO
CSV=TAB

```
0 -6.46 1.83 .28 217 85 1 2.9 1 2.9 1
1 -5.14 1.08 .81 278 50 0 .0 1 2.9 3
2 -4.22 .86 1.29 321 40 1 2.9 2 5.7 4
```

with column headings, HLINES=YES, the standard:

```
";" "KID" "SCORE FILE FOR"
"; TABLE OF SAMPLE NORMS (500/100) AND FREQUENCIES CORRESPONDING TO COMPLETE TEST"
";SCORE" "MEASURE" "S.E." "INFO" "NORMED" "S.E." "FREQUENCY" "%" "CUM.FREQ." "%" "PERCENTILE"
0 -6.46 1.83 .28 217 85 1 2.9 1 2.9 1
```

ROW1HEADING= No

```
"; TABLE OF SAMPLE NORMS (500/100) AND FREQUENCIES CORRESPONDING TO COMPLETE TEST"
";SCORE" "MEASURE" "S.E." "INFO" "NORMED" "S.E." "FREQUENCY" "%" "CUM.FREQ." "%" "PERCENTILE"
0 -6.46 1.83 .28 217 85 1 2.9 1 2.9 1
```

Control variables	Effect on Output files (IFILE=, PFILE=, ...)	Example for IFILE=
HLINES=Yes, ROW1HEADING=Yes (the default, unless changed in Output file specifications dialog box "Set as default" or changed by the type of output file chosen))	All output file headings shown	; TAP KNOX CUBE TEST ;ENTRY MEASURE ST C 1 -6.59 -1 35.0
HLINES=Yes ROW1HEADING=No	Only column headings shown	;ENTRY MEASURE ST C 1 -6.59 -1 35.0
HLINES=No ROW1HEADING=No	No headings	1 -6.59 -1 35.0
HLINES=No ROW1HEADING=Yes	No headings	1 -6.59 -1 35.0

11.66 IADD= add item difficulty to GRFILE= measure

IADD= No	Do not add item difficulties to measures in GRFILE=
IADD= Yes	Add item difficulties to measures in GRFILE=

Example in GRFILE=

11.67 IAFILE= item anchor file

The IFILE= from one analysis can be used unedited as the item anchor file, IAFILE=, of another.

IAFILE= *file name	file containing details
IAFILE = *	in-line list
IAFILE = $S1W1	field in item label
IAFILE=?	opens a Browser window to find a file containing the details

The item parameter values (deltas) can be anchored (fixed) using IAFILE=. Anchoring facilitates equating test forms and building item banks. The items common to two test forms, or in the item bank and also in the current form, can be anchored at their other form or bank calibrations. Then the measures constructed from the current data will be equated to the measures of the other form or bank. Other measures are estimated in the frame of reference defined by the anchor values. The anchored values are imputed (inserted) in place of the estimated-from-the-data values. Mathematically, the anchor values are treated as though they, like the estimated-from-the-data values, are the best available estimates of the true values.

Displacements are reported, indicating the differences between the anchored values and the freely estimated values. If these are large, please try changing the setting of ANCESTIM=.

For polytomies (rating scales, partial credit), IAFILE= must have SAFILE=. The IFILE= and the SFILE= are really one file. For dichotomies, the SFILE= is uninformative, so it can be ignored. For polytomies, the IFILE= and the SFILE= form a pair, and so do the IAFILE= and the SAFILE=. For polytomies, anchoring with the IAFILE= without the SAFILE= is usually meaningless. The items are not completely anchored. Use IAFILE= and SAFILE= if you need the polytomous item in one analysis to be identical in thresholds and overall difficulty to the same item in another analysis. Use only SAFILE= if you need the polytomous item in one analysis to be identical in thresholds to the same item in another analysis, but the overall item difficulties can differ.

How anchoring works:

The anchored items together with the unanchored items determine the person measures based on the data. The person measures determine the calibrations of the unanchored items and the displacements of the anchored items. The person measures are adjusted so that the mean displacement of the anchored items is zero.

Let's imagine some situations with complete data:
1. The data fit the anchored anchored items exactly. There are no displacements and the unanchored items slot exactly into the hierarchy of the anchored items. Person measures are the same as in an unanchored analysis, but the mean ability measure is adjusted so that the anchored item displacements are all zero. Unanchored items with the same p-values as the anchored items have the same calibrations.

2. All the anchored items happen to have the same item calibration, but have different p-values in the data. The mean ability measure is adjusted so that the mean anchored item displacement is zero. The ability measures are more central than in an unanchored analysis. The calibrations of the unanchored items are more central than in an unanchored analysis, but not the same as anchored items with the same p-values.

3. The anchored items have calibrations that are random with respect to the current data. The mean ability measure is adjusted so that the mean anchored item displacement is zero. The ability measures are more central than in an unanchored analysis. The calibrations of the unanchored items are more central than in an unanchored analysis, but not the same as anchored items with the same p-values.

4. The anchored items have calibrations that are correlated with the current data, but more extreme than their values in an unanchored analysis. The mean ability measure is adjusted so that the mean anchored item displacement is zero. The ability measures are more diverse than in an unanchored analysis. The calibrations of the unanchored items are more diverse than in an unanchored analysis, but not the same as anchored items with the same p-values.

Anchor file format:

In order to anchor items, a data file must be created of the following form:
1. Use one line per item (or item range) to be anchored.
2. Type the sequence number of the item in the current analysis, a blank, and the measure-value at which to anchor the item (in logits if UASCALE=1, or in your user-rescaled USCALE= units otherwise). Arithmetical expressions are allowed. Further values in each line are ignored. An IFILE= works well as an IAFILE=.
3. **If the same item appears more than once, the first anchor value is used.** When an IFILE= will be used as an IAFILE=, be sure to output the measures with many decimal places: UDECIMALS=4

UIMEAN= and UPMEAN= are ignored when there are anchor values, IAFILE= or PAFILE=

Stopping estimation: usually Winsteps estimation converges successfully by itself. If it does not, the ctrl+F stops estimation. If this happens repeatedly for an analysis, then you can explicitly tell Winsteps to do whatever you see when you decide to end estimation. For instance, if your decide to stop estimation when the biggest change to logit estimates is less than .01 logits,
LCONV=.01
CONVERGE=L
With anchor values, which usually mean that sum score residuals will never be zero, this choice makes sense.

Examples:
2 3.47 ; anchors item 2 at 3.47 logits (or USCALE= values)
10-13 1.3 ; items 10, 11, 12, 13 are each anchored at 1.3 logits
2 5.2 ; item 2 is already anchored. This item anchoring is ignored
1-50 0 ; all the unanchored items in the range 1-50 are anchored at 0.

Anything after ";" is treated as a comment.

IAFILE = filename
Item anchor information is in a file containing lines of format
item entry number anchor value
item entry number anchor value

IAFILE=*
Item anchor information is in the control file in the format
IAFILE=*
item entry number anchor value
item entry number anchor value
*

IAFILE=$SnnEnn or IAFILE=$SnnWnn or @Field
Item anchor information is in the item labels using the column selection rules. Blanks or non-numeric values indicate no anchor value.

Anchoring and Extreme items

In the original calibration, extreme items are given an estimated finite difficulty. They are not used in fit reporting and person measurement.

In the anchored calibration, all items are anchored at their estimated difficulties, including the previously extreme items. All items including previously extreme items are used in fit reporting and person measurement.

If the anchor values for the extreme items are not to be used in the anchored analysis, we need to eliminate the extreme items from the anchor file:

1. In an interactive run of Winsteps,
1. analyze any dataset
2. Output Files menu

3. IFILE=
4. Select fields and other options
5. Check "flag extremes with ;"
6. "Make default"
7. Cancel your way out of Winsteps

The result is that all IFILE= output files will have ; as the first character of extreme score lines These will be treated as comments when processed as anchor files by IAFILE=.

Example 0: only one item is to be anchored:
Slow method - include in your control file:
USCALE=1 ; anchor value and analysis in logits
CONVERGE= L ; Convergence decided by logit change
LCONVERGE=.00001 ; Set logit convergence tight because of anchoring
IAFILE = * ; Item anchor file to preset the difficulty of an item
6 0.25 ; Item 6 exactly at 0.25 logit point.
*

Faster method:
1) do a standard unanchored analysis
2) output Table 14 items
3) see the measure for item 6 (for me it is1.30)
4) edit your control file so that UIMEAN = wanted value - current value = 1.30 - 0.25 = 1.05
5) do the standard unanchored analysis again: item 6 is now 0.25

Example 1: The third item is to be anchored at 1.5 logits, and the fourth at 2.3 logits.
1. Create a file named, say, "ANC.FIL"
2. Enter the line "3 1.5" into this file, which means "item 3 in this test is to be fixed at 1.5 logits".
3. Enter a second line "4 2.3" into this file, which means "item 4 in this test is to be fixed at 2.3 logits".
3. Specify, in the control file,
USCALE=1 ; anchor value and analysis in logits
IAFILE=ANC.FIL
CONVERGE=L ; only logit change is used for convergence
LCONV=0.005 ; logit change too small to appear on any report.

or place directly in the control file:
IAFILE=*
3 1.5
4 2.3
*
CONVERGE=L ; only logit change is used for convergence
LCONV=0.005 ; logit change too small to appear on any report.

or in with the item labels:
IAFILE=$S10W4 ; location of anchor value in item label
CONVERGE=L ; only logit change is used for convergence
LCONV=0.005 ; logit change too small to appear on any report.
&END
Zoo
House 1.5 ; item label and anchor value
Garden 2.3
Park
END LABELS

To check: "A" after the measure means "anchored"

```
+-----------------------------------------------------------------------------------------+
|ENTRY    RAW                          |   INFIT   |  OUTFIT  |PTMEA|         |             |
|NUMBER  SCORE  COUNT  MEASURE  ERROR|MNSQ  ZSTD|MNSQ  ZSTD|CORR.|DISPLACE| ITEMS        |
```

```
|-----------------------------------+----------+----------+-----+--------+--------------|
|     3     32     35     1.5A    .05| .80   -.3| .32    .6|  .53|     .40| House        |
```

Example 2: The calibrations from one run are to be used to anchor subsequent runs. The items have the same numbers in both runs. This is convenient for generating tables not previously requested.
1. Perform the calibration run, say,
C:> Winsteps SF.TXT SOMEO.TXT IFILE=ANCHORS.SF TABLES=111

2. Perform the anchored runs, say,
C:> Winsteps SF.TXT MOREO.TXT IAFILE=ANCHORS.SF TABLES=0001111
C:> Winsteps SF.TXT CURVESO.TXT IAFILE=ANCHORS.SF CURVES=111

Example 3: Score-to-measure Table 20 is to be produced from known item and rating scale structure difficulties.
Specify:
USCALE=values ; scaling of the anchor values
IAFILE=iafile.txt ; the item anchor file
SAFILE=safile.txt ; the structure/step anchor file (only for polytomies)
TFILE=*
20 ; the score table
*
CONVERGE=L ; only logit change is used for convergence
LCONV=0.005 ; logit change too small to appear on any report.
STBIAS=NO ; anchor values do not need estimation bias correction.
The data file comprises two dummy data records, so that every item has a non extreme score, e.g.,
For dichotomies:
CODES = 01

```
 Record 1: 10101010101
 Record 2: 01010101010
```

For a rating scale from 1 to 5:
CODES = 12345

```
 Record 1: 15151515151
 Record 2: 51515151515
```

Example 4. Anchoring polytomous items for the Rating Scale Model

```
CODES = 012 ; 3 category Rating Scale Model
IAFILE=*
1 2.37 ; anchor item 1 at 2.37 logits
2 -1.23
*

SAFILE=*
0 0 ; the bottom category is always anchored at 0
1 -2.34 ; Andrich threshold (step difficulty) from category 0 to 1
2 2.34 ; Andrich threshold (step difficulty) from category 2 to 3
*
```

Example 5. Anchoring polytomous items for the Partial Credit and Grouped-Items models

```
CODES = 012 ; 3 category Rating Scale Model
ISGROUPS=0
IAFILE=*
1 2.37 ; anchor item 1 at 2.37 logits
2 -1.23
*

SAFILE=*
; for item 1, relative to the difficulty of item 1
1 0 0 ; the bottom category is always anchored at 0
1 1 -2.34 ; Andrich threshold (step difficulty) from category 0 to 1
1 2 2.34 ; Andrich threshold (step difficulty) from category 2 to 3
```

```
; for item 2, relative to the difficulty of item 2
2 0 0 ; the bottom category is always anchored at 0
2 1 -1.54 ; Andrich threshold (step difficulty) from category 0 to 1
2 2 1.54 ; Andrich threshold (step difficulty) from category 2 to 3
*
```

11.68 IANCHQU= anchor items interactively

Items to be anchored can be entered interactively by setting IANCHQ=Y. If you specify this, you are asked if you want to anchor any items. If you respond "yes", it will ask if you want to read these anchored items from a file; if you answer "yes" it will ask for the file name and process that file in the same manner as if IAFILE= had been specified. If you answer "no", you will be asked to enter the sequence number of each item to be anchored, one at a time, along with its logit (or user-rescaled by USCALE= or UASCALE=) value. When you are finished, enter a zero.

Example: You are doing a number of analyses, anchoring a few, but different, items each analysis. You don't want to create a lot of small anchor files, but rather just enter the numbers at the terminal, so specify:
IANCHQ=Y
CONVERGE=L ; only logit change is used for convergence
LCONV=0.005 ; logit change too small to appear on any report.

You want to anchor items 4 and 8.
Winsteps asks you:

```
DO YOU WANT TO ANCHOR ANY ITEMS?
respond YES(Enter)
DO YOU WISH TO READ THE ANCHORED ITEMS FROM A FILE?
respond NO(Enter)
INPUT ITEM TO ANCHOR (0 TO END):
respond 4(Enter) (the first item to be anchored)
INPUT VALUE AT WHICH TO ANCHOR ITEM:
respond 1.45(Enter) (the first anchor value)
INPUT ITEM TO ANCHOR (0 TO END): 8(Enter)
INPUT VALUE AT WHICH TO ANCHOR ITEM:-0.23(Enter)
INPUT ITEM TO ANCHOR (0 TO END): 0(Enter) (to end anchoring)
```

11.69 ICOLORFILE= colors for item labels in PKMAPs

Item labels (identifiers) in Table 36 PKMAPs are colored using default colors. These can be replaced with other colors using commands in PKMAP= file.

Instead, item identifiers can be colored by matching with the identifiers in ICOLORFILE=. The matching color is the first in the list that matches the start of the 1R value on the PKMAP.

ICOLORFILE=* or filename
Item identifier = color
Item identifier = color
....
*

Example: in the Liking for Science analysis: Example0.txt

ASCII=Webpage or ASCII=Doc
; use item label on PKMAP.
PKMAP=*
1R = #NAME#
*
ICOLORFILE=* or filename
Wat = lightgreen
Loo = lightblue
....
*
Output Tables menu: Table 36 PKMAPS

Excerpt from webpage output:: "Watch bugs" matches "Wat" in ICOLORFILE= which has color "lightgreen"

```
__|________________________
  |
  |  Watch bugs
  :
XXX
  |  Look in sidewalk cracks
  |
__|________________________
```

Color Names

11.70 ICORFILE= item residual correlation file

This writes out the Table of inter-item correlations which is the basis of the principal components analysis of residuals.
The basis for the correlations is controlled by PRCOMP=.
PRCOMP=R correlates the raw residuals
PRCOMP=S correlates the standardized residuals
PRCOMP=O correlates the observations

CIMPUTE= controls imputing missing values

ICORFILE=? opens a Browse window

Extreme scores: minimum possible (0) and maximum possible (perfect) person scores are omitted from the computation of the correlations. Items with extreme scores are not reported. Their correlation is 0.

Missing data: for these Winsteps substitutes their expectations when possible. For residuals and standardized residuals, these are 0. Persons with extreme scores (minimum possible or maximum possible): Winsteps drops these from the correlation computation. The reason for these choices is to make the principal components analysis of residuals as meaningful as possible.

Expected correlations: the expected inter-item correlation between any two items is -1/(L-1). Anscombe & Tukey, 1963, p. 144, *courtesy of Larry Ludlow.*

ICORFILE= file name

Example 1: Write out the Table of inter-item residual correlations. PRCOMP=R. ICORFILE=file.txt - Then file.txt contains, for SF.txt, fixed-field columns 12 characters wide.

ITEM	ITEM	CORRELATION
1	2	-.171665
1	3	-.144027
1	4	-.009290
1	5	-.103947

Example 2: When ICORFILE= is selected on the Output Files menu or MATRIX=YES, the Data Format: Matrix option can be selected:

This produces 10-character wide columns in fixed-field format

1	2	3	4	...
1.000000	-.171665	-.144027	-.009290	...
-.171665	1.000000	.175921	.039622	...
-.144027	.175921	1.000000	-.101622	...
-.009290	.039622	-.101622	1.000000	...
-.103947	.099335	-.021021	.145339	...
.107936	-.009881	-.039799	-.109941	...
.108457	-.061624	.015850	-.001168	...

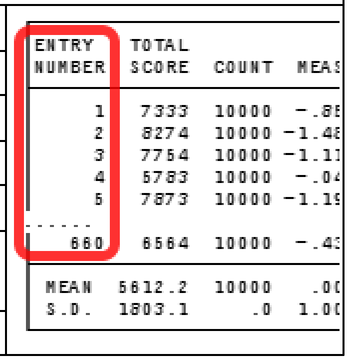
Example 3: Is there a way to include extreme scores?
1. All the correlations relating to extreme scores are zero.
2. If you select ICORFILE= from the Output Files menu, and click on "matrix". You will get all pairs of non-extreme correlations.
3. You can obtain a matrix of raw or standardized response-residuals including extreme scores, by using IPMATRIX= from the Output Files menu (check the extreme score boxes). Then use this to compute the correlations with a standard

statistical package etc. You will notice that the residuals for extreme scores may not be zero. This is because they are computed based on the measures shown for extreme scores in the measure Tables.

11.71 IDELETE= item one-line item deletion

A one-line list of items to be deleted or reinstated can be conveniently specified with IDELETE=. ThisIt has the same functionality as IDFILE=. ISELECT= is another way of deleting items.

The formats are:	
IDELETE= 3	3 is an item entry number: delete item 3
IDELETE= 6 1	delete items 6 and 1
IDELETE= 2-5	delete items 2, 3, 4, 5
IDELETE= +3-10	delete all items, then reinstate items 3 to 10
IDELETE= 4-20 +8	delete items 4-20 then reinstate item 8
IDELETE= 3,7,4,10	delete items 3, 7, 4, 10. Commas, blanks and tabs are separators. At the "Extra information" prompt, use commas as separators
IDELETE= (blank)	In the Specification Menu dialog box, resets temporary item deletions



```
ENTRY   TOTAL
NUMBER  SCORE   COUNT  MEAS
     1   7333   10000   -.8
     2   8274   10000 -1.4
     3   7754   10000 -1.1
     4   5783   10000   -.0
     5   7873   10000 -1.1
------
   660   6564   10000   -.4

  MEAN  5612.2  10000    .0
  S.D.  1803.1     .0   1.0
```

Example 1: After an analysis is completed, delete all items except for one subtest in order to produce a score-to-measure Table for the subtest.
In the Specifications pull-down box:
IDELETE = +11-26 ; the subtest is items 11-26
Screen displays: CURRENTLY REPORTABLE ITEMS = 16
In the Output Tables menu (or SCOREFILE=)
Table 20. Measures for all possible scores on items 11-26.

Example 2: 9 common items. 3 items on Form A. 4 items on Form B. Score-to-measure tables for the Forms.
For Form A: in the Specifications pull-down box:
IDELETE = 13-16 ; deletes Form B items
In the Output Tables menu:
Table 20. Measures for all possible scores on items in Form A.
For Form B: in the Specifications pull-down box:
IDELETE= ; to reset all deletions
then
IDELETE = 10-12 ; deletes Form A items
In the Output Tables menu:
Table 20. Measures for all possible scores on items in Form B.

11.72 IDELQU= delete items interactively

IDELETE= and/or IDFILE= at Extra Specifications? are easier.

If your system is interactive, items to be deleted or selected can be entered interactively by setting IDELQU=Y. If you specify this, you will be asked if you want to delete any items. If you respond "yes", it will ask if you want to read these deleted items from a file; if you answer "yes" it will ask for the file name and process that file in the same manner as if IDFILE= had been specified. If you answer "no", you will be asked to enter the sequence number or numbers of items to be deleted or selected one line at a time, following the rules specified for IDFILE=. When you are finished, enter a zero.

Example: You are doing a number of analyses, deleting different items each analysis.
NI=60
ITEM1=30
IDELQU=Y
&END

Winsteps asks you:

```
 DO YOU WANT TO READ SOME TAP DELETIONS FROM A FILE? (Y/N)
Y
    WHAT IS THE NAME OF THE TAP DELETE FILE?
MYIDFILE.TXT
 Processing TAP IDELQU=MYIDFILE.TXT

 DO YOU WANT TO READ MORE TAP DELETIONS FROM A FILE? (Y/N)
N

 DO YOU WANT TO TYPE IN MORE TAP DELETIONS? (Y/N)
Y
 TYPE IN THE DELETIONS IN IDELETE= FORMAT:
3 4-10 +6

 DO YOU WANT TO TYPE IN MORE TAP DELETIONS? (Y/N)
N
```

11.73 IDFILE= item deletion file

Deletion or selection of items from a test for an analysis, but without removing the responses from your data file, is easily accomplished by creating a file in which each line contains the sequence number or numbers of items to be deleted or selected. Specify this file by means of the control variable, IDFILE=, or enter the deletion list in the control file using IDFILE=*. Your control file should include item labels for all items, including the ones you are deleting. It has the same functionality as IDELETE=. ISELECT= is another way of deleting items. IDFILE=filename can be action from the Specification menu dialog box.

IDFILE= file name	file containing list of item entry numbers to be deleted or reinstated. Each line in the file is in the IDELETE= format
IDFILE = ?	opens a Browser window to find the file
IDFILE = * 4 18-23 6 5.23 *	in-line list in the control file delete item entry number 4 delete item entry number 18 to 23 second number 5.23 is ignored, so that IWEIGHT= can be changed to IDFILE=
IDFILE=* 4 18-23 *	At the Extra Specifications prompt
IDFILE=	In the Specifications Menu dialog box, reinstates all temporary deletions

a) Delete an item: enter the item number. E.g., to delete item 5, enter
 5

b) Delete a range of items: enter the starting and ending item number on the same line separated by a blank or dash. E.g., to delete items 13 through 24
 13-24
or
 13 24

c) Select an item for analysis: enter a plus sign then the number.
E.g., to select item 19 from a previously deleted range
 +19

d) Select a range of items for analysis: enter a plus sign, the starting number, a blank or dash, then the ending number. E.g., to select items 17 through 22
 +17-22
or
 +17 22

e) If a + selection is the first entry in the deletion file, then all items are deleted before the first selection is undertaken, so that the items analyzed will be limited to those selected, e.g,
if +10-20 is the only line in the item deletion file for a 250 item test, it means
1-250 ; delete all 250 items
+10-20 ; reinstate items 10 through 20.

f) You may specify an item deletion list in your control with
IDFILE=*
(List)
*
e.g.,
IDFILE=*
17 ; delete item 17
2 ; delete item 2
*

g) each line can have multiple instructions:
IDFILE=*
17 2 +10
3
*

Item Deletion and Reinstatement Sequence	
Control File or at Extra Specifications: Order of Processing	Here, 123 is an example item entry number. It can be any item entry number.
IDELETE=list	+123 deletes all items only if it is the first deletion instruction in the first of these deletion commands that is active. +123 always reinstates item 123.
IDFILE=* list * or filename	
IDELQU=Yes	
ISELECT=selection	selects the specified items and permanently deletes all other items
Specification Menu Dialog Box	
IDELETE=(nothing), IDFILE=(nothing)	reinstates all temporary deletions
ISELECT=(nothing) or ISELECT=*	reinstates all temporary deselections
IDELETE=list, IDFILE=filename	temporary deletions, in addition to previous temporary deletions, if any. If the first deletion instruct starts +123 then temporarily deletes all items and reinstates item 123 if not permanently deleted
ISELECT=selection	temporary deselections, in addition to previous temporary deselections, if any

Example 1: You wish to delete the fifth and tenth through seventeenth items from an analysis, but then keep item fourteen.
1. Create a file named, say, ITEM.DEL
2. Enter into the file, the lines:
5
10-17
+14

3. Specify, in the control file,
NI=50
ITEM1=63
IDFILE=ITEM.DEL

TABLES=1110111
&END

or, specify in the control file,
NI=50
ITEM1=63
IDFILE=*
5
10-17
+14
*
TABLES=1110111
&END

Example 2: The analyst wants to delete the most misfitting items reported in Table 10.
1. Set up a standard control file.
2. Specify
IDFILE=*
*
3. Copy the target portion of Table 10.
4. Paste it between the "*"
5. Delete characters before the entry numbers.
6. Type ; after the entry numbers to make further numbers into comments.

TITLE = 'Example of item deletion list from Table 10'
IDFILE = *
Delete the border character before the entry number

```
; ENTRY   RAW                              INFIT     OUTFIT
;   NUM  SCORE  COUNT  MEASURE  ERROR MNSQ  ZSTD MNSQ  ZSTD PTBSE  ACTS                          G
      5 ; 2      4      .00      1.03 1.48   1.8 1.50   1.8 A-.83  FIND BOTTLES AND CANS         0
      8 ; 2      4      .00      1.03 1.40   1.6 1.43   1.6 B-.71  LOOK IN SIDEWALK CRACKS       0
      4 ; 3      4      .00       .62 1.33    .7 1.49    .9 C-.21  WATCH GRASS CHANGE            0
      9 ; 4      4      .00       .74 1.51    .8 1.57    .9 D-.59  LEARN WEED NAMES              0
     20 ; 1      4      .00      1.03 1.12    .5 1.14    .6 E-.05  WATCH BUGS                    0
     24 ; 6      4      .30      1.03 1.15    .6 1.13    .5 F-.15  FIND OUT WHAT FLOWERS LIVE ON 0
```

Enter the ; to make details to right of entry numbers into comments
*

Example 3: The analyst want to delete item 4 and items 18 to 23 on the DOS control (or Extra Specifications) line:
Extra specifications? IDFILE=* 4 18-23 * (Enter)
or
C:>Winsteps CONTROL.FIL OUTPUT.FIL IDFILE=* 4 18-23 *

Example 3. In Winsteps analyses, the data file is not changed.

1. To delete items or persons:
IDFILE= (list of item entry numbers)
PDFILE= (list of person entry numbers)

2. To edit the data file:
EDFILE=
(person entry number) (item entry number) (new data value or missing)

For instance in an analysis of Exam1.txt, we can place these instructions in the Winsteps control file:

IDFILE=*
4 ; delete item 4
8 ; delete item 8
*

PDFILE=-*
6 ; delete person 6

*

EDFILE=*
1 2 0   ; person 1 on item 2 scored a 0
3 4 -1 ; person 3 on item 4 scored -1 = missing, not administered
*

11.74 IDROPEXTREME= drop items with extreme scores

Unanchored items with extreme (zero, minimum possible or perfect, maximum possible) scores provide no information for estimating person measures, but they are reported and included in summary statistics. To remove them:

IDROPEXTREME = No ; do not drop extreme items (standard)

IDROPEXTREME = Yes or All ; drop items with zero (minimum possible) and perfect (maximum possible) scores

IDROPEXTREME = Zero or Low or Bottom or Minimum ; drop items with zero or minimum-possible scores

IDROPEXTREME = Perfect or High or Top or Maximum ; drop items with perfect or maximum-possible scores

Example: The instrument contains items asking about very rare conditions (scored "0" - not observed). These are skewing the survey summary statistics:
 IDROPEXTREME = Minimum ; items about conditions never observed in the sample are dropped.

11.75 IFILE= item output file

IFILE=filename produces an output file containing the information for each item. This file contains 4 heading lines (unless HLINES=N or ROW1HEADING=N), followed by one line for each item containing the following fields and the standard field selection. To change the output-field selection, go to the Output File menu, IFILE=, Field selection, Make default., or IOFSFIELDS=.

IFILE= file name	output file containing details. Usual file types: .txt, .xls
IFILE = ?	opens a Browser window to find the file

"Status=-2 to -6" means that there are no measurable responses by those items in this analysis. The items may be listed in the IFILE= and in Table 14, but all the numbers shown are default values. They have no meaning. Please do not include those items in summary statistics.

Columns:		with "Select All Fields" using Output File Field Selection		
Start	**End**	**Label**	**Format**	**Description**
1	1		A1	Blank or ";" if HLINES=Y and there are no responses or deleted or extreme (status: 0,-1, -2, -3)
2	6	ENTRY	I5	1. The item sequence entry number
7	14	MEASURE	F8.2	2. Item's JMLE estimated difficulty calibration user-rescaled by UMEAN=, USCALE=, UDECIM=. Measures for deleted or inestimable items are shown as NOMEASURE=, which defaults to 9999.
15	17	STATUS	I3	3. The item's status: 2 = Anchored (fixed) measure 1 = Estimated measure 0 = Extreme maximum measure (estimated using EXTRSC=) for extreme maximum person raw score, or extreme minimum item raw score (-1 if USCALE= < 0) -1 = Extreme minimum measure (estimated using EXTRSC=) for extreme minimum person raw score (usually 0), or extreme maximum item raw score (0 if USCALE= < 0) -2 = No responses available for measure -3 = Deleted by user. PDELETE=, PDFILE=, IDELETE=, IDFILE=, PSELECT=, ISELECT=

				-4 = Inestimable: high (all responses in the same category with ISGROUPS=0 or CUTHI=) -5 = Inestimable: low (all responses in the same category with ISGROUPS=0 or CUTLO=) -6 = Anchored (fixed) measure with extreme (minimum or maximum) observed raw score -7 to -16 = Temporarily deselected by Specification box with iSELECT= (usual STATUS - 10) -17 to -26 = Temporarily deleted by Specification box with IDELETE= (usual STATUS - 20) -27 to -36 = Temporarily deselected and deleted by Specification box with iSELECT= and iDELETE= (usual STATUS - 30)
18	25	COUNT	F8.1	4. The number of responses used in calibrating (TOTAL=N) or the observed count (TOTAL=Y)
26	34	SCORE	F9.1	5. The raw score used in calibrating (TOTAL=N) or the observed score (TOTAL=Y)
35	41	MODLSE REALSE	F7.2	6. Standard error of the JMLE or WMLE item difficulty estimate adjusted by REALSE= and user-rescaled by USCALE=, UDECIM=
42	48	IN.MSQ IN.CHI	F7.2	7. Item infit: mean square infit. Chi-square = IN.MSQ* INDF If CHISQUARE=Yes, IN.CHI = Infit Chi-square
49	55	IN.ZSTD, ZEMP, LOG, PROB	F7.2	8. Item infit: t standardized, locally t standardized, log-scaled or probability of mean-square/chi-square (LOCAL=)
56	62	OUT.MS OUT.CHI	F7.2	9. Item outfit: mean square outfit. Chi-square = OUT.MS * OUTDF If CHISQUARE=Yes, OUT.CHI = Outfit Chi-square (= Yen's Q1 statistic)
63	69	OUT.ZSTD, ZEMP, LOG, PROB	F7.2	10. Item outfit: t standardized, locally t standardized, log-scaled or probability of mean-square/chi-square (LOCAL=)
70	76	DISPLACE	F7.2	11. Item displacement (user-rescaled by USCALE=, UDECIM=)
77	83	PBSA, PTBIS=A PBSX, PTBIS=Y PTMA, PTBIS=N PTMX, PTBIS=X	F7.2	12. Item by test-score correlation: point-biserial or point-measure. PTBIS= PBSA = Point-Biserial correlation including all responses in the raw score PBSX = Point-Biserial correlation excluding the current item's response from the raw score PTMA = Point-Measure correlation including all responses for the measure PTMX = Point-Biserial excluding the current item's response from the measure
84	90	WEIGHT	F7.2	13. Item weight IWEIGHT=
91	96	OBSMA	F6.1	14. Observed percent of observations within 0.5 score-points of their expected values
97	102	EXPMA	F6.1	15. Expected percent of observations within 0.5 score-points of their expected values
103	109	DISCRIM	F7.2	16. Item discrimination (this is not a parameter estimate, merely a descriptive statistic) DISCRIM=
110	115	LOWER	F6.2	17. Item lower asymptote: ASYMPTOTE=Yes
116	121	UPPER	F6.2	18. Item upper asymptote: ASYMPTOTE=Yes
122	127	PVALU	F6.2	19. Item proportion-correct-values or average ratings: PVALUE=Yes:
128	133	PBA-E PBX-E, PBSX-E PMA-E PMX-E	F6.2	20. Expected value of Item by test-score correlation. PTBIS= PBA-E = Expected value of Point-Biserial including all responses in the raw score PBX-E = Expected value of Point-Biserial excluding the current response from the raw score PMA-E = Expected value of Point-Measure including all responses in the measure PMX-E = Expected value of Point-Biserial excluding the current response from the measure
134	139	RMSR	F6.2	21. Root-mean-square residual RMSR=

140	147	WMLE	F8.2	22. Warm's Weighted Maximum Likelihood Estimate (WLE) of Item Difficulty user-rescaled by UMEAN=, USCALE=, UDECIM=
148	153	INDF	F6.2	23. degrees of freedom of Infit mean-square
154	159	OUTDF	F6.2	24. degrees of freedom of Outfit mean-square
160	167	QCMLE	F8.2	25. Quasi-CMLE estimates for dichotomous data. 0 otherwise.
				If CMLE=Yes
		CMLEM	F8.2	CMLE item measure estimate
		CMLESE	F8.2	CMLE item measure standard error
		CMLEIms	F8.2	CMLE item INFIT mean-square fit statistic
		CMLEIz	F8.2	CMLE item INFIT standardized fit statistic
		CMLEOms	F8.2	CMLE item OUTFIT mean-square statistic
		CMLEOz	F8.2	CMLE item OUTFIT standardized fit statistic
		CMLEWML	F8.2	CMLE Warm's Weighted Maximum Likelihood item measure Estimate (WLE)
		CMLEIdf	F8.2	CMLE item INFIT degrees of freedom
		CMLEOdf	F8.2	CMLE item OUTFIT degrees of freedom
168	168		1X	Blank
169	169	GROUPING	A1	26. Grouping to which item belongs (G) ISGROUPS=
170	170		1X	Blank
171	171	MODEL	A1	27. Model used for analysis (R=Rating, S=Success, F=Failure) MODELS=
172	172		1X	Blank
173	173	RECODE	A1	28. Recoding/Rescoring indicator: "." = only CODES= "A" = ALPHANUM= "K" = KEY1= "N" = RESCORE=2 and NEWSCORE= "1" = RESCORE=1 and NEWSCORE= Others = IREFER=
174	174		1X	Blank
175	205	NAME	A30+	29. Item name or label: use ILFILE= for different item names

The format descriptors are:

	In = Integer field width n columns
	Fn.m = Numeric field, n columns wide including n-m-1 integral places, a decimal point and m decimal places
	An = Alphabetic field, n columns wide
	nX = n blank columns.

When CSV=Y, commas separate the values, which are squeezed together without spaces between. Quotation marks surround the "Item name", e.g., 1,2,3,4,"Name". When CSV=T, the commas are replaced by tab characters.

Example: You wish to write a text file on disk called "ITEMCAL.txt" containing the item statistics for use in updating your item bank, with values separated by commas:

```
IFILE=ITEMCAL.txt
CSV=Y
```

When W300=Yes, then this is produced in Winsteps 3.00, 1/1/2000, format:

Columns:				
Start	End	Label	Format	Description
1	1		A1	Blank or ";" if HLINES=Y and there are no responses or deleted (status = -2, -3)
2	6	ENTRY	I5	1. The item sequence number

7	14	MEASURE	F8.2	2. Item's JMLE estimated calibration (user-rescaled by UMEAN=, USCALE=, UDECIM)
15	17	STATUS	I3	3. The item's status: 3 = Anchored (fixed) measure with extreme (minimum or maximum) observed raw score 2 = Anchored (fixed) measure 1 = Estimated measure 0 = Extreme minimum (estimated using EXTRSC=) -1 = Extreme maximum (estimated using EXTRSC=) -2 = No responses available for measure -3 = Deleted by user -4 = Inestimable: high (all responses in the same category with ISGROUPS=0 or CUTHI=) -5 = Inestimable: low (all responses in the same category with ISGROUPS=0 or CUTLO=) -6 = Deselected
18	23	COUNT	I6	4. The number of responses used in calibrating (TOTAL=N) or the observed count (TOTAL=Y)
24	30	SCORE	I6	5. The raw score used in calibrating (TOTAL=N) or the observed score (TOTAL=Y)
31	37	MODLSE REALSE	F7.2	6. Item calibration's standard error with REALSE= and user-rescaled by USCALE=, UDECIM=
38	44	IN.MSQ	F7.2	7. Item mean square infit
45	51	ZSTD, ZEMP, LOG	F7.2	8. Item infit: t standardized (ZSTD), locally t standardized (ZEMP) or log-scaled (LOG)
52	58	OUT.MS	F7.2	9. Item mean square outfit
59	65	ZSTD, ZEMP, LOG	F7.2	10. Item outfit:t standardized (ZSTD), locally t standardized (ZEMP) or log-scaled (LOG)
66	72	DISPLACE	F7.2	11. Item displacement (user-rescaled by USCALE=, UDECIM=)
73	79	PBSA PBSX PTMA PTMX	F7.2	12. Item by test-score correlation: point-biserial or point-measure. PTBIS= PBSA = Point-Biserial correlation including all responses in the raw score PBSX = Point-Biserial correlation excluding the current item's response from the raw score PTMA = Point-Measure correlation including all responses for the measure PTMX = Point-Biserial excluding the current item's response from the measure
80	80		1X	15. Blank
81	81	G	A1	16. Grouping to which item belongs, ISGROUPS=
82	82		1X	17. Blank
83	83	M	A1	18. Model used for analysis (R=Rating, S=Success, F=Failure) MODELS=
84	84		1X	19. Blank
85	132+	NAME	A30+	18. Item name

Example of IFILE= (to see other fields: : IFILE= Field Selection)

```
; ACT  LIKING FOR SCIENCE (Wright & Masters p.18)  Aug  8 22:17 2013
;ENTRY MEASURE ST   COUNT    SCORE MODLSE IN.MSQ IN.ZST OUT.MS OUT.ZS  DISPL   PBSA WEIGHT OBSMA EXPMA DISCRM LOWER UPPER PVALU PBA-E
       RMSR    WMLE G M R NAME
     1    -.40  1    75.0    109.0    .21    .55  -3.48    .49  -2.53    .00    .69   1.00  77.0  61.7   1.52   .00  2.00  1.45   .53
        .42    -.39 1 R . Watch birds
     2    -.71  1    75.0    116.0    .22    .93   -.39    .72  -1.02    .00    .66   1.00  74.3  64.4   1.26   .00  2.00  1.55   .50
        .52    -.70 1 R . Read books on animals
```

Example: If you have your anchor values connected to unique item IDs (item labels), then

(1) put your item IDs and anchor values in an Excel table with the item IDs in the first column
(2) run an unanchored analysis in Winsteps. Output the IFILE= to Excel.
(3) VLOOKUP the item IDs in (2) using the Table in (1) to place the anchor values in the Measure column
(4) Save the entry number and measures from (2) to use as an anchor file.

11.76 ILFILE= item label file

Useful item identification greatly enhances the output tables. ILFILE= is a list of item labels starting at item 1. Blank lines for unused items. You usually specify items labels between &END and END LABELS in the control file. You may also use ILFILE= for the initial or additional sets of item labels.

ILFILE= file name	file containing details
ILFILE = *	in-line list
ILFILE = ?	opens a Browser window to find the file
(between &END and END LABELS or END NAMES)	in-line list

Example: You wish to use abbreviated item labels for the initial analysis, but then switch to longer item labels to produce the final reports.
In your control file specify the shorter labels, one per line,
(a) between &END and END LABELS
or (b) between ILFILE=* and * in the control file
or (c) in a separate file identified by ILFILE=*

You can switch to the longer labels, in a file called "Longer.txt" by using the "Specification" menu item, and entering ILFILE=Longer.txt

If you have ILFILE= in your control file and your data is also in your control file , be sure that there is an "END LABELS" before your data.

Example 1: 4 item arithmetic test with items in ILFILE=*
```
NI=4
ILFILE=*
Addition  ; labels for the 4 items
Subtraction
Multiplication
Division
*
&End
END LABELS     ; <-  required!
```

Example 2: One set of item labels, then another ....
```
NI=4
&End
Addition  ; labels for the 4 items
Subtraction
Multiplication
Division
END LABELS
```

Contents of "labels.txt"
```
Plus
Minus
Product
Quotient
```

After standard reporting:
Specification pull-down menu box
ILFILE=labels.txt

or
ILFILE=(full path)\labels.txt
OK
further reporting

11.77 IMAP= item label on item maps Tables 1, 12

This specifies what part of the item label is to be used on the item map. The length of IMAP= overrides NAMLMP=.

It's format is IMAP = $S..W.. or $S..E. etc. using the column selection rules.

Example: Item type is in columns 3 and 4 of the item label. Item content area is in columns 7 and 8.
IMAP= $S3W2+"/"+$S7W2
tfile=*
12 ; Item maps in Table 12 (or use Output Tables menu)
*
If the item label is "KH323MXTR", the item label on the map will be "32/XT"

11.78 INDEXED= summarize response strings for estimation = Yes

INDEXED=Yes - Winsteps scans the data rows (persons) and builds an index of persons who responded to the same items and achieved the same raw score. Then each index entry is estimated. This can speed up analysis if many persons were administered the same items and obtained the same score. But building the index takes time.

INDEXED=No - Winsteps estimates each person separately.

The very small differences in estimates between the INDEX= settings are due to computer floating-point imprecision. INDEXED=No requires more floating=point additions than INDEXED=Yes (when successful).Enter topic text here.

Example 1: 2,000 persons take the same 10-item test. We expect many persons to achieve the same score on the same items. INDEXED=Yes will speed up estimation.

Example 2: 2,000 persons take an adaptive test with an item bank of 200 items. Few people achieve the same score on the same items. INDEXED=Yes will slow down estimation. Set INDEXED=No.

11.79 INUMB= label items by sequence numbers

Are item names provided, or are they the entry sequence numbers?

INUMB=Y
a name is given to each item based on its sequence number in your data records. The names are "I0001", "I0002", ..., and so on for the NI= items. This is a poor choice as it produces non-informative output.

INUMB=N, the standard
Your item names are entered (by you) after the "&END" at the end of the control variables. Entering detailed item names makes your output much more meaningful to you.

The rules for supplying your own item names are:
1. Item names are entered, one per line, generally directly after &END.
2. Item names begin in column 1.
3. Up to 300 characters (or ITLEN=) in each item name line will be used, but you may enter longer names in the control file for your own record keeping.
4. The item names must be listed in exactly the same order as their responses appear in your data records.
5. There should be the same number of item names as there are items specified by NI=. If there are too many or too few names, a message will warn you and sequence numbers will be used for the names of any unnamed items. You can still proceed with the analysis.
6. Type END NAMES starting in column 1 of the line after the last item name.

Example: An analysis of 4 items for which you supply identifying labels.

```
; these lines can start at any column
  NI=4  four items
ITEM1=10 responses start in column 10
INUMB=N item names supplied (the standard)
  &END
My first item name ; must start at column 1.
My second item label
My third item identifier
My fourth and last item name
END NAMES  ; must start at column 1, in capital letters
Person A 1100 data records
 |
Person Z 1001
```

11.80 IOFSFIELDS= field selection for IFILE=

IOSFIELDS= is set using the Output Field selection dialog box.

Field Number
1 Flag extremes with ;
2 Entry number
3 JMLE Measure
4 Status
5 Count of observations
6 Raw score
7 Standard error
8 Infit mean-square (CHISQUARE=)
9 Infit t standardized (LOCAL=)
10 Outfit mean-square (CHISQUARE=)
11 Outfit t standardized (LOCAL=)
12 Displacement
13 Correlation (PTBIS=)
14 Weight
15 Observed matches
16 Expected match
17 Discrimination
18 Lower asymptote
19 Upper asymptote
20 P-value: average rating
21 Expected correlation (PTBIS=)
22 Isgroups= group
23 Models= model
24 Name or Label
25 Include deleted
26 RMS Residual
27 Recode / rescore
28 WMLE measure
29 Infit d.f
30 Outfit d.f.
31 Quasi-CMLE measure
32 -
33 -
34 -
35 CMLE-measure (CMLE=)
36 CMLE S.E.
37 CMLE Infit mean-square
38 CMLE Infit t standardized
39 CMLE Outfit mean-square
40 CMLE Outfit t standardized

41 CMLE-WMLE
42 CMLE Infit d.f
43 CMLE Outfit d.f.

Example: Output into the IFILE= file only the Entry number and the WMLE measures.
IOSFIELDS = NYNNNNNNNNNNNNNNNNNNNNNNNNNNY

11.81 IPDECIMALS= decimals reported for values in IFILE=, PFILE=

IPDECIMALS=	the default decimal places reported in IFILE= and PFILE=
IPDECIMALS= any number 0 to 6 example: IPDECIMALS=4	this number of decimal places are reported in IFILE= and PFILE= example: 12.3456

11.82 IPEXTREME= placement of extreme scores on maps

IPEXTREME= Yes	place persons and items with extremes scores at the extreme top and bottom in Tables 1, 12, 16.
IPEXTREME= No	place persons and items with extremes scores at their estimated measures in Tables 1, 12, 16.

Example 1: Exam1.txt. Table 1.0

IPEXTREME=Yes. Persons and items with extreme scores (here in red) placed at the extreme ends of the map.
Here, T1MWE=No. Items and persons with extreme scores are omitted from the Mean computation. Notice that the mean item difficulty is 0. UEXTREME=No. Items with extreme scores not included in UIMEAN=0.

```
MEASURE                                               KID - MAP - TAP
                                                       <more>|<rare>
    5                                                        +  1-3- 1-4- 1-4- 4-1-
                                                             |
    4                                                       T+
                                                 Ric Sus   |S 1-4-
    3                                                Fra   +
                                                             |
    2                                    Ber Bet Els Tho S+  1-3- 1-4-
                                                             |
    1                                Bri Car Dav Joe Zul  +  1-3-
                                                             |
    0                                                       M+M   <- UIMEAN=0 UEXTREME=No
    T1MWE=No
      Ann Aud Bar Dor Jam Kim Lin Mik Ron Tra Wal Wil  |
   -1                                                        +
                                             Jan Lis Rod  |  2-4-
   -2                                            Bre Pet S+
                                                             |  1-4-
   -3                                            Ada Ric  +
                                                 Bla Mar  |S 1-3- 3-4-
   -4                                                     T+  1-4- 2-1-
                                                     Don  |  1-3-
   -5                                                Hel  +  1-2- 1-4  2-3
                                                       <less>|<frequent>
```

IPEXTREME=No. Persons and items with extreme scores (here in red) placed at their estimated measures on the map. Here, T1MWE=Yes. Items and persons with extreme scores are included in the Mean computation. Notice that including the extreme items has moved the mean item difficulty to -1 logit. UEXTREME=No. Items with extreme scores not included in UIMEAN=0.

```
MEASURE                                               KID - MAP - TAP
                                                       <more>|<rare>
    6                                                        +  4-1-3-
                                                             |
    5                                                        +  1-3-2- 1-4-2- 1-4-3-
                                                             |
    4                                                       T+
                                                   Ric Sus  |S 1-4-2-
    3                                                  Fra  +
                                                             |
    2                                       Ber Bet Els Tho S+  1-3-2- 1-4-3-
                                                             |
    1                                   Bri Car Dav Joe Zul  +  1-3-1-
                                                             |
    0                                                        +
      Ann Aud Bar Dor Jam Kim Lin Mik Ron Tra Wal Wil M|
   -1                                                        +M   <- UIMEAN=0 UEXTREME=No
    T1MWE=Yes
                                                Jan Lis Rod  |  2-4-3-
   -2                                               Bre Pet  +
                                                            S|  1-4-2-
   -3                                               Ada Ric  +
                                                    Bla Mar  |  1-3-2- 3-4-1
   -4                                                        +  1-4-3- 2-1-4
                                                        Don  |  1-3-4
   -5                                                       T+S
                                                             |
   -6                                                        +
                                                        Hel  |  1-2-4  1-4    2-3
   -7                                                        +
                                                       <less>|<frequent>
```

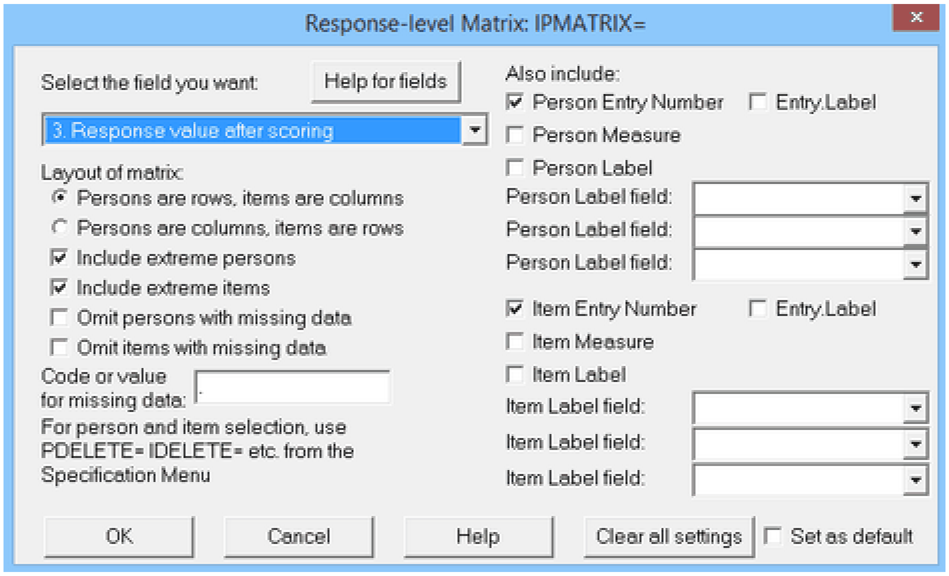
IPEXTREME=No, Persons and items with extreme scores (here in red) placed at their estimated measures on the map. Here, T1MWE=Yesand UEXTREME=Yes Items and persons with extreme scores are included in the Mean computation. Extreme items are now included in UIMEAN=0.

```
MEASURE                                               KID - MAP - TAP
                                                       <more>|<rare>
    6                                                        +  4-1-3-
                                                             |
    5                                                        +  1-3-2- 1-4-2- 1-4-3-
                                                             |S
    4                                                       T+
                                                   Ric Sus   |  1-4-2-
    3                                                  Fra  +
                                                             |
    2                                       Ber Bet Els Tho S+  1-3-2- 1-4-3-
                                                             |
    1                                   Bri Car Dav Joe Zul  +  1-3-1-
                                                             |
    0                                                        +M   <- UIMEAN=0 UEXTREME=Yes
    T1MWE=Yes
      Ann Aud Bar Dor Jam Kim Lin Mik Ron Tra Wal Wil M|
   -1                                                        +
                                                Jan Lis Rod  |  2-4-3-
   -2                                               Bre Pet  +
                                                            S|  1-4-2-
   -3                                               Ada Ric  +
                                                    Bla Mar  |  1-3-2- 3-4-1
   -4                                                        +S 1-4-3- 2-1-4
                                                        Don  |  1-3-4
   -5                                                       T+
                                                             |
```

```
 -6                                                        +
                                                     Hel   |  1-2-4  1-4    2-3
 -7                                                        +
                                                     <less>|<frequent>
```

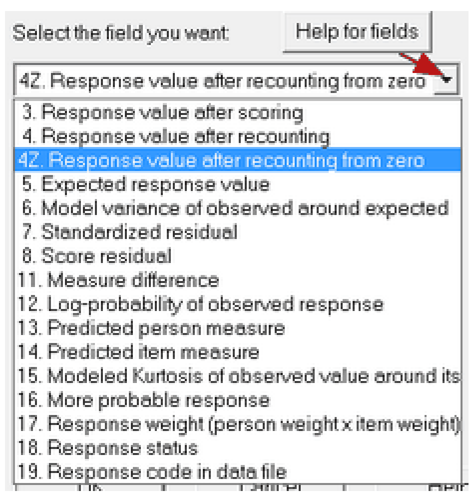
11.83 IPMATRIX= response-level matrix

IPMATRIX= constructs a rectangular matrix in which there is one row for each person and one column for each item, or vice-versa. The entries in the matrix are selected from the following screen:

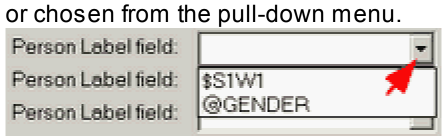


The first rows and columns can be the entry numbers, measures, labels and/or fields from the labels.

The matrix contents are selected from the "Select the field you want" pull-down menu (red arrow above). The identifying numbers in the drop-down list are those for XFILE=.



The "Person Label field" and "Item Label field" boxes enable you to select columns from the person and item labels to use as demographics. These can be typed in or chosen from the pull-down menu.



Depending on CSV=, data values are separated by "tab" or comma characters. In fixed field format, all fields are 7 characters long, separated by a blank. Missing data codes are "." as standard, but can be any character, or nothing.

When IPMATRIX=filename.txt is included in a control file, the default options are used. These can be changed with the "Make default" button.
a) in a standard run of Winsteps:
First do IPMATRIX= from the Output Files menu.
"Set as default" the settings you want.

b) Then you can IPMATRIX=response.csv in your control file or batch file.
use CSV= in your control file for the separators in the .csv file: CSV=, or CSV=Tab

Example:

```
"Entry"       1       2       3       4  <- Item entry numbers
      1    .162    .162       .    .482  <- standardized residuals. "." is missing or
inestimable data
      2    .042    .042    .044    .126
      3    .042    .042    .044    .126
      4    .225    .225    .236    .671
      5    .042    .042    .044    .126
      6    .042    .042    .044    .126
      7    .006    .006    .006    .017
      8    .042    .042    .044    .126
      9    .042    .042    .044    .126
      ^
      Person entry numbers
```

11.84 IPRFILE= change codes for blocks of persons and items

IPRFILE= enables rectangles of item and person observations to be changed based on their data codes. This is done after reading in the data files and performing EDFILE= (if specified).

IPRFILE= file name	file containing details
IPRFILE= file name + file name + ...	multiple files
IPRFILE = *	in-line list
IPRFILE = ?	opens a Browser window to find the file

IPRFILE= cannot add extra items. Please increase NI= to add extra items. Please specify the highest person beyond those in the data file by means of EDFILE=.

Several selections and recodings can be specified. An observation is recoded according to the first selection that it matches.

The format is:

IPRFILE=* (or IPRFILE= filename)	item-person-recode sublist or file
#ITEMS	start of item list (if omitted, select all items)
Item number	select this item
Item number - Item number	select this range of items
- Item number	exclude this item from this selection
- Item number - Item number	exclude this range of items item from this selection
"Item selection value"	select items using ISELECT= values, in quotation marks
- "Item selection value"	exclude these items
#PERSONS	start of person list (if omitted, select all persons)
Person number	select this person

Person number - Person number	select this range of persons
- Person number	exclude this person from this selection
- Person number - Person number	exclude this range of persons item from this selection
"Person selection value"	select persons using PSELECT= values, in quotation marks
- "Person selection value"	exclude these persons
#RECODE="codes"	a string of codes which align with the CODES= codes, and indicate the new code values. If a code in #RECODE= is not in CODES=, then it is interpreted as "change that valid code to missing data".
#MISSING="code"	this is the code in CODES= to replace "missing-data" in the selection. If this code is not in CODES=, then missing-data in the selection continues to be missing-data.
#	next selection begins (if any) ....
#ITEMS	start of list for items and persons not selected yet
......	
#RECODE="codes"	list of codes for the second selection
#	next selection begins (if any) ....
#ITEMS	start of list for items and persons not selected yet
.....	
*	end of IPRECORD=

Example 1: Convert all responses to items 3 and 7-10 by persons 4 and 13-22 into missing (not administered) data. Other missing responses are to be treated as incorrect.

```
NI = 16                          ; 16 item test
CODES = ABCDM                    ; the data are multiple-choice responses
IPRFILE = *                      ; start of rectangular recode
#ITEMS                           ; list of items to select
3
7-10
#PERSONS                         ; list of persons to select
4
13-22
; CODES = ABCDM                  ; this comment is a reminder of the CODES=
#RECODE = MMMMM                  ; A,B,C, D will all be converted to invalid code
*
IREFER = CBADBACDDCCABDBA        ; same as scoring key (for convenience)
; CODES = ABCDM                  ; comment: another reminder
IVALUEA = 1000M                  ; A scored 1. M scored "M", non-numeric, "missing, not administered"
IVALUEB = 0100M                  ; B scored 1
IVALUEC = 0010M                  ; C scored 1
IVALUED = 0001M                  ; D scored 1
MISSING-SCORED = 0               ; all responses not in CODES= scored 0.
```

Example 2: Convert all "C" responses to items 3 and 7-10 by persons 4 and 13-22 into "A".
Convert all "C" responses to the other items by persons 4 and 13-22 into "B".
Convert all other "C" responses into "D".

```
CODES = ABCD                           ; valid data codes
```

```
IPRFILE = *                     ; start of rectangular recode
#ITEMS                          ; list of items to select
3
7-10
#PERSONS                        ; list of persons to select
4
13-22
; CODES = ABCD                  ; this comment is a reminder of the CODES=
#RECODE = ABAD                  ; C is converted into A
#                               ; end of this recode: start of next recode
; #ITEMS                        ; commented out: applies to all items
#PERSONS
4
13-22
#RECODE = ABBD                  ; C is converted into B
; #ITEMS                        ; commented out: applies to all items
; #PERSONS                      ; commented out: applies to all persons
#RECODE = ABDD                  ; C is converted into D
*
```

Example 3: Select everyone with a person label beginning "A". Make their responses to items with labels starting "Z" into missing data.

```
CODES = ABCD                    ; valid data codes
IPRFILE = *                     ; start of rectangular recode
; #ITEMS                        ; commented out - all items
"Z"                             ;Item labels starting Z
#PERSONS                        ; list of persons to select
"A"                             ; person labels starting A
; CODES = ABCD                  ; this comment is a reminder of the CODES=
#RECODE = ....                  ; All responses made missing.
*
```

11.85 IREFER= identifying items for recoding

Responses are revalued according to the matching codes in IVALUE=. If this implies that the items may have different rating (or partial credit) scale structures, so ISGROUPS= may also be required.

IREFER= *file name	file containing details
IREFER = *	in-line list
IREFER = codes	codes for item groups

IREFER= has three forms: IREFER=AABBCDAAD and IREFER=* list * and IREFER=*filename

Valid one-character IREFER= codes include: !#$%&-./123456789<>@ABCDEFGHIJKLMNOPQRSTUVWXYZ^_|~

A-Z are the same as a-z.

Characters with ASCII codes from 129-255 can also be used, but display peculiarly: ÎÏÐÑÒÓÔÕÖ×ØÙÚÛÜÝÞßàáâã etc.

When XWIDE=2 or more, then
either (a) Use one character per XWIDE and blanks,

```
NI=8
XWIDE=2
IREFER=' A B C D D C B A'
```

or (b) Use one character per item with no blanks

```
NI=8
XWIDE=2
NEWSCORE='ABCDDCBA'
```

Item identifying codes can be letters or numbers. "A" is the same as "a", etc.

Example 1. There are 3 item types. Items are to rescored according to Type A and Type B. Other items to keep original scoring.

```
CODES = 1234
IREFER = AAAAAAAABBBBBBBB******* 3 item types: ("a" is the same as "A" in these codes)
IVALUEA = 1223  Recode Type A items
IVALUEB = 1123  Recode Type B items
IVALUE* = 1234  Recode Type * item. Can be omitted
```

or

```
IREFER=*
1-8 A
9-16 B
17-23 *
*
```

or

```
IREFER=*filename.txt
```

in filename.txt:

```
1-8 A
9-16 B
17-23 *
```

Example 2. There are 3 item types. Responses are 2 characters wide. Items are to rescored according to Type A and Type B. Other items to keep original scoring.

```
XWIDE=2
CODES = '1 2 3 4 '
IREFER = AAAAAAAABBBBBBBB******* 3 item types
IVALUEA = '1 2 2 3 '  Recode Type A items
IVALUEB = '1 1 2 3 '  Recode Type B items
IVALUE* = 1234  Recode Type * item. Can be omitted
```

Example 3: All items are to be rescored the same way

```
NI = 100   100 ITEMS
IREFER=*
1-100 X   FOR ALL 100 ITEMS, reference is X
*
Codes = 12345  rescore 12345
IVALUEX = 12223  into 12223
```

Example 4: Items are to be rescored in 3 different ways, forward scoring, reversed scoring and dichotomized scoring. Then the items are to be divided into 4 rating scale structures.

```
ISGROUPS=11112223312444 ; 4 RATING SCALE GROUPINGS
IREFER  =AAAABBBCCABBBB ; 3 RECODINGS
CODES   =01234 ; ORIGINAL CODES IN DATA
IVALUEA =01234 ; ORIGINAL CODING MAINTAINED - THIS LINE CAN BE OMITTED
IVALUEB =43210 ; CODING IS REVERSED
IVALUEC =*112* ; DICHOTOMIZED WITH EXTREME CATEGORIES MARKED MISSING
```

Example 5: Multiple-choice test with 4 options, ABCD

```
IREFER=ABCDDABADCDA ; SCORING KEY
CODES  =ABCD   ; VALID DATA CODES
IVALUEA=1000   ; A SCORED 1
IVALUEB=0100   ; B SCORED 1
IVALUEC=0010   ; C SCORED 1
IVALUED=0001   ; D SCORED 1
MISSCORE=0  ; EVERYTHING ELSE IN THE DATA SCORED 0
```

Example 6: A 10 item multiple choice test with 4 partial credit performance items scores 0,1,2,3.

```
NI = 14    ; 14 items
;         12345678901234
ISGROUPS=DDDDDDDDDD0000 ; 10 Dichotomies in Group "D". 4 Partial Credit items each in its own group "0"
IREFER  =ABCDDABADC1111 ; ITEM REFERENCE FOR THE 14 ITEMS
CODES  =ABCD0123  ; VALID DATA CODES
IVALUEA=10000000  ; A SCORED 1
IVALUEB=01000000  ; B SCORED 1
IVALUEC=00100000  ; C SCORED 1
IVALUED=00010000  ; D SCORED 1
IVALUE1=00000123  ; PERFORMANCE ITEMS: 0,1,2,3
MISSING-SCORED=0  ; EVERYTHING ELSE IN THE DATA SCORED 0
```

Example 7: Partial credit items are to be rescored:

```
IREFER = ABCAAB ; there are six items items 1, 4 and 5 have one rescoring. Items 2 and 6
another rescoring. Item 3 a third rescoring
CODES = 1234 ; the original scoring
IVALUEA = 1123 ; the new scoring for A-type items
IVALUEB = 1334 ; for B-type items
IVALUEC = 1234 ; original scoring maintained
```

Now there is a decision:
does 134 mean the same as 123, so that 2 is a structural zero, if so **STKEEP=NO**
does 134 mean the same as 1(2)34, so that 2 is an incidental or sampling zero, if so **STKEEP=YES**

Example 8: An MCQ item where two boxes can be checked for one item, e.g., choose 2 options out of 5.

Load the data into Excel. Each one-box item has a separate column. The two-box item is converted into 5 columns, one for each option. For example, 2 out 5 becomes 5 dichotomies, one for each option:, A-E,
Each dichotomy is scored 1 if the response is right, 0 if wrong, so
the two correct answers are scored 1 if selected, 0 if not
the three incorrect answers are scored 0 if selected, 1 if not
then
the two correct dichotomies are weighted 1
and the three incorrect dichotomies are weighted 0
Use Winsteps Excel/RSSST menu to create the Winsteps data file.

11.86 ISELECT= item selection criterion

Items to be selected may be specified by using the ISELECT= instruction to match characters within the item name. Items deleted by IDELETE= or IDFILE= are never selected by ISELECT=.

This can be done before analysis in the control file or with "Extra specifications". It can also be done after the analysis using the "Specification" pull-down menu.

Selection rules. Person and item selections must be in quotation marks " " if they contain blanks or tabs, and follow the selection rules:	
Control characters match label or name. They start at the first column of the label or name.	
?	matches any character

*	matches any string of characters - must be last selection character. If * is in the first column, then every available person or item is selected.
A	matches A in the person label, and similarly all other characters except these: { }"
{..}	braces characters which can match a single character: {ABC} matches A or B or C.
{.. - ..}	matches single characters in a range. {0-9} matches digits in the range 0 to 9.
{.. --..}	matches a single "-" {AB--} matches A or B or "-".
{~ABX}	omits persons or items which match A or B or X
{" "}	matches a blank in the label
@fieldname=	positions the next selection character at the start of the specified field

Each ISELECT= performed using the "Specification" pull-down menu selects from all those analyzed. For incremental selections from the Specification menu, i.e., selecting from those already selected, specify +ISELECT=

Example 0: In Example 10, select bank 6:
@BANK=5 ; Bank number is in column 5 of the item label
ISELECT=@BANK=6

Example 1: Select for analysis only items with M in the 5th column of item name.
ISELECT=????M* M in column means Math items
0001M 2x4 *; selected*
0002R the cat *; omitted*
END NAMES

Example 2: Select for analysis all items with code "A 4" in columns 2-4 of their names.
ISELECT="?A 4*" quotes because a blank is included. A is in col. 2 etc.
ZA 4PQRS selected

Example 3: Select all Math (M in column 2) items which are Addition or Division (A or D in column 4):
ISELECT="?M?{AD}*"
1M3A456 2+2 selected
1M5D689 23/7 selected
1H2A123 George omitted (History, American)

Example 3: Select codes A, 1,2,3,4,5,6 in column 3:
ISELECT=??{A1-6}*

Example 4: Select "- " in columns 2 and 3:
ISELECT="?- "

Example 5: Select "-" or "x" in column 2 with " " in column 3:
ISELECT="?{--x} "

Example 6: Analyze only math (column 4 or person-id). Then report only items in Topic C (column 1). Then only report items in Strands 4 and 5 (column 2) in Topic C.

ISELECT=???M* in the Control file or at the Extra Specifications prompt.
ISELECT=C* using the Specification pull-down menu, after the analysis
+ISELECT=?{45}* using the Specification pull-down menu.

Example 7: 4 forms in one analysis with common items. Produce a score table for each form.
In the item labels, columns 1-4 of item label are form indicator. Items can be in more than one form
1xxx for form 1 items
12xx for form 1 and 2 items
xx3x for form 3
xx34 for form 3 and 4
etc.

Then, use the Specification menu box:
ISELECT = 1??? will select all items on form 1
Output Tables: Table 20 score table
ISELECT = * select all items
ISELECT = ?2?? will select all items on form 2
etc.

Example 8: Omit unwanted items, marked by "x" in the first character of the item label:
ISELECT={~x}

Example 9: If the field to be selected is already identified, then this simplifies counting the column:

```
@Dx = 16E17 ; $C44W2
```

16E17 means that the field is in columns 16 and 17 of the item label. Look at a data record to see what is actually there.

```
ISELECT=???????????????23 ; selects "23" in columns 16 and 17 of the item label
```

Example 10: We want item type group X (in column 4 of the item label) except for sub-types 11, 24 (in columns 6, 7 of the item label):

```
ISELECT = "???X?{12}{14}"  ; this selects X and 11, 14, 21, 24
EDFILE=*
"?" "?????14" . ; convert 14 to missing data
"?" "?????21" . ; convert 21 to missing data
*
```

Example 11: multiple levels in the Specification menu box:
Between each step, in the Specification menu box, please specify ISELECT= (nothing) to reinstate all the items.

Example using Example0.txt and the Specification menu box:

iselect=L
"ISELECT=L*" selected 5 ACT
CURRENTLY REPORTABLE ACT = 5

iselect=W
"ISELECT=W*" selected 0 ACT
CURRENTLY REPORTABLE ACT = 5
... not done

iselect=
"ISELECT=*" selected 25 ACT
CURRENTLY REPORTABLE ACT = 25

iselect=W
"ISELECT=W*" selected 7 ACT
CURRENTLY REPORTABLE ACT = 7

11.87 ISFILE= item structure output file

Do not use this file for anchor values. Instead use IFILE= (becomes IAFILE=) and SFILE= (becomes SAFILE=).

Communicating the functioning of a rating scale is challenging, especially if your audience think of its categories as separate and equally-spaced points on the latent variable.

If you want to communicate the categories as points, then the best points for the intermediate categories are the locations on the latent variable at which the probability of observing each category is the highest. These are also the points where the expected score on the item is the category value. In Winsteps these are the "AT CAT" measures in the ISFILE= output file. These points are at infinity for the extreme categories, so Winsteps reports the measures for expected scores of "lowest category + 0.25" (= CAT +0.25) and "highest category - 0.25" (= CAT - 0.25).

The Rasch-Thurstonian thresholds (50%PRB in ISFILE=) dichotomize the rating scale at each category boundary into 50% probability of being observed below the category and 50% probability of being observed in or above the category.

The points on the latent variable where the expected scores are 2.5, etc., are called the CAT-0.5 and TOP-0.5 points in ISFILE=.

The Rasch item difficulty (in IFILE=) is the point on the latent variable at which the highest and lowest categories are equally probable.

ISFILE=? opens a Browse window

ISFILE=filename produces an output file containing the category structure measure (Andrich threshold) information for each item. All measures are added to the corresponding item's calibration and rescaled by USCALE= and UDECIMALS=. This file contains 4 heading lines (unless HLINES=N or ROW1HEADING=N), followed by one line for each item containing:

DISFILE=, DISOPTION=Score shows the contents of each ISFILE= category.

Columns:				
Start	End	Heading	In Table	Description
1	1			Blank or ";" if no responses or deleted (status = -2, -3)
2	6	ENTRY		The item sequence number
7	11	STATUS STAT		2. The item's status 1 = Estimated calibration 2 = Anchored (fixed) calibration 3 = Anchored (fixed) calibration with extreme (minimum or maximum) observed raw score 0 = Extreme minimum (estimated using EXTRSC=) -1 = Extreme maximum (estimated using EXTRSC=) -2 = No responses available for calibration -3 = Deleted by user
12	16	MAXIMUM MAX		Number of active categories
17	21	CAT BOT		Lowest active category number, bottom category
22	29	BOT+.25	2.2	Measure for an expected score of bottom category + LOWADJ= Useful as a measure for a performance in the bottom category, for which the performance range extends to -infinity.
The following fields are repeated for the remaining active categories:				
30	34	CAT		Active category number
35	39	ORDINAL ORD		Ordered category number in structure = "Step counting from bottom category"
40	47	THRESHOL D THRESH		Rasch-Andrich threshold (step difficulty) relative to item difficulty = Rasch parameter Fj. Use this or SFILE= for anchoring in SAFILE=.
48	55	I+THRESH I+THRSH	2.4	item measure + Rasch-Andrich threshold = Structure measure = Step calibration = Delta = Rasch parameter Dij. Do not use for anchoring. Use SFILE= for SAFILE= and IFILE= for IAFILE=.
56	63	S.E.		Rasch-Andrich threshold's standard error, with the item difficulty S.E. assumed to be 0.0.
64	71	CAT-0.5 (TOP-0.5)	2.2	Measure for an expected score of category - 0.5 score points. This is the Rasch-half-point threshold, the boundary between categories when conceptualized as average performances. It is not a model parameter. TOP-0.5 for the highest (top) category,

72	79	AT CAT (TOP-0.25)	2.2	Measure for an expected score of category score points (AT CAT). This is the measure corresponding to a category when predicting for an individual or sample about which nothing else is known. For items with fewer rating-scale categories, the AT CAT value shown for the highest category is the TOP-0.25 value.
80	87	PR50%	2.3	Probability 50%. Measure at Rasch-Thurstonian threshold = 50% cumulative probability.
Only for the top (highest) category				
		TOP-0.25	2.2	For the highest (top) category this value corresponds to the top category value less HIADJ= , the measure for an expected score of HIADJ= score points less than the top category value. This is useful as a measure for a performance in the top category, for which the performance range extends to infinity. For items with fewer rating-scale categories, the AT CAT value shown for the highest category is the TOP-0.25 value.
		ITEM		Item label

The "AT CAT" values in the ISFILE= are based on the Rasch-model. They are the points on the "expected score" ogive for the rating scale (also called "the model ICC") at which the expected score = the category number. This is also the point at which the probability of observing the category is highest.

For extreme categories (top and bottom of the rating scale), the model values are infinite, so an adjustment is made. The "AT CAT" values correspond to expected scores bottom+0.25 score points and top-0.25 score points. These provide reasonable estimates for performance in the extreme categories of the rating scale. The adjustment of 0.25 can be changed with LOWADJ= and HIADJ=. The "AT CAT" values are plotted on Table 2.2.

Since the ISFILE= has the same number of category entries for every item, the repeated fields are filled out with "0" for any further categories up to the maximum categories for any item.

When CSV=Y, commas separate the values with quotation marks around the "Item name". When CSV=T, the commas are replaced by tab characters.

When STKEEP=YES and there are intermediate null categories, i.e., with no observations, then the Rasch-Andrich threshold into the category is set about 40 logits above the previous threshold. The threshold out of the category, and into the next category, is set about 40 logits above. The exact values depend on the category frequencies of the observed categories. Thus:

Rasch-Andrich Thresholds for Unobserved Categories		
Category	in Table 3.2	in SFILE=
0 (observed) 1 (observed) 2 (unobserved) 3 (observed)	NULL -1.00 NULL 1.00	0.00 -1.00 39.00 -38.00
Total:	0.00	0.00

Meanings of the columns
There are several ways of conceptualizing the category boundaries or thresholds of a rating (or partial credit) scale item. Imagine a rating (or partial credit) scale with categories, 1, 2, 3:

From the "expected score ogive", also called the "model item characteristic curve"

Average rating:	Measure (must be ordered)
1.25	Measure for an expected score of 0.25 (BOT+.25) when LOWADJ=0.25

1.5	Measure for an expected score of category - 0.5 score points (CAT-0.5)
2.0	Measure for an expected score of category score points (AT CAT)
2.5	Measure for an expected score of category - 0.5 score points (CAT-0.5)
2.75	Measure for an expected score of category score points (AT CAT) Since this is the top extreme category the reported values is for TOP-0.25 when HIADJ=0.25

From the "category probability curves" relative to the origin of the measurement framework (need not be ordered)

1-2 equal probability	Structure measure = Rasch-Andrich threshold + item measure = Dij (MEASURE)
standard error	Rasch-Andrich threshold's standard error (ERROR)
2 maximum probability	Measure for an expected score of category score points (AT CAT) - (yes, same as for the ogive)
2-3 equal probability	Structure measure = Rasch-Andrich threshold + item measure = Dij (MEASURE)
standard error	Rasch-Andrich threshold's standard error (ERROR)

From the "cumulative probability curves" (preferred by L.L.Thurstone) (must be ordered)

Category 1 at .5 probability	Measure at the Rasch-Thurstonian threshold = 50% cumulative probability (50%PRB)
Category 1+2 at .5 probability	Measure at the Rasch-Thurstonian threshold = 50% cumulative probability (50%PRB)

Example 1: You wish to write a file on disk called "ITEMST.FIL" containing the item statistics reported in Table 2.2, for use in constructing your own tables:
ISFILE = ITEMST.FIL
ISGROUPS = 0 ; each item has its own "partial credit" scale
LOWADJ = 0.25 ; the standard for the low end of the rating scale
HIADJ = 0.25 ; the standard for the high end of the rating scale

For column definitions, see above.

```
; ACT ITEM-STRUCTURE FILE (not for anchoring: use SFILE=) FOR LIKING FOR SCIENCE (Wright & Masters p.18) Mar 24 20:55 2015
;ENTRY STAT  MAX  CAT BOT+.25  CAT  ORD  THRESH I+THRSH    S.E. CAT-0.5  AT CAT   PR50%  CAT  ORD  THRESH I+THRSH    S.E. CAT-0.5 TOP-
     .25   PR50% ACT
    1    1    2    0   -2.68    1    1   -1.03   -1.50     .14   -1.76    -.47   -1.61    2    2    1.03     .55     .13     .81
    1.74     .66 Watch birds
    2    1    2    0   -3.01    1    1   -1.03   -1.83     .14   -2.09    -.80   -1.94    2    2    1.03     .23     .13     .49
    1.41     .33 Read books on animals
```

Example 2: To produce a Table of expected measures per item-category similar to Pesudovs, K., E. Garamendi, et al. (2004). "The quality of life impact of refractive correction (QIRC) questionnaire: Development and validation." Optometry and Vision Science 81(10): 769-777, write the ISFILE= to Excel. Then delete or hide unwanted columns.

	Response category				
Item number	**1**	**2**	**3**	**4**	**5**
1	60.51	45.06	29.61	29.61	29.61
2	65.11	49.66	34.21	34.21	34.21
3	56.71	41.26	25.81	25.81	25.81

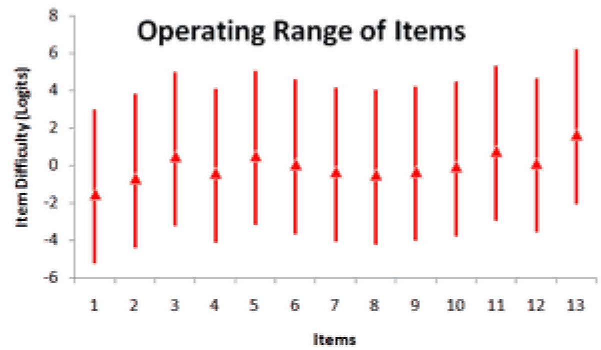
Example 3: To plot the operating range of each item using Excel.

"Output Files", "ISFILE=", output to Excel.
"Output Files", "IFILE=", output to Excel.

Paste the "MEASURE" column from the Excel IFILE= into the Excel ISFILE=
Arrange the columns: TOP-.25, BOT+.25, MEASURE
If some items have fewer categories, then paste their highest values into the TOP-.25 column
Draw a "hi-lo-close" plot with TOP-.25, BOT+.25, MEASURE for each item

If some items have fewer categories, then use their highest values in ISFILE=

This is one I have drawn from Exam12.txt with Exam12lo.txt+Exam12hi.txt



Example 4: To produce ISFILE= without the addition of item difficulties (similar to Table 3.2 for a rating scale)

We can do this by writing out the SFILE=sf.txt from the original analysis. Then do the analysis again with SAFILE=sf.txt and IAFILE=*
1-number of items 0
*

11.88 ISGROUPS= or GROUPS= assigns items to rating scale groupings

Winsteps chooses the model-family based on MODELS=
Models=R (or MODELS= is omitted) is the rating-scale family of models which includes the Andrich Rating-Scale Model, the Masters Partial-Credit Model, the Grouped Rating-Scale Model and the Rasch Dichotomous Model.

Within Models=R, the choice of model is decided by ISGROUPS= or GROUPS= or IGROUPS=
If ISGROUPS= is omitted, then
1) If there are only two categories in the data the dichotomous model
2) If there are more than two categories the Andrich Rating-Scale Model

ISGROUPS= *file name	file containing details
ISGROUPS = *	in-line list
ISGROUPS = codes	codes for item groups

If ISGROUPS=0 then
the Masters Partial Credit Model

If ISGROUPS=(something else)
the Grouped Rating-Scale Model

Please look at the output in Table 3.2, 3.3, ... to see exactly how the data have been modeled.

Items in the same "grouping" share the same dichotomous, rating scale or partial credit response structure. For tests comprising only dichotomous items, or for tests in which all items share the same rating (or partial credit) scale definition, all items belong to one grouping, i.e., they accord with the simple dichotomous Rasch model or the Andrich "Rating Scale" model. For tests using the "Masters' Partial Credit" model, each item comprises its own grouping (dichotomous or polytomous). For tests in which some items share one polytomous response-structure definition, and other items another response-structure definition, there can be two or more item groupings. Groups are called "blocks" in the PARSCALE software. All the items in the same group of items must have the same number of categories. If an item has a different number of categories, place it in a different item group, or in an item group by itself. In ISGROUPS=, an item in a item group by itself can be given its own item group code or group "0". Item difficulty measures are the locations on the latent variable (Rasch dimension) where the highest and lowest categories of the item are equally probable, regardless of the number of categories the item has.

$$\log\left(\frac{P_{nij}}{P_{ni(j-1)}}\right) = B_n - D_{gi} - F_{gj}$$

where P is a probability, and the Rasch parameters are Bn, the ability of person, Dgi, the difficulty of item i of grouping g, and Fgj, the Rasch-Andrich threshold between categories j-1 and j of grouping g. If there is only one grouping, this is the Andrich "rating scale" model. If each item forms a grouping of its own, i.e., g=i, this is the Masters' "partial credit' model. When several items share the rating scale, then this could be called an item-grouping-level Andrich rating-scale model, or an item-grouping-level Masters' partial-credit model. They are the same thing.

ISGROUPS= also acts as IREFER=, when IVALUE= is specified, but IREFER= is omitted.

ISGROUPS= has three forms: ISGROUPS=1101110 and ISGROUPS=* list * and `ISGROUPS=*filename`

ISGROUPS=" "	(standard if only one model specified with MODELS=) All items belong to one grouping. This is sometimes called "Andrich's Rating Scale Model"
ISGROUPS=0	(standard if MODELS= specifies multiple models) Each item has a grouping of its own, so that a different response structure is defined for each item, as in the "Masters' Partial Credit model". This is also used for rank order data.
ISGROUPS= some combination of numbers and letters	Use only one letter or number per grouping, regardless of the XWIDE= setting. Valid are: 0's, 1's, 2's, A's, B's, etc. ("a" is the same as "A"), also #, @, !,& etc. Items are assigned to the grouping label whose location in the ISGROUPS= string matches the item sequence number. Items in groupings labeled "1", "2", "A", etc. share the response-structure definition with other items in the same labeled grouping, which is the "Grouped Rating Scale Model". Each item assigned to grouping 0 is allocated to a "partial credit" grouping by itself, which is the same as having only one item in a group.
ISGROUPS= with extreme items	If there are items with minimum-possible or maximum-possible total raw scores, then please group those items with other items which do not have extreme scores, so that Winsteps knows which categories should have been observed for the extreme item. This does not change the response structure for the non-extreme items.

Valid one-character ISGROUPS= codes include: !#$%&-./123456789<>@ABCDEFGHIJKLMNOPQRSTUVWXYZ^_|~

A-Z are the same as a-z.

For the ISGROUPS= specification, "0" has the special meaning: "this is a one item grouping" - and can be used for every 1 item grouping.
NI=9
ISGROUPS=0
is the same as
ISGROUPS=000000000
is the same as
ISGROUPS=123456789

Characters with ASCII codes from 129-255 can also be used, but display peculiarly: ÎÏÐÑÒÓÔÕÖ×ØÙÚÛÜÝÞßàáâã etc.

When XWIDE=2 or more, then
either (a) Use one character per XWIDE= and blanks,
NI=8
XWIDE=2
ISGROUPS=' 1 0 1 0 1 0 1 1'
or (b) Use one character per item with no blanks
NI=8
XWIDE=2
ISGROUPS='10101011'

ISGROUPS=*
item number grouping code
item number-item number grouping code
*
Each line has an item number, e.g., 23, or an item number range, e.g., 24-35, followed by a space and then a grouping code, e.g., 3. The items can be out of order. If an item is listed twice, the last entry dominates.

ISGROUPS=*file name
This has a file with the format of the ISGROUPS=* list.

Particularly with ISGROUPS=0, some extreme categories may only be observed for persons extreme scores. To reinstate them into the measurement analysis, see Extreme Categories: Rescuing the Dropped.

Groupings vs. Separate Analyses

ISGROUPS= is very flexible for analyzing together different item response structures in one analysis. Suppose that an attitude survey has 20 Yes-No items , followed by 20 5-category Likert (Strongly disagree - disagree - neutral - agree-strongly agree) items, followed by 20 3-category frequency (never - sometimes - often) items. When possible, we analyze these together using ISGROUPS=. But sometimes the measurement characteristics are too different. When this happens, the fit statistics stratify by item type: so that, say, all the Yes-No items overfit, and all the Frequency items underfit. Then analyze the test in 3 pieces, and equate them together - usually into the measurement framework of the response structure that is easiest to explain. In this case, the Yes-No framework, because probabilistic interpretation of polytomous logits is always difficult to explain or perform.

The "equation" would be done by cross-plotting the person measures for different item types, and getting the slope and intercept of the conversion from that. Drop out of the "equation" any noticeably off-trend-line measures. These are person exhibiting differential performance on the different item types.

Example 1: Responses to all items are on the same 4-point rating scale, an Andrich "Rating Scale" model, ISGROUPS=" "

Example 2: An arithmetic test in which partial credit is given for an intermediate level of success on some items. There is no reason to assert that the intermediate level is equivalent for all items. 0=No success, 1=Intermediate success (or complete success on items with no intermediate level), 2=Complete success on intermediate level items.
CODES=012 valid codes
ISGROUPS=0 each item has own response structure, i.e., Masters' Partial Credit model
or
ISGROUPS=*
1 0 ; item 1 is in Grouping 0, no other items mentioned, so all assumed to be in Grouping 0
*

Example 3: An attitude survey consists of four questions on a 0,1,2 rating scale (grouping 1), an Andrich "Rating Scale" model, followed by three 0,1 items (grouping 2), an other Andrich "Rating Scale" model, and ends with one 0,1,2,3,4,5 question (grouped by itself, 0), a Masters' "Partial Credit" model.

NI=8 number of items
CODES=012345 valid codes for all items
ISGROUPS=11112220 the item groupings

or

ISGROUPS=*
1-4 1
5-7 2
8 0 ; this line is optional, 0 is the standard.
*

When XWIDE=2, use two columns for each ISGROUPS= code. Each ISGROUPS= code must be one character, a letter or number, specified once in the two columns, e.g. " 1" or "1 " mean "1", and " 0" or "0 " mean "0".

Example 4: You wish most items on the "Liking for Science" Survey to share the same rating scale, an Andrich "Rating Scale" model, (in Grouping A). Items about birds (1, 10, 21) are to share a separate response structure, another Andrich "Rating Scale" model, (in Grouping B). Items 5 (cans) and 18 (picnic) each has its own response structure, i.e., the "Masters' Partial Credit" model, (Grouping 0).
NI=25 number of items
XWIDE=2
CODES=000102 valid codes for all items
ISGROUPS=' B A A A 0 A A A A B A A A A A A A 0 A A B A A A A'
item groupings - use only one letter/number codes.

or

ISGROUPS=* ; XWIDE=2 is not a worry here, but use one letter/number codes.
1-25 A ; most items in grouping A
1 B ; item 1 transferred to grouping B
10 B
21 B
5 0 ; grouping 0 means item is by itself
18 0
*

Example 5: Four separate tests of patient performance (some on a 4-point rating scale, some on a 5-point rating scale) are to be Rasch-analyzed. All 500 persons were given all 4 tests. I analyzed each separately, to get an idea of good-fitting and bad-fitting items, etc. Now, I'd like to run all 4 tests together using a partial credit model.
There is no problem running all four tests together. Put them all in one file, or use MFORMS=. If you intend every item of every test to have its own rating scale (i.e., a strict partial-credit model), use ISGROUPS=0. But if you intend items on test 1 to share the same rating scale, similarly test 2 etc. (i.e., a test-level partial-credit model), then specify ISGROUPS=111111112222233334444.... matching the grouping number indicators to the count of items in each test.

Example 6: Items are to be rescored in 3 different ways, and then the items are to be divided into 4 rating scale structures.

```
ISGROUPS=11112223312444 ; 4 RATING SCALE GROUPINGS
IREFER  =AAAABBBCCABBBB ; 3 RECODINGS
CODES   =01234 ; ORIGINAL CODES IN DATA
IVALUEA =01234 ; ORIGINAL CODING MAINTAINED - THIS LINE CAN BE OMITTED
IVALUEB =43210 ; CODING IS REVERSED
IVALUEC =*112* ; DICHOTOMIZED WITH EXTREME CATEGORIES MARKED MISSING
```

Example 7: A five-item test.
Item 1: Dichotomy already scored 0-1 ; let's call this a "D" (for dichotomy) group item
Item 2: Dichotomy already scored 0-1 ; this is another "D" (for dichotomy) group item. Under the Rasch model, all dichotomies have the same response structure.
Item 3: Partial credit polytomy already scored 0-1-2 ; this is an "0" type item. "0" means "this item has its own response structure".
Item 4: Rated polytomy already scored 1-2-3-4 ; let's call this an "R" group items
Item 5: Rated polytomy already scored 1-2-3-4 with the same rating scale as item 4, so this is another "R" group item,
CODES = 01234 ; this is all possible valid codes in the data
ISGROUPS = DD0RR ; Winsteps detects from the data which are the responses for each item-group and what they mean.

Example 8: An attitude survey in which the rating-scale items are worded alternately positively and negatively.

CODES = 12345 ; the rating scale of 5 categories
; rescore the items
IREFER = PNPNPNPNPN ; 10 item, alternately positively-worded and negatively-worded
IVALUEP = 12345 ; the positive orientation
IVALUEN = 54321 ; the negative orientation
; model the rating scales
GROUPS = PNPNPNPNPN ; model the two item orientations with separate rating scale structures

Example 9: A test with 5 dichotomous items and 5 partial credit items:

CODES = 01234 ; all possible item scores
GROUPS = 1111100000 ; 5 dichotomies share the same response structure

Example 10: 3 rating-scales in one instrument.

```
NAME1   = 1             ; First column of person label in data file
NAMLEN  = 14
ITEM1   = 19            ; First column of responses in data file
NI      = 57
XWIDE   = 1
GROUPS=111111111111111111111111111222222222222222222222222222233
; Group 1 categories 0,1,2,3,4    ; Winsteps discovers this by inspecting the data
; Group 2 categories 0,1,2,3
; Group 3 categories 0,1,2,3,4,5,6
CODES=0123456              ; Valid response codes in the data file
&END
.....
END NAMES                ; END NAMES or END LABELS must come at end of list
XX 10001 1 2 2    444444444442434444234444444333332333333333333233133323366
XX 10002 1 2 1    444444444442444344334343334133333333333333333333333333366
XX 10003 1 1 3    4444444440324 44444202344443333332333333331333233333333366
XX 10004 1 2 1    444444444043444444444444444433333333333333333333333333345
XX 10005 1 2 1    443334444431441033113312332233332232303323032332020333243
XX 10006 1 2 1    233334442422323442333333343123332332222323332331233223344
```

Example 11: I have 10 items, 9 of them are dichotomous (0,1). One item gets a range between 1 and 10.
Please use 2 columns for each response:

```
codes= "0 1 2 3 4 5 6 7 8 9 10"
xwide=2
isgroups=1111111112
```

Example 12: The item's rating scale changes. The rating scale changed for certain items. Some respondents used a 1-4 scale and others used a 1-5 scale for the same items.

When the rating scale changed from 1-4 to 1-5 the items became new items. For instance, if there are 10 items:
the first people responded to items 1 to 10.
the later people responded to items 1 to 6 and 9. And also 7B, 8B, 10B
The data looks like

```
NI=13
CODES=12345
ISGROUPS=4444444444555
DATA=
1234123412...   first person
....
342132..4.234   later person
....
```

Then look at Table 2.2 to see how the 4-point items and the 5-point items align.

Example 13: I have 100 items with different categorizations. I want to group together items with the same maximum category:

Use Winsteps to analyze your data with ISGROUPS=0 and STKEEP=Yes
Output Files menu: output the ISFILE= to Excel
In Excel, delete the second column
In your Winsteps control file

ISGROUPS=*
copy the Excel ENTRY and MAX columns here
*

11.89 ISORT= column within item name for alphabetical sort in Table 15

Table 15 lists items alphabetically. Table 1 and Table 12 list them alphabetically within lines. As standard, the whole item name is used. Select the sorting columns in the item labels with ISORT= using the column selection rules, e.g., starting in column Snn and ending in column Enn or of width Wnn.

Example 1: The item name is entered in the specification file as sequence number, followed by identification in column 6. Sort by identification for Table 15.
NI=4
TABLES=1111111111111111111111111
ISORT=5-30 ; sort the items reported in Table 15 by item descriptions
&END
0001 Addition Item
0002 Subtraction Item
0003 Multiplication item
0004 Division item
sort column
END NAMES

Example 2: The item name contains several important classifiers. Table 15 is required for each one:
TFILE=*
15 - - - 1 ; sort starts with column 1 of item name
15 - - - 6 ; sort starts with column 6
15 - - - 13 ; sort starts with column 13 of the item name and goes to the end of the item name
- entered as place-holders, see TFILE=
*
&END
MCQU Geogrp 1995-0234
sort column
sort column
sort column
|
END NAMES

Example 3: A version of Table 15, sorted on item name column 13, is to be specified on the DOS command line or on the Extra Specifications line. Commas are used as separators, and "-" as place-holders:
TFILE=* 15,-,-,-,13 *

11.90 ISRANGE= category range of a rating scale

By default, Winsteps deduces the range of categories of an item group from the data. ISRANGE= or ICRANGE= states the range of category numbers explicitly. This is useful with SFUNCTION=

ISRANGE= file name	file containing details
ISRANGE = *	in-line list, follwed by *
ISRANGE = ?	opens a Browser window to find the file
Formats:	Item Entry Number Low category number High category Number
	Item Entry Number-Item Entry Number= Low category number High category Number

	Item Entry Number Low category number-High category Number

The Item Entry Number is for any item in the ISGROUPS= group. All items in the group have the same category range.

Example1 : For the Olympic Ice-Skating in Exam15.txt, the rating scale range is 0-60 though the observed range is 29-60. All items (raters) share the same rating scale.

```
ISRANGE=*
2 00 60   ; 2 is an example rater number in the group
*
```

Example 2: there are 25 Partial Credit items. All have the range 0-4

```
ISGROUPS=0
ISRANGE=*
1-25 0 4
*
```

11.91 ISUBTOTAL= columns within item label for Table 27

This specifies what part of the data record is to be used to classify items for subtotal in Table 27.

ISUBTOTAL= file name	file containing details
ISUBTOTAL = *	in-line list
ISUBTOTAL = $S1W1	field in item label

Format 1: ISUBTOTAL = $S..W.. or $S..E.. using the column selection rules.
$S..W.. e.g., $S2W13 means that the label to be shown on the map starts in column 2 of the item label and is 13 columns wide.

$S..E.. e.g., $S3E6 means that the label to be shown on the map starts in column 3 of the item label and ends in column 6.

These can be combined, and constants introduced, e.g,
ISUBTOTAL=$S3W2+"/"+$S7W2

If the item label is "KH323MXTR", the sub-grouping will be shown as "32/XT"

Format 2: ISUBTOTAL=*
This is followed by a list of sub-groupings, each on a new line using the column selection rules:

```
ISUBTOTAL=*
$S1W1+$S7W2  ; Subtotals reported for item classifications according to these columns
$S3E5   ; Subtotals reported for item classifications according to these columns
*
```

Example: Subtotal by first letter of item name:

```
ISUBTOTAL=$S1W1
or
@SGROUP=$S1W1
ISUBTOTAL=@SGROUP

TFILE=*
27 ; produce the subtotal report
*
```

Here is a subtotal report (Tables 27) for items beginning with "R"

```
"R" SUBTOTAL FOR 8 NON-EXTREME ITEMS
+-----------------------------------------------------------------------------+
|           RAW                                MODEL         INFIT        OUTFIT    |
|          SCORE      COUNT      MEASURE    ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      28.1       25.0          4.04     3.48        .91    -.5   1.04     .0 |
| P.SD       5.5         .0          6.63      .14        .31    1.1    .54    1.4 |
| MAX.      38.0       25.0         16.30     3.82       1.61    2.0   2.37    3.4 |
| MIN.      19.0       25.0         -6.69     3.38        .64   -1.6    .60   -1.2 |
|-----------------------------------------------------------------------------|
| REAL RMSE    3.63 TRUE SD     5.54  SEPARATION  1.52  PUPIL  RELIABILITY  .70 |
|MODEL RMSE    3.48 TRUE SD     5.64  SEPARATION  1.62  PUPIL  RELIABILITY  .72 |
| S.E. OF PUPIL MEAN = 2.50                                                   |
| WITH 2 EXTREME = TOTAL 10 PUPILS  MEAN = 3.05,  P.SD = 28.19                |
| REAL RMSE    8.88 TRUE SD    26.75  SEPARATION  3.01  PUPIL  RELIABILITY  .90 |
|MODEL RMSE    8.83 TRUE SD    26.77  SEPARATION  3.03  PUPIL  RELIABILITY  .90 |
| S.E. OF PUPIL MEAN = 9.40                                                   |
+-----------------------------------------------------------------------------+
  MAXIMUM EXTREME SCORE: 1 PUPILS
  MINIMUM EXTREME SCORE: 1 PUPILS
      LACKING RESPONSES: 1 PUPILS
                DELETED: 1 PUPILS
```

11.92 ITEM= title for item labels

Up to 12 characters to use in table headings to describe the kind of items, e.g.
ITEM=MCQ.

11.93 ITEM1= column number of first response

Specifies the column position where the response-string begins in your data file record, or the column where the response-string begins in the new record formatted by FORMAT=.
If you have the choice, put the person-identifiers first in each record, and then the item responses with each response taking one column.

For comma-separated or tab-separated data files, count the columns in the same way as Excel.

Error messages regarding **ITEM1=** may be because your control file is not in "Text with line breaks" format.

It is easy to miscount the ITEM1= column. Scroll to the top of the Winsteps screen and check column positions:

```
 Input in process..
Input Data Record:
         1         2
1234567890123456789012345678
Richard M 111111100000000000
^P        ^I                ^N
       35 KID    Records Input.
```

^P marks the Name1=1 column position with ^.
^I marks the Item1=11 column position with ^.
^N marks the NI=18 column position with ^.

Example 1: The string of 56 items is contained in columns 20 to 75 of your data file.

```
 ITEM1=20  response to item 1 in column 20
 NI=56    for 56 items
 XWIDE=1  one column wide (the standard)
```

Example 2: The string of 100 items is contained in columns 30 to 69 of the first record, 11 to 70 of the second record, followed by 10 character person i.d.

```
XWIDE=1  one column wide (the standard)
FORMAT=(T30,40A,/,T11,60A,10A) two records per person
ITEM1=1  item 1 in column 1 of reformatted record
NI=100   for 100 items
NAME1=101  person id starts in column 101
NAMLEN=10  person id starts in 10 columns wide
```

Example 3: Comma-separated data:

```
DELIMITER = ","
ITEM1=2  ; first item in seccond CSV column
NI=56   for 56 items
XWIDE=1  one column wide (the standard)
CODES=12345 valid codes in data
......
END LABELS
first name,3,2,5,
```

11.94 ITLEN= maximum length of item label

ITLEN= specifies the maximum number of columns in the control file that are to be used as item names. The maximum possible is 300 characters. ITLEN= can be specified in the Specification box. Its length cannot exceed the original maximum label length. If your item labels are longer than 300 characters, please use ITEM1= and ITLEN= to pick out the important part of the label, and use FORMAT= if the important parts are too far apart.

Example 1: You only wish to use the first five columns of item information to identify the items on the output:

```
NI=4
ITLEN=5
&END
AX123 This part is not shown on the output
BY246 Trial item
AZ476 This item may be biased
ZZ234 Hard item at end of test
END NAMES
```

Example 2: Your item names may be up to 50 characters long:

```
NI=4
ITLEN=50
&END
This item demonstrates ability for constructive reasoning
This item flags rigid thinking
This item detects moral bankruptcy
This item is a throw-away
END NAMES
```

11.95 IVALUEx= recoding of data

Responses are revalued according to the matching codes in IREFER= (or ISGROUPS= if IREFER= is omitted). Items in IREFER= not referenced by an IVALUEx= are not recoded.

IVALUEa= is the same as IVALUEA=

The recoded values in IVALUEx= line up vertically with the response codes in CODES=, if a data value does not match any value in CODES= it will be treated as missing.

Valid one-character IVALUE= codes include: 123456789ABCDEFGHIJKLMNOPQRSTUVWXYZ^_|~!#$%&-./<>@

A-Z are the same as a-z.

Characters with ASCII codes from 129-255 can also be used, but their appearance depends on the font chosen:
ÀÁÂÃÄÅÆÇÈÉÊËÌÍÎÏÐÑÒÓÔÕÖ×ØÙÚÛÜÝÞßàáâãäåæçèéêëìíîïðñòóôõö÷øùúûüýþÿ

‚ƒ„…†‡ˆ‰Š‹ŒŽ‘’“”•–—˜™š›œžŸ ¡¢£¤¥¦§¨©ª«¬®¯°±²³´µ¶·¸¹º»¼½¾¿

When XWIDE=2 or more, then
either (a) Use one character per XWIDE and blanks,

```
NI=8
XWIDE=2
IREFER=' A B C D D C B A'
```

or (b) Use one character per item with no blanks

```
NI=8
XWIDE=2
RESCORE='ABCDDCBA'
```

Layout is:

```
NI = 17
IREFER = AABCADBCDEEDEAABC  ; the recoding type designators for the 17 items
;  see the vertical line up here
CODES   = 0123456 ; valid codes across all items
IVALUEA = 012**** ; recodes for Grouping A
IVALUEB = *1224** ; recodes for Grouping B: "2" and "3" recoded to "2"
IVALUEC = *122226 ; 1-2-6 acts as 1-2-3 because STKEEP=NO
IVALUED = 012333*
IVALUEE = 00123**
STKEEP=NO  ; missing intermediate codes are squeezed out
```

Example 1: Items identified by Y and Z in IREFER= are to be recoded.
Y-type items are 1-3, 7-8. Z-type items are 4-6, 9-10. All items have their own rating (or partial credit) scales,

```
NI = 10
IREFER = YYYZZZYYZZ ; items identified by type: item 1 is Y, item 4 is Z etc.
CODES  = ABCD ; original codes in the data
IVALUEY= 1234 ; for Y-type items, this converts A to 1, B to 2, C to 3, D to 4
IVALUEZ= 4321 ; for Z-type items, this converts A to 4, B to 3, C to 2, D to 1
ISGROUPS=0 ; allow each item to have its own rating (or partial credit) scale structure
```

Example 2: Items identified by 1, 2, 3 in ISGROUPS= are to be recoded and given there own rating (or partial credit) scales
Y-type items are 1-3, 7-8. Z-type items are 4-6, 9-10.

```
NI = 10
ISGROUPS = YYYZZZYYZZ
CODES= ABCD ; original codes in the data
IVALUEY= 1234
IVALUEZ= 4321
```

or

```
NI = 10
ISGROUPS = YYYZZZYYZZ
IREFER = YYYZZZYYZZ
CODES= ABCD ; original codes in the data
IVALUEY= 1234
IVALUEZ= 4321
```

Example 3: All items are to be recoded the same way.

```
 NI = 100  ; 100 ITEMS
 IREFER=*
 1-100 X  ; FOR ALL 100 ITEMS, reference is X
 *
 Codes = 12345  ; rescore 12345
IVALUEX = 12223 ; into 12223
```

11.96 IWEIGHT= item (variable) weighting

IWEIGHT= allows for differential weighting of items. The standard weights are 1 for all items. To change the weighting of persons, specify PWEIGHT=.

IWEIGHT of 2 has the same effect on person estimation as putting the item and its responses into the analysis twice. It does not change an item scored 0-1 into an item scored 0-2. When IWEIGHT is 0 for an item, the measure and fit statistics are reported for the item, but the item does not influence the measures or fit statistics of the other items or persons. IWEIGHT= applies to everything except the dimensionality computations (Tables 23, 24) where PWEIGHT= is set to 1 and IWEIGHT= is set to 1 for all persons and items.

IWEIGHT= file name	file containing details
IWEIGHT = * 1 0.5 2 0 *	in-line list item entry number 1 is weighted 0.5 item entry number 2 is weighted 0. Item 2 is reported, but it is not used to estimate person measures
IWEIGHT = $S1W1	field in item label

Raw score, count, and standard error of measurement reflect the absolute size of weights as well as their relative sizes. Measure, infit and outfit and correlations are sensitive only to relative weights.

Weighting is treated for estimation as that many independent observations. So, if you weight all items by two, you will divide the S.E. by the square-root of 2, but will not change the measures or fit statistics.

If you want to do different weighting at different stages of an analysis, one approach is to use weighting to estimate all the measures. Then anchor them all (IFILE= and IAFILE= etc.) and adjust the weighting to meet your "independent observation" S.E. and reporting requirements.

If you want the standard error of the final weight-based measure to approximate the S.E. of the unweighted measure, then ratio-adjust case weights so that the total of the weights is equal to the total number of independent observations.

Formats are:

IWEIGHT=file name the weights are in a file of format:
item number weight

IWEIGHT=*
item number weight
....
*

IWEIGHT=$S...$W... or $S...$E... weights are in the item labels using the column selection rules, e.g.,starting in column S... with a width of W... or starting in column S and ending in column E. This can be expanded, e.g.,
IWEIGHT = $S23W1+"."+$S25W2
places the columns next to each other (not added to each other)

Example 0: What happens when an item is weighted

IWEIGHT=*
1 0.5
*
1) Table 14: the item scores and counts are not changed
2) Table 18: the person scores and counts are changed. Item 1 score and count is weighted by 0.5
3) Table 3.2: the response counts for the rating scale are weighted

Example 1: In a 20-item test, item 1 is to be given a weight of 2.5, all other items have a weight of 1.

IWEIGHT=*
1 2.5
2-20 1
*

A better weighting, which would make the reported person standard errors more realistic by maintaining the original total sum of weights at 20 , is:
IWEIGHT=*
1 2.33 ; 2.5 * 0.93
2-20 0.93 ; the sum of all weights is 20.0
*

or adjust the weights to keep the sample-based "test" separation and reliability about the same - so that the reported statistics are still reasonable:
e.g., original sample "test" reliability (person separation index) = .9, separation coefficient = 3, but separation coefficient with weighting = 4
Multiply all weights by $(3/4)^2$ to return separation coefficient to about 3.

Example 2: The item labels contain the weights in columns 16-18.
IWEIGHT= $S16W3 ; or $S16E18
&END
Item 1 Hello   0.5
Item 2 Goodbye 0.7
......
END NAMES

Example 3: Item 4 is a pilot or variant item, to be given weight 0, so that item statistics are computed, but this item does not affect person measurement.
IWEIGHT=*
4 0 ; Item 4 has weight 0, other items have standard weight of 1.
*

Example 4: We have 24 0/1 items and 5 0/1/2/3 items. We want them to weight equally. There are several concerns here. These may require different weights for different purposes, i.e., several runs.
(a) Raw score reporting. For 24 items of 0/1 and 5 items of 0/0.33/0.67/1. Then
IWEIGHT=*
1-24 1
25-29 0.333
*
This will give the reportable raw scores you want, 0-29, but incorrect reliabilities (too small).

(b) Statistical information. The total amount of overall statistical information can be maintained approximately by maintaining the total raw score. So original ordinal unweighted raw score range = 0 - (24x1 +5x3) = 39. New raw score in (a) = 29. So we need to up the weights by 39/29 = 1.345. This will give peculiar-looking raw scores, but a better estimate of fit.
IWEIGHT=*
1-24 1.345
25-29 0.448
*
The Rasch measures for (a) and (b) will be the same, but the standard errors, reliabilities and fit statistics will differ.

(c) Reliability maintenance. If you want to maintain the same person "test" reliability (i.e., measure reproducibility), then
approximate weighting factor = (1 - weighted person model reliability) / (1 - unweighted person model reliability)
IWEIGHT=*
1-24 3 * weighting factor
25-29 1 * weighting factor
*

(d) recoding the 0/1 data into 0/3 to give equal weighting with 0/1/2/3 is not recommended because of the two unobserved categories, 1, 2, which change the slope of the model ICC, so distorting the measures, altering the fit and creating artificially high reliabilities.

Example 5: The items are to be weighted in accordance with Jian Tao, Ning-Zhong Shi and Hua-Hua Chang (2012). Item-Weighted Likelihood Method for Ability Estimation in Tests Composed of Both Dichotomous and Polytomous Items. Journal of Educational and Behavioral Statistics, 2012, 37, 2, 298-315.

In their empirical example, items 1-50 are dichotomies. Item 51 is a 0-4 polytomy. Their weighting is:
IWEIGHT=*
1-50 0.9924 ; this is the weighting for the 50 dichotomous items
51 1.3795 ; this is the weighting for the 1 polytomous (0-4) item
*

Example 6: A demonstration:

1. Analyze exam1.txt in the Winsteps Examples folder. Save the person measures. Table 17.

```
-----------------------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL           MODEL|   INFIT  |  OUTFIT  |PT-MEASURE |EXACT MATCH|          |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%| KID      |
|------------------------------------+----------+----------+-----------+-----------+----------|
|     7     14     18    3.73     .94| .95    .1| .39   -.1|  .69   .69| 85.7  88.8| Susan   F|
```

2. Add these lines to the exam1.txt control file:
IWEIGHT=*
13 2 ; weight item 13 double
*

3. Analyze exam1.txt in the Winsteps Examples folder. Compare the person measures. Table 17, with Table 17 from 1.

```
-----------------------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL           MODEL|   INFIT  |  OUTFIT  |PT-MEASURE |EXACT MATCH|          |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%| KID      |
|------------------------------------+----------+----------+-----------+-----------+----------|
|     7     15     19    3.85     .91| .92    .0| .37   -.1|  .67   .66| 86.7  89.2| Susan   F|
```

There are also differences in the item Table 14:

```
-------------------------------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL           MODEL|   INFIT  |  OUTFIT  |PT-MEASURE |EXACT MATCH|     |              |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%|WEIGH| TAP          |
|------------------------------------+----------+----------+-----------+-----------+-----+--------------|
|    13      7     35    1.87     .54| .49  -1.9| .24   -.6|  .67   .42| 94.1  86.4| 2.00| 1-4-3-2-4    |
```

11.97 KEYFROM= location of KEYn

KEYFROM= instructs where to find the KEYn= information. *Only use this if you have the scoring Key conveniently in data-record format.*

KEYFROM= 0	KEY1= through KEY99=, if used, are control variables before &END.
KEYFROM= 1	KEY1 information follows after &END, but before the item names. The key is formatted exactly like a data record. It is helpful to place the name of the key, e.g. "KEY1=", where the person name would usually go, for reference.
KEYFROM= n (a positive number up to 99)	KEY1, then KEY2, and so on up to KEYn (where n is a number up to 99) follow &END, but placed before the item names. Each key is formatted exactly like a data record. It is helpful to place the name of the key, e.g. "KEY2", where the person name would usually go.
SPFILE= filename	KEY1=, KEY2=, etc., in a separate file in control-file format

Example: KEY1 and KEY2 information are to follow directly after &END

```
NAME1=1  start of person-id (the standard)
ITEM1=10  start of response string
NI=7  number of items
CODES=abcd  valid codes
KEYFROM=2  two keys in data record format
```

```
&END
KEY1=****bacddba keys formatted as data
KEY2=****cdbbaac
Item 1 name  item names
 |
Item 7 name
END NAMES
Mantovanibbacdba first data record
 |  subsequent data records
```

11.98 KEYn= scoring key

Usually only KEY1= is needed for an MCQ scoring key.

Key format
Key1= ABDE .... for 0,1 data Key2= BCCA.... for 0,1,2 data
Key1= * list * is not available. Use IREFER= Example 5. IREFER= * list *
Key1= filename.txt is not available. Use IREFER= Example 5 and IREFER= Example 1. IREFER=*filename.txt

Up to 99 keys can be provided for scoring the response choices, with control variables KEY1= through KEY99=. Usually KEY1= is a character string of "correct" response choices. The standard is one column per correct response, or two columns if XWIDE=2.

As standard, responses matching the characters in KEY1= are scored 1. Other valid responses are scored 0. KEY2= through KEY99= are character strings of successively "more correct" response choices to be used when more than one level of correct response choice is possible for one or more items. The standard score value for KEY2= is 2, and so on up to the standard score value for KEY99= which is 99. The values assigned to these keys can be changed by means of KEYSCR=. If XWIDE=1, only the values assigned to KEY1= through KEY9= can be changed, KEY10= through KEY99= retain their standard values of 10 through 99. If XWIDE=2, the all KEYn= values can be changed.

More complicated scoring can be done with IREFER=

Example 1: A key for a 20-item multiple choice exam, in which the choices are coded "1", "2", "3" and "4", with one correct choice per item, scored 1. Wrong, invalid and missing responses are scored 0.

```
CODES = 1234    ; valid codes
KEY1  = 31432432143142314324 ; correct answers scored 1
; incorrect responses in CODES= automatically scored 0
MISSING-SCORED = 0 ; scoring of responses not in CODES=
```

Example 2: A 20-item MCQ test with responses entered as "a", "b", "c", "d". Wrong responses scored 0. Invalid and missing responses are scored "not administered", and so excluded from the analysis

```
CODES=abcd    ; valid responses
KEY1 =cadcbdcbadcadbcadcbd ; ; correct answers scored 1
; incorrect responses in CODES= automatically scored 0
MISSING-SCORED = -1 ; scoring of responses not in CODES= (default)
```

Example 3: A 20 item multiple choice exam with two somewhat correct response choices per item. One of the correct choices is "more" correct than the other choice for each item, so the "less correct" choice will get a score of "1" (using KEY1=) and the "more correct" choice will get a score of "2" (using KEY2=). All other response choices will be scored "0":

```
CODES=1234   valid responses
KEY1=23313141324134242113  assigns 1 to these responses
KEY2=31432432143142314324  assigns 2 to these responses
;     0 is assigned to other valid responses
ISGROUPS = 0 ; for the Partial Credit model
MISSING-SCORED = 0 ; scoring of responses not in CODES=
```

Example 4: A 100 item multiple choice test key.

```
 CODES= ABCD
 KEY1 = BCDADDCDBBADCDACBCDADDCDBBADCDACBCDADDCA+
  +DBBADCDACBCDADDCDBBADCDACBCDADDCDBBADCCD+
  +ACBCDADDCDBBADCDACBC ; continuation lines
```

Example 5: Multiple score key for items 1 to 10. Items 11 to 15 are on a rating scale of 1 to 5

```
  CODES   = abcd12345
  KEY1    = bacdbaddcd*****
  RESCORE= 111111111100000 ; RESCORE= signals when to apply KEY1=
 ISGROUPS= 111111111122222 ; 1 indicates dichotomy, 2 indicates rating scale
```

Example 6: A 12 item test. Items 1-5 are MCQ with responses entered as "ABCD", with one of those being correct: Item 1, correct response is B. Item 2 is C. 3 is D. 4 is A. 5 is C. Then items 6-10 are partial-credit performance items rated 0-5. Items 11-12 are two dichotomous items, scored 0,1.

```
  CODES =ABCD012345 ; screen for all valid codes in the data file
  KEY1 = BCDAC******* ; Key1= automatically has the value "1", etc.
RESCORE= 111110000000 ; "1" selects the KEY1=
ISGROUPS=111110000022 ; 1 indicates MCQ, 0 indicates partial credit, 2 indicates dichotomy
```

Example 7: Item 1 has correct options B,D,E. Other items have only one correct option.

```
ITEM1=1
NI=10
NAME1=11
NAMELENGTH=8
CODES = "ABCDE"
; B,D,E ARE ALL CORRECT FOR ITEM 1
KEY1 = BBADCBDDC
KEY2 = D********
KEY3 = E********
KEYSCR = 111  ; ALL KEYS ARE WORTH 1 POINT
&END
Item 1
Item 2
Item 3
Item 4
Item 5
Item 6
Item 7
Item 8
Item 9
END NAMES
123456789
ADABADCCD Person 1  ; this scores as 001000000
BBDDDCAAB Person 2  ;          110100000
CDCCDBABA Person 3  ;          000001000
DCBCCACDC Person 4  ;          100010011
EDCDCDCBD Person 5  ;          100110000
```

Example 8: the answer to each one of the options, but the options differ across items. Item 1 has options ABC with correct option B. Item 2 has options CDEF with correct option E.

```
CODES = ABCDEF  ; all options
KEY1 = BE ; correct options
```

11.99 KEYSCR= reassign scoring keys

This is only needed for complicated rescoring.

Specifies the score values assigned to response choices which match KEY1= etc. To assign responses matching key to the "missing" value of -1, make the corresponding KEYSCR= entry blank or some other non-numeric character.

When XWIDE=1, each value can only take one position, so that only KEY1= through KEY9= can be reassigned. KEY10= through KEY99= can also be used but keep their standard values of 10 through 99.

When XWIDE=2, each value takes two positions, and the values corresponding to all keys, KEY1= through KEY99=, can be reassigned.

Example 1: Three keys are used, and XWIDE=1.
Response categories in KEY1= will be coded "1"
Response categories in KEY2= will be coded "2"
Response categories in KEY3= will be coded "3"

```
KEYSCR=123 (standard)
```

Example 2: Three keys are used, and XWIDE=1.
Response categories in KEY1= will be coded "2"
Response categories in KEY2= will be coded "1"
Response categories in KEY3= will be coded "1"

```
KEYSCR=211
```

Example 3: Three keys are used, and XWIDE=2
Response categories in KEY1= will be coded "3"
Response categories in KEY2= will be coded "2"
Response categories in KEY3= will be coded "1"

```
KEYSCR=030201
```

or

```
KEYSCR=" 3 2 1"
```

Example 4: Three keys are used, and XWIDE=1
Response categories in KEY3= will be coded "1"
Response categories in KEY6= will be coded "missing"
Response categories in KEY9= will be coded "3"

```
KEY3=BACDCACDBA response keys
KEY6=ABDADCDCAB
KEY9=CCBCBBBBCC
KEYSCR=xx1xxXxx3 scores for keys
```

The "x"s correspond to unused keys, and so will be ignored.
The "X" corresponds to specified KEY6=, but is non-numeric and so will cause responses matching KEY6= to be ignored, i.e. treated as missing.

Example 5: Some items in a test have two correct answers, so two keys are used. Since both answers are equally good, KEY1= and KEY2= have the same value, specified by KEYSCR=. But some items have only one correct answer so in one key "*", a character not in CODES=, is used to prevent a match.

```
CODES=1234
KEY1 =23313141324134242113
KEY2 =31*324321*3142314*** ; * is not in CODES=
KEYSCR=11 both KEYs scored 1
```

Example 6: More than 9 KEYn= lines, together with KEYSCR=, are required for a complex scoring model for 20 items, but the original data are only one character wide.

Original data: Person name: columns 1-10
20 Item responses: columns 21-40

Looks like: M. Stewart..........13212332123212321 34

Solution: reformat from XWIDE=1 to XWIDE=2

```
TITLE="FORMAT= from XWIDE=1 to =2"
FORMAT=(10A1,10X,20A1) ; 10 of Name, skip 10, 20 of responses
```

```
NI=20
NAME1=1
ITEM1=11   Responses in column 11 of reformatted record
XWIDE=2
CODES="1 2 3 4 "  Original response now "response blank"
KEY1 ="1 2 1 3 2 1 2 3 1 4 3 2 1 1 1 1 1 2 1 1 " Keying 20 items
KEY2 ="2 1 2 1 1 2 1 1 2 1 1 1 2 3 3 2 2 * 2 1 "
....
KEY10="3 3 3 2 3 3 4 2 3 * * * 4 4 4 4 4 4 4 4 "
KEYSCR="1 2 3 2 2 2 3 4 1 4 " ; Renumbering 10 KEYn=
&END
```

11.100 LCONV= logit change at convergence

Measures are only reported to 2 decimal places, so a change of less than .005 logits will probably make no visible difference. The minimum possible value is LCONV=0.0001

Specifies what value the largest change in any logit estimate for a person measure or item calibration or rating (or partial credit) scale structure calibration must be less than, in the iteration just completed, for iteration to cease. The current largest value is listed in Table 0 and displayed on your screen. See convergence considerations.

The standard setting is CONVERGE="E", so that iteration stops when either LCONV= or RCONV= is satisfied. (Note: this depends on Winsteps version - and may explain differences in converged values.)

Example 1: To set the maximum change at convergence to be less or equal to .001 logits:
LCONV=.001
RCONV=0 ; set to zero, so does not affect convergence decision
CONVERGE=Logit

Example 2: To set the maximum change at convergence to less or equal to .1 user-scale USCALE= units:

USCALE = 50 ; 50 user-scaled units per logit

LCONV = .002 ; logit value = .002*50 = 0.1 user-scaled units

11.101 LESS= heading in Tables 1, 12, 16

Please see MORE=

11.102 LINELENGTH= length of printed lines

The misfitting responses, name maps, scalogram, and option frequency tables can be output in any convenient width up to 3003 characters. Specify LINELENGTH=0 for a large page width (503 characters).

Example 1: You want to print the map of item names with up to 100 characters per line.
LINELENGTH=100 set line length to 100 characters

Example 2: Table 1 etc. Wright maps.
See MTOP=

11.103 LOCAL= locally restandardize fit statistics

LOCAL=N accords with large-sample statistical theory.

Standardized fit statistics test report on the hypothesis test: "Do these data fit the model (perfectly)?" With large sample sizes and consequently high statistical power, the hypothesis can never be accepted, because all empirical data exhibit some degree of misfit to the model. This can make t standardized statistics meaninglessly large. t standardized statistics are reported as unit normal deviates. Thus ZSTD=2.0 is as unlikely to be observed as a value of 2.0 or greater is for a random selection from a normal distribution of mean 0.0, standard deviation, 1.0. ZSTD (standardized as a z-score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic distribution value has been adjusted to a unit normal value.

Control	Column Heading in Table	Explanation
LOCAL=No	ZSTD standardized like a Z-score	*t*-standardized fit statistics are computed in their standard form. Even the slightest item misfit in tests taken by many persons will be reported as very significant misfit of the data to the model. Columns reported with this option are headed "ZSTD" for model-exact standardization. This is a "significance test" report on "How unexpected are these data if the data fit the model perfectly?" Adjusted by WHEXACT=
LOCAL=Log	LOG $\log_e$(mean-square)	Instead of *t*-standardized statistics, the natural logarithm of the mean-square fit statistic is reported. This is a linearized form of the ratio-scale mean-square. Columns reporting this option are headed "LOG", for mean-square logarithm.
LOCAL=Yes	ZEMP locally standardized ZSTD	*t*-standardized fit statistics are transformed to reflect their level of unexpectedness in the context of the amount of disturbance in the data being analyzed. The model-exact t standardized fit statistics are divided by their local standard deviation. Thus their transformed standard deviation becomes 1.0. Columns reported with this option are headed "ZEMP" for "empirically re-standardized to match a unit-normal (Z) distribution". The effect of the local-rescaling is to make the fit statistics more useful for interpretation. The meaning of ZEMP statistics is an "acceptance test" report on "How unlikely is this amount of misfit in the context of the overall pattern of misfit in these data?" Adjusted by WHEXACT=
LOCAL=Prob	PROB probability f mean-square	2-sided probability of the mean-square (CHISQUARE=No) or chi-square (CHISQUARE=Yes).. The degrees of freedom are in the IFILE= or PFILE=. The chi-square is mean-square * d.f.

The ZSTD t-standardized-as-a-Z-score fit statistics test a null hypothesis. The usual null hypothesis is "These data fit the Rasch model exactly after allowing for the randomness predicted by the model." Empirical data never do fit the Rasch model exactly, so the more data we have, the more certain we are that the null hypothesis must be rejected. This is what your fit statistics are telling you. But often we don't want to know "Do these data fit the model?" Instead, we want to know, "Is this item behaving much like the others, or is it very different?"

Ronald A. Fisher ("Statistical Methods and Scientific Inference"New York: Hafner Press, 1973 p.81) differentiates between "tests of significance" and "tests of acceptance". "Tests of significance" answer hypothetical questions: "how unexpected are the data in the light of a theoretical model for its construction?" "Tests of acceptance" are concerned with whether what is observed meets empirical requirements. Instead of a theoretical distribution, local experience provides the empirical distribution. The "test" question is not "how unlikely are these data in the light of a theory?", but "how acceptable are they in the light of their location in the empirical distribution?"

This also parallels the work of Shewhart and W.E. Deming in quality-control statistics. They construct the control lines on their quality-control plots based on the empirical "common-cause" variance of the data, not on a theoretical distribution or specified tolerance limits.

So, in Winsteps, you can specify LOCAL=Yes to test a different null hypothesis for "acceptance" instead of "significance". This is not "cheating" as long as you inform the reader what hypothesis you are testing. The revised null hypothesis is: "These data fit the Rasch model exactly after allowing for a random normal distribution of standardized fit statistics equivalent to that observed for these data."

The ZEMP transformed standardized fit statistics report how unlikely each original standardized fit statistic ZSTD is to be observed, if those original standardized fit statistics ZSTD were to conform to a random normal distribution with the same variance as that observed for the original standardized fit statistics.

To avoid the ZEMP values contradicting the mean-square values, Winsteps does separate adjustments to the two halves of the ZSTD distribution. ZEMP takes ZSTD=0 as the baseline, and then linearly adjusts the positive and negative halves of the ZSTD distribution independently, giving each half an average sum-of-squares of 1.0 away from 0. When the two halves are put together, the model distribution of ZEMP is N[0,1], and the empirical distribution of ZEMP approximates a mean of 0 and a standard deviation of 1. Usually there is no ZSTD with value exactly 0.000. Algebraically:

for all $k_{positive}$ items where ZSTD(i) >0 and i =1, test length
ZEMP(i) = ZSTD(i)/($S_{positive}$), where $S_{positive}$ = sqrt [(1/$k_{positive}$) Sum(ZSTD(i)² for $k_{positive}$ items)]

for all $k_{negative}$ items where ZSTD(i) <0 and i =1, test length
ZEMP(i) = ZSTD(i)/($S_{negative}$), where $S_{negative}$ = sqrt [(1/$k_{negative}$) Sum(ZSTD(i)² for $k_{negative}$ items)]

11.104 LOGFILE= accumulates control files

Specifying LOGFILE=file name in the Winsteps control file causes the current control file to be appended to the log file, enabling an audit trail of the Winsteps analysis. The contents of Table 0.3 are saved.

LOGFILE=? opens a Browse window

Example: An audit trail of Winsteps analyses is to be maintained at c:\Winsteps.log.txt
 LOGFILE= c:\Winsteps.log.txt

11.105 LOGLIKE= log-likelihood of response string

Not actioned.

Please output your XFILE=
In Excel: custom sort on person entry number or item entry number
Highlight the entry number column and the log-probability column
Excel Data menu: Subtotal. Subtotal log-probability on change in entry number.

Then in the Subtotal pane:
Click on 2 to see only the Subtotals.

11.106 LOWADJ= correction for bottom rating scale categories

The Rasch model models the measure corresponding to a bottom rating (or partial credit) scale category as infinite. This is difficult to think about and impossible to plot. Consequently, graphically in Table 2.2 and numerically in Table 3.1 a measure is reported corresponding to a bottom category. This is the measure corresponding to an imaginary rating LOWADJ= rating points above the bottom category. HIADJ= is the corresponding instruction for top categories. For choice of value, see EXTRSCORE=

Example: The standard spread in Table 2.2 is based on LOWADJ=0.25. You wish the bottom category number to be printed more to the right, close to the other categories.
 LOWADJ=0.4

11.107 MAKEKEY= construct MCQ key

For multiple-choice and True-False questions, the analyst is usually provided with the answer key. When an answer key is not available, MAKEKEY=YES constructs one out of the most frequent responses to each item. The answer key is used in the analysis and reported at the end of Table 0.3 in the Report Output File. Inspect the Item Tables, particularly the "CATEGORY/OPTION/Distractor FREQUENCIES", to identify items for which this scoring key is probably incorrect. The correct answer is expected to have the highest measure.

If you have no KEY1= at all, put in a dummy key, e.g., all A's or whatever, to get Winsteps to run.

Example: The scoring key for Example5.con is lost.

```
 MAKEKEY=YES
            KEY1 = aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa ; dummy key
```

Constructed key is:

KEY1 =
dabbbbadbdcacaadbabaabaaaacbdddabccbcacccbccccacbbcbbbacbdbacaccbcddb

Original key was:
KEY1 = dcbbbbadbdcacacddabadbaaaccbddddcaadccccdbdcccbbdbcccbdcddbacaccbcddb

The keys match for 48 of the 69 items. Item fit Tables suggest up to 29 items whose keys may not be correct.

The key is reported on the Iteration screen and after Table 0.3 in the Report Output file accessed by the Edit File pull-down menu.

11.108 MATRIX= correlation output format

The correlation matrix ICORFILE= or PCORFILE= can be produced in list or matrix format.

MATRIX = NO is the list format

```
Item Item Correlation
1 2 -.04
1 3 .05
```

MATRIX = YES is the matrix format

```
 1.0000  -.0451   .0447   .0095  .....
 -.0451  1.0000  -.0448  -.2024  .....
  .0447  -.0448  1.0000  -.0437  .....
 ......  ......  ......  ......  .....
```

11.109 MAXPAGE= the maximum number of lines per page

For no page breaks inside Tables, leave MAXPAGE=0

If you prefer a different number of lines per page of your output file, to better match the requirements of your printer or word processor, give that value (see Using a Word Processor or Text Editor). If you prefer to have no page breaks, and all plots at their maximum size, leave MAXPAGE=0.

On Table 1 and similar Tables, MAXPAGE= controls the length of the Table.

Example: You plan to print your output file on standard paper with 60 lines per page (pages are 11 inches long, less 1 inch for top and bottom margins, at 6 lpi):
MAXPAGE=60 (set 60 lines per page)
FORMFEED=^ (standard: Word Processor form feed)

11.110 MBOTTOM= lowest measure in Table 1 etc.

See MTOP=

11.111 MCMLE= maximum number of CMLE iterations = 0, no limit

see MJMLE=

11.112 MFORMS= reformat input data

MFORMS= supports the reformatting of input data records, and also equating multiple input files in different formats, such as alternate forms of the same test. Data after END NAMES or END LABELS is processed first, as is data specified by DATA= in the core control file.

MFORMS= file name	file containing details
MFORMS= file name + file name + ...	multiple file names
MFORMS = *	in-line list

MFORMS = ?	opens a Browser window to find the file

Question: I've been trying to analyze two test forms, sharing 1-50 as common and 51-70 as unique. The common items also have IWEIGHT=. I am trying to estimate the difficulties for each form. I want to retain the KEY1= so I can have option information (so using CODES=ABCD), but also enable test form comparisons. I've tried building the combined control and data file using MFORMS=, but no success yet. Any advice would be great.

Reply: The items become
    1-50 common
    51-70 form 1
    71-90 form2
and the Item labels, KEY1= and IWEIGHT= match these numbers

Combine the data files by
    a) copying your form 1 data into the combined file
    followed by
    b) items1-50 of your form 2 data
    c) and then items 51-70 of your form2 data into the position for items 71-90 of the combined data.

To do this copying, please use "rectangular copying" (alt+Mouse). This is available in Microsoft Word and also the freeware NotePad++ https://notepad-plus-plus.org/

Data reformatted by MFORMS= can be accessed, viewed, edited and "saved as" permanently using the "Edit" pull-down menu. It has a file name of the form: ZMF.....txt

Procedure:
1. Make a list of all your different items. Usually we list the common items first.
2. For each item, list its entry number (sequence number) on each form.
3. Use MFORMS=. Transform the list of item numbers into MFORMS= instructions.

Here is the layout:

MFORMS=*	
DATA=forma.txt	; the name of an input data file
L=2	; there are 2 lines in input data file for each data record
I1 = 20	; response to item 1 of the combined test is in column 20 of the input data file
I3-5 = 21	; items 3, 4, 5 are in columns 21, 22, 23 of the input data file
I16-20=11	; items 16, 17,18, 19, 20 are in columns 11, 12, 13, 14, 15
P1=9	; the first character of person label is in column 9 of the input data file
P3-8=1	; person label characters 3 through 8 start in column 1
C20-24="FORMA"	; put in columns 20-24 the letters FORMA
C40-90 = 2:1	; put in columns 40-90 the characters in the second line of the data record
#	; end of definition - start of next file reformat
DATA=formb.txt	; name of input data file
P3-7=1	; information for columns 3-7 of person label starts in column 1 of data record
.....	
*	; end of mforms= command

Details:	

MFORMS=* or filename	* instructions follow in control file, and end with another * or instructions are in a file.
data=filename	name of input file name to be reformatted. The reformatted records are placed in a temporary work file. This may be accessed from the Edit pull-down menu, and saved into a permanent file. This temporary file is processed after any Data Files specified with the master data= instruction and in the same way, e.g., any FORMAT= command will be applied also to the temporary work file.
L=nnn	nnn is the count of lines in each input data record. If L=1 this can be omitted. L=4 means that 4 input data lines are processed for each data record output.
Cnnn= column in original data record	nnn is the column number in the formatted data record. XWIDE= does not apply. C10-12 means columns 10, 11, 12 of the formatted record. C1= refers to column 1 of the formatted data record. This can also be used to move item and person information.
Innn= column in original data record	nnn is the starting **item number** in the formatted data record. nnn-mmm are the starting to ending item numbers in the formatted data record. XWIDE= is applied, so that I3-5= with XWIDE=2 means 6 characters. I1= points to column Item1= in the formatted data record.
Pnnn= column in original data record	nnn is the starting column number in the person label in the formatted person label. XWIDE= is not applied. P6-8= always means 3 columns starting in column 6. P1= points to column Name1= in the formatted data record.
.....=nnn	nnn is the starting column of the only, or the first, line in the input data record.
....=m:nnn	m is the line number in each data record nnn is the starting column number of that line
....="xxxx"	xxxx is a character constant to be placed in the formatted data record. Note: for I18-20="abc" with XWIDE=2, then response to Item 18 is "ab", 19 is "c ", 20 is " ".
#	end of processing of one file, start of the next
*	end of Mforms= processing

Check that everything is correct, by looking at the Edit menu, MFORMS= file.

Example 1: See Exam10c.txt

Example 2: Three data files with common items and one MCQ scoring key. See below for constructing a combined scoring key.

Item bank	Datafile1.txt	Datafile2.txt	Datafile3.txt
1-3	1-3	1-3	1-3
4-6	4-6	-	-
7-9	-	4-6	-
10-12	-	-	4-6

```
Datafile1.txt: (Items 1-6)
TOMY       ABCDAB
BILL       BCDADD

Datafile2.txt (Items 1-3 and 7-9)
TOTO       BBADAB
MOULA      BADADD
```

```
Datafile3.txt (Items 1-3 and 10-12)
IHSANI    ACCDAB
MALIK     CBDDCD
```

Control file:

```
TITLE="Multiple MCQ forms with one scoring key"
NI=12  ; 12 ITEMS IN TOTAL
ITEM1=11
NAME1=1
CODES="ABCD"
KEY1=BACCADACADDA
mforms=*
data=datafile1.txt ; name of data file
L=1   ; one line per person
P1-10=1  ; person label in columns 1-10
I1-3=11  ; items 1-3 in columns 11-13
I4-6=14  ; items 4-6 in columns 14-16
#
data=datafile2.txt
L=1
P1-10=1
I1-3=11
I7-9=14  ; items 8-9 in columns 14-16
#
data=datafile3.txt
L=1
P1-10=1
I1-3=11
I10-12=14  ; items 10-12 in columns 14-16
*
&END
; item identification here
END NAMES
```

Here is how the data appear to Winsteps for analysis:

```
TOMY      ABCDAB
BILL      BCDADD
TOTO      BBA   DAB
MOULA     BAD   ADD
IHSANI    ACC      DAB
MALIK     CBD      DCD
```

Example 3: Test 1 is a 4-item survey. Test 2 is a 4-item survey its first two items are the last two items on Test 1. Those items share the same rating scale, called "C". The other 4 items also share another rating scale, called "U".

Item bank	Datafile1.txt	Datafile2.txt
1-2	1-2	-
3-4	3-4	1-2
5-6	-	3-4

```
Datafile1.txt: (Items 1-4)
TOMY      3241
BILL      3352

Datafile2.txt (Items 3-4 and 5-6)
TOTO      3325
MOULA     2143

TITLE="Combing two surveys"
NI=6  ; 6 ITEMS IN TOTAL
ITEM1=11
NAME1=1
```

```
CODES="12345"  ; all valid codes on all the survey items
ISGROUPS = UUCCUU ; assigns items to rating scales
mforms=*
data=datafile1.txt ; name of data file
L=1   ; one line per person
P1-10=1  ; person label in columns 1-10
I1-4=11  ; items 1-4 in columns 11-14
#
data=datafile2.txt
L=1
P1-10=1
I1-2=13  ; items 1-2 on the second survey are items 3 and 4 on the first survey
I3-4=15  ; items 3-4 in columns 15-16
#
&END
; item identification here
END NAMES
```

Here is how the data appear to Winsteps for analysis:

```
TOMY      3241 ; items 1-2 unique, items 3-4 common
BILL      3352
TOTO        3325 ; items 3-4 common, items 5-6 unique
MOULA       2143
```

Example 4: Test 1 is a 4-item survey. Test 2 is a 4-item survey with two items in common with Test 1 which are to be anchored to their Test 1 values.

Item bank	data1.txt	data2.txt
1	1	-
2	2	3
3	3	-
4	4	2
5	-	1
6	-	4

Test 1 has 4 rating scale items. Each item has its own partial-credit structure:

```
title = "Test 1"
item1 = 1 ; items start in column 1
ni = 4 ; 4 items
name1 = 5 ; person label starts in column 5
namlen = 14 ; length of person name
codes =  01234  ; rating scale
ISGROUPS = 0 ; each item has its own rating scale structure
stkeep = YES ; this is probably what you want for these type of data
data = data1.txt
ifile = items1if.txt ; item calibrations from Test 1 for Test 2 (output)
sfile = items1sf.txt ; structure calibrations from Test 1 for Test 2 (output)
&END
Test 1 item 1
Test 1 item 2
Test 1 item 3
Test 1 item 4
END NAMES
```

data1.txt is:

```
1234Person 1-1
3212Person 1-2
 ......
```

Test 2 has 4 items. 1 and 4 are new - we will call these items 5 and 6 of the combined Test 1 and 2. Item 2 is Test 1 item 4, and item 3 is Test 1 item 2.

```
title = "Test 2 (formatted to match Test 1)"
item1 = 1 ; items start in column 1
ni = 6 ; 4 items in Test 1 + 2 more in Test 2
name1 = 7 ; person label starts in column 7
namlen =14 ; length of person name
codes =  01234 ; rating scale
stkeep = YES ; this is probably what you want for these type of data
ISGROUPS = 0  ; each item has its own rating scale structure
iafile = items1if.txt ; item calibrations from Test 1 (input - unchanged)
safile = items1sf.txt ; structure calibrations from Test 1 (input - unchanged)
MFORMS = *  ; reformat the Test 2 data to align with Test 1
data = data2.txt ; the name of an input data file
L = 1   ; there is 1 line in input data file for each data record
I2 = 3  ; response to item 2 of Test  1 is in 3 of the data2.txt file
I4 = 2  ; response to item 4 of Test  1 is in 2 of the data2.txt file
I5 = 1  ; item 5 is in column 1 of data2.txt
I6 = 4  ; item 6 is in column 4 of data2.txt
P1-14 = 5  ; the first character of person label is in column 5 of data2.txt for 14 columns.
*   ; end of mforms= command
&END
Test 1 item 1 (blank in Test 2)
Test 1 item 2 (Test 2 item 3)
Test 1 item 3 (blank in Test 2)
Test 1 item 4  (Test 2 item 2)
Item 5 (not in Test 1, Test 2 item 1)
Item 6 (not in Test 1, Test 2 item 4)
END NAMES
```

data2.txt is:

```
5426Person 2-1
1234Person 2-2
....
```

The formatted file (see Edit pull-down menu MFORMS==) is

```
2 456Person 2-1
3 214Person 2-2
....
```

Example 5. For my computer-adaptive test (CAT), I want a new MFORMS= specification for each respondent.

In your Winsteps control file, put
MFORMS=myrespondents.txt   (or any other file name)

Then myrespondents.txt can contain an unlimited number of MFORMS instructions

```
DATA=respondent1.txt
....
#
DATA=respondent2.txt
....
#
DATA=respondent3.txt
....
#
......
......
#
```

Example 6: Constructing a combined scoring key.

1. Construct MFORMS= as above.
2. Put each data files scoring key in the format of that data file in a separate data file.
3. In your control file, include:
CODES= list of valid data codes, e.g., CODES=ABCDE

IREFER=*
1-number of items A ; all items will be scored by IVALUEA=
*
IVALUEA=10000
IVALUEB=01000
IVALUEC=00100
IVALUED=00010
IVALUEE=00001

Run your control file with MFORMS=, using the data files containing only the keys.

Look at Edit menu, MFORMS=. It will have a data record for each files key, in the combined file format.

Now, Output Files menu, XFILE=,
clear all settings
check: item entry number
        response code in data file
OK

Output to text file space separated.

You will see something like:
; RESIDUAL FILE FOR YOUR TEST
  ITEM C
    11 A
    12 B
    13 E
    14 A

Delete the two heading lines.
The other lines are the scoring key.

In IREFER=, replace
1-number of items A
with all these lines, or you can also put them in a separate file,, and specify IREFER=theirfilename

IREFER is acting like a key, by referring each observation to the IVALUE which matches its scoring key

Now run your Winsteps control file with the correct data files (delete the scoring keys in the data files).

Winsteps should produce the correct output.

11.113 MHSLICE= Mantel-Haenszel slice width

Differential item functioning (DIF) is investigated using log-odds estimators in Table 30.1Mantel-Haenszel (1959) for dichotomies or Mantel (1963) for polytomies. The sample is divided into difference classification groups (also called reference groups and focal groups) which are shown in Table 30 and specified with DIF=.

MHSLICE= specifies the width of the slice (in logits) of the latent variable be included in each cross-tab. The lower end of the lowest slice is always the lowest observed person measure.

MHSLICE = 0 bypasses Mantel-Haenszel or Mantel computation.

MHSLICE = .1 logits and smaller. The latent variable is stratified into thin slices. This corresponds to the slicing by raw scores with complete data

MHSLICE = 1 logit and larger. The latent variable is stratified into thick slices.

For each slice, a cross-tabulation is constructed for each pair of person classifications against each scored response level. An odds-ratio is computed from the cross-tab. Zero and infinite ratios are ignored. A homogeneity chi-square is also computed when possible.

Example: The sample size is small, but an approximate Mantel-Haenszel estimate is wanted:
MHSLICE=3 ; this probably divides the sample into 3 strata.

11.114 MHZERO= adjustment to zero cells in Mantel cross-tabulation

The Mantel-Haenszel and Mantel DIF statistics are based on 2x2 cross-tabulations of response frequencies for the Reference and Focal groups.

	Low Category	High Category
Focal Group	FL	FH
Reference Group	RL	RH

If all 4 cells of the cross-tab are non-zero, then the computation proceeds.
If FL+RL = 0 and/or FH+RH=0 then the computation is skipped.
Otherwise FL = maximum of FL + MHZERO and similarly for the other 4 cells, and the computation proceeds.

The default is MHZERO = 0, no adjustment.
SAS uses MHZERO = 0.5

Example: with Exam1.txt

MHZERO=0

```
-----------------------------------------------------------------------------------------
| KID   KID       DIF     JOINT  Rasch-Welch   Mantel-Haenszel Size Active TAP          |
| CLASS CLASS CONTRAST  S.E.     t  d.f. Prob. Chi-squ Prob. CUMLOR Slices Number  Name |
|---------------------------------------------------------------------------------------|
| F     M          1.23  2.11   .58   21 .5677   .0000 1.000             5      4 1-3-4   |
| F     M          1.92  2.06   .93   20 .3626                           5      5 2-1-4   |
| F     M         -1.22  1.28  -.95   31 .3484   .6901 .4061             5      6 3-4-1   |
| F     M         -2.20  1.46 -1.51   31 .1414  1.0057 .3159             5      7 1-4-3-2 |
| F     M         -1.86  1.09 -1.71   31 .0982   .6901 .4061             5      8 1-4-2-3 |
```

MHZERO=0.5

```
-----------------------------------------------------------------------------------------
| KID   KID       DIF     JOINT  Rasch-Welch   Mantel-Haenszel Size Active TAP          |
| CLASS CLASS CONTRAST  S.E.     t  d.f. Prob. Chi-squ Prob. CUMLOR Slices Number  Name |
|---------------------------------------------------------------------------------------|
| F     M          1.23  2.11   .58   21 .5677   .2222 .6374   1.39     10      4 1-3-4   |
| F     M          1.92  2.06   .93   20 .3626   .6000 .4386   -.69     10      5 2-1-4   |
| F     M         -1.22  1.28  -.95   31 .3484   .0360 .8496  -1.30     10      6 3-4-1   |
| F     M         -2.20  1.46 -1.51   31 .1414   .4792 .4888  -2.23     10      7 1-4-3-2 |
| F     M         -1.86  1.09 -1.71   31 .0982   .0360 .8496  -1.30     10      8 1-4-2-3 |
```

Notice that CUMLOR, the cumulative log-odds ratio, the size of the DIF according to Mantel-Haenszel/Mantel, cannot be computed for these data with MHZERO=0, and generally approximates the Rasch DIF CONTRAST when MHZERO=0.5

If Rasch and Mantel-Haenszel/Mantel disagree, then there is probably not enough data to draw strong conclusions.

11.115 MISSCORE= scoring of missing data codes

This is NOT the missing-value code in your data. All codes NOT in CODES= are missing value codes. Use this control specification when you want missing data to be treated as valid responses. Winsteps and Missing Data: No Problem!

Winsteps processes one observation at a time. For each observation, Xni by person n on item i, it computes an expectation Eni, based on the current person measure estimate Bn and the current item measure Di and, if relevant, the current rating (or partial credit) scale structure (calibrations) {Fk}. Pnik is the probability of observing category k for person n on item i.

In this computation it skips over, omits, ignores "missing" data.

It then compares sum(Xni) with sum(Eni) for each person n, and adjusts Bn.
It then compares sum(Xni) with sum(Eni) for each item i, and adjusts Di
It then compares the count of (Xni=k) with the sum (Pnik) for each k, and adjusts Fk

These sums and counts are only over the observed data. There is no need to impute missing data.

There are no pairwise, listwise or casewise deletions associated with missing data.

MISSCORE= says what to do with characters that are not valid response codes, e.g. blanks and data entry errors. Usually any characters not in CODES= are treated as missing data, and assigned a value of -1 which mean "ignore this response." This is usually what you want when such responses mean "not administered". If they mean "I don't know the answer", you may wish to assign missing data a value of 0 meaning "wrong", or, on a typical attitude survey, 3, meaning "neutral" or "don't know".

MISSCORE=255 is the same as MISSCORE=-1
MISSING=0 is the same as MISSCORE=0 meaning that all codes in the data not listed in CODES= are to be scored 0.

Non-numeric codes included in CODES= (without rescoring/recoding) or in NEWSCORE= or IVALUE= are always assigned a value of "not administered", -1.

Much more at www.rasch.org/rmt/rmt142h.htm

Example 0a: In my data file, missing data are entered as 9. I want to score them 0, wrong answers. Valid codes are 0 and 1.

```
 CODES = 01 ; do not specify a 9 as valid
 MISSCORE = 0 ; specifies that all codes not listed in CODES=, e.g., 9's. are to be scored 0.
```

Example 0b: In my data file, missing data are entered as 9. I want to ignore them in may analysis. Valid codes are 0 and 1.

```
   CODES = 01 do not specify a 9 as valid
; the following line is the standard, it can be omitted.
 MISSCORE = -1 specifies that all codes not listed in CODES=, e.g., 9's.
     are to be treated as "not administered"
```

Example 1: Assign a code of "0" to any responses not in CODES=

```
   MISSCORE=0 missing responses are scored 0.
```

Example 2: In an attitude rating scale with three categories (0, 1, 2), you want to assign a middle code of "1" to missing values

```
   MISSCORE=1 missing responses scored 1
```

Example 3: You want blanks to be treated as "wrong" answers, but other unwanted codes to be ignored items, on a questionnaire with responses "Y" and "N".

```
   CODES="YN " blank included as valid response
   NEWSCORE=100 new response values
   RESCORE=2  rescore all items
   MISSCORE=-1 ignore missing responses (standard)
```

Example 4: Your optical scanner outputs an "@" if two bubbles are marked for the same response. You want to ignore these for the analysis, but you also want to treat blanks as wrong answers:

```
   CODES ="1234 " blank is the fifth valid code
   KEY1  =31432432143142314324    correct answers
   MISSCORE=-1  applies to @ (standard)
```

Example 5: Unexpected codes are scored "wrong", but 2's to mean "not administered".

```
CODES = 012
NEWSCORE= 01X ; X is non-numeric, matching 2's ignored
MISSCORE= 0  ; all non-CODES= responses scored 0
```

Example 6: You have a long 4-option MCQ test with data codes ABCD. Most students do not have the time to complete all the items. This requires a two-stage item analysis:

1. Estimate the item difficulties without allowing missing data to bias them
Missing data = -1 ; not administered. Perform the analysis estimate the item difficulties. Save them with IFILE=if.txt

2. Estimate the person measures lowering the estimates if there is missing data
Missing data = 0 ; incorrect. Anchor the item difficulties with IAFILE=if.txt to estimate the person measures and report them.

So, in this Example:

Stage 1. *Item calibration:*
Deliberately skipped responses are coded "S" and scored incorrect. The student could not answer the question. Not-reached items are coded "R" and scored "not administered". This prevents easy items at the end of the test being calibrated as "very difficult".

```
CODES="ABCDS"
KEY1="CDBAD....."
MISSCORE=-1
IFILE=ITEMCAL.TXT ; write out the item calibrations
```

Stage 2. *Person measurement:*
The convention with MCQ tests is that all missing responses are scored incorrect when measuring the persons.

```
IAFILE=ITEMCAL.TXT ; anchor on the Stage 1 item calibrations
CODES="ABCDS"
KEY1="CDBAD....."
MISSCORE=0  ; all missing data are scored incorrect
```

11.116 MJMLE= or MUCON= maximum number of JMLE iterations

JMLE iterations may take a long time for big data sets, so initially set this to -1 for no JMLE iterations. Then set MJMLE= to 10 or 15 until you know that more precise measures will be useful. The number of PROX iterations, MPROX=, affects the number of JMLE iterations but does not affect the final estimates.

MJMLE= (or MUCON=) specifies the maximum number of JMLE iterations to be performed. Iteration will always cease when both LCONV= and RCONV= criteria have been met, see CONVERGE=. To specify no maximum number limitation, set MJMLE=0. Iteration always be stopped by Ctrl with F, see "Stopping Winsteps".

Example 1: To allow up to 4 iterations in order to obtain rough estimates of a complex rating (or partial credit) scale:
MJMLE=4 ; 4 JMLE iterations maximum

Example 2: To allow up to as many iterations as needed to meet the other convergence criteria:
MJMLE=0 ; Unlimited JMLE iterations

Example 3: Perform no JMLE iterations, since the PROX estimates are good enough.
MJMLE=-1 ; No JMLE iteration

Example 4: Run as quick estimation as possible to check out control options.
MPROX=-1 ; minimal PROX estimation iterations
MJMLE=-1 ; no JMLE iterations

Example 5: To perform an exact number of JMLE iterations.
a) set the convergence criteria very tight, so that they are never satisfied:
CONVERGE=B
RCONV=.00001
LCONV=.00001
b) set the maximum number of JMLE iterations equal to the desired number:
MJMLE = 99 (or whatever)

11.117 MNSQ= show mean-square or standardized fit statistics

The mean-square or t standardized fit statistics are shown in Tables 7, 11 to quantify the unexpectedness in the response strings, and in Tables 4, 5, 8, 9 for the fit plots.

MNSQ=N Show standardized (ZSTD) fit statistics. ZSTD (standardized as a z-score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic distribution value has been adjusted to a unit normal value.

MNSQ=Y Show mean-square fit statistics. Use LOCAL=L for log scaling.

```
TABLE 7.1 TABLE OF POORLY FITTING PERSONS   ( ITEMS IN ENTRY ORDER)
NUMBER - NAME -- POSITION ------ MEASURE - INFIT (MNSQ) OUTFIT

    17  Rod     M                  -1.41     2.4   A    2.2
  RESPONSE:      1:  0 0 2 4 1  4 3 1 3 3  1 4 3 2 3  3 1 4 2 1
Z-RESIDUAL:                -2  2          -2            -2 2  -2
```

Mean-square:

```
TABLE 9.1
      -5      -4      -3      -2      -1       0       1       2       3
      ++-------+-------+-------+-------+-------+-------+-------+-------++
    2 +                                |                                +   2
I     |                                |                                |
T     |                                |                                |
E     |                                |       B    A                   |
M     |                                | FDE        C                   |
    1 +--------------------------------|-----iIJg-Hj------G-------------+   1
O     |                                | e          d  f                |
U     |                               c|             b                  |
T     |                                |  a                     h       |
F     |                                |                                |
I   0 +                                |                                +   0
T     ++-------+-------+-------+-------+-------+-------+-------+-------++
      -5      -4      -3      -2      -1       0       1       2       3
                                   ITEM MEASURE
```

***t* standardized ZSTD:**

```
      -5      -4      -3      -2      -1       0       1       2       3
      ++-------+-------+-------+-------+-------+-------+-------+-------++   2
      |                                |            A                   |
      |                                |       B                        |
I     |                                |                                |
T   1 +                                |            C                   +   1
E     |                                |  DE                            |
M     |                                | F                              |
      |                                |          H                     |
O   0 +--------------------------------|------IJ---j------G-------------+   0
U     |                                |     i                          |
T     |                                |        g               h       |
F     |                                |               f                |
I  -1 +                                |                                +  -1
T     |                                | e          d                   |
      |                               c|                                |
Z     |                                |                                |
S  -2 +--------------------------------|--------------------------------+  -2
T     |                                |                                |
D     |                                |             b                  |
      |                                |                                |
   -3 +                                |                                +  -3
      |                                |  a                             |
      |                                |                                |
      |                                |                                |
   -4 +                                |                                +  -4
      ++-------+-------+-------+-------+-------+-------+-------+-------++
      -5      -4      -3      -2      -1       0       1       2       3
                                   ITEM MEASURE
```

11.118 MODELS= assigns model types to items

Do **not** specify MODELS= unless you intend to use the "S" , "F" or "C" models.

MODELS =	Winsteps chooses the model-family based on MODELS=. Models=R (or MODELS= is omitted) is the rating-scale family of models which includes the Andrich Rating-Scale Model, the Masters Partial-Credit Model, the Grouped Rating-Scale Model and the Rasch Dichotomous Model.
MODELS= *file name	file containing details
MODELS = *	in-line list. See Example 2.
MODELS = codes	codes for item groups, R (standard). S (success), F (failure), D (dichotomy), C (consecutive dichotomy). Items are assigned to the model for which the serial location in the MODELS= string matches the item sequence number. When only one letter is specified with MODELS=, e.g., MODELS=R, all items are analyzed using that model.
MODELS = D	Rasch dichotomous model. Dichotomous data. Items with only two response categories are analyzed using the Rasch dichotomous model, regardless of what model is specified unless they are grouped with a polytomous item.
MODELS = R	ISGROUPS= omitted, Andrich "Rating Scale" model ISGROUPS=0, Masters' "Partial Credit" model ISGROUPS=11222 or something else, the Grouped Rating Scale Model Andrich D. (1978) A rating scale formulation for ordered response categories. Psychometrika, 43, 561-573. Masters G.N. (1982) A Rasch model for partial credit scoring. Psychometrika, 47, 149-174. Linacre J.M. (2000) Comparing and Choosing between "Partial Credit Models" (PCM) and "Rating Scale Models" (RSM). www.rasch.org/rmt/rmt143k.htm
MODELS = S	uses the Rasch dichotomous model and the Glas-Verhelst "Success" (growth) model, also called the "Steps" Model (Verhelst, Glas, de Vries, 1997). If and only if the person succeeds on the first category, another category is offered until the person fails, or the categories are exhausted, e.g. an arithmetic item, on which a person is first rated on success on addition, then, if successful, on multiplication, then, if successful, on division etc. "Scaffolded" items can function this way. This is a continuation ratio model parameterized as a Rasch model with missing data on unreached categories. Verhelst N.D., Glas C.A.W. & De Vries H.H. (1997) A Steps model to analyze partial credit. In W.J. van der Linden & R.K. Hambleton (Eds.), Handbook of modern item response theory (pp. 123 - 138) New York: Springer
MODELS = F	uses the Rasch dichotomous model and the Linacre "Failure" (mastery) model. If a person succeeds on the first category, top rating is given and no further categories are offered. On failure, the next lower category is administered until success is achieved, or categories are exhausted. This is a continuation ratio model parameterized as a Rasch model with missing data on unreached categories. The Success and Failure model computations were revised at Winsteps version 3.36, August 2002. Recommendation: Instead of an F-type polytomy, model each step to be a dichotomy: 1=succeeded, 0=failed, missing=not reached. This facilitates much more powerful diagnosis of the functioning of the failure process. Linacre J.M. (1991) Beyond Partial Credit: Rasch Success and Failure Models. www.rasch.org/rmt/rmt52j.htm
MODELS = C	the rating scale for each item is analyzed as a set of consecutive dichotomies with one dichotomy for each category boundary, CDM - Consecutive Dichotomizations Model. This is similar to MSD, see Bradley C., Massof R. (2018) Method of successive dichotomizations: An improved method for estimating measures of latent variables from rating scale data. PLoS One.

Please look at the output in Table 3.2, 3.3, ... to see exactly how the data have been modeled.

Use one character per item with no blanks

```
NI=8
MODELS='RSRFRSRR' ; this also forces ISGROUPS=0 to be the default
```

When XWIDE=2, you can also use one character per XWIDE with blanks,

```
NI=8
XWIDE=2
MODELS=' R S R F R S R R' ; this also forces ISGROUPS=0 to be the default
```

Example 1: All items are to be modeled with the "Success" model.

```
MODELS=S ; the Success model
```

Example 2: A competency test consists of 3 success items followed by 2 failure items and then 10 dichotomies. The dichotomies are to be reported as one grouping.

```
NI=15  fifteen items
MODELS=SSSFFRRRRRRRRRR ; matching models: ; forces ISGROUPS=0 to be the default
ISGROUPS=000001111111111 ; dichotomies grouped: overriding the default ISGROUPS=0
```

or

```
MODELS=*
1-3 S
4 F
5 F
6-15 R
*
```

MODELS= Demonstration

Score on item	RSM Andrich thresholds	RSM Thurstone thresholds	Consecutive Dichotomy thresholds	Success Model thresholds	Failure Model thresholds
5	.00	.68	1.61	.00	1.61
4	.00	.24	.69	-.69	1.38
3	.00	.00	.00	-1.10	1.10
2	.00	-.24	-.69	-1.38	.69
1	.00	-.68	-1.61	-1.61	.00
0	-		-	-	-

This control and data file demonstrates that the C, S and F models produce the same Andrich thresholds as the equivalent sets of dichotomous items. The standard errors and fit statistics differ because the sets of dichotomous items are treated as independent, but the rating scale categories are dependent.

```
TITLE = MODELS= Demonstration
ITEM1 = 1
NI=19
NAME1 = 21 ; the score on the item or item set
NAMELEN = 1
CODES=012345
ISGROUPS=0 ; each item has its own rating or other scale
; MODELS=
; R = RATING SCALE MODEL AND SIMPLE DICHOTOMIES
; C = CONSECUTIVE DICHOTOMIZATION
; S = SUCCESS MODEL
; F = FAILURE MODEL
MODELS=RCRRRRRSRRRRRFRRRRR
OFILE=RCSF.txt
PAFILE=*
1-6 0  ; anchor at zero to avoid item interactions
*
TFILE=*
14.1  ; item difficulties
3.2+  ; rating scales
*
CMATRIX = No ; omit confusiion matrix
&END
1.  RATING-SCALE MODEL
2.  CONSECUTIVE DICHOTOMIZATION
3.  5 CONSECUTIVE DICHOTOMY
```

```
4.  4 CONSECUTIVE DICHOTOMY
5.  3 CONSECUTIVE DICHOTOMY
6.  2 CONSECUTIVE DICHOTOMY
7.  1 CONSECUTIVE DICHOTOMY
8.  SUCCESS MODEL
9.  5 SUCCESS DICHOTOMY
10. 4 SUCCESS DICHOTOMY
11. 3 SUCCESS DICHOTOMY
12. 2 SUCCESS DICHOTOMY
13. 1 SUCCESS DICHOTOMY
14. FAILURE MODEL
15. 5 FAILURE DICHOTOMY
16. 4 FAILURE DICHOTOMY
17. 3 FAILURE DICHOTOMY
18. 2 FAILURE DICHOTOMY
19. 1 FAILURE DICHOTOMY
END LABELS
551111151111151.... 5
4411110411110401... 4
331110031110.3001.. 3
22110002110..20001. 2
1110000110...100001 1
000000000....000000 0
```

```
        ITEM STATISTICS:  ENTRY ORDER

------------------------------------------------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL    JMLE   MODEL|   INFIT   |  OUTFIT   |PTMEASUR-AL|EXACT MATCH|                                  |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%| ITEM                         M G |
|------------------------------------+----------+----------+-----------+-----------+----------------------------------|
|     1     15      6      .00    .24|1.00   .12|1.00   .12|  .00   .00| 33.3  16.7| 1.  RATING-SCALE MODEL         0 |
|     2     15      6      .00    .24|1.00   .12|1.00   .12|  .00   .00| 16.7  16.7| 2.  CONSECUTIVE DICHOTOMIZATION C 0 |
|     3      5      6    -1.61   1.10|1.00   .24|1.00   .24|  .00   .00| 83.3  83.3| 3.  5 CONSECUTIVE DICHOTOMY    0 |
|     4      4      6    -.69     .87|1.00   .10|1.00   .10|  .00   .00| 66.7  66.7| 4.  4 CONSECUTIVE DICHOTOMY    0 |
|     5      3      6      .00    .82|1.00   .00|1.00   .00|  .00   .00|100.0  50.0| 5.  3 CONSECUTIVE DICHOTOMY    0 |
|     6      2      6      .69    .87|1.00   .10|1.00   .10|  .00   .00| 66.7  66.7| 6.  2 CONSECUTIVE DICHOTOMY    0 |
|     7      1      6     1.61   1.10|1.00   .24|1.00   .24|  .00   .00| 83.3  83.3| 7.  1 CONSECUTIVE DICHOTOMY    0 |
|     8     15      6    -.96     .24|1.00   .12|1.00   .12|  .00   .00| 16.7  16.7| 8.  SUCCESS MODEL            S 0 |
|     9      5      6    -1.61   1.10|1.00   .24|1.00   .24|  .00   .00| 83.3  83.3| 9.  5 SUCCESS DICHOTOMY        0 |
|    10      4      5    -1.39   1.12|1.00   .22|1.00   .22|  .00   .00| 80.0  80.0| 10. 4 SUCCESS DICHOTOMY        0 |
|    11      3      4    -1.10   1.15|1.00   .19|1.00   .19|  .00   .00| 75.0  75.0| 11. 3 SUCCESS DICHOTOMY        0 |
|    12      2      3    -.69    1.22|1.00   .14|1.00   .14|  .00   .00| 66.7  66.7| 12. 2 SUCCESS DICHOTOMY        0 |
|    13      1      2      .00   1.41|1.00   .00|1.00   .00|  .00   .00|100.0  50.0| 13. 1 SUCCESS DICHOTOMY        0 |
|    14     15      6      .96    .24|1.00   .12|1.00   .12|  .00   .00| 16.7  16.7| 14. FAILURE MODEL            F 0 |
|    15      1      6     1.61   1.10|1.00   .24|1.00   .24|  .00   .00| 83.3  83.3| 15. 5 FAILURE DICHOTOMY        0 |
|    16      1      5     1.39   1.12|1.00   .22|1.00   .22|  .00   .00| 80.0  80.0| 16. 4 FAILURE DICHOTOMY        0 |
|    17      1      4     1.10   1.15|1.00   .19|1.00   .19|  .00   .00| 75.0  75.0| 17. 3 FAILURE DICHOTOMY        0 |
|    18      1      3      .69   1.22|1.00   .14|1.00   .14|  .00   .00| 66.7  66.7| 18. 2 FAILURE DICHOTOMY        0 |
|    19      1      2      .00   1.41|1.00   .00|1.00   .00|  .00   .00|100.0  50.0| 19. 1 FAILURE DICHOTOMY        0 |
|------------------------------------+----------+----------+-----------+-----------+----------------------------------|
| MEAN     5.0    4.9      .00    .93|1.00   .15|1.00   .15|           | 68.1  59.3|                                  |
| P.SD     5.3    1.4     1.04    .39| .00   .08| .00   .08|           | 26.7  24.5|                                  |
------------------------------------------------------------------------------------------------------------------------
```

11.119 MODFROM= location of MODELS

This command has not proved productive. It is maintained for backwards compatibility.

Instructs where to find the MODELS= information.
Only use this if you have too many items to put conveniently on one line of the MODELS= control variable. It is easier to use "+" continuation lines

MODFROM=N MODELS= is a control variable before &END (the standard).

MODFROM=Y

MODELS= information follows just after &END but before the item names. It is formatted exactly like a data record. It is helpful to enter "MODELS=" where the person name would go.

Example: A test consists of 10 three-category items. The highest level answer is scored with KEY2=. The next level with KEY1=. Some items have the "Success" structure, where the higher level is administered only after success has been achieved on the lower level. Some items have the "Failure" structure, where the lower level is administered only after failure at the higher level. The MODELS=, KEY1=, KEY2= are formatted exactly like data records. The data records are in a separate file.

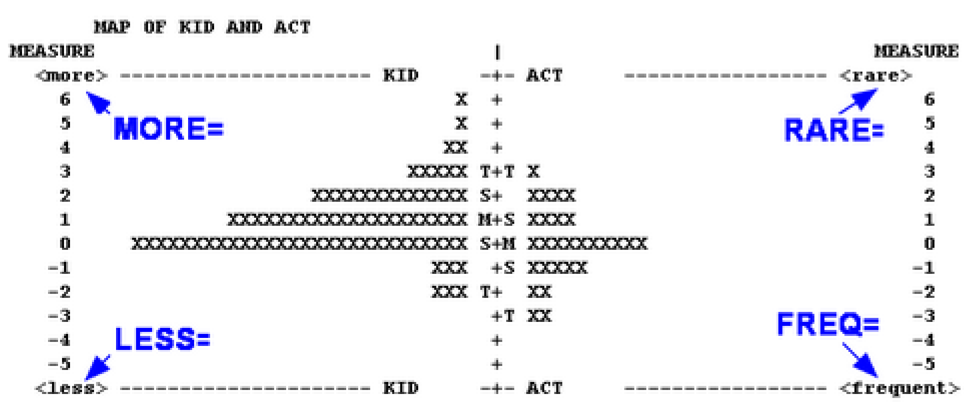
```
NAME1 = 5   start of person-id
ITEM1 = 20  start of responses
NI = 10   ten items
CODES = ABCDE valid codes
MODFRM = Y  MODELS= in data format
KEYFRM = 2  two keys in data format
DATA = DATAFILE location of data
;         1         2 columns
;2345678901234567890
&END
MODELS=            SSSFFFSSSS  data format
KEY1=              BCDABCDABC  starts in column ITEM1 = 20
KEY2=              ABCDDBCBAA
Item name 1 first item name
|
Item name 10
END NAMES
```

11.120 MORE= heading in Tables 1, 12, 16

MORE=, LESS=, RARE=, FREQ= control the column headings in Tables 1, 12 and 16. The first 8 characters of each variable are displayed, and sometimes more. Please change these headings to match the meaning of more and less of your latent variable.

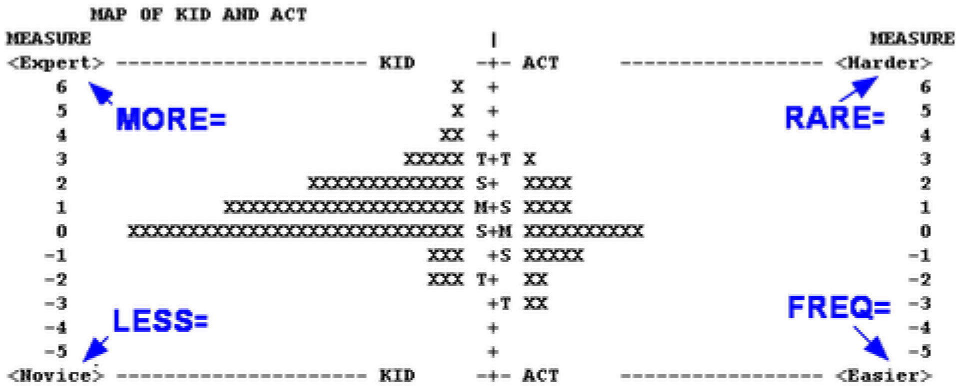
The default values are:	*Meaning relative to the latent variable*
MORE = <more>	More ability, higher ability
LESS = <less>	Less ability, lower ability
RARE= <rare>	Rarer success, higher item difficulty, harder item
FREQ= <frequent>	More frequent success, lower item difficulty, easier item

Example 1: Table 1.1. Default values:
PERSON= KID
ITEM= ACT
MAXPAGE= 40

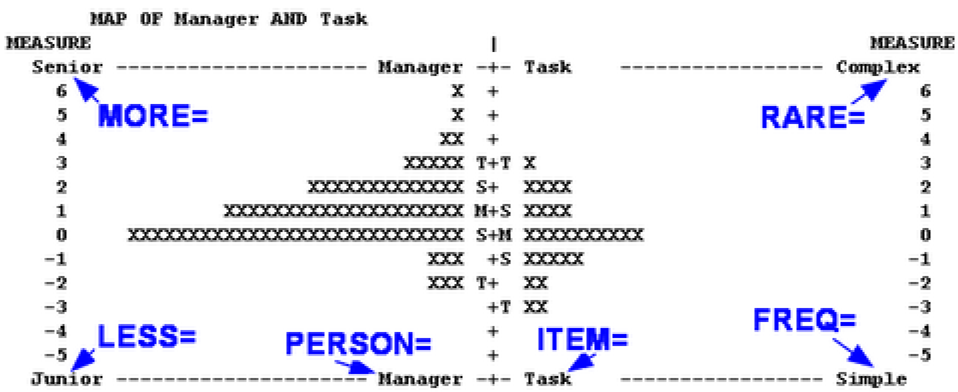


Example 2:
MORE= <Expert>

LESS= <Novice>
RARE= <Harder>
FREQ= <Easier>
PERSON= KID
ITEM= ACT
MAXPAGE= 40



Example 3:
MORE= Senior
LESS= Junior
RARE= Complex
FREQ= Simple
PERSON= Manager
ITEM= Task
MAXPAGE= 40



11.121 MPROX= maximum number of PROX iterations

Specifies the maximum number of PROX iterations to be performed. The PROX, "normal approximation", algorithm provides starting values for the JMLE algorithm, in order to speed up estimation. PROX has little influence on the final JMLE estimates.

MPROX= 1 or more	PROX iterations are performed so long as inestimable parameters have been detected in the previous iteration, because inestimable parameters are always dropped before the next iteration. At least 2 PROX iterations will be performed. PROX iteration ceases when the specified number of iterations have been done or the spread of the persons and items no longer increases noticeably (0.5 logits). The spread is the logit distance between the top 5

	and the bottom 5 persons or items. Then JMLE iterations begin.
MPROX= 0	Continue PROX iterations indefinitely until you intervene with Ctrl+f
MPROX= -1 (or there are anchored items or persons)	No PROX estimation is done

Example 1: To set the maximum number of PROX iterations to 20, in order to speed up the final JMLE estimation of a symmetrically-distributed set of parameters,
MPROX=20

Example 2: To minimize the influence of PROX on the final JMLE estimates,
MPROX=-1

11.122 MRANGE= half-range of measures on plots

Specifies the measure half-range, (i.e., range away from the origin or UMEAN=), of the maps, plots and graphs. This is in logits, unless USCALE= is specified, in which case it must be specified in the new units defined by USCALE=. To customize particular tables, use the Specification pull-down menu, or see TFILE=.

Example 1: You want the vertical range on the Table 1 map to be -5 to +5
MRANGE=5

Example 1: You want to see the category probability curves in the range -3 to +3 logits:
MRANGE=3

Example 2: With UMEAN=500 and USCALE=100, you want the category probability curves to range from 250 to 750:
UMEAN=500 ; item mean calibration
USCALE=100 ; value of 1 logit
MRANGE=250 ; to be plotted each way from UMEAN=

11.123 MTICK= measure distance between tick marks on plots = 0, auto-size

Specifies the measurement distance between tick marks in Tables 1, 2, 3.2, 4, 5, 8, 9, 12, 16, and more. This is in logits, unless USCALE= is specified, in which case it must be specified in the new units defined by USCALE=. To customize particular tables, use the Specification pull-down menu. See MTOP=

Example 1: You want the vertical range on the Table 2.2 map to be -6 to +6 logits with tick marks every 2 logits:
MRANGE=6
MTICK=2

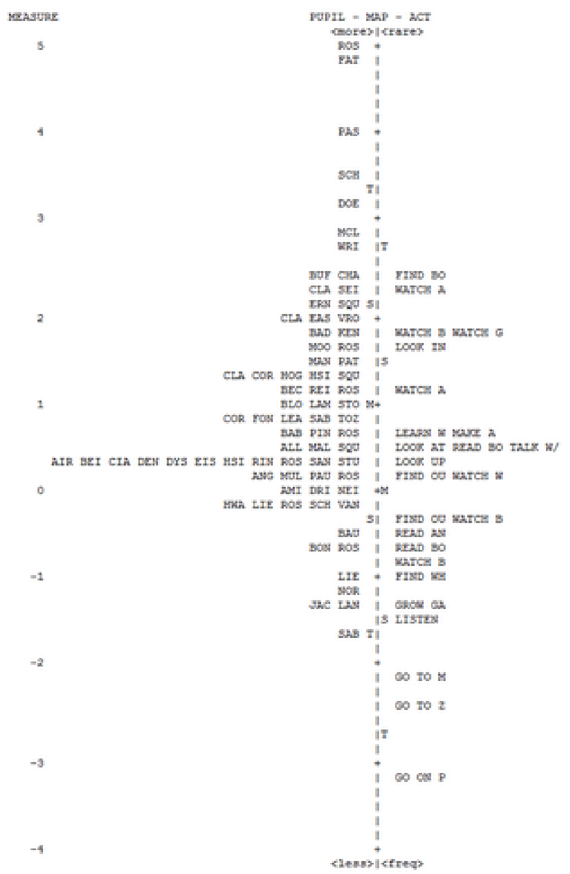
```
 -6        -4        -2         0         2         4         6
 |---------+---------+---------+---------+---------+---------|  NUM   TAP
 0                                              0    :      1    15   1-3-2-4-1-3
```

11.124 MTOP= highest measure in Table 1 etc.

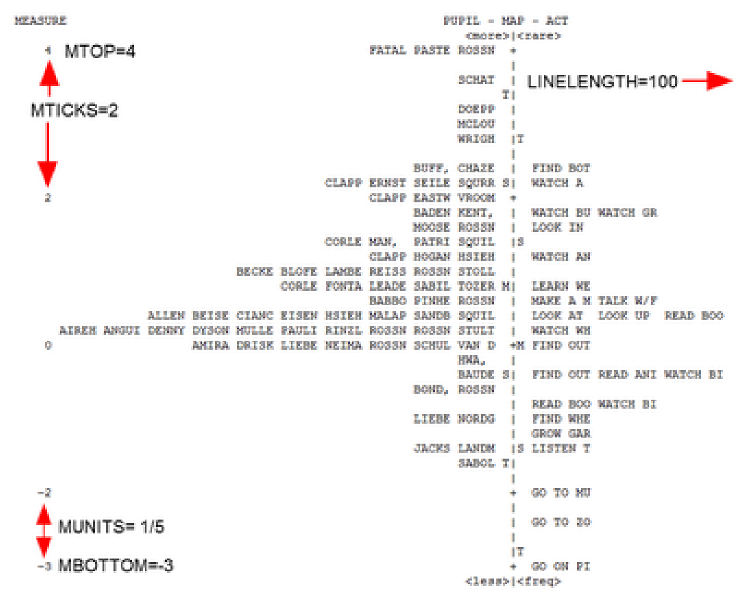
Table 1, Table 12 and Table 16 can be customized using MTOP=, MBOTTOM=, MUNITS=, MTICK= and LINELENGTH=.
See also MTOP= Calculator.

Control Variable	Default	Example	Explanation
MTOP=	MTOP=0 and MBOTTOM=0	MTOP= 4	Sets the top of the Wright map
MBOTTOM=	MBOTTOM=0 and MTOP=0	MBOTTOM= -3	Sets the bottom of the Wright map

MUNITS=	MUNITS=0	MUNITS= 1/5 (each row or each column is 0.2 units)	Sets the number of measurement units for each line (row) advance or each column advance
MTICKS=	MTICKS=0	MTICKS= 2	number of measurement units per tick mark
LINELENGTH=	LINELENGTH=0	LINELENGTH=100	Sets the page width



Original Scaling



MTOP= 4
MBOTTOM= -3
MUNITS= 1/5
MTICKS= 2
LINELENGTH=100

11.125 MUCON= or MJMLE= maximum number of JMLE iterations

See MJMLE=

11.126 MUNITS= measurement units per line in Table 1 etc.

See MTOP=

Example:
MTOP= 5
MBOTTOM= -5
MUNITS= 0.5   2 lines (rows) for each measurement unit
Plot is 20 lines

11.127 NAME1= first column of person label

NAME1= gives the column position where the person label information starts in your data file or in the new record formatted by FORMAT=.

It is easy to miscount the NAME1= column. Scroll to the top of the Winsteps screen and check column positions:

```
 Input in process..
Input Data Record:
         1         2
1234567890123456789012345678
Richard M 111111100000000000
^P        ^I               ^N
       35 KID    Records Input.
```

^P marks the Name1=1 column position with ^.
^I marks the Item1=11 column position with ^.
^N marks the NI=18 column position with ^.

Example 1: The person-id starts in column 10, data responses are 1 column wide, in columns 1-8:

```
NAME1=10 starting column of person-id
XWIDE=1 width of response
NI=8  number of responses
```

Example 2: The person-id in column 10, there are 4 data responses are 2 columns wide, in columns 1-8:

```
NAME1=10 starting column of person-id
XWIDE=2 width of response
NI=4  number of responses
```

Example 3: The person id starts in column 23 of the second record.

```
FORMAT=(80A,/,80A)  concatenate two 80 character records
NAME1=103   starts in column 103 of combined record
```

Example 4: The person id starts in column 27 of a record with XWIDE=2 and FORMAT=.
This becomes complicated, see FORMAT=

Example 5: How do I add convenient IDs (e.g., 1, 2, 3...) to the control file?
Give NAME1= a value beyond the end of the data record.

```
NAME1=100 ; a number that is bigger than the longest data record
NAMELENGTH = 5 ; allows numbers up to 99999
```

11.128 NAMLEN= length of person label

Use this if too little or too much person-id information is printed in your output tables.

NAMLEN= allows you define the length of the person-id name with a value in the range of 1 to 30 characters. This value overrides the value obtained according to the rules which are used to calculate the length of the person-id. These rules are:
1) Maximum person-id length is 300 characters
2) Person-id starts at column NAME1=
3) Person-id ends at ITEM1= or end of data record.
4) If NAME1= equals ITEM1= then length is 30 characters.

Example 1: The 9 characters including and following NAME1= are the person's Social Security number, and are to be used as the person-id.

```
NAMLEN=9
```

Example 2: We want to show the responses in Example0.txt as the person label to help diagnose the fit statistics:

```
ITEM1 = 1
NI = 25
```

```
NAME1 = 1
NAMLEN = 25
```

```
+-------------------------------------------------------------------------------------------+
|ENTRY    RAW                      MODEL|   INFIT  |  OUTFIT  |PTMEA|                           |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.| KID                       |
|------------------------------------+----------+----------+-----+---------------------------|
|    12     17     25    -.85     .36|1.90   2.7|2.86   3.9|A .24| 0100220101210011021000101|
|     6     24     25    -.02     .34|1.48   1.7|1.83   2.3|B .30| 1011211011121010122101210|
|    15     27     25     .31     .33| .86   -.5|1.72   1.9|C .10| 1111111111111111112211111|
|     7     44     25    2.62     .47|1.71   1.7|1.00    .3|D .41| 2220022202222222222222222|
|    14     23     25    -.14     .34|1.62   2.1|1.53   1.6|E .54| 2110020212022100022000120|
```

11.129 NAMLMP= name length on map for Tables 1, 12, 16

Person and item labels are often too long to display nicely on the maps in Tables 1, 12, 16. NAMLMP= (name length on maps) limits the number of characters of item and person labels displayed.

NAMLMP=0 to ignore this instruction.
For item labels, NAMLMP= is ignored when IMAP= is specified.
For person labels, NAMLMP= is ignored when PMAP= is specified.

Example: The 9 characters of the person label are the person's Social Security number, and are to be displayed on the person maps.

NAME1 = 23 ; start of person label
NAMLMP=9 ; number of characters of person label to show on the person maps. The item labels will also be truncated to display the first 9 characters.

11.130 NEWSCORE= recoding values

NEWSCORE= says which values must replace the original codes when RESCORE= is used. If XWIDE=1 (the standard), use one column per code. If XWIDE=2, use two columns per code. The length of the NEWSCORE= string must match the length of the CODES= string. For examples, see RESCORE=. NEWSCORE= is ignored when KEYn= is specified.

The responses in your data file may not be coded as you desire. The responses to some or all of the items can be rescored or keyed using RESCORE=. RESCORE= and NEWSCORE= are ignored when KEYn= is specified, except as below.

RESCORE=" " or 2 or is omitted
All items are recoded using NEWSCORE=. RESCORE=2 is the standard when NEWSCORE= is specified.

RESCORE= some combination of 1's and 0's
Only items corresponding to 1's are recoded with NEWSCORE= or scored with KEYn=. When KEYn= is specified, NEWSCORE= is ignored.

If some, but not all, items are to be recoded or keyed, assign a character string to RESCORE= in which "1" means "recode (key) the item", and "0" (or blank) means "do not recode (key) the item". The position of the "0" or "1" in the RESCORE= string must match the position of the item-response in the item-string.

Example 0: I want to collapse data, rating scale 1,2,3,4,5 6 to 0 through 3 is 0, 4 through 6 is 1

```
CODES    = 123456
NEWSCORE = 000111 ; the codes align vertically
```

Example 1: The original codes are "0" and "1". You want to reverse these codes, i.e., 1 0 and 0 1, for all items.

```
   XWIDE=1   one character wide responses (the standard)
   CODES =01  valid response codes are 0 and 1 (the standard)
   NEWSCORE=10  desired response scoring
   RESCORE=2  rescore all items - this line can be omitted
or
   NI = 100  100 ITEMS
   IREFER=*
   1-100 X  FOR ALL 100 ITEMS, reference is X
```

```
*
Codes = 01  recode 01
IVALUEX = 10  into 10
```

Example 2: Your data is coded "0" and "1". This is correct for all 10 items except for items 1 and 7 which have the reverse meaning, i.e. 1 0 and 0 1.

```
NI=10  ten items
CODES =01  the standard, shown here for clarity
```

(a) old method - which still works:

```
NEWSCORE=10  revised scoring
RESCORE=1000001000 only for items 1 and 7
```

(b) new method - recommended:

```
IVALUE1 =10  revised scoring
IVALUE0 =01  scoring unchanged, so this line can be omitted.
IREFER   =1000001000 only for items 1 and 7
```

If XWIDE=2, use one or two columns per RESCORE= code, e.g., " 1" or "1 " mean recode (key). " 0" or "0 " mean do not recode (key).

Example 3: The original codes are " 0" and " 1". You want to reverse these codes, i.e., 1 0 and 0 1, for items 1 and 7 of a ten item test.

```
NI    =10   ten items
XWIDE =2   two characters wide
CODES =  " 0 1"  original codes
NEWSCORE=" 1 0"  new values
RESCORE =" 1 0 0 0 0 0 1 0 0 0" rescore items 1 & 7
```

Example 4: The original codes are "0", "1", and "2". You want 0 0, 1 1, and 2 1 for all items

```
XWIDE=1  one character wide (standard)
CODES =012  valid codes
NEWSCORE=011  desired scoring
```

Example 5: The original codes are "0", "1", and "2". You want to make 0 2, 1 1, and 2 0, for even-numbered items in a twenty item test.

```
NI=20   twenty items
CODES =012  three valid codes
NEWSCORE=210  desired scoring
RESCORE=01010101010101010101 rescore "even" items
```

Example 6: The original codes are "0", "1", "2", "3" and some others. You want to make all non-specified codes into "0", but to treat codes of "2" as missing.

```
CODES = 0123  four valid codes
NEWSCORE= 01X3 response code 2 will be ignored
MISSCORE=0  treat all invalid codes as 0
```

Example 7: The original codes are "0", "1", "2", "3". You want to rescore some items selectively using KEY1= and KEY2= and to leave the others unchanged - their data codes will be their rating values. For items 5 and 6, 0 0, 1 0, 2 1, 3 2; for item 7, 0 0, 1 0, 2 0, 3 1. Responses to other items are already entered correctly as 0, 1, 2, or 3.

```
CODES =0123 valid codes
RESCORE=0000111000 rescore items 5,6,7
KEY1   =****223*** keyed for selected items
KEY2   =****33X*** the X will be ignored
  ^ read these columns vertically
```

11.131 NI= number of items

NI= is the total number of items to be read in (including those to be deleted by IDFILE= etc.). The maximum value of NI= is about 65,000 for one column responses or about 32,500 for two column responses in the standard program. NI= is usually the length of your test (or the total number of items in all test forms to be combined into one analysis).

Example: If there are 230 items in your test, enter

```
   NI=230   ; 230 items
```

It is easy to miscount the NI= column. Scroll to the top of the Winsteps screen and check column positions:

```
 Input in process..
Input Data Record:
         1         2
1234567890123456789012345678
Richard M 111111100000000000
^P        ^I               ^N
       35 KID    Records Input.
```

^P marks the Name1=1 column position with ^.
^I marks the Item1=11 column position with ^.
^N marks the NI=18 column position with ^.

11.132 NOMEASURE= measure value for deleted and inestimable = 9999

In the PFILE= and IFILE=, deleted, deselected and inestimable are listed with the measure value set by NOMEASURE=

NOMEASURE= can have any value except blank. If blank is entered, the value defaults to 9999

Example:
   NOMEASURE=NA ; for R Statistics

11.133 NORMAL= normal distribution for standardizing fit

The standard generally matches the statistics used in BTD and RSA.

Specifies whether distribution of squared residuals is hypothesized to accord with the chi-square or the normal distribution. Values of t standardized fit statistics are obtained from squared residuals by means of one of these distributions.

NORMAL=N	t standardized fit statistics are obtained from the squared residuals by means of the chi-square distribution and the Wilson-Hilferty transformation (the standard).
NORMAL=Y	t standardized fit statistics are obtained from the squared residuals by means of an asymptotic normal distribution (F.A.G. Windmeijer, The asymptotic distribution of the sum of weighted squared residuals in binary choice models, Statistica Neerlandica, 1990, 44:2, 69-78).

11.134 OFILE= report output file

A. Output Tables requested from the Output Tables menu are displayed in temporary files. These can be "Saved As" permanent files.

B. Output Tables can be requested in the control file or at the Extra Specifications prompt using TABLES= or TFILE=. These are output to a report file.

1) if no report output file is specified, then the tables are output to a temporary file which is displayed after the analysis phase is completed.

2) if a report output file is specified when Winsteps is launched interactively, then the tables are output to the specified file which is displayed after the analysis phase is completed.

3) if a report output file is specified when Winsteps is launched in Batch mode, then the tables are output to the specified file.

4) report output files can be specified in the control file or at the Extra Specifications prompt using OFILE=. These can be displayed from the Edit menu. When Winsteps is launched interactively, the last output report file containing a Table is displayed.

TFILE=*	
OFILE = C:\MyFile.txt 12	writes Table 12 to file c:\MyFile.txt
OFILE = 7	writes Table 7 to the default (usually temporary) Table output file
OFILE = "c:\MyFolder\"+@SCHOOL+"\"+@CLASS+".htm" 36 ; only Table 36 with this format of OFILE=	writes Table 36 PKMAPs to CLASS files in SCHOOL folders. $S...W... can also be used.

Example 1: Winsteps is launched interactively, but we want the Output Tables to be written to file "mytables.txt". Press enter when Winsteps asks for a Report Output file name.

```
TITLE="My analysis"
TABLES=1110110101
OFILE=mytables.txt
.....
```

Example 2: We want Winsteps to analyze the data once, but produce the same Output Tables twice in different scaling written to the same report output files:

```
TITLE="My analysis"
TFILE=*
OFILE="mytable1s.txt"
UMEAN=500 ; item mean calibration
USCALE=100 ; value of 1 logit
MRANGE=250 ; to be plotted each way from UMEAN=
1 ; Table 1
UMEAN=0 ; item mean calibration
USCALE=1 ; value of 1 logit
MRANGE=5 ; to be plotted each way from UMEAN=
1 ; Table 1 again
*
```

Example 3: output a Wright Map to HTML:

```
Tables=0111
TFILE=*
Header=No
OFILE=table1.0.htm
1.0
OFILE=myoutputfile.txt
Header = Yes
*
```

11.135 OSORT= option/distractor sort

Specifies the order in which categories, options and distractors are listed within items in the Item Category/Option/Distractor Tables, such as Table 13.3

OSORT = D Options within items are listed in their Data order in CODES= (the standard).
OSORT = S or V or " " Score or Value: Options are listed in their Score Value order.
OSORT = A or M Average or Measure: Options are listed in their Average Measure order.

Example: List distractors in original CODES= order:
 OSORT=D
 CODES=000102
 XWIDE=2

```
        ACTS CATEGORY/OPTION/Distractor FREQUENCIES:  MISFIT ORDER
+-----------------------------------------------------------------------------+
|ENTRY   DATA  SCORE |     DATA    | AVERAGE  S.E.  OUTF|                      |
|NUMBER  CODE  VALUE |  COUNT    % | MEASURE  MEAN  MNSQ| ACT                  |
|--------------------+-------------+------------------+----------------------|
|   23 A 00        0 |     44  59 |    9.57  1.37  1.7 |WATCH A RAT           | 00 dislike
|        01        1 |     20  27 |   10.35  3.79  2.4 |                      | 01 neutral
|        02        2 |     11  15 |    8.92  6.48  7.6 |                      | 02 like
|        MISSING *** |      1   1 |                    |                      |
|                    |            |                    |                      |
|    5 B 00        0 |     47  63 |    9.57  1.48  1.8 |FIND BOTTLES AND CANS | 00 dislike
|        01        1 |     19  25 |    8.34  3.45  2.9 |                      | 01 neutral
|        02        2 |      9  12 |   13.14  8.10  6.1 |                      | 02 like
```

11.136 OUTFIT= sort misfits on infit or outfit

Other Rasch programs may use infit, outfit or some other fit statistic. There is no one "correct" statistic. Use the one you find most useful.

Specifies whether mean-square infit or mean-square outfit is used as your output sorting and selection criterion for the diagnosis of misfits in Tables 6, 7, 10, 40, 41.

OUTFIT=Yes or Both or 2	For each person, the greater of the outfit mean-square and infit mean-square is used as the fit statistic for sorting and selection (the standard).
OUTFIT=No or Infit or 1	Infit mean-square only is used as the fit statistic for sorting and selection.
OUTFIT=Outfit or 0	Outfit mean-square only is used as the fit statistic for sorting and selection.

Example: We want Table 6 sorted by Outfit Mean-square descending:
 OUTFIT = Outfit
 Output Tables: 6

11.137 PAFILE= person anchor file

The PFILE= from one run can be used unedited as the person anchor file, PAFILE=, of another.

PAFILE= file name	file containing details
PAFILE = *	in-line list
PAFILE = $S1W1	field in person label

The person parameter values (thetas) can be anchored (fixed) using PAFILE=. Person anchoring can also facilitate test form equating. The persons common to two test forms can be anchored at the values for one form. Then the measures constructed from the second form will be equated to the measures of the first form. Other measures are estimated in the frame of reference defined by the anchor values.

Displacements are reported, indicating the differences between the anchored values and the freely estimated values. If these are large, please try changing the setting of ANCESTIM=.

PAFILE=? opens a Browse window

In order to anchor persons, a data file must be created of the following form:
1. Use one line per person (or person range) to be anchored.
2. Type the sequence number of the person in the current analysis, a blank, and the measure-value at which to anchor the person (in logits if UASCALE=1, or in your user-rescaled USCALE= units otherwise). Arithmetical expressions are allowed.
 Further values in each line are ignored. An IFILE= works well as an IAFILE=.
3. If the same person appears more than once, the first anchor value is used.

UIMEAN= and UPMEAN= are ignored when there are anchor values, IAFILE= or PAFILE=

Examples:

```
PAFILE=*
2 3.47 ; anchors person 2 at 3.47 logits (or USCALE= values)
10-13 1.3 ; persons 10, 11, 12, 13 are each anchored at 1.3 logits
2 5.2 ; person 2 is already anchored. This person anchoring is ignored
1-50 0 ; all the unanchored persons in the range 1-50 are anchored at 0.
*
```

Anything after ";" is treated as a comment.

PAFILE = filename
Person anchor information is in a file containing lines of format
person entry number anchor value
person entry number anchor value

PAFILE=*
Person anchor information is in the control file in the format
PAFILE=*
person entry number anchor value
person entry number anchor value
*

PAFILE=$SnnEnn or PAFILE=$SnnWnn
Person anchor information is in the person data records using the column selection rules, e.g., starting in column Snn and ending in column Enn or of width Wnn. Blanks of non-numeric values indicate no anchor value. PAFILE=$S10E12 or PAFILE=$S10W2 means anchor information starts in column 10 and ends in column 12 of the person's data record (not person label). This can be expanded, e.g, PAFILE = $S23W1+"."+$S25W2 places the columns next to each other (not added to each other)

Example 1: The first 3 persons are to be anchored at pre-set values

```
TITLE = "PAFILE TEST"
ITEM1 = 1
NI = 4
NAME1 = 6
CODES = 01
PAFILE=*
1 0.6  ; PERSON 1 ANCHORED AT 0.6 LOGITS
2 2.4 ; PERSON 2 ANCHORED AT 2.4 LOGITS
3 -1.8 ; PERSON 3 ANCHORED AT -1.8 LOGITS
*
&END
Item 1
Item 2
Item 3
Item 4
END LABELS
0101 Person 1
1110 Person 2
1000 Person 3
0110 Person 4
```

Example 2: The third person in the test is to be anchored at 1.5 logits, and the eighth at -2.7.
1. Create a file named, say, "PERSON.ANC"
2. Enter the line "3 1.5" into this file, meaning "person 3 is fixed at 1.5 logits".
3. Enter the line "8 -2.7", meaning "person 8 is fixed at -2.7 logits".
4. Specify, in the control file,
PAFILE=PERSON.ANC
CONVERGE=L ; only logit change is used for convergence
LCONV=0.005 ; logit change too small to appear on any report.

or, enter directly into the control file

```
PAFILE=*
3 1.5
8 -2.7
*
```

```
 CONVERGE=L  ; only logit change is used for convergence
 LCONV=0.005  ; logit change too small to appear on any report.
```

or, include the anchor information in the data record

```
 PAFILE=$S1E4
 NAME1=5
 ITEM1=11
 NI=12
 CONVERGE=L  ; only logit change is used for convergence
 LCONV=0.005  ; logit change too small to appear on any report.
 &END
 .....
 END LABELS
     Fred  111010111001 ; this is the first data line
     Mary  011010111100
 1.5 Jose  101001111010 ; this data line has an PAFILE= anchor value
     Jo    111110011101
```

etc.

To check: "A" after the measure means "anchored"

```
+----------------------------------------------------------------------------------------+
|ENTRY    RAW                          |   INFIT  |  OUTFIT  |PTMEA|        |              |
|NUMBER  SCORE  COUNT  MEASURE  ERROR|MNSQ  ZSTD|MNSQ  ZSTD|CORR.|DISPLACE| PERSONS      |
|------------------------------------+----------+----------+-----+--------+--------------|
|     3     32     35     1.5A    .05| .80   -.3| .32    .6|  .53|     .40| Jose         |
```

Example 2: Matching person labels.

Winsteps expects the person entry numbers for the common persons to be the same in both tests. If they are not, then here is a procedure using Excel.

Run the two analyses independently.
Output the two PFILE= to Excel files.
Sort the two Excel Pfiles by person label.
Copy and paste the two files into one excel worksheet:

The columns are:
Columns A,B,C: Test 1: person id, entry number, measure
Columns D,E :Test 2: person id, entry number

The person labels will not align, because some people are in Test 1 and not Test 2, and some people are in Test 2 but not Test 1.

We need to apply anchor values from Test 1 in the Test 2 analysis.

Now we want Excel to do a look-up for us:
Paste into cell F1:
=VLOOKUP(D1,A$1:C$999,3,FALSE)
This looks up the person label in cell D1 in column A, and puts the measure in column C into column F1.
Change 999 to match the number of rows in column A

Copy and paste cell F1 into F2:F999 (to the bottom row of Test 2)
The anchor measures are now in column F, with #N/A where there is no measure.

Copy and paste columns E and F into a new text file: test2pafile.txt.
Add to your Test 2 control file:
PAFILE=test2pafile.txt
The lines containing #N/A will be ignored by Winsteps.
Perform the Test 2 analysis.
Check that all is correct by looking at the entry-order measure Table for Test 2.

11.138 PAIRED= correction for paired comparison data

Paired comparison data is entered as only two observations in each row (or each column). The raw score of every row (or column) is identical. In the simplest case, the "winner" receives a '1', the "loser" a '0', and all other column (or rows) are left blank, indicating missing data.

Example 1: Data for a chess tournament is entered. Each row is a player. Each column a match. The winner is scored '2', the loser '0' for each match. For draws, each player receives a '1'. See Bradley-Terry model.
PAIRED=YES ; paired comparisons
  CODES=012 ; valid outcomes
  NI=56 ; number of matches

Example 2: From a research paper - mcg.lboro.ac.uk/mji/files/BERJpre.pdf
" for each question used in the main study (38 in total)"
"Judges ... 250 pairwise comparisons of question responses via the comparative judgement website. 5000 pairwise judgement decisions were collected in total." = 20 judges.

So we follow www.rasch.org/rmt/rmt113o.htm with Winsteps:

1. The 38 questions are 38 Winsteps items
2. The 5000 judgements are 5000 "persons". Each person has two responses: "1" (yes/more/better) and "0" (no/less/worse)
3. Each of the 20 judges has a code in the person label, so we can summarize the judges with Winsteps Table 28
4. Since the data are pairwise, in the Winsteps control file,
PAIRED=YES

11.139 PANCHQU= anchor persons interactively

If your system is interactive, persons to be anchored can be entered interactively by setting PANCHQ=Y before the &END line. If you specify this, you will be asked if you want to anchor any persons. If you respond "yes", it will ask if you want to read these anchored persons from a file; if you answer "yes" it will ask for the file name and process that file in the same manner as if PAFILE= had been specified. If you answer "no", you will be asked to enter the sequence number of each person to be anchored, one at a time, along with the logit (or user-rescaled by UASCALE=, USCALE=) calibration. When you are finished, enter a zero.

Example: You are doing a number of analyses, anchoring a few, but different, persons each analysis. This time, you want to anchor person 4.

Enter on the DOS control line, or in the control file:

```
  PANCHQ=Y
  CONVERGE=L   ; only logit change is used for convergence
  LCONV=0.005  ; logit change too small to appear on any report.

You want to anchor person 4:
  Winsteps asks you:
DO YOU WANT TO ANCHOR ANY PERSONS?
respond YES(Enter)
DO YOU WISH TO READ THE ANCHORED PERSONS FROM A FILE?
respond NO(Enter)
INPUT PERSON TO ANCHOR (0 TO END):
respond 4(Enter) (the first person to be anchored)
INPUT VALUE AT WHICH TO ANCHOR PERSON:
respond 1.45(Enter) (the first anchor value)
INPUT PERSON TO ANCHOR (0 TO END): 0(Enter) (to end anchoring)
```

11.140 PCORFIL= person residual correlation file

This writes out the Table of inter-person correlations which is the basis of the principal components analysis of residuals. The basis for the correlations is controlled by PRCOMP=.
PRCOMP=R correlates the raw residuals

PRCOMP=S correlates the standardized residuals
PRCOMP=O correlates the observations

CIMPUTE= controls imputing missing values

Extreme scores: minimum possible (0) and maximum possible (perfect) item scores are omitted from the computation of the correlations. Persons with extreme scores are not reported. Their correlation is 0.

Missing data: for these Winsteps substitutes their expectations when possible. For residuals and standardized residuals, these are 0. Items with extreme scores (minimum possible or maximum possible): Winsteps drops these from the correlation computation. The reason for these choices is to make the principal components analysis of residuals as meaningful as possible.

PCORFILE=? opens a Browse window

Example 1: Write out the Table of inter-person residual correlations. PCORFIL=file.txt - Then file.txt contains, for SF.txt, in 12-character, fixed-format, columns:

```
      PERSON      PERSON CORRELATION
           1           2     .028295
           1           3     .376179
           1           4     .457773
           1           5     .212332
           1           6    -.452587
           1           7     .338937
 .....
```

Example 2: When PCORFILE= is selected on the Output Files menu or MATRIX=YES, the Data Format: Matrix option can be selected:

This produces in 10-character wide columns:

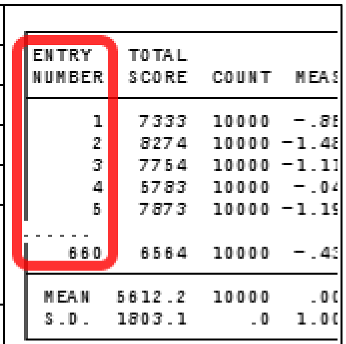
```
         1         2         3         4
  1.000000   .028295   .376179   .457773
   .028295  1.000000   .460451  -.314252
   .376179   .460451  1.000000  -.083707
   .457773  -.314252  -.083707  1.000000
   .212332  -.258320  -.009482   .270427
  -.452587   .271853  -.443830  -.118054
   .338937  -.556438   .204127   .348083
```

11.141 PDELETE= person one-line item deletion

A one-line list of persons to be deleted or reinstated can be conveniently specified with PDELETE=. It has the same functionality as PDFILE=. PSELECT= is another way of deleting persons.

The formats are:

PDELETE= 3	3 is an person entry number: delete person 3
PDELETE= 6 1	delete persons 6 and 1
PDELETE= 2-5	delete persons 2, 3, 4, 5
PDELETE= +3-10	delete all persons, then reinstate persons 3 to 10
PDELETE= 4-20 +8	delete persons 4-20 then reinstate person 8
PDELETE= 3,7,4,10	delete persons 3, 7, 4, 10. Commas, blanks and tabs are separators. At the "Extra information" prompt, use commas as separators
PDELETE= (blank)	In the Specification Menu dialog box, resets temporary person deletions



ENTRY NUMBER	TOTAL SCORE	COUNT	MEAS
1	7333	10000	-.8
2	8274	10000	-1.4
3	7754	10000	-1.1
4	5783	10000	-.0
5	7873	10000	-1.1

660	6564	10000	-.4
MEAN	5612.2	10000	.0
S.D.	1803.1	.0	1.0

Example 1: After an analysis is completed, delete cases 16, 25 and 87 from the reporting.
In the Specification pull-down box:
PDELETE=16 25 87

Example 2: Delete all except persons 5-10 and report
Specification menu box: PDELETE=+5-10
Output Tables Menu
Now reinstate person 11 and report persons 5-11.
Specification menu box: PDELETE= 11 +11 ; person 11 is already deleted, but prevents deletion of all except +11.
Output Tables Menu

11.142 PDELQU= delete persons interactively

PDELETE= and/or PDFILE= at Extra Specifications? are easier.

Persons to be deleted or selected can be entered interactively by setting PDELQU=Y. If you specify this, you will be asked if you want to delete any persons. If you respond "yes", it will ask if you want to read these deleted persons from a file; if you answer "yes" it will ask for the file name and process that file in the same manner as if PDFILE= had been specified. If you answer "no", you will be asked to enter the sequence number or numbers of persons to be deleted or selected one line at a time, following the rules specified for IDFILE=. When you are finished, enter a zero.

Example: You are doing a number of analyses, deleting a few, but different, persons each analysis. You don't want to create a lot of small delete files, but rather just enter the numbers at the terminal, so specify:
PDELQU=Y

Winsteps asks you:

```
 DO YOU WANT TO READ SOME KID DELETIONS FROM A FILE? (Y/N)
Y
    WHAT IS THE NAME OF THE KID DELETE FILE?
MYPDFILE.TXT
 Processing KID PDELQU=MYPDFILE.TXT

 DO YOU WANT TO READ MORE KID DELETIONS FROM A FILE? (Y/N)
N

 DO YOU WANT TO TYPE IN MORE KID DELETIONS? (Y/N)
Y
 TYPE IN THE DELETIONS IN PDELETE= FORMAT:
1 5 9

 DO YOU WANT TO TYPE IN MORE KID DELETIONS? (Y/N)
N
```

11.143 PDFILE= person deletion file

Deletion or selection of persons from a test to be analyzed, but without removing their responses from your data file, is easily accomplished by creating a file in which each line contains the sequence number of a person or persons to be deleted or selected (according to the same rules given under IDFILE=), and then specifying this file by means of the control variable, PDFILE=, or enter the deletion list in the control file using PDFILE=*. PDFILE=filename can be action from the Specification menu dialog box. See also PDELETE=.

PDFILE= file name	file containing list of person entry numbers to be deleted or reinstated. Each line in the file is in the PDELETE= format.
PDFILE = ?	opens a Browser window to find the file
PDFILE = * 4 18-23 6 5.23 *	in-line list in the control file delete person entry number 4 delete person entry number 18 to 23 second number 5.23 is ignored, so that PWEIGHT= can be changed to PDFILE=
PDFILE=* 4 18-23 *	At the Extra Specifications prompt
PDFILE=	In the Specifications Menu dialog box, reinstates all temporary deletions

Example 1: You wish to delete the fifth and tenth persons from this analysis.
1. Create a file named, say, "PERSON.DEL"
2. Enter into the file, the lines:
5
10
3. Specify, in the control file,
PDFILE=PERSON.DEL

or, enter directly into the control file,
PDFILE=*
5
10
*

Example 2: The analyst wants to delete the most misfitting persons reported in Table 6.
1. Set up a standard control file.
2. Specify
PDFILE=*
*
3. Copy the target portion of Table 6.
4. Paste it between the "*"
5. Delete characters before the entry numbers.
6. Type ; after the entry numbers to make further numbers into comments.

Example 3:
```
TITLE = 'Example of person deletion list from Table 6'
PDFILE = *
 Delete the border character before the entry number
; ENTRY   RAW                                INFIT      OUTFIT
;    NUM  SCORE COUNT MEASURE  ERROR MNSQ  ZSTD MNSQ  ZSTD PTBSE  PUP
   73   ; 21    22      .14     .37  .95   -.3 1.03    .2 B-.19  SAN
   75   ; 16    22     -.56     .39  .95   -.3 1.03    .2 C-.19  PAU
        Enter the ; to make other numbers into comments
*    ; closure of PDFILE=*
```

Example 4: My sample is large enough (n>2000). I want to exclude in the analysis the persons and items that have infit or outfit statistics of less than -2 or greater than +2.

1. Perform your analysis.
2. Output files menu: PFILE to Excel.
3. In Excel sort the persons in Outfit ZSTD order.
4. Delete all person rows you want to keep in your analysis.
5. Copy the column of entry numbers of persons you want to delete.

6. Create a new text file "delete.txt"
7. Paste the list of entry numbers into the text file
8. In your Winsteps control file, add
PDFILE = delete.txt
9. Perform your revised analysis

11.144 PDROPEXTREME= drop persons with extreme scores

Unanchored persons with extreme (zero, minimum possible or perfect, maximum possible) scores provide no information for estimating item measures, but they are reported and included in summary statistics. To remove them:

PDROPEXTREME = No ; do not drop extreme persons (standard)

PDROPEXTREME = Yes or All ; drop zero (minimum possible) and perfect (maximum possible) scores

PDROPEXTREME = Zero or Low or Bottom or Minimum ; drop zero or minimum-possible scores

PDROPEXTREME = Perfect or High or Top or Maximum ; drop perfect or maximum-possible scores

Example 1: The data file contains many data records of persons who did not attempt this test and so were scored 0. They are skewing the test statistics:
PDROPEXTREME = Zero

Example 2: On a satisfaction survey, hurried respondents mindlessly code every item "highly satisfied".
PDROPEXTREME = Perfect

11.145 PERSON= title for person labels

Up to 12 characters to use in table headings to describe the kind of persons, e.g.
PERSON=KID

11.146 PFILE= person output file

PFILE=filename produces an output file containing the information for each person. This file contains 4 heading lines (unless HLINES=N or ROW1HEADING=N), followed by one line for each person containing the following fields and the standard field selection. To change the output-field selection, go to the Output File menu, PFILE=, Field selection, Make default., or POFSFIELDS=.

PFILE=? opens a Browse window

"Status=-2 to -6" means that there are no measurable responses by those persons in this analysis. The persons may be listed in the PFILE= and in Table 18, but all the numbers shown are default values. They have no meaning. Please do not include those persons in summary statistics.

Columns:		with 'Select All" fields using Output File Field Selection		
Start	End	Label	Format	Description
1	1		A1	Blank or ";" if HLINES=Y and there are no responses or deleted or extreme (status =0,-1, -2, -3)
2	6	ENTRY	I5	1. The person sequence entry number
7	14	MEASURE	F8.2	2. JMLE person ability estimate user-rescaled by UMEAN=, USCALE=, UDECIM=. Measures for deleted or inestimable persons are shown as the NOMEASURE= value, which defaults to 9999.
15	17	STATUS	I3	3. The person's status 2 = Anchored (fixed) measure 1 = Estimated measure 0 = Extreme maximum measure (estimated using EXTRSC=) for extreme maximum raw score

				-1 = Extreme minimum measure (estimated using EXTRSC=) for extreme minimum raw score (usually 0) -2 = No responses available for measure -3 = Deleted by user -4 = Inestimable: high (all responses in the same category with ISGROUPS=0 or CUTHI=) -5 = Inestimable: low (all responses in the same category with ISGROUPS=0 or CUTLO=) -6 = Anchored (fixed) measure with extreme (minimum or maximum) observed raw score -7 to -16 = Temporarily deselected by Specification box with PSELECT= (usual STATUS - 10) -17 to -26 = Temporarily deleted by Specification box with PDELETE= (usual STATUS - 20) -27 to -36 = Temporarily deselected and deleted by Specification box with PSELECT= and PDELETE= (usual STATUS - 30)
18	25	COUNT	F8.1	4. The number of responses used in calibrating (TOTAL=N), or the observed count (TOTAL=Y)
26	34	SCORE	F9.1	5. The raw score used in calibrating (TOTAL=N) or the observed score (TOTAL=Y)
35	41	MODLSE REALSE	F7.2	6. Standard error of the JMLE or WMLE person ability estimate adjusted by REALSE= and user-rescaled by USCALE=, UDECIM=
42	48	IN.MSQ IN.CHI	F7.2	7. Person infit: mean square infit. Chi-square = IN.MSQ* INDF If CHISQUARE=Yes, IN.CHI = Infit Chi-square
49	55	IN.ZSTD, ZEMP, LOG, PROB	F7.2	8. Person infit: t standardized, locally t standardized,, log-scaled or probability (LOCAL=)
56	62	OUT.MS OUT.CHI	F7.2	9. Person outfit: mean square outfit. Chi-square = OUT.MSQ* OUTDF If CHISQUARE=Yes OUT.CHI = Outfit Chi-square
63	69	OUT.ZSTD, ZEMP, LOG, PROB	F7.2	10. Person outfit: t standardized, locally t standardized, log-scaled or probability (LOCAL=)
70	76	DISPLACE	F7.2	11. Person displacement (user-rescaled by USCALE=, UDECIM=)
77	83	PTBS, PTMEAS	F7.2	12. Person by test-score correlation: point-biserial, or point-measure (PTBIS=). This is 0.00 if inestimable.
84	90	WEIGHT	F7.2	13. Person weight (PWEIGHT=)
91	96	OBSMA	F6.1	14. Observed percent of observations matching prediction
97	102	EXPMA	F6.1	15. Expected percent of observations matching prediction
103	108	PVALUE	F6.2	16. P-value: proportion correct or average rating (PVALUE=)
109	114	PME-E	F6.2	17. Expected value of Person by test-score correlation. This is 0.00 if inestimable. See www.rasch.org/rmt/rmt221e.htm
115	120	RMSR	F6.2	18. RMSR: root-mean-square residual (RMSR=)
121	128	WMLE	F8.2	19. Warm's Weighted Maximum Likelihood Estimate (WLE) of person Ability user-rescaled by UMEAN=, USCALE=, UDECIM=
129	134	INDF	F6.2	20. degrees of freedom of Infit mean-square
135	140	OUTDF	F6.2	21. degrees of freedom of Outfit mean-square
141	148	QCMLE	F8.2	22. Quasi-CMLE estimates for dichotomous data. 0 otherwise.
		CMLEM	F8.2	AMLE person measure estimate based on CMLE item estimates
		CMLESE	F8.2	AMLE person measure standard error
		CMLEIms	F8.2	CMLE person INFIT mean-square fit statistic based on CMLE probabilities
		CMLEIz	F8.2	CMLE person INFIT standardized fit statistic based on CMLE probabilities
		CMLEOms	F8.2	CMLE person OUTFIT mean-square statistic based on CMLE probabilities

		CMLEOz	F8.2	CMLE person OUTFIT standardized fit statistic based on CMLE probabilities
		CMLEWML	F8.2	WMLE Warm's Weighted Maximum Likelihood person measure Estimate (WLE)
		CMLEIdf	F8.2	CMLE person INFIT degrees of freedom based on CMLE probabilities
		CMLEOdf	F8.2	CMLE person OUTFIT degrees of freedom based on CMLE probabilities
149	149		1X	Blank
150	150+	NAME	A30+	23. Person name: change NAME1= and NAMELENGTH= to alter this.

The format descriptors are:

	In = Integer field width n columns
	Fn.m = Numeric field, n columns wide including n-m-1 integral places, a decimal point and m decimal places
	An = Alphabetic field, n columns wide
	nX = n blank columns.

When CSV=Y, commas separate the values, which are squeezed together without spaces between. Quotation marks surround the "Person name", e.g., 1,2,3,4,"Name". When CSV=T, the commas are replaced by tab characters.

When W300=Yes, then this is produced in Winsteps 3.00, 1/1/2000, format:

Columns:				
Start	End	Label	Format	Description
1	1		A1	Blank or ";" if HLINES=Y and there are no responses or deleted (status = -2, -3)
2	6	ENTRY	I5	1. The person sequence number
7	14	MEASURE	F8.2	2. Person's ability estimate (user-rescaled by UMEAN=, USCALE=, UDECIM)
15	17	STATUS	I3	3. The person's status: 3 = Anchored (fixed) measure with extreme (minimum or maximum) observed raw score 2 = Anchored (fixed) measure 1 = Estimated measure 0 = Extreme minimum (estimated using EXTRSC=) -1 = Extreme maximum (estimated using EXTRSC=) -2 = No responses available for measure -3 = Deleted by user -4 = Inestimable: high (all responses in the same category with ISGROUPS=0 or CUTHI=) -5 = Inestimable: low (all responses in the same category with ISGROUPS=0 or CUTLO=) -6 = Deselected
18	23	COUNT	I6	4. The number of responses used in measuring (TOTAL=N) or the observed count (TOTAL=Y)
24	30	SCORE	I6	5. The raw score used in calibrating (TOTAL=N) or the observed score (TOTAL=Y)
31	37	MODLSE REALSE	F7.2	6. Person ability standard error adjusted by REALSE= and user-rescaled by USCALE=, UDECIM=
38	44	IN.MSQ	F7.2	7. Person mean square infit
45	51	ZSTD, ZEMP, LOG	F7.2	8. Person infit: t standardized, locally t standardized, or log-scaled (LOCAL=)
52	58		F7.2	9. Person mean square outfit (OUT.MS)

59	65	ZSTD, ZEMP, LOG	F7.2	10. Person outfit: t standardized, locally t standardized, or log-scaled (LOCAL=)
66	72	DISPLACE	F7.2	11. Person displacement (user-rescaled by USCALE=, UDECIM=)
73	79	PTBS, PTME	F7.2	12. Person by test-score correlation: point-biserial, or point-measure
80	80		1X	13. Blank
81	112+	NAME	A30+	14. Person name

Example of standard PFILE= (to see other fields: PFILE= Field Selection)

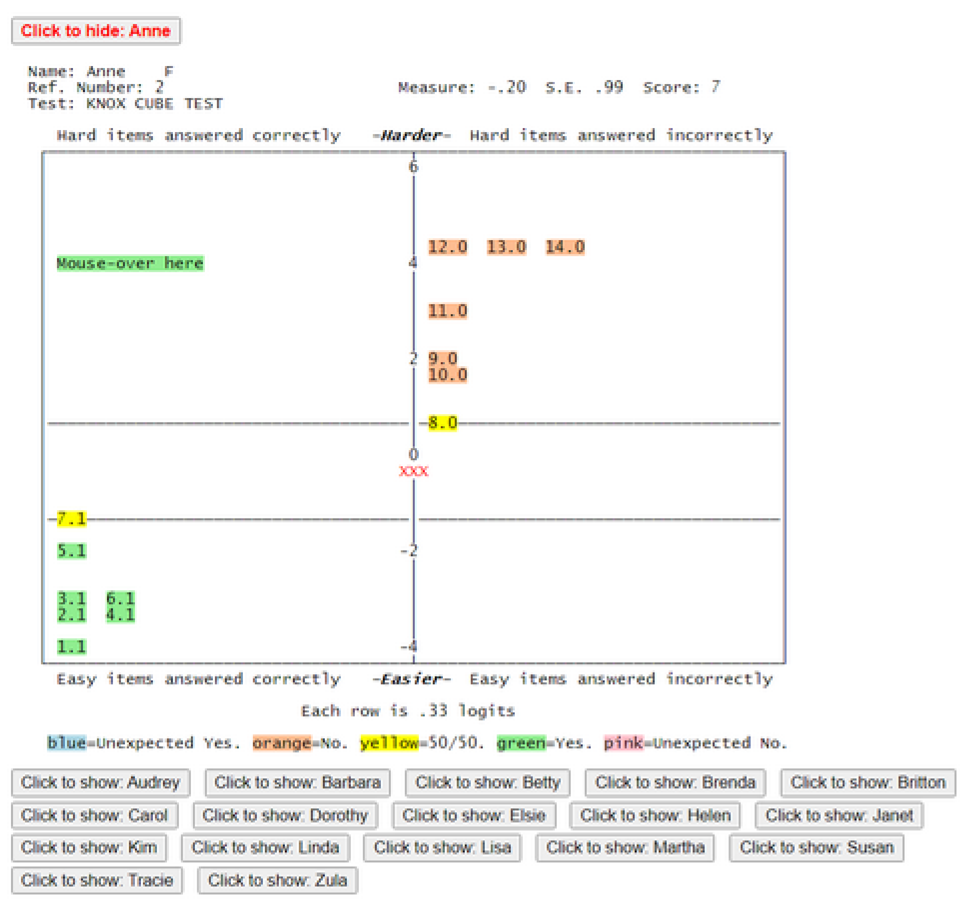
```
; PERSON  Survey Analysis  Dec  7 19:21 2009
;ENTRY MEASURE ST   COUNT    SCORE  ERROR IN.MSQ IN.ZST OUT.MS OUT.ZS  DISPL PTMEAS WEIGHT OBSMA EXPMA PVALU PME-E  RMSR NAME
     1     .95  1     4.0     19.0    .88   1.34    .65   2.67   1.63    .00   -.87   1.00  50.0  66.0  4.75   .43   .66 M Richard
     2     .26  1     4.0     18.0    .79   1.31    .63   1.90   1.22    .00    .30   1.00  50.0  60.3  4.50   .35   .72 F Tracie
     3    -.93  1     4.0     16.0    .78    .49   -.78    .80   -.25    .00    .87   1.00  50.0  53.9  4.00   .18   .45 M Walter
     4   -1.59  1     4.0     15.0    .86   1.00    .22   1.12    .40    .00    .62   1.00  25.0  50.2  3.75   .10   .58 M Blaise
     5    -.93  1     4.0     16.0    .78    .21  -1.71    .33  -1.64    .00   -.87   1.00 100.0  53.9  4.00   .18   .29 M Ron
     6    1.85  1     4.0     20.0   1.02    .20  -1.10    .19   -.77    .00    .88   1.00 100.0  74.5  5.00   .47   .22 M William
```

Example: You wish to write a file on disk called "STUDENT-PF.txt" containing the person statistics for import later into a student information database:

PFILE=STUDENT-PF.txt

11.147 PKMAP= customize Table 36 diagnostic maps

PKMAP= can be used to customize Table 36 diagnostic maps. These maps are based on the KIDMAP - www.rasch.org/rmt/rmt82k.htm



Webpage example of a PKMAP

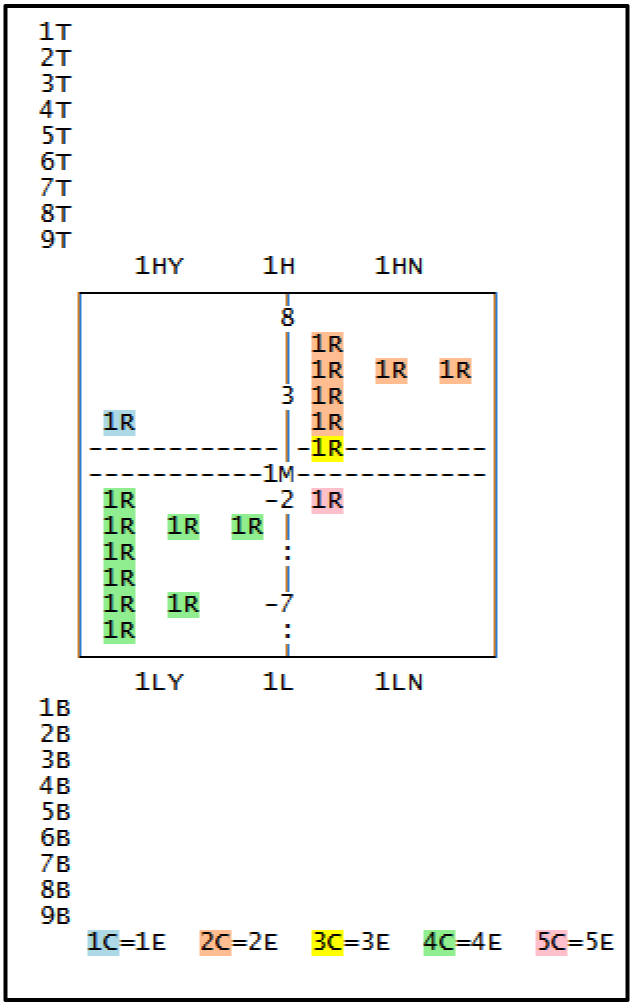


Figure: PKMAP field numbers and positions

PKMAP= customization, see also ICOLORFILE= for more color options

Format in Winsteps control file:
ASCII=Webpage ; for the colored output
PKMAP=* ; inline instructions for the PKMAP output in Table 36
(Field number)= value
....
*

PKMAP Size
The internal height of PKMAP grid box is 61 or MAXPAG= value - 8.
The internal width of the PKMAP grid box is LINELENGTH= value - 6.

Format in text file:
use Edit menu
Edit/Create file with NOTEPAD to modify these settings.
In text file, for example:
1D = Yes
Save text file as MyPKMAP.txt in the same folder as the Control file
Specification menu: PKMAP = MyPKMAP.txt

Field code	Values	Meaning
1CLICK = display button	1CLICK = #LABEL# and codes below	Click on button to display PKMAP

	1CLICK = (blank) to display all (the default)	Click to show: Adam Click again to hide PKMAP Click to hide: Adam
1T-9T = Top headings 1HY, 1H, 1HN = High side of grid 1M = Measure = Middle (ability) 1LY, 1L , 1LN = Low side of grid 1B-9B = Bottom footers 1E-5E = Color explanations	(blank)	do not display the field
	\	blank line
	text	display the text in the field location
	#nnn# (can be included in text)	display the statistic in the field location

1R = Response = Rating	(blank) or text or #nnn#, e.g.,
	1R = #LABEL#
	1R = #CODE#
	1R = #CAT#
		displays the response value positioned on the page
		Response code in the data file
		Scored category number
		For coloring based on 1R value, see ICOLORFILE=

1MH = Mouse Hover	1MH=".#LABEL#"	when the Mouse pointer is hovered over the 1R value on a webpage, this value is displayed next to it: 5.1Look up strange animal
1G = Grid for PKMAP layout	Top left cell of grid is: HY High measure, Yes reached HN High measure, Not reached LY Low measure, Yes reached LN Low measure, Not reached	Controls layout of the PKMAP by identifying the top left quadrant
1C-5C = Color codes	HTML color codes, e.g., light-green #E7C4A3	The color codes for text in the grid cells: 1C = High Yes (Current level) 2C = High No (Next level) 3C = 50-50 4C = Low Yes (Current level) 5C = Low No (Next level)
1P = Placement of response	F = Full-point thresholds (polytomies) D = Item difficulties (dichotomies)	Vertical measure at which to place a response.
1D = Display all the field numbers	"Y" = Display field numbers and values at start of output	The field codes and their values
1F = Minimum mean-square to report	0 = all mean-squares 1.5 = only persons with infit or outfit mean-squares greater than 1.5 are reported	Selects only Kidmaps for misfitting response strings
1S = Sort instructions	n = Entry number descending N = Entry number ascending m = Measure descending M = Measure ascending f = Mean-square fit descending F = Mean-square fit ascending fI, FI = use Infit mean-square fO, FO = use Outfit mean-square fB, FB = use bigger of both mean-squares a = Alphabetical label descending A = Alphabetical label ascending a$S3W10, A$S3W10 = Alphabetical sort on part of person label	Order of the PKMAP Kidmaps in the output table.
1V-9V = Criterion lines	numbers followed by L or U	logit L or uscale U values for

		horizontal === lines across the grid. Useful for indicating cut-points, overall average performances, etc.
1A = Ability lines	00000 = no lines 10000 = Line at ability level 01000 = Line 1 S.E. above ability level 00100 = Line 1 S.E. below ability level 01100 = Both 1 S.E. lines (default) 00010 = Line 2 S.E. above ability level 00001 = Line 2 S.E. below ability level These can be combined	show lines around 1M ability level
Field number not in PKMAP= list	none	(ignored)
Control variable= PSELECT=???A ; selection PDELETE=(list of entry numbers) PDFILE=(file of entry numbers)	value	control variable for the PKMAP display
ASCII=Webpage	Format as a webpage	

#nnn#	Value: 1= to 8= Person. 9= Item
#NAME# or #LABEL#	Name or label
#ENTRY#	Entry number
#MEASURE#	Measure (user-rescaled by UMEAN=, USCALE=, UDECIM=)
#COUNT#	Total number of scored responses
#SCORE#	Total raw score
#ERROR#	Standard error of measure (user-rescaled by USCALE=, UDECIM=)
#INMNSQ#	Infit mean-square
#INZSTD#	Standardized Infit statistic: t standardized, locally t standardized, or log-scaled (LOCAL=)
#OUTMNSQ#	Outfit mean-square
#OUTZSTD#	Standardized Outfit statistic: t standardized, locally t standardized, or log-scaled (LOCAL=)
#TITLE#	TITLE= of this analysis
#Y#	Measure-units for each row (line) advance on vertical y-axis.
#$S1W1# #@fieldname#	Display the label substring: Example: 1R=#$S1W5#.#CODE# ; first 5 characters in the item label and the response code 1MH=#$S7W50# ; characters 7 onwards in the item label: "50" is more than the longest label
##	#
#CENTER#	Center this field (1T-9T and 1B-9B only)

PKMAP= default values for dichotomies (True/False, Multiple-Choice)

```
PKMAP = *
1D = "No"
1F = "0"
1S = "N"
1T = " Name: #NAME#"
2T = " Ref. Number: #ENTRY#                    Measure: #MEASURE#  S.E. #ERROR#  Score: #SCORE#"
3T = " Test: #TITLE#"
4T = "\"
1G = "HY"
1P = "Half-point threshold"
1R = "#ENTRY#.#CAT#"
1HY = "Hard items answered correctly"
1H = "\<b\>\<i\>-Harder-\</b\>\</i\>"
```

```
1HN = "Hard items answered incorrectly"
1M = "\<FONT COLOR="RED"\>XXX\</FONT\>"
1LY = "Easy items answered correctly"
1L = "\<b\>\<i\>-Easier-\</b\>\</i\>"
1LN = "Easy items answered incorrectly"
1B = "\"
2B = "#CENTER#Each row is #Y# logits" "units" if USCALE<>0
3B = "\"
1E = "\<SPAN CLASS=1C\>blue\</SPAN\>=Unexpected Yes."
2E = " \<SPAN CLASS=2C\>orange\</SPAN\>=No."
3E = " \<SPAN CLASS=3C\>yellow\</SPAN\>=50/50."
4E = " \<SPAN CLASS=4C\>green\</SPAN\>=Yes."
5E = " \<SPAN CLASS=5C\>pink\</SPAN\>=Unexpected No."
1C = "lightblue"
2C = "#FFBD91"
3C = "yellow"
4C = "lightgreen"
5C = "pink"
; = = = "default values above. User-set values below."
*
```

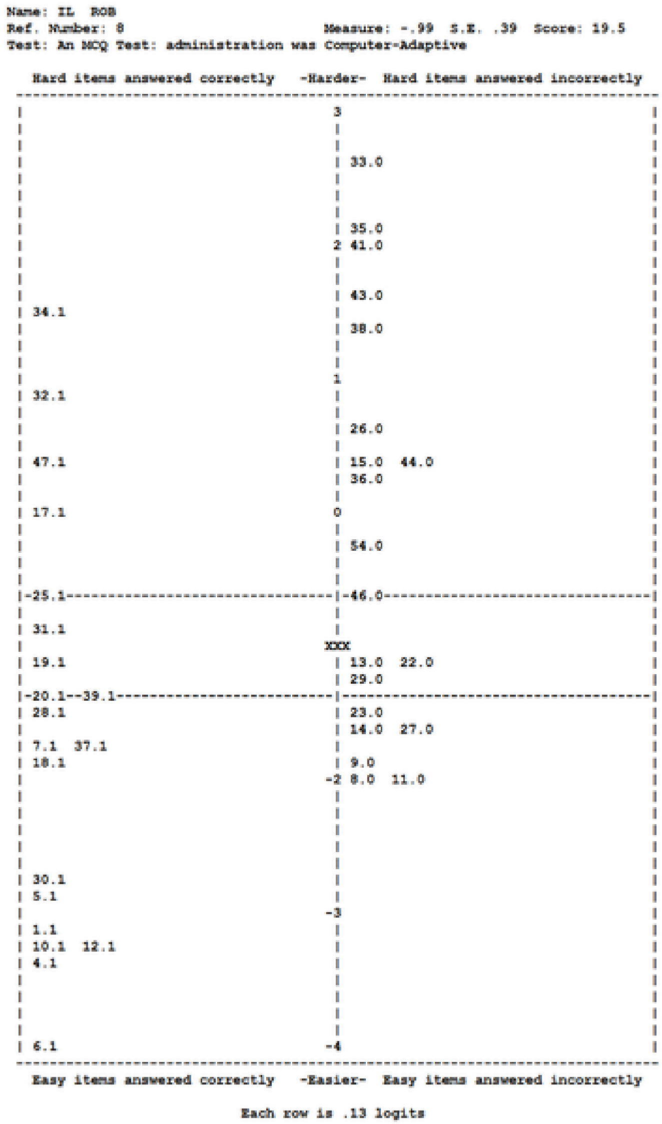
PKMAP= default values for polytomies (Rating Scale, Partial Credit)

```
PKMAP = *
1D = "No"
1F = "0"
1S = "N"
1T = " Name: #NAME#"
2T = " Ref. Number: #ENTRY#                       Measure: #MEASURE#  S.E. #ERROR#  Score: #SCORE#"
3T = " Test: #TITLE#"
4T = "\"
1G = "HY"
1P = "Full-point threshold"
1R = "#ENTRY#.#CODE#"
1HY = "Hard levels reached"
1H = "\<b\>\<i\>-Higher-\</b\>\</i\>"
1HN = "Hard levels not reached"
1M = "\<FONT COLOR="RED"\>XXX\</FONT\>"
1LY = "Easy levels reached"
1L = "\<b\>\<i\>-Lower-\</b\>\</i\>"
1LN = "Easy levels not reached"
1B = "\"
2B = "#CENTER#Each row is #Y# logits" "units" if USCALE<>0
3B = "\"
1E = "\<SPAN CLASS=1C\>blue\</SPAN\>=Unexpected Yes."
2E = " \<SPAN CLASS=2C\>orange\</SPAN\>=No."
3E = " \<SPAN CLASS=3C\>yellow\</SPAN\>=50/50."
4E = " \<SPAN CLASS=4C\>green\</SPAN\>=Yes."
5E = " \<SPAN CLASS=5C\>pink\</SPAN\>=Unexpected No."
1C = "lightblue"
2C = "#FFBD91"
3C = "yellow"
4C = "lightgreen"
5C = "pink"
; = = = "default values above. User-set values below."
*
```

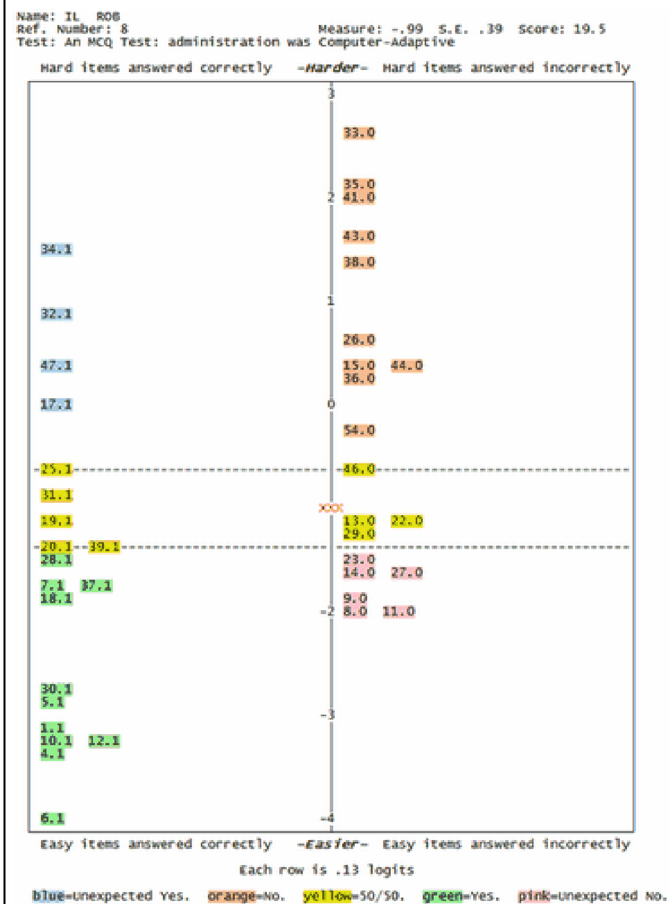
HTML codes can be used with \< and \> replacing < and >. HTML codes are ignored for text output.
Color: \<font color=red\>....\</font\> for HTML colors
or \<span class=1C\>....\</span\> for the colors defined in 1C, 2C, 3C, 4C, 5C
A list of color names is shown at https://www.w3schools.com/colors/colors_names.asp - Hex values can also be used.
These color names and hex values are used for 1C-5C.
Bold: \<b\>...\</b\> but bold for 1M and 1R may cause misalignment. Use a color instead.
Italic: \<i\>...\</i\> but bold for 1M and 1R may cause misalignment. Use a color instead.

Example 1: Exam5.txt - dichotomy (Yes/No, True/False, Multiple-Choice Question) -

PKMAP (KIDMAP) text output - default settings: ASCII=Yes	PKMAP (KIDMAP) webpage output - default settings: ASCII=Webpage
(see below)	(see below)



```
Name: IL  ROB
Ref. Number: 8                      Measure: -.99  S.E. .39  Score: 19.5
Test: An MCQ Test: administration was Computer-Adaptive

   Hard items answered correctly   -Harder-  Hard items answered incorrectly
 ------------------------------------------------------------------------------
 |                                      3                                     |
 |                                      |                                     |
 |                                      |                                     |
 |                                      | 33.0                                |
 |                                      |                                     |
 |                                      |                                     |
 |                                      |                                     |
 |                                      | 35.0                                |
 |                                      2 41.0                                |
 |                                      |                                     |
 |                                      |                                     |
 |                                      | 43.0                                |
 | 34.1                                 |                                     |
 |                                      | 38.0                                |
 |                                      |                                     |
 |                                      |                                     |
 |                                      1                                     |
 | 32.1                                 |                                     |
 |                                      |                                     |
 |                                      | 26.0                                |
 |                                      |                                     |
 | 47.1                                 | 15.0  44.0                          |
 |                                      | 36.0                                |
 |                                      |                                     |
 | 17.1                                 0                                     |
 |                                      |                                     |
 |                                      | 54.0                                |
 |                                      |                                     |
 |                                      |                                     |
 |-25.1---------------------------------|-46.0--------------------------------|
 |                                      |                                     |
 | 31.1                                 |                                     |
 |                                     XXX                                    |
 | 19.1                                 | 13.0  22.0                          |
 |                                      | 29.0                                |
 |-20.1--39.1---------------------------|-------------------------------------|
 | 28.1                                 | 23.0                                |
 |                                      | 14.0  27.0                          |
 | 7.1   37.1                           |                                     |
 | 18.1                                 | 9.0                                 |
 |                                     -2 8.0  11.0                           |
 |                                      |                                     |
 |                                      |                                     |
 |                                      |                                     |
 |                                      |                                     |
 |                                      |                                     |
 | 30.1                                 |                                     |
 | 5.1                                  |                                     |
 |                                     -3                                     |
 | 1.1                                  |                                     |
 | 10.1  12.1                           |                                     |
 | 4.1                                  |                                     |
 |                                      |                                     |
 |                                      |                                     |
 |                                      |                                     |
 |                                      |                                     |
 | 6.1                                 -4                                     |
 ------------------------------------------------------------------------------
   Easy items answered correctly   -Easier-  Easy items answered incorrectly

                        Each row is .13 logits
```



Example 2: Example0.txt - "Liking for Science" rating-scale

```
Name: M Rossner, Tr Cat
 Ref. Number: 6                       Measure: -.08  S.E. .34  Score: 24
 Test: LIKING FOR SCIENCE (Wright & Masters p.18)

        Hard levels reached        -Higher-      Hard levels not reached
  -----------------------------------------------------------------------
  |                                  5                                  |
  |                                  |                                  |
  |                                  |                                  |
  | 5.2                              |                                  |
  | 23.2                             |                                  |
  |                                  |                                  |
  |                                  4                                  |
  |                                  |                                  |
  |                                  |                                  |
  |                                  |                                  |
```

```
|                                    |                                    |
|         Success                    |                                    |
|                                    3                                    |
|                                    |                                    |
|                                    |                                    |
|                                    |                                    |
|                                    |                                    |
|                                    |                                    |
|                                    2                                    |
| 20.1                              |                                    |
| 4.1                               |                                    |
|                                    |                                    |
|                                    |                                    |
| 7.1                               |                                    |
|                                    1                                    |
|                                    |                                    |
| 9.1                               |                                    |
| 3.1                               |                                    |
|-6.1--------------------------------|-----------------------------------|
| 17.1  22.1                        |                                    |
| 12.2                              0                                    |
|                                  XXX <--Person ability                 |
| 19.2                              | 1.1   8.0   24.1                  |
|-----------------------------------|-15.1------------------------------|
|                                    |                                    |
|                                    |                                    |
| 18.2                             -1 11.1                               |
|                                    |                                    |
|                                    | 13.1                               |
|                                    | 10.1  16.0  25.0                   |
|                                    | 14.0                               |
|                                    |                                    |
|                                  -2          Failure                    |
|                                    |                                    |
|                                    |                                    |
|                                    |                                    |
|                                    |                                    |
|                                    | 2.0                                |
|                                  -3 21.0                               |
---------------------------------------------------------------------------
        Easy levels reached        -Lower-      Easy levels not reached

                               Each row is .17 logits
```

Responses are positioned vertically to match the expected scores in Table 2.2
Responses in the top category, here "2", always go in the left-hand column.
Responses in the bottom category, here "0", always go in the right-hand column.
Responses in intermediate categories, here "1", go in the left-hand column if they are above the person ability.
Responses in intermediate categories, here "1", go in the right-hand column if they are below the person ability.

Left column: success = higher rating on the rating scale
Item 18 (bottom left of PKMAP) is the easiest item. Person 6 rated in the top category 2. - a success - an "easy level reached"
"18.2" on the PKMAP is positioned at the ability level corresponding to that rating on that item.
"18.0" would have been much lower in the right-hand column.

Item 20 (upper left of PKMAP) is a hard item. Person 6 rated in the middle category 1. - a partial success - a "hard level reached"
"20.1" on the PKMAP is positioned at the ability level corresponding to that rating on that item.
"20.2" would have been much higher in the left-hand column.
"20..0" would have been much lower in the right-hand column.

Example 3: To display webpage maps by classroom:

ASCII=Webpage
@CLASS = class-identifying columns
TFILE=*
PSELECT=@CLASS=1
OFILE=CLASS1.HTM
36
PSELECT=@CLASS=2
OFILE=CLASS2.HTM
36
etc.
*

Example 4. Automating Example 3 for many classrooms. Here is a simple procedure:

1. Output the PFILE= to Excel

2. Delete all columns except the person label

3. On the person label column:
Excel: Data, Text-to-columns, Fixed format, and mark the classroom codes, OK
so now the classroom codes are in a column by themselves, say column U

4. Select the classroom codes

5. Insert pivot table

6. Location of pivot table column V
Add to report: check box
Pivot table output to column V

7. Copy the unique classroom codes from column V to columns B and D

8. Arrange the columns:
blank column (column A)
classroom codes (column B)
blank column (column C)
classroom codes again (column D)
blank column (column E)

9. Fill column A with
%PSELECT=@CLASS=

10. Fill column C with
%OFILE=CLASS-

11. Fill column E with
.HTM%36

So now row 1 looks like:
%PSELECT=@CLASS= 1 %OFILE=CLASS- 1 .HTM%36

12. Combine cols A-E into column F. Fill column F with
=CONCATENATE(A1, B1, C1, D1, E1)

Column E looks like:
%PSELECT=@CLASS=1%OFILE=CLASS-1.HTM%36

13. Copy column E into Microsoft Word

14. In Microsoft Word, replace % with a new-line code ^p

The column in Word now looks like
PSELECT=@CLASS=1
OFILE=CLASS-1.HTM
36

15. Save this to a separate text file, mytfile.txt

16. In your Winsteps control file, put
TFILE=mytfile.txt

11.148 PLFILE= person label file

PLFILE= enables person labels to be inserted or changed after a data file has been processed. It complements EDFILE= which performs the same function for response-level data. Person labels can be in any order in PLFILE= and can be omitted.

PLFILE= file name	file containing person entry numbers and labels
PLFILE= file name + file name + ...	multiple files
PLFILE = *	in-line list
PLFILE = ?	opens a Browser window to find the file

Suggestion: sort the PLFILE= data lines as "person-entry-number ascending" for faster processing.

Its format is:

PLFILE=*	
person entry number	insertion or replacement person label
*	

Ranges are permitted for entry numbers: first-last.

Example: Computer-adaptive test (CAT) data are analyzed. The responses are in EDFILE= in any order of person-entry-number item-entry-number response-code.
The person labels are in any order of person-entry-number person-label.

```
PLFILE=*
103  George
23-37 Anonymous
*
Title = CAT data
Item1 =1
NI=500 ; highest item entry number
Name1=502
NAMELENGTH=30 ; length of longest person label or more
CODES=ABCD
KEY1=BBACDBACD.... ; mcq scoring key from item bank
EDFILE=catdata.txt
&END
; item labels here or use ILFILE=
END NAMES
(no data here)
```

11.149 PMAP= person label on person map: Tables 1, 16

This specifies what part of the data record is to be used on the person map: Table 1 and Table 16.

It's format is PMAP = $S..W.. or $S..E.. using the column selection rules.
$S..W.. e.g., $S2W13 means that the person label to be shown on the map starts in column 2 of the person label and is 13 columns wide.

$S..E.. e.g., $S3E6 means that the person label to be shown on the map starts in column 3 of the person label and ends in column 6.

These can be combined, and constants introduced, e.g,
PMAP= $S3W2+"/"+$S7W2

If the person label is "KH323MXTR", the person label on the map will be "32/XT"

The length of PMAP= overrides NAMLMP=

11.150 POFSFIELDS= field selection for PFILE=

POSFIELDS= is set using the Output Field selection dialog box.

Field Number
1 Flag extremes with ;
2 Entry number
3 Measures
4 Status
5 Count of observations
6 Raw score
7 Standard error
8 Infit mean-square
9 Infit t standardized
10 Outfit mean-square
11 Outfit t standardized
12 Displacement
13 Correlation
14 Weight
15 Observed matches
16 Expected match
17 (not used)
18 (not used)
19 (not used)
20 P-value: average rating
21 Expected correlation
22 (not used)
23 (not used)
24 Name or Label
25 Include deleted
26 RMS Residual
27 (not used)
28 WMLE measure
29 Infit d.f
30 Outfit d.f.
31 Quasi-CMLE measure
32 -
33 -
34 -
35 CMLE-measure (CMLE=) - these are AMLE for persons
36 CMLE S.E.
37 CMLE Infit mean-square
38 CMLE Infit t standardized
39 CMLE Outfit mean-square
40 CMLE Outfit t standardized
41 CMLE-WMLE

42 CMLE Infit d.f
43 CMLE Outfit d.f.

Example: Output into the PFILE= file only the Entry number and the WMLE measures.
POFSFIELDS = NYNNNNNNNNNNNNNNNNNNNNNNNNNNY

11.151 PRCOMP= residual type for principal components analyses in Tables 23, 24

Principal components analysis of item-response or person-response residuals can help identify structure in the misfit patterns across items or persons. The measures have been extracted from the residuals, so only uncorrelated noise would remain in the residuals, if the data fit the Rasch model. For options for missing observations, see CIMPUTE=

PRCOMP=S or Y Analyze the standardized residuals, (observed - expected)/(model standard error).
Simulation studies indicate that PRCOMP=S gives the most accurate reflection of secondary dimensions in the items.

PRCOMP=R Analyze the raw score residuals, (observed - expected) for each observation. These report Wendy Yen's Q3 in Table 23.99

PRCOMP=L Analyze the logit residuals, (observed - expected)/(model variance).

PRCOMP=O Analyze the observations themselves.

PRCOMP=K Observation probability

PRCOMP=H Observation log-probability

PRCOMP=G Observation logit-probability

PRCOMP=N Do not perform PCA analysis

Example 1: Perform a Rasch analysis, and then see if there is any meaningful other dimensions in the residuals:
PRCOMP=S Standardized residuals

Example 2: Analysis of the observations themselves is more familiar to statisticians.
PRCOMP=O Observations
In the PCA of th observations, Chien's (2012) Dimension Coefficient is DC = (R12/R23)/(1 + (R12/R23)) which simplifies to (eigenvalue of first component in the raw observations) / (first eigenvalue + third eigenvalue). Chien suggests values below 0.67 indicate a lack of unidimensionality.
Cronbach's Alpha with the Dimension Coefficient to Jointly Assess a Scale's Quality. Tsair-Wei Chien … Rasch Measurement Transactions, 2012, 26:3 p. 1379 www.rasch.org/rmt/rmt263c.htm

11.152 PSELECT= person selection criterion

Persons to be selected may be specified by using the PSELECT= instruction to match characters within the person name. Persons deleted by PDFILE= etc. are never selected by PSELECT=.

This can be done before analysis in the control file or with "Extra specifications". It can also be done after the analysis using the "Specification" pull-down menu.

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This can be done before analysis in the control file or with "Extra specifications". It can also be done after the analysis using the "Specification" pull-down menu.

Selection rules. Person and item selections must be in quotation marks " " if they contain blanks or tabs, and follow the selection rules:

Control characters match label or name. They start at the first column of the label or name.	
?	matches any character
*	matches any string of characters - must be last selection character. If * is in the first column, then every available person or item is selected.
A	matches A in the person label, and similarly all other characters except these: { }"
{..}	braces characters which can match a single character: {ABC} matches A or B or C.
{.. - ..}	matches single characters in a range. {0-9} matches digits in the range 0 to 9.
{.. --..}	matches a single "-" {AB--} matches A or B or "-".
{~ABX}	omits persons or items which match A or B or X
{" "}	matches a blank in the label
@fieldname=	positions the next selection character at the start of the specified field

Each PSELECT= performed using the "Specification" pull-down menu selects from all those analyzed. For incremental selections from the Specification menu, i.e., selecting from those already selected, specify +PSELECT=

Example 0: In Example 0, select only Males:
PSELECT=@GENDER=M
In Example 0, select only Males with last names starting with R
PSELECT=@GENDER=M?R
In Example 0, select only Males with last names not starting with R
PSELECT=@GENDER=M?{~R}
To select only Males and Females, not missing data codes or data entry errors:
PSELECT=@GENDER={MF}

Example 1: Select for analysis only persons with M in the 5th column of person name. Person name starts in column 6 of the data record:

```
   NAME1=6  Person name field starts in col. 6
   NAMLEN=8  Person name field is 8 characters long
PSELECT=????M* Column 5 of person name is sex
|
END NAMES
xxxxxBPL M J 01101000101001 selected
xxxxxMEL F S 01001000111100 omitted
-----1234 selection column
```

Example 2: Select for analysis all persons with code "A 4" in columns 2-4 of their names. Person name starts in column 23, so target characters starts in column 24:

```
NAME1=23  person name starts in column 23
PSELECT="?A 4*" quotes because a blank is included. A is in col. 2 etc.
selects  ZA 4PQRS
```

Example 3: Select all Male (M in column 2) persons who are Asian or Hispanic (A or H in column 4):

```
PSELECT=?M?{AH}*
selects 1M3A456 MPQRS
selects 1M5H689 ABCDE
omits   1X2A123 QWERT
```

Example 4: Select Males (M in column 8) in School 23 (023 in column 14-16):

```
PSELECT= ???????M?????023*
Selects: 1234567MABCDE023XYZ
```

Example 5: Select codes 1,2,3,4,5,6,7, in column 2:
PSELECT=?{1-7}*

Example 6: Analyze only males (column 4 or person-id). Then report only School C (column 1). Then only report Grades 4 and 5 (column 2) in School C.

```
PSELECT=???M* in the Control file or at the Extra Specifications prompt.
PSELECT=C*  using the Specification pull-down menu, after the analysis
+PSELECT=?{45}* using the Specification pull-down menu.
```

Example 7: There are 100000 examinees from 17 school districts in one data file. I want to process only 16 districts.

If the district code is one character, then you can select the 16 codes you want, for instance:
If the codes are letters in column 4 of the person label
PSELECT=???{ABDEFGHIJKLMNOPQR}
or
PSELECT=???{~C} ; omits unwanted school district C

Example 8: If the field to be selected is already identified, then this simplifies counting the column:
@Dx = 16E17 ; $C44W2
16E17 means that the field is in columns 16 and 17 of the person label. Look at a data record to see what is actually there.
PSELECT=???????????????23 ; selects "23" in columns 16 and 17

Example 9: We want person group X (in column 4 of the person label) except for subgroups 11, 24 (in columns 6, 7 of the person label):

```
PSELECT = "???X?{12}{14}"  ; this selects X and 11, 14, 21, 24
    EDFILE=*
    "?????14" "?" . ; convert 14 to missing data
    "?????21" "?" . ; convert 21 to missing data
    *
```

Example 10: Item statistics are needed for each person classification.

If you want PSELECT= to alter the item statistics, then please do separate Winsteps analyses for each PSELECT= value. Place the PSELECT= in your control file, or enter it at the "Extra Specifications (if any)" prompt. This PSELECT= will change what is shown for the persons and the items.

If you want to keep the item difficulties, person abilities and rating scale structure from the complete analysis, rather than re-estimating them. Then
Complete analysis -> PFILE=pf.txt, IFILE=if.txt, SFILE=sf.txt,
PAFILE=pf.txt, IAFILE=if.txt, SAFILE=sf.txt, PSELECT= -> selected analysis.

The "Specification" pull-down menu alter what is included in directly-relevant output tables.
So, entering PSELECT= at the "Specification" pull-down menu will change what is shown in the person tables, but not what is shown in the item tables.

Example 11: Select persons by ability level:
We need a code in the person label for the person's performance level:
Suggestion: analyze the data with Winsteps
Output the original data codes with IPMATRIX=, the person labels and the person measures to Excel
Sort the Excel worksheet by person measure: put the level code in a new Excel columns
Winsteps Excel/RSSST menu to go from the Excel worksheet back to the Winsteps control and data file. Include the level code column with the person label
Add in the scoring key etc.
Analyze the revised Winsteps control and data file
Then we can PSELECT= each performance level

11.153 PSORT= column within person label for alphabetical sort in Table 19

Table 19 lists persons alphabetically. Table 1 and Table 16 list them alphabetically within lines. Ordinarily, the whole person name is used. Select the sorting columns in the person labels using the column selection rules, e.g., starting in column Snn and ending in column Enn or of width Wnn.

Example 1: The person name is entered in the data file starting in column 20. It is a 6-digit student number followed by a blank and then gender identification in column 8 of the person name. Sort by gender identification for Table 19, then by student number.

```
NAME1=20
NAMLEN=8   ; student number + gender
PSORT=$S8W1+$S8W6 alphabetical sort on gender
TABLES=1111111111111111111111111
&END
|
END NAMES
xxxxxxxxxxxxxxxxxxx123456 M 0010101101001002010102110011
xxxxxxxxxxxxxxxxxxx229591 F 1102010020100100201002010021
           sort columns ^ ^
```

Example 2: The person name contains several important classifiers. Table 19 is needed for each one:

```
NAME1=14 Person name starts in column 14
ITEM1=24 Response start in column 24
TFILE=*
19 - - - 1 sort starts with column 1 of person name
19 - - - 8 sort starts with column 8 of person name
19 - - - 6 sort starts with column 6 of person name up to the end of the person name
     - entered as place-holders, see TFILE=
*
&END
|
END NAMES
xxxxxxxxxxxxx1234 M 12 0010101101001002010102110011
xxxxxxxxxxxxx2295 F 09 1102010020100100201002010021
```

Example 3: A version of Table 19, sorted on person name column 6, is to be specified on the DOS command line or on the Extra Specifications line. Commas are used as separators, and "-" as place-holders:

```
TFILE=* 19,-,-,-,6 *
```

11.154 PSUBTOTAL= columns within person label for Tables 28, 35

This specifies what part of the data record is to be used to classify persons for subtotal in Table 28.

PSUBTOTAL= file name	file containing details
PSUBTOTAL = *	in-line list
PSUBTOTAL = $S1W1	field in person label

With tab-separated data and the subtotal indicator in a separate field from the Person label, specify the subtotal field as the person label field using NAME1=, then PSUBTOTAL=$S1W1

Format 1: PSUBTOTAL = $S..W.. or $S..E.. using the column selection rules.
$S..W.. e.g., $S2W13 means that the label to be shown on the map starts in column 2 of the person label and is 13 columns wide.

$S..E.. e.g., $S3E6 means that the label to be shown on the map starts in column 3 of the person label and ends in column 6.

These can be combined, and constants introduced, e.g,
PSUBTOTAL=$S3W2+"/"+$S7W2

If the person label is "KH323MXTR", the sub-grouping will be shown as "32/XT"

Format 2: PSUBTOTAL=*
This is followed by a list of sub-groupings, each on a new line:

PSUBTOTAL=*

$S1W1+$S7W2 ; Subtotals reported for person classifications according to these columns
$S3E5 ; Subtotals reported for person classifications according to these columns
*

Example: Subtotal by first letter of person name:

PSUBTOTAL=$S1W1
TFILE=*
27 ; produce the subtotal report
*

Here is a subtotal report (Table 28) for person beginning with "R"

```
"R" SUBTOTAL FOR 8 NON-EXTREME PUPILS
+-----------------------------------------------------------------------------+
|          RAW                          MODEL         INFIT        OUTFIT    |
|         SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      28.1      25.0        4.04    3.48       .91    -.5   1.04      .0 |
| P.SD       5.5        .0        6.63     .14       .31    1.1    .54     1.4 |
| MAX.      38.0      25.0       16.30    3.82      1.61    2.0   2.37     3.4 |
| MIN.      19.0      25.0       -6.69    3.38       .64   -1.6    .60    -1.2 |
|-----------------------------------------------------------------------------|
| REAL RMSE   3.63 TRUE SD    5.54  SEPARATION  1.52  PUPIL  RELIABILITY  .70 |
|MODEL RMSE   3.48 TRUE SD    5.64  SEPARATION  1.62  PUPIL  RELIABILITY  .72 |
| S.E. OF PUPIL MEAN = 2.50                                                   |
| WITH 2 EXTREME = TOTAL 10 PUPILS  MEAN = 3.05,  P.SD = 28.19                |
| REAL RMSE   8.88 TRUE SD   26.75  SEPARATION  3.01  PUPIL  RELIABILITY  .90 |
|MODEL RMSE   8.83 TRUE SD   26.77  SEPARATION  3.03  PUPIL  RELIABILITY  .90 |
| S.E. OF PUPIL MEAN = 9.40                                                   |
+-----------------------------------------------------------------------------+
  MAXIMUM EXTREME SCORE: 1 PUPILS
  MINIMUM EXTREME SCORE: 1 PUPILS
      LACKING RESPONSES: 1 PUPILS
                DELETED: 1 PUPILS
```

Example: You want an average score for each option on a multiple-choice test.

1. Include the item response string in the person label

Data record
Fred ABCDE

```
NI = 5
Item1=6
Name1=1
Namelength=10
```

2. Produce subtotals for every item

```
PSUBTOT=*
6  ; corresponds to Item 1
7
8
9
10
...
*
```

3. Specify Table 28

```
TFILE=*
28
*
```

4. Table 28 output is voluminous, but the numbers are there. Do a search for "**| MEAN**".

11.155 PTBISERIAL= point-biserial-type correlation coefficient

The point-biserial correlation (or the point-polyserial correlation) is the Pearson correlation between on the observations on an item (or by a person) and the person raw scores or measures (or item marginal scores or measures). These are crucial for evaluating whether the coding scheme and person responses accord with the requirement that "higher observations correspond to more of the latent variable" (and vice-versa). These are reported in Tables 14 for items and Table 18 for items persons. They correlate an item's (or person's) responses with the measures of the encountered persons (or items). In Rasch analysis, the point-biserial correlation, r_{pbis}, is a useful diagnostic indicator of data mis-coding or item mis keying: negative or zero values indicate items or persons with response strings that contradict the variable. Positive values are less informative than INFIT and OUTFIT statistics. For more, see Correlations

Point-Biserial and Point-Measure Correlations			
Control Instruction	**Column Label**	**Explanation**	**Expected value (EXP.)**
PTBISERIAL= Yes PTBISERIAL= Exclude	PBSX PTBISERL-EX	Point-biserial (or point-polyserial) correlation **excluding** the current observation from the raw score. Computes the point-biserial or point-polyserial correlation coefficients, r_{pbis}, for persons and items. This is the Pearson product-moment correlation between the scored responses (dichotomies and polytomies) and the "rest scores", the corresponding total (marginal) scores **excluding** the scored responses to be correlated. This is a point-biserial correlation for dichotomies, or a point-polyserial correlation for polytomies. Extreme (perfect, maximum possible and zero, minimum possible) scores are included in the computation, but missing observations are omitted pairwise. The Biserial correlation can be computed from the Point-biserial. This correlation loses its meaning when there are missing data or with CUTLO= or CUTHI=. Specify PTBISERIAL=X instead. In Table 14.1, etc., and IFILE= For each item, this correlates the current observation with the (raw score - current observation) The actual number of observations summed into the raw score is ignored. In Table 14.3, etc., and DISFILE= For each item, each possible response option is evaluated in turn. • If the option matches the current observation and is not missing, then the option is score 1, if not the option is scored 0. Missing observations are ignored. Then the scored option is correlated with the (raw score - current observation) . • if the option matches the current observation and is missing, then the option is score 1, if not the option is scored 0 including different missing observation options. :Then the scored option is correlated with the raw score.	PBSX-E PBX-E
PTBISERIAL= All PTBISERIAL= Include	PBSA PTBISERL-AL	Point-biserial correlation for all observations **including** the current observation in the raw score. Computes the Pearson correlation between the total (marginal) scores including all responses and the responses to the targeted item and person. This is a point-biserial correlation for dichotomies, or a point-polyserial correlation for polytomies. This correlation loses its meaning when there are missing data or with CUTLO= or CUTHI=. Specify PTBISERIAL=N instead.	PBSA-E PBA-E
PTBISERIAL= No	PTMA	Point-measure correlation for all observations. Computes the	PTMA-E

PTBISERIAL= RPM PTBISERIAL= Measure PTMEASURE=Measure	PTMEASUR-AL	Pearson point-measure correlation coefficients, r_{pm} between the observations and the measures, estimated from the raw scores **including** the current observation or the anchored values. Measures corresponding to extreme scores are included in the computation.	PMA-E
PTBISERIAL= X PTMEASURE=X	PTMX PTMEASUR-EX	Point-measure correlation **excluding** the current observation from the estimation of the measure. Computes the Pearson point-measure correlation coefficients, r_{pm} between the observations and the measures or anchor values adjusted to exclude the current observation. Measures corresponding to extreme scores are included in the computation. This is an approximation to the exact value. See "Numerical Example"	PTMX-E PMX-E
PTBISERIAL= Skip	----	Point- correlations are not computed. This speeds up estimation process.	----

Point-correlations are always reported for items. Point-correlations are reported for persons when (i) all the items are dichotomies, (ii) all the items have three categories, or (iii) all the items are in the same item group (Andrich Rating Scale Model). Otherwise, the observed and expected correlations are reported as zero in PFILE=.

Here's how these correlations work:
Think of an item (or a person).
That item has a string of responses.
Each response ("point") is made by a person who has a raw score and a Rasch measure.
1. Correlate the raw scores with the responses. This is the point-biserial correlation (including the current response), PTBSA. (PTBIS=All)
2. Correlate the raw scores (less the current response) with the responses. This is the point-biserial correlation corrected for auto-correlation, PTBSE. (PTBIS=Yes)
3. Correlate the Rasch measures (estimated including the current response) with the responses. This is the point-measure correlation, PTMEA. (PTBIS=No)
4. Correlate the Rasch measures (estimated without the current response) with the responses. This is the point-measure correlation: corrected for autocorrelation, PTMEX. (PTBIS=X)

The "expected correlations" (the values of the correlations we would expect when the data fit the Rasch model perfectly) were introduced to avoid incorrect inferences based on the point-biserial correlations. For instance, eliminating items with low point-biserial correlations in situations where it is impossible for the point-biserial correlations to be high. In fact, without an "expected" reference point, it can be impossible to identify whether a reported correlation is too high, about right or too low.

For tests of different lengths including the same items we would first need to compare the items' "expected" correlation values, no matter which correlation we chose to report. This would provide the baseline for discussion about the idiosyncrasies of each item in each test.

Example 1: For rank-order or paired-comparison data, point-biserials are all -1. So specify Point-measure correlations.
PTBISERIAL=NO

Example 2: Winsteps results are to be compared to previous results for which the point-biserial correlation was based on the total marginal scores, including the responses to the targeted item.
PTBISERIAL=ALL

Example 3: For more, see Correlations

11.156 PVALUE= proportion correct or average rating

An important statistic in classical item analysis is the item proportion-correct (item-analysis p-value), the proportion of the sample succeeding on a dichotomous item. In Winsteps, this value is interpreted as the average of the responses to the item for both dichotomous and polytomous items.

This proportion-correct-value is not a hypothesis test probability-value (statistical p-value). For hypothesis tests of fit, use the ZSTD values, which are probability-values expressed as unit-normal deviates.

PVALUE = NO Do not report the item observed proportion-correct-value.

PVALUE=YES Report item obsered proportion-correct-values in Tables 6, 10, etc. and IFILE= (over-riding the existing default setting.)

Example: To parallel a classical analysis of an MCQ data set, it is desired to report the raw scores (including extreme persons and items), the point-biserials and the proportion-correct-values or average ratings.
  TOTALSCORE= YES ; report original total raw scores
  PTBISERIAL = YES ; report point-biserial, not point-measure correlations
  PVALUE = YES ; report proportion-correct-values

```
+-------------------------------------------------------------------------------+
|ENTRY   TOTAL                           |   INFIT   |   OUTFIT   |PTBSE|PROP-|                |
|NUMBER  SCORE   COUNT  MEASURE    ERROR|MNSQ  ZSTD|MNSQ  ZSTD|CORR.|VALUE| ITEM             |
|-----------------------------------+----------+----------+-----+-----+----------------|
|     1     35      35    -6.59     1.85| MINIMUM ESTIMATED MEASURE | 1.00| 1= 1-4           |
|     4     32      35    -4.40      .81| .90     .0| .35     .8|  .48|  .91| 4= 1-3-4         |
|    12      6      35     2.24      .55|1.16     .6|1.06     .5|  .26|  .17| 12=1-3-2-4-3     |
|    18      0      35     6.13     1.84| MAXIMUM ESTIMATED MEASURE |  .00| 18=4-1-3-4-2-1-4|
```

11.157 PWEIGHT= person (case) weighting

PWEIGHT= allows for differential weighting of persons. The standard weights are 1 for all persons. To change the weighting of persons, specify IWEIGHT=.

PWEIGHT of 2 has the same effect on item estimation as putting the person and responses into the analysis twice. It does not change a person's responses scored 0-1 into responses scored 0-2. When PWEIGHT is 0 for a person, the measure and fit statistics are reported for the person, but the person does not influence the measures or fit statistics of the other persons or items. PWEIGHT= applies to everything except the dimensionality computations (Tables 23, 24) where PWEIGHT= is set to 1 and IWEIGHT= is set to 1 for all persons and items.

Raw score, count, and standard error of measurement reflect the absolute size of weights as well as their relative sizes. Measure, infit and outfit and correlations are sensitive only to relative weights. If you want the standard error of the final weight-based measure to approximate the S.E. of the unweighted measure, then ratio-adjust case weights so that the total of the weights is equal to the total number of independent observations.

PWEIGHT= file name	weights are in a text file of format: (person entry number) (weight)
PWEIGHT = * (person entry number) (weight) 1 0.5 2 0 *	in-line list of person-entry numbers and weights person entry number 1 is weighted 0.5 person entry number 2 is weighted 0.Person 2 is reported, but it is not used to estimate item measures
PWEIGHT = $S2W3 PWEIGHT = $S2E4	weights in person labels which start at NAME1= using the column selection rules, e.g., starting in column S... with a width of W... or starting in column S and ending in column E. This can be expanded, e.g, PWEIGHT = $S23W1+"."+$S25W2 places the columns next to each other (not added to each other)
PWEIGHT = $C2W3 PWEIGHT = $C2E4	weights in data records using the column selection rules. column1 of the data recode is C1. The format is starting in column C... with a width of W... or starting in column C... and ending in column E. The columns can be anywhere in the data record

Example 1:
In a sample of 20 respondents, person 1 is to be given a weight of 2.5, all other persons have a weight of 1.
```
PWEIGHT=*
```

```
1 2.5
2-20 1
*
```

A better weighting, which would make the reported item standard errors more realistic by maintaining the original total sum of weights at 20 , is:

```
PWEIGHT=*
1 2.33 ; 2.5 * 0.93
2-20 0.93 ; the sum of all weights is 20.0
*
```

```
+-----------------------------------------------------------------------------+
|ENTRY    RAW                        MODEL|   INFIT   |  OUTFIT   |PTMEA|     |          |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.|WEIGH| KID       |
|-----------------------------------+----------+----------+-----+-----+----------|
|     1      4     10    -1.20     .85| .65   -.9| .41    .3|  .82| 2.33| Richard M|
|     2      7     10     1.70    1.17| .18  -1.2| .10   -.4|  .94|  .93| Tracie  F|
|     3      7     10     1.70    1.17|2.04   1.2|1.32    .7|  .84|  .93| Walter  M|
```

Example 2:

The data records contain the weights in columns 16-18 of the record. The person label starts in column 15, so this is also column 2 of the person label

```
NAME1 = 15  ; start of person label
NAMELEN = 20  ; length of person label
PWEIGHT= $S2W3 ; location in person label
 &END
...
END NAMES
10110110011001 0.5 Person A
01001100011011 0.7 Person B
......
```

or

```
NAME1 = 15  ; start of person label
NAMELEN = 20  ; length of person label
PWEIGHT= $C16W3 ; or $C16E18 ; column in data record also in person label
```

or

```
NAME1 = 20  ; start of person label in column 20 excluding the person weight
NAMELEN = 15  ; length of person label
PWEIGHT= $C16W3 ; or $C16E18 ; column in data record, not in person label
```

Example 3:

Person 4 is a dummy case, to be given weight 0. The measure and fit statistics are reported for person 4, but person 4 does not influence the measures or fit statistics of the other persons or items.

```
PWEIGHT=*
4 0 ; Person 4 has weight 0, other persons have standard weight of 1.
*
```

11.158 QCMLE = Quasi-CMLE estimates

QCMLE=Yes reports quasi-CMLE estimates in the measure tables.

For dichotomous data, CMLE item (delta) estimates can be deduced from the CMLE item probabilities for a person with score 1. Since JMLE probabilities are close to CMLE item probabiities, approximate item deltas, known as QCMLE estimates, can be calculated from JMLE probabilities. Similarly for person theta QCMLE estimates.

The theory of QCMLE is explained in Rasch Measurement Transactions 2020, 33:1, P. 1751.

11.159 QUOTED= quote-marks around labels

Non-numeric values in the output files can be placed within quote-marks. This is required by some software in order to decode internal blanks within labels correctly. These apply to comma-separated and tab-separated output files.

QUOTED=Y "non-numeric values within quotation marks"

QUOTED=N non-numeric values without quotation marks.

Example: Produce an SFILE=
 CSV=Y ; produce a comma-separated output file
 QUOTED=Y ; with labels in quotation marks
```
";STRUCTURE MEASURE ANCHOR FILE"
";CATEGORY","Rasch-Andrich Threshold"
0,.00
1,-.86
2,.86
```
 QUOTED=N ; labels without quotation marks
```
;STRUCTURE MEASURE ANCHOR FILE
;CATEGORY,Rasch-Andrich Threshold
0,.00
1,-.86
2,.86
```

11.160 RARE= heading in Tables 1, 12, 16

Please see MORE=

11.161 RCONV= score residual at convergence

Scores increment in integers so that 0.1 is about as precise a recovery of observed data as can be hoped for. The minimum possible value is RCONV=0.0001

Specifies what value the largest score residual, corresponding to any person measure or item calibration, must be less than in the iteration just completed for iteration to cease. The current largest value is listed in Table 0, and displayed on your screen. In large data sets, the smallest meaningful logit change in estimates may correspond to score residuals of several score points. See convergence considerations.

The standard setting is CONVERGE="E", so that iteration stops when either LCONV= or RCONV= is satisfied. (Note: this depends on Winsteps version - and may explain differences in converged values.)

Example: To set the maximum score residual, when convergence will be accepted, at 5 score points and maximum logit change in estimates of .01 logits. Your data consists of the responses of 5,000 students to a test of 250 items.
 NI=250 ; 250 items
 RCONV=5 ; score residual convergence at 5 score points
 LCONV=.01 ; this is the standard.
 CONVERGE=Both ;convergence when both RCONV= and LCONV= are met

11.162 REALSE= inflate S.E. for misfit

The modeled, REALSE=N, standard errors of measure estimates (abilities and difficulties) are the smallest possible errors. These always overstate the measurement precision.

Controls the reporting of standard errors of measures in all tables.

REALSE=N
Report modeled, asymptotic, standard errors (the standard).

REALSE=Y
Report the modeled standard errors inflated by the square root of the infit mean square, when it is greater than 1.0. This **inflates** the standard error to include uncertainty due to overall lack of fit of data to model.

See Standard Errors: Model and Real for more details.

11.163 RESCORE= response recoding

The responses in your data file may not be coded as you desire. The responses to some or all of the items can be rescored or keyed using RESCORE=. RESCORE= and NEWSCORE= are ignored when KEYn= is specified, except as below. If rescoring implies that the items have different rating (or partial credit) scale structures, ISGROUPS= may also be required.

RESCORE= *file name	file containing details
RESCORE = *	in-line list
RESCORE = codes	codes for item groups

RESCORE= has three forms: RESCORE=1101110 and RESCORE=* list * and RESCORE=*filename

RESCORE=" " or 2 or is omitted
All items are recoded using NEWSCORE=. RESCORE=2 is the standard when NEWSCORE= is specified.

RESCORE= some combination of 1's and 0's
Only items corresponding to 1's are recoded with NEWSCORE= or scored with KEYn=. When KEYn is specified, NEWSCORE= is ignored.

If some, but not all, items are to be recoded or keyed, assign a character string to RESCORE= in which "1" means "recode (key) the item", and "0" (or blank) means "do not recode (key) the item". The position of the "0" or "1" in the RESCORE= string must match the position of the item-response in the item-string.

When XWIDE=2 or more, then
either (a) Use one character per XWIDE and blanks,
```
NI=8
XWIDE=2
RESCORE=' 1 0 1 0 1 0 1 1'
```
or (b) Use one character per item with no blanks
```
NI=8
XWIDE=2
RESCORE='10101011'
```

Example 1: The original codes are "0" and "1". You want to reverse these codes, i.e., 1 0 and 0 1, for all items.
```
XWIDE=1  one character wide responses (the standard)
CODES =01  valid response codes are 0 and 1 (the standard)
NEWSCORE=10  desired response scoring
RESCORE=2  rescore all items - this line can be omitted
```

Example 2: Your data is coded "0" and "1". This is correct for all 10 items except for items 1 and 7 which have the reverse meaning, i.e. 1 0 and 0 1.
```
NI=10  ten items
CODES =01  standard, shown here for clarity
```

(a) old method - which still works:
```
NEWSCORE=10  revised scoring
RESCORE=1000001000 only for items 1 and 7
```

or
```
NEWSCORE=20
RESCORE=*
1 1  item 1 is to be rescored
7 1  item 7 is to be rescored
*
```

(b) new method - recommended:
```
IVALUE1 =10  revised scoring
```

IVALUE0 =01 scoring unchanged, so this line can be omitted.
IREFER =1000001000 only for items 1 and 7

If XWIDE=2, use one or two columns per RESCORE= code, e.g., " 1" or "1 " mean recode (key). " 0" or "0 " mean do not recode (key).

Example 3: The original codes are " 0" and " 1". You want to reverse these codes, i.e., 1 0 and 0 1, for items 1 and 7 of a ten item test.
NI =10 ; ten items
XWIDE =2 ; two characters wide
CODES =" 0 1" ; original codes
NEWSCORE=" 1 0" ; new values
RESCORE =" 1 0 0 0 0 0 1 0 0 0" ; rescore items 1 & 7

Example 4: The original codes are "0", "1", and "2". You want 0 0, 1 1, and 2 1 for all items
XWIDE=1 one character wide (standard)
CODES =012 valid codes
NEWSCORE=011 desired scoring

Example 5: The original codes are "0", "1", and "2". You want to make 0 2, 1 1, and 2 0, for even-numbered items in a twenty item test.
NI=20 twenty items
CODES =012 three valid codes
NEWSCORE=210 desired scoring
RESCORE=01010101010101010101 rescore "even" items

Example 6: The original codes are "0", "1", "2", "3" and some others. You want to make all non-specified codes into "0", but to treat codes of "2" as missing.
CODES = 0123 four valid codes
NEWSCORE= 01X3 response code 2 will be ignored
MISSCORE=0 treat all invalid codes as 0

Example 7: The original codes are "0", "1", "2", "3". You want to rescore some items selectively using KEY1= and KEY2= and to leave the others unchanged - their data codes will be their rating values. For items 5 and 6, 0 0, 1 0, 2 1, 3 2; for item 7, 0 0, 1 0, 2 0, 3 1. Responses to other items are already entered correctly as 0, 1, 2, or 3.
CODES =0123 valid codes
RESCORE=0000111000 rescore items 5,6,7
KEY1 =****223*** keyed for selected items
KEY2 =****33X*** the X will be ignored
^ read these columns vertically

Example 8: Multiple score key for items 1 to 10. Items 11 to 15 are on a rating scale of 1 to 5

CODES = abcd12345
KEY1 = bacdbaddcd*****
RESCORE= 111111111100000 ; RESCORE= signals when to apply KEY1=

11.164 RESFROM= location of RESCORE

Only use this if you have too many items to put conveniently on one line of the RESCORE= control variable.

RESFRM= instructs where to find the RESCORE= information.

RESFRM=N
RESCORE= is a control variable between before &END (the standard).

RESFRM=Y
RESCORE= information follows after &END but before the item names, if any, and is formatted exactly like a data record. It is helpful, for reference, to enter the label "RESCORE=" where the person name would go in your data record.

Example: KEY1= and KEY2= information follows the RESCORE= information, all are formatted like your data. No item names are provided,

```
NAME1 = 1 start of person-id
ITEM1 = 10 start of responses
NI = 10 ten items
INUMB = Y use item sequence numbers as names
CODES = ABCDE valid codes
RESFRM = Y rescore information in data record format
KEYFRM = 2 two keys in data record format
&END
RESCORE= 0000110000 RESCORE= looks like data
KEY1=    ****AB**** KEY1= looks like data
KEY2=    ****CA**** KEY2= looks lie data record
George   ABCDABCDAB first data record
|    subsequent data records
```

11.165 RFILE= scored response file

Useful for reformatting data from a family of test forms, linked by a network of common items, into a single common structure suitable for one-step item banking.

RFILE=filename outputs a file which contains a scored/keyed copy of the input data. This file can be used as input for later analyses. Items and persons deleted by PDFILE= or the like are replaced by blank rows or columns in the scored response file. The file format is:

1. Person-id: 30 columns wide or maximum person-id length, whichever is larger.
2. Responses one per item:
   One column for each response if largest scored response is less than or equal to 9.
   Two columns for each responses if largest scored response is more than 9.
   Missing or unscored data are indicated by "."
   The width of the responses is not determined by XWIDE=.

RFILE=? opens a Browse window

```
M Rossner, Marc Daniel         1.1110.01....0.11..0.10.0
M Rossner, Lawrence F.         .........................
M Rossner, Toby G.             ..1101101....1..1..1.1111
M Rossner, Michael T.          10100101..1..1111..0.1111
F Rossner, Rebecca A.          10101010011110011..111110
M Rossner, Tr Cat              1011.110111.10101..101.10
M Wright, Benjamin             ...00...0................
M Lambert, Md., Ross W.        ..100.10.....0.01..0..0..
M Schulz, Matthew              011010011.1..0011.11.0.11
M Hsieh, Daniel Seb            .1000101....11.11..0110.1
```

Example: I have 9 scored items. for example LP1, LP2, CS1, CS2, CS3, D1, R1, R2, TE1. I would like to combine the following into one subtest (LP1 and LP2) and (CS1,CS2,CS3) and (R1 and R2) using Winsteps. D1 and TE1 will remain unchanged. This means I will ultimately have 5 items LP, CS, D, R, and TE.

Winsteps cannot combine items automatically. So here is a suggestion if your data file is already in Winsteps format:

1. Launch Winsteps
2. Analyze your 9-item file
3. Winsteps menu bar, "Output Files", Output the RFILE= to Excel
4. In Excel, combine your items into subtests
5. Winsteps menu bar, "Data Setup", convert your Excel file into a new Winsteps control file
6. Analyze the new Winsteps control file.

11.166 RMSR= report root-mean-square residuals in measure tables

RMSR=Yes reports the summary root-mean-square residual (= observation - expectation) for each person or item in the measure tables.. Observations in extreme scores are excluded.

```
------------------------------------------------------------------------------------
|   INFIT   |  OUTFIT   |PT-MEASURE |EXACT MATCH|     |                          |
|MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%| RMSR| ITEM                     |
+----------+----------+-----------+-----------+-----+--------------------------|
|1.23   1.2|1.09    .5|  .83   .84| 42.9  50.9| .855| A. EATING                |
|1.51   2.6|1.63   3.1|  .79   .85| 37.7  44.4|1.023| B. GROOMING              |
| .85   -.9| .82  -1.0|  .88   .87| 48.6  42.8| .802| C. BATHING               |
| .69  -2.0| .73  -1.7|  .91   .86| 42.9  44.0| .704| D. UPPER BODY DRESSING|
| .57  -3.0| .56  -2.9|  .92   .87| 64.3  43.3| .656| E. LOWER BODY DRESSING|
| .71  -1.9| .71  -1.8|  .89   .86| 54.3  44.1| .732| F. TOILETING             |
|2.03   4.7|2.08   4.9|  .76   .86| 34.3  44.1|1.216| G. BLADDER               |
|1.50   2.6|1.53   2.7|  .78   .85| 37.1  44.1|1.034| H. BOWEL                 |
| .52  -3.4| .60  -2.7|  .92   .86| 55.7  43.9| .616| I. BED TRANSFER          |
| .49  -3.7| .53  -3.3|  .91   .86| 54.3  44.0| .608| J. TOILET TRANSFER       |
| .85   -.9| .85   -.8|  .88   .88| 54.3  45.2| .796| K. TUB, SHOWER           |
| .91   -.5| .80  -1.2|  .88   .87| 51.4  44.1| .830| L. WALK/WHEELCHAIR       |
|1.02    .1| .83   -.8|  .90   .88| 44.3  51.3| .806| M. STAIRS                |
```

The blue column is the root-mean-square residual. The red box shows how it relates to item misfit Table 14.1.

11.167 ROW1HEADING = heading in first row of output file

ROW1HEADING = Yes (default)
Most output files have a descriptive comment as the first line in the file. Column labels (fi any) are in the second line.

Example: IFILE=

```
Test (Best Test Design p.31)
;ENTRY MEASURE ST   COUNT    SCORE MODLSE IN.MSQ
     1  -60.86 -1    35.0     35.0  18.48   1.00
```

ROW1HEADING = No
Output files do have a descriptive comment as the first line in the file. Column labels (if any) are in the first line.

HLINES=No removes the descriptive comment and also any column labels.

Control variables	Effect on Output files (IFILE=, PFILE=, ...)	Example for IFILE=
HLINES=Yes, ROW1HEADING=Yes (the default, unless changed in Output file specifications dialog box "Set as default" or changed by the type of output file chosen)	All output file headings shown	; TAP KNOX CUBE TEST ;ENTRY MEASURE ST C 1 -6.59 -1 35.0
HLINES=Yes ROW1HEADING=No	Only column headings shown	;ENTRY MEASURE ST C 1 -6.59 -1 35.0
HLINES=No ROW1HEADING=No	No headings	1 -6.59 -1 35.0
HLINES=No ROW1HEADING=Yes	No headings	1 -6.59 -1 35.0

11.168 SAFILE= structure-threshold input anchor file

The SFILE= (not ISFILE=, but see PCM anchoring) of one analysis may be used unedited as the SAFILE= of another.

The rating-scale structure parameter values (taus, Rasch-Andrich thresholds, steps) can be anchored (fixed) using SAFILE=. The anchoring option facilitates test form equating. The structure in the rating (or partial credit) scales of two test forms, or in the item bank and in the current form, can be anchored at their other form or bank values. Then the common rating (or partial credit) scale calibrations are maintained. Other measures are estimated in the frame of reference defined by the anchor values. Use IAFILE= and SAFILE= if you need the polytomous item in one analysis to be identical in thresholds and overall difficulty to the same item in another analysis. Use only SAFILE= if you need the polytomous item in one analysis to be identical in thresholds to the same item in another analysis, but the overall item difficulties can differ.

SAFILE= file name	file containing details
SAFILE = *	in-line list
SAFILE = ?	opens a Browser window to find the file
No ISGROUPS= or all items in one group	
(bottom category) 0 example: 0 0	place holder for bottom category of rating scale in case it is not observed in the data
(category number) (anchor value) example: 2 1.5	Andrich threshold (step calibration) between categories 1 and 2 is anchored at 1.5 for all items (unless overridden)
ISGROUPS= specifies more than one group of items or PCM	
(item number) (bottom category) 0 example: 34 0 0 ; place holder for bottom category	For item 34 and all items in the same ISGROUPS= group, place holder for bottom category in case it is not observed in the data
(item number) (category number) (anchor value) example: 34 2 1.5 ; Andrich threshold	For item 34 and all items in the same ISGROUPS= group, Andrich threshold (step calibration) between categories 1 and 2 is anchored at 1.5
(item number-item number) (category number) (anchor value) example: 34-39 2 1.5	For items 34 to 39 and all items in the same ISGROUPS= group(s), Andrich threshold (step calibration) between categories 1 and 2 is anchored at 1.5
(1-NI=) (category number) (anchor value) example: 1-47 1 2.0	Specify the default value for a category threshold for all items (and so for all ISGROUPS= groups)
*	end of list

Using CMLE thresholds as anchor values: This is the SFILE= from a CMLE analysis:

```
; STRUCTURE-THRESHOLD MEASURE ANCHOR FILE FOR ....
; ACT CATEGORY  Rasch-Andrich threshold MEASURE
     1  0      .00 ;      .00  ; CMLE
     1  1    -3.94 ;    -3.62
     1  2     -.92 ;     -.74
     1  3     3.65 ;     3.65
     1  4    40.74 ;    40.67  ; NULL
     1  5   -39.52 ;   -39.96
```

Unchanged, this anchors at the JMLE values. Delete the JMLE column and the ; to anchor at the CMLE values:

```
; STRUCTURE-THRESHOLD MEASURE ANCHOR FILE FOR ....
; ACT CATEGORY  Rasch-Andrich threshold MEASURE
     1  0        .00  ; CMLE
     1  1      -3.62
     1  2       -.74
     1  3       3.65
     1  4      40.67  ; NULL
     1  5     -39.96
```

In order to anchor category structures, an anchor file must be created of the following form:
1. Use one line per category Rasch-Andrich threshold to be anchored.
2. If all items use the same rating scale (i.e. ISGROUPS=" ", the standard, or you assign all items to the same grouping, e.g ISGROUPS=222222..), then type the category number, a blank, and the "structure measure" value (in logits or your

user-rescaled units) at which to anchor the Rasch-Andrich threshold measure corresponding to that category (see Table 3.2). Arithmetical expressions are allowed.

3. If you wish to force category 0 to stay in an analysis, anchors its calibration at 0. Specify SAITEM=Yes to use the multiple ISGROUP= format

or

If items use different rating (or partial credit) scales (i.e. ISGROUPS=0, or items are assigned to different groupings, e.g ISGROUPS=122113..), then type the sequence number of any item belonging to the grouping, a blank, the category number, a blank, and the "structure measure" value (in logits if USCALE=1, otherwise your user-rescaled units) at which to anchor the Rasch-Andrich threshold up to that category for that grouping. If you wish to force category 0 to stay in an analysis, anchor its calibration at 0.

This information may be entered directly in the control file using SAFILE=*

Anything after ";" is treated as a comment.

Example 1: Dichotomous: A score of, say, 438 means that you have 62% odds (and not 50% as it is default in Winsteps/Ministep!) of answering correctly to a dichotomous item of difficulty 438. How can I set this threshold from 50% to 62%?

In your control file, include:
UASCALE=1 ; anchoring is in logits
SAFILE=* ; anchors the response structure
0 0 ; place holder for bottom category
1 -0.489548225   ; ln((100%-62%)/62%)
*
When you look at Table 1, you should see that the person abilities are now lower relative to the item difficulties.

Example 2: Polytomous: A score of, say, 438 means that you have 62% expectation of answering correctly to a polytomous item (0-1-2-3) of difficulty 438. How can I set the thresholds to 62%?

The default item difficulty for a polytomy is the point where the lowest and highest categories are equally probable. We need to make a logit adjustment to all the category thresholds equivalent to a change of difficulty corresponding to a rating of .62*3 = 1.86.
This is intricate:
1. We need the current set of Rasch-Andrich thresholds (step calibrations) = F1, F2, F3.
2. We need to compute the measure (M) corresponding to a score of 1.86 on the rating scale
3. Then we need to anchor the rating scale at:
SAFILE=*
0 0 ; place holder for bottom category
1 F1 - M
2 F2 - M
3 F3 - M
*

An easy way to obtain M is to produce Winsteps "Output Files" menu, GRFILE= and then look up the Measure for the Score you want.

Example 3: A rating scale, common to all items, of three categories numbered 2, 4, and 6, is to be anchored at pre-set calibrations. The calibration of the Rasch-Andrich threshold from category 2 to category 4 is -1.5, and of the Rasch-Andrich threshold to category 6 is +1.5.
1. Create a file named, say, "STANC.FIL"
2. Enter the lines
 2 0 ; place holder for bottom category of this rating scale
 4 -1.5 ; Rasch-Andrich threshold from category 2 to category 4, anchor at -1.5 logits
 6 1.5 ; Rasch-Andrich threshold from category 4 to category 6, anchor at +1.5 logits

Note: categories are calibrated pair-wise, so the Rasch-Andrich threshold values do not have to advance.

3. Specify, in the control file,
 ISGROUPS=" "   (the standard)

SAFILE=STANC.FIL structure anchor file

or, enter directly in the control file,

```
SAFILE=*
4 -1.5
6 1.5
*
```

If you wish to use the multiple grouping format, i.e., specify an example item, e.g., 13

```
SAITEM=YES
SAFILE=*
13 4 -1.5
13 6 1.5
*
```

To check this: "A" after the Andrich threshold measure

```
+-----------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------+
|  4    4     620  34|   .14   .36|   .87   .72||   -1.50A|    .00 |
```

Example 4: A partial credit analysis (ISGROUPS=0) has a different rating scale for each item. Item 15 has four categories, 0,1,2,3 and this particular response structure is to be anchored at pre-set calibrations.

1. Create a file named, say, "PC.15"
2. Enter the lines
   15 0 0 Bottom categories are always at logit 0
   15 1 -2.0 item 15, Rasch-Andrich threshold to category 1, anchor at -2 logits
   15 2 0.5
   15 3 1.5
3. Specify, in the control file,
   ISGROUPS=0
   SAFILE=PC.15
   IAFILE= file of item calibrations

Example 5: A grouped rating scale analysis (ISGROUPS=21134..) has a different rating scale for each grouping of items. Item 26 belongs to grouping 5 for which the response structure is three categories, 1,2,3 and this structure is to be anchored, but the difficulties of the individual items are to be re-estimated.

1. Create a file named, say, "GROUPING.ANC"
2. Enter the lines
   26 2 -3.3 for item 26, representing grouping 5, Rasch-Andrich threshold to category 2, anchored at -3.3
   26 3 3.3
3. Specify, in the control file,
   ISGROUPS =21134..
   SAFILE=GROUPING.ANC
   ; there is no IAFILE= because we want to re-estimate the item difficulties

Example 6: A partial-credit scale has an unobserved category last time, but we want to use those anchor values where possible.
We have two choices.

a) Treat the unobserved category as a structural zero, i.e., unobservable. If so...
Rescore the item using IVALUE=, removing the unobserved category from the category hierarchy, and use a matching SAFILE=.

In the run generating the anchor values, which had STKEEP=NO,

```
+-----------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------+
|  1    1      33   0|  -.23  -.15|   .91   .93||  NONE   |(  -.85)| 1
|  2    2      23   0|   .15   .05|   .88   .78||   -1.12 |   1.44 | 2
|  4    3       2   0|   .29   .17|   .95   .89||    1.12 |(  3.73)| 4
```

```
|-------------------+------------+------------++---------+--------+
```

In the anchored run:
IREFER=A...... ; item 1 is an "A" type item
CODES=1234 ; valid categories
IVALUEA=12*3 ; rescore "A" items from 1,2,4 to 1,2,3
SAFILE=*
1 1 .00 ; place holder for bottom category
1 2 -1.12
1 3 1.12
*

If the structural zeroes in the original and anchored runs are the same then, the same measures would result from:
STKEEP=NO
SAFILE=*
1 1 .00 ; place holder for bottom category
1 2 -1.12
1 4 1.12
*

b) Treat the unobserved category as an incidental zero, i.e., very unlikely to be observed.
Here is Table 3.2 from the original run which produced the anchor values. The NULL indicates an incidental or sampling zero.

```
+-----------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------+
|  1   1      33   0|  -.27  -.20|   .91   .95||  NONE   |(  -.88)| 1
|  2   2      23   0|   .08  -.02|   .84   .68||    -.69 |    .72 | 2
|  3   3       0   0|            |   .00   .00||  NULL   |   1.52 | 3
|  4   4       2   0|   .22   .16|   .98   .87||     .69 |(  2.36)| 4
|-------------------+------------+------------++---------+--------+
```

Here is the matching SAFILE=

SAFILE=*
1 1 .00 ; place holder for bottom category
1 2 -.69
1 3 46.71 ; flag category 3 with a large positive value, i.e., unlikely to be observed.
1 4 -46.02 ; maintain sum of Andrich thresholds (step calibrations) at zero.
*

Example 7: Partial-credit Item difficulty is are to be set at an expected score of 1.3333 for an item scored 0,1,2 :
1. Do the standard analysis with UPMEAN=0. Center the person abilities, so we can see the change in item difficulties later.
2. Output the SFILE= to Excel of Rasch-Andrich thresholds
3. Output the GRFILE= to Excel of the ICCs, item characteristic curves
4. From the GRFILE=, discover the measure for each item corresponding to 1.3333
5. Output the IFILE= to Excel showing the item difficulties
6. Subtract the item difficulty from the 1.3333 measure. This is the necessary shift in the item difficulty
7. Subtract this shift from every threshold for the item in the SFILE=
8. Copy-and-paste-text the shifted thresholds into a text-file SAFILE=
9. Reanalyze the data with the SAFILE= and UPMEAN=0. All the item difficulties should now be at their RP67 values, relative to the mean of the person abilities.

Example 8: Score-to-measure Table 20 is to be produced from known item and rating scale structure difficulties.
Specify:
IAFILE= ; the item anchor file
SAFILE= ; the structure/step anchor file (if not dichotomies)
CONVERGE=L ; only logit change is used for convergence
LCONV=0.005 ; logit change too small to appear on any report.
STBIAS=NO ; anchor values do not need estimation bias correction.

The data file comprises two dummy data records, so that every item has a non extreme score, e.g.,
For dichotomies:

```
Record 1: 10101010101
Record 2: 01010101010

For a rating scale from 1 to 5:
Record 1: 15151515151
Record 2: 51515151515
```

Redefining the Item Difficulty of Rating Scale items:

We want to define the difficulty of an item as 65% success on the item, instead of the usual approximately 50% success.

1.Suppose we have these Rasch-Andrich thresholds (step calibrations) from a standard rating-scale analysis:

Category	Rasch-Andrich Threshold
1	(0.00)
2	-.98
3	-.25
4	1.22

2. The item score range is 1-4, so
a) we need the relative measure corresponding to an expected score of 65% on the item = 1+ (4-1)*0.65 = 2.95

3. We look at the GRFILE= and see that the measure corresponding to an expected score of 2.95 is about 0.58 (we can verify this by looking at the Graphs window, Expected score ICC)

ITEM	MEAS	SCOR	INFO	0	1	2	3
1	.48	2.89	.67	.05	.23	.48	.23
1	.56	2.94	.65	.05	.22	.49	.25
1	.64	2.99	.63	.04	.20	.49	.27

4. We want the item difficulty to correspond to 65% success instead of its current approximately 50% correct. So we have raised the bar for the item. The item is to be reported as about 0.57 logits more difficult.

5. To force the item to be reported as 0.57 logits more difficult, we need the Andrich thresholds (step calibrations) to be 0.57 logits **easier** = -0.57 logits.

Category	Rasch-Andrich Threshold
1	(0.00)
2	-.98 + -.57 = -1.55
3	-.25 + -.57 = -.82
4	1.22 + -.57 = .64

6. Now, since the item mean remains 0, all the person measures will be reduced by 0.57 logits relative to their original values.

Dichotomies (MCQ, etc.) Mastery Levels:
Example 9: To set mastery levels at 75% on dichotomous items (so that maps line up at 75%, rather than 50%), we need to adjust the item difficulties by ln(75/(100-75)) = 1.1 logits.
SAFILE=*
0 0 ; place holder for bottom category

1 -1.1 ; set the Rasch-Andrich threshold point 1.1 logits down, so that the person ability matches item difficulty at 75% success.
  ; If you are using USCALE=, then the value is -1.1 * USCALE=
 *

Similarly for 66.67% success or 66.67% master level: ln(66.67/(100-66.67)) = 0.693 logits.
SAFILE=*
0 0
0 -0.6931 ; notice that this is negative
*

Similarly for 65% success or 65% master level: ln(65/(100-35)) = 0.691logits.
SAFILE=*
0 0 ; place holder for bottom category
0 -0.691 ; notice that this is negative
*

Polytomies (rating scales, partial credit, etc.:
When a variety of rating (or partial credit) scales are used in an instrument, their different formats perturb the item hierarchy. This can be remedied by choosing a point along each rating (or partial credit) scale that dichotomizes its meaning (not its scoring) in an equivalent manner. This is the pivot point. The effect of pivoting is to move the structure calibrations such that the item measure is defined at the pivot point on the rating (or partial credit) scale, rather than the standard point (at which the highest and lowest categories are equally probable).

Example 1. Anchoring polytomous items for the Rating Scale Model

```
CODES = 012 ; 3 category Rating Scale Model
IAFILE=*
0 0  ; place holder for bottom category
1 2.37 ; anchor item 1 at 2.37 logits
2 -1.23
*

SAFILE=*
0 0 ; the bottom category is always anchored at 0
1 -2.34 ; Andrich threshold (step difficulty) from category 0 to 1
2 2.34 ; Andrich threshold (step difficulty) from category 2 to 3
*
```

Example 2. Anchoring polytomous items for the Partial Credit and Grouped-Items models

```
CODES = 012 ; 3 category Rating Scale Model
ISGROUPS=0
IAFILE=*
0 0  ; place holder for bottom category
1 2.37 ; anchor item 1 at 2.37 logits
2 -1.23
*

SAFILE=*
; for item 1, relative to the difficulty of item 1
1 0 0 ; the bottom category is always anchored at 0
1 1 -2.34 ; Andrich threshold (step difficulty) from category 0 to 1
1 2 2.34 ; Andrich threshold (step difficulty) from category 2 to 3
; for item 2, relative to the difficulty of item 2
2 0 0 ; the bottom category is always anchored at 0
2 1 -1.54 ; Andrich threshold (step difficulty) from category 0 to 1
2 2 1.54 ; Andrich threshold (step difficulty) from category 2 to 3
*
```

Example 3. For item 47, categories 3 and 5are the most probable and I would like the item difficulty to be based on the intersect of these two probability curves. For item 123, categories 8 and 9 are the most probable... how do I specify this with SAFILE=...?"

The items must be in different item groups. Simplest is the Partial Credit Model so that each item has its own rating-scale structure:
ISGROUPS=0

SAFILE=*
; the intersection of categories 3 and 5 is not a Rasch parameter, so you need to:
; 1. look at Winsteps GRFILE=
; 2. find the measure for item 47 where categories 3 and 5 are equally probable = M35
; 3. find the measure for item 47 where categories 4 and 5 are equally probable = M45
; 4. compute xxx.xx = M45-M35
47 5 xxx.xx ; distance of reference point 3-5 from 4-5 threshold

123 9 0 ; threshold between categories 8 and 9 is set at 0
*

Here is a general procedure.
Use ISGROUPS=
Do an unanchored run, make sure it all makes sense.
Write out an SFILE=structure.txt of the rating scale (partial credit) structures.

Calculate, for each item, the amount that you want the item difficulty to move. Looking at the Graphs menu or Table 2 may help you decide.

Make this amount of adjustment to every value for the item in the SFILE=*
So, suppose you want item 3 to be shown as 1 logit more difficult on the item reports.
The SFILE=structure.txt is
3 0 0.0 ; place holder for bottom category
3 1 -2.5
3 2 -1.0
...
*
Change this to (add 1 to the values for 1 logit more difficult)
3 0 0 ; place holder for bottom category
3 1 -1.5
3 2 -0.0
...
*
This becomes the SAFILE=structure.txt of the pivoted analysis.

Example 10: Pivoting with ISGROUPS=. Positive (P) items pivot at an expected score of 2.5. Negative (N) items at an expected score of 2.0
ISGROUPS=PPPPPNNNNN
SAFILE=*
1 2 0.7 ; put in the values necessary to move the center to the desired spot
5 2 0.5 ; e.g., the "structure calibration" - "score-to-measure of pivot point"
*

Example 11: To set a rating (or partial credit) scale turning point: In the Liking for Science, with 0=Dislike, 1=Neutral, 2=Like, anything less than an expected score of 1.5 indicates some degree of lack of liking:
SAFILE=*
1 -2.22 ; put in the Andrich threshold (step calibration) necessary to move expected rating of 1.5 to the desired spot
*

```
RATING SCALE PIVOTED AT 1.50
+------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
```

```
|-------------------+------------+------------++---------+--------+
|  0   0     197  22| -2.29 -2.42|  1.05   .99||  NONE   |( -3.42)| dislike
|  1   1     322  36| -1.17  -.99|   .90   .79||   -2.22 |  -1.25 | neutral
|  2   2     368  41|   .89   .80|   .98  1.29||    -.28 |(   .92)| like
|-------------------+------------+------------++---------+--------+
|MISSING       1   0|   .04      |            ||         |        |
+------------------------------------------------------------------
AVERAGE MEASURE is mean of measures in category.

+-------------------------------------------------------------------+
|CATEGORY   STRUCTURE    |  SCORE-TO-MEASURE   |CUMULATIV| COHERENCE|
| LABEL   MEASURE   S.E. | AT CAT. ----ZONE----|PROBABLTY| M->C C->M|
|------------------------+---------------------+---------+----------|
|   0      NONE          |( -3.42) -INF   -2.50|         |  63%  44%| dislike
|   1       -2.22    .10 |  -1.25  -2.50    .00|   -2.34 |  55%  72%| neutral
|   2        -.28    .09 |(   .92)   .00  +INF |    -.16 |  84%  76%| like
+-------------------------------------------------------------------+
```

Values of .00 for scores of 1.5 show effect of pivot anchoring on the rating (or partial credit) scale. The structure calibrations are offset.

```
TABLE 21.2 LIKING FOR SCIENCE (Wright & Masters p.18)  sf.out Aug  1 21:31 2000
        EXPECTED SCORE OGIVE: MEANS
       ++------+------+------+------+------+------+------+------++
     2 +                                               2222222222+
       |                                       22222222          |
       |                                   2222                  |
       |                                222                      |
E      |                              22                         |
X  1.5 +                            12                           +
P      |                          11|                            |
E      |                        11  |                            |
C      |                      11    |                            |
T      |                     1      |                            |
E    1 +                   11       |                            +
D      |                 11*        |                            |
       |                1  *        |                            |
S      |              11   *        |                            |
C      |            11     *        |                            |
O   .5 +          01       *        |                            +
R      |        00|        *        |                            |
E      |     000  |        *        |                            |
       |00000     |        *        |                            |
       |          |        *        |                            |
     0 +          |        *        |                            +
       ++------+------+------+------+------+------+------+------++
       -4     -3     -2     -1      0      1      2      3      4
                        PUPIL [MINUS] ACT MEASURE
```

Example 12: A questionnaire includes several rating (or partial credit) scales, each with a pivotal transition-structure between two categories. The item measures are to be centered on those pivots.

1. Use ISGROUPS= to identify the item response-structure groupings.
2. Look at the response structures and identify the pivot point:

e.g., here are categories for "grouping A" items, after rescoring, etc.

Strongly Disagree 1
Disagree 2
Neutral 3
Agree   4
Strongly Agree 5

If agreement is wanted, pivot between 3 and 4, identified as transition 4.
If no disagreement is wanted, pivot between 2 and 3, identified as transition 3.

3. Anchor the transition corresponding to the pivot point at 0, e.g., for agreement:

e.g., for
```
ISGROUPS=AAAAAAABBBBAACCC
SAFILE=*
6 4 0  6 is an item in grouping A, pivoted at agreement (Rasch-Andrich threshold from category 3 into category 4)
8 2 0  8 is an item in grouping B, pivoted at Rasch-Andrich threshold from category 2 into category 3
; no pivoting for grouping C, as these are dichotomous items
*
```

Example 13: Anchor files for dichotomous and partial credit items. Use the IAFILE= for anchoring the item difficulties, and SAFILE= to anchor partial credit structures. Winsteps decomposes the (delta) Dij of partial credit items into Di + Fij.
The Di for the partial credit and dichotomous items are in the IAFILE=
The Fij for the partial credit files are in the SAFILE=

Suppose the data are A,B,C,D, and there are two partial credit items, scored 0,1,2, and two merely right-wrong. 0,1 then: :

```
 CODES=ABCD
 KEY1=BCBC     ; SCORE OF 1 ON THE 4 ITEMS
 KEY2=DA**     ; SCORE OF 2 ON THE PARTIAL CREDIT ITEMS
 ISGROUPS=0
```

If the right-wrong MCQ items are to be scored 0,2, then

```
 CODES=ABCD
 KEY1=BC**     ; SCORE OF 1 ON THE 4 ITEMS
 KEY2=DABC     ; SCORE OF 2 ON THE PARTIAL CREDIT ITEMS
 ISGROUPS=0
```

but better psychometrically is:

```
 CODES=ABCD
 KEY1=BCBC     ; SCORE OF 1 ON THE 4 ITEMS
 KEY2=DA**     ; SCORE OF 2 ON THE PARTIAL CREDIT ITEMS
 IWEIGHT=*
 3-4  2        ; items 3 and 4 have a weight of 2.
 *
 ISGROUPS=0
```

Then write out the item and partial credit structures

```
 IFILE= items.txt
 SFILE=pc.txt
```

In the anchored run:

```
 CODES= ... etc.
 IAFILE=items.txt
 SAFILE=pc.txt
 CONVERGE=L  ; only logit change is used for convergence
 LCONV=0.005  ; logit change too small to appear on any report.
```

Anchored values are marked by "A" in the Item Tables, and also Table 3.2

Anchoring with Partial-Credit Delta δ_{ij} (D_{ij}) values

Example:

```
Title = "Partial credit with anchored Dij structures"
;---------------------------
;        STRUCTURE MEASURE (Andrich threshold)
;       --------------------
;Item i delta_i1    delta_i2
;---------------------------
;Item 1   -3.0      -2.0
;Item 2   -2.0       1.0
;Item 3    0.0       2.0
;Item 4    1.0       3.0
;Item 5    2.0       3.0
;---------------------------

Item1 = 11 ; observations start in column 11
NI=5   ; 5 items
Name1 = 1 ; person label in column 1
CODES = 012  ; valid data values
ISGROUPS = 0  ; partial-credit model

IAFILE=*
```

```
1-5 0     ; item difficulties for all items set at 0
*

SAFILE=*
1 0 0       ; this is a placeholder for data code 0 for item 1
1 1 -3.0           ; value from ISFILE= I+THRESH column
1 2 -2.0
2 0 0
2 1 -2.0
2 2 1.0
3 0 0
3 1 0.0
3 2 2.0
4 0 0
4 1 1.0
4 2 3.0
5 0 0
5 1 2.0
5 2 3.0
*

&END
END LABELS
Person 1  22111
Person 2  21010
```

Equating with Partial Credit (PCM) items

Question: My data has three time-points, and I want to compare the item difficulty hierarchies across time-points, but the PCM thresholds are different at each time-point. What should I do?

Answer: Equating with PCM is always problematic. The threshold estimates are highly influenced by idiosyncrasies in the local dataset. Since Rasch findings are usually based on person estimates, and these are based on the item ICCs (expected scores on the items), then it really makes more sense to compare the ICCs than the thresholds.

Ben Wright.'s recommendation was to analyze all the data together to obtain the best compromise for the thresholds, and then anchor the thresholds at those values for the analysis of each time-point separately. See www.rasch.org/rmt/rmt101f.htm stage II. Accordingly the SFILE=sf.txt from the joint analysis becomes the SAFILE=sf.txt for all the separate time-point analyses.

Another approach is to treat each PCM item essentially as a dichotomy by choosing one Andrich threshold as the "pivot" threshold for each item, and then anchoring this threshold of each item at 0. Then the item difficulties are forced to conform with this threshold value at all time-points. Accordingly SAFILE= 0 for the pivot thresholds of all the items (other thresholds are not anchored) in all the time-point analyses. For example, in all the analyses:

ISGROUPS=0 ; Partial Credit Model
SAFILE=*
1 3 0 ; for item 1, anchor thresholds between categories 2 and 3 at 0
2 2 0 ; for item 2, anchor thresholds between categories 1 and 2 at 0
3 2 0 ; for item 3, anchor thresholds between categories 1 and 2 at 0
.....
*

11.169 SAITEM= item numbers in SAFILE with one grouping

Rating-scale Structure-Threshold Files SFILE= and Structure-Threshold Anchor Files SAFILE= (Rating (or partial credit) scale step anchoring files) have the format:

For only one active grouping in ISGROUPS=, or no ISGROUPS=	
scored-category number	**Andrich threshold relative to item difficulty (step-calibration)**
For multiple groupings in ISGROUPS=, or SAITEM= Yes	

example-item-number in grouping	scored-category number	Andrich threshold relative to item difficulty (step-calibration)

Example 1: "Liking for Science" structure-threshold anchor file:
Standard format for the Rating Scale model:
ISGROUPS= ; no groupings specified
SAFILE=*
0 0 ; bottom category threshold is 0 as a place-holder
1 -1.8 ; Rasch-Andrich threshold from category 0 to category 1
2 1.8 ; Rasch-Andrich threshold from category 1 to category 2
*

Alternative format allowing an example item number to identify the grouping, say item 10
SAITEM=Yes
SAFILE=*
10 0 0 ; bottom category threshold is 0 as a place-holder
10 1 -1.8
10 2 1.8
 *

11.170 SANCHQ= anchor category structure interactively

If your system is interactive, steps to be anchored can be entered interactively by setting SANCHQ=Y before the &END line. If you specify this, you will be asked if you want to anchor any steps. If you respond "yes", it will ask if you want to read these anchored items from a file; if you answer "yes" it will ask for the file name and process that file in the same manner as if SAFILE= had been specified. If you answer "no", you will be asked to enter the step measures (found in Table 3).

If there is only one rating (or partial credit) scale, enter the category numbers for which the Rasch-Andrich thresholds are to be anchored, one at a time, along with their logit (or user-rescaled by USCALE=) Andrich threshold (structure measure) calibrations. Bypass categories without measures. Enter 0 where there is a measure of "NONE". When you are finished, enter -1 in place of the category number.

If there are several rating (or partial credit) scales, enter one of the item numbers for each rating (or partial credit) scale, then the Andrich thresholds corresponding to its categories. Repeat this for each category of an item for each rating (or partial credit) scale. Enter 0 where there is a Andrich Threshold for a category of "NONE". Entering 0 as the item number completes anchoring.

Example 1: You are doing a number of analyses, anchoring the common rating (or partial credit) scale to different values each time. You want to enter the numbers at your PC:
  SANCHQ=Y

You want to anchor items 4 and 8.

```
Winsteps asks you:
DO YOU WANT TO ANCHOR ANY STRUCTURES? respond YES(Enter)
DO YOU WISH TO READ THE ANCHORED STRUCTURES FROM A FILE?
   respond NO(Enter)
INPUT STRUCTURE TO ANCHOR (-1 TO END):
respond 2(Enter) (the first category Rasch-Andrich threshold to be anchored)
INPUT VALUE AT WHICH TO ANCHOR Rasch-Andrich threshold:
respond 0(Enter) (the first anchor value)
INPUT Rasch-Andrich threshold TO ANCHOR (-1 TO END): 4(Enter)
INPUT VALUE AT WHICH TO ANCHOR Rasch-Andrich threshold:-1.5(Enter)
INPUT Rasch-Andrich threshold TO ANCHOR (-1 TO END): 6(Enter)
INPUT VALUE AT WHICH TO ANCHOR Rasch-Andrich threshold:1.5(Enter)
INPUT Rasch-Andrich threshold TO ANCHOR (-1 TO END): -1(Enter) (to end anchoring)
```

Example 2: You wish to enter the Andrich Thresholds for several rating scales, each comprising a grouping of items:
SANCHQ=Y

```
Winsteps asks you:
```

```
DO YOU WANT TO ANCHOR ANY Rasch-Andrich thresholdS? YES(Enter)
DO YOU WANT TO READ THE ANCHORED Rasch-Andrich thresholdS FROM A FILE? NO
Item 1 represents the first grouping of items, sharing a common rating scale:
INPUT AN ITEM, REPRESENTING A GROUPING (0 TO END): 1
INPUT Rasch-Andrich threshold TO ANCHOR (-1 TO END): 0 bottom category
INPUT VALUE AT WHICH TO ANCHOR Rasch-Andrich threshold: 0 "NONE"
INPUT AN ITEM, REPRESENTING A GROUPING (0 TO END): 1
INPUT Rasch-Andrich threshold TO ANCHOR (-1 TO END): 1
INPUT VALUE AT WHICH TO ANCHOR Rasch-Andrich threshold: -0.5
INPUT AN ITEM, REPRESENTING A GROUPING (0 TO END): 1
INPUT Rasch-Andrich threshold TO ANCHOR (-1 TO END): 2
INPUT VALUE AT WHICH TO ANCHOR Rasch-Andrich threshold: 0.5
Item 8 represents the second grouping of items, sharing a common rating scale:
INPUT AN ITEM, REPRESENTING A GROUPING (0 TO END): 8
INPUT Rasch-Andrich threshold TO ANCHOR (-1 TO END): 0 bottom category
When all are anchored, enter 0 to end:
INPUT AN ITEM, REPRESENTING A GROUPING (0 TO END): 0
```

11.171 SCOREFILE= person score file

If SCOREFILE=filename is specified, a file is output which contains the measure and model standard error corresponding to every possible score on a test consisting of all the non-extreme items.

The SCOREFILE= and Table 20 person ability estimates are estimated on the basis that the current item difficulty estimates are the "true" estimates. These are the person estimates if you anchored (fixed) the items at their reported estimates. PFILE=, Table 17 and the other Person Measure Tables show the person abilities that are the maximum likelihood estimates at the current stage of estimation. To make these two sets of estimates coincide, please tighten the convergence criteria in your Winsteps control file:
CONVERGE=L
LCONV=*.001 ; or tighter

If you want the score file for person measures including the extreme (zero, perfect) items, then
1. Run a standard analysis.
2. Output: IFILE=if.txt SFILE=sf.txt
3. Run the analysis again, with Extra specifications: IAFILE=if.txt SAFILE=sf.txt
4. The person measures will have altered somewhat to adjust for the imputed difficulties of the extreme items.
5. Output Table 20 and SCOREFILE=

SCOREFILE=? opens a Browse window

This is also shown in Table 20. It has 2 heading lines (unless HLINES=N or ROW1HEADING=N), and has the format:

```
KID SCORE FILE FOR KNOX CUBE TEST Dec 12 2020 10: 8 USCALE=1.00
 SCORE  MEASURE    S.E.   INFO NORMED S.E.  FREQUENCY %   CUM.FREQ. % PERCENTILE        1  ...
     4  ...  18
     3    -6.66    1.88    .28   217   85        1   2.9        1   2.9         1.4     1.00
   .00       .00
     4    -5.30    1.11    .81   278   50        0    .0        1   2.9         2.9     1.00
   .29       .00
     5    -4.35     .88   1.29   321   40        1   2.9        2   5.7         4.3     1.00
   .51       .00
     6    -3.64     .82   1.49   353   37        2   5.7        4  11.4         8.6     1.00
   .68       .00
     7    -2.97     .82   1.48   383   37        2   5.7        6  17.1        14.3     1.00
   .81       .00
     8    -2.26     .88   1.29   415   40        2   5.7        8  22.9        20.0     1.00
   .90       .00
     9    -1.39     .99   1.01   454   45        3   8.6       11  31.4        27.1     1.00
   .95       .00
    10     -.26    1.11    .81   505   50       12  34.3       23  65.7        48.6     1.00
   .98       .00
```

11	.94	1.05	.90	559	48	5	14.3	28	80.0	72.9	1.00	1.00	.00
12	1.96	.98	1.05	605	44	4	11.4	32	91.4	85.7	1.00	1.00	.00
13	2.88	.95	1.12	646	43	1	2.9	33	94.3	92.9	1.00	1.00	.00
14	3.76	.94	1.14	686	42	2	5.7	35	100.0	97.1	1.00	1.00	.00
15	4.65	.96	1.07	726	43	0	.0	35	100.0	100.0	1.00	1.00	.00
16	5.73	1.16	.75	775	52	0	.0	35	100.0	100.0	1.00	1.00	.00
17	7.15	1.90	.28	839	86	0	.0	35	100.0	100.0	1.00	1.00	.00

1. SCORE: Score on test of all items. TOTALSCORE=Yes includes extreme items. TOTALSCORE=No excludes extreme items (if any).
   The score file shows integer raw scores, unless there are decimal weights for IWEIGHT=. In which case, scores to 1 decimal place are shown. To obtain other decimal raw scores for short tests, go to the Graphs pull-down menu. Select "Test Characteristic Curve". This displays the score-to-measure ogive. Click on "Copy data to clipboard". Open Excel. Paste. There will be to three columns. The second column is the measure, the third column is the raw score.

2. MEASURE: Measure (user-scaled by USCALE=)
   If this value is not the same as in PFILE=
   1. Missing data. The measure in the PFILE= is based on the responses observed. The measure in the SCOREFILE= is based on all the items.
   2. Convergence criteria. The convergence criteria: CONVERGE=, LCONV=, RCONV= are not tight enough for your data. Please try setting LCONV= and RCONV= to smaller values. SCFILE= measures are estimated from the item estimates reported in Table 14 using the technique at https://www.rasch.org/rmt/rmt102t.htm
   a. PFILE= values are obtained from the main estimation procedure, controlled by LCONV=, RCONV= and CONVERGE=
   b. SCOREFILE= person values are obtained from the stored item estimates from the main analysis, controlled by LCONV/1000 and RCONV/1000 which is higher numerical precision than a.
   If you need 1. and 2. to report the same values please set LCONV= and/or RCONV= smaller. For example, LCONV=.001 and RCONV=.005. This will cause more estimation iterations.

3. S.E.: Standard error (user scaled by USCALE=) - model, because empirical future misfit is unknown.
4. INFO: Statistical information in measure (=1/Logit S.E.^{2}) = observable points of the Test Information Function (TIF).

Measures locally-rescaled, so that sample mean=500, standard deviation=100
5. NORMED: Measure (rescaled)
6. S.E.: Standard error (rescaled)

Sample distribution:
7. FREQUENCY: Count of sample at this measure
8. %: Percent of sample at this measure
9. CUM.FREQ.: Count of sample at or below this measure
10. %: Percent of sample at or below this measure
11. PERCENTILE: The percent of the sample below the current measure.There are several definitions of percentile. Winsteps uses this one: Percentile Rank: The percentile is the cumulative frequency percent for the score below + half the frequency percent for the current score, half-rounded, and constrained to the range 1-99 for non-zero frequencies: . Percentiles for other definitions can be computed from the CUM. FREQ column. See, for instance, how-to-calculate-percentile. If the data are complete, then the raw data and the Rasch measures produce the same percentiles. If the data are incomplete, then the Rasch measures are used because they are robust against missing data.

Expected scores on items:
12. - ... one score for each item. This can be used for inferring raw scores from Angoff-type standard-setting scores.

If CSV=Y, these values are separated by commas. When CSV=T, the commas are replaced by tab characters.

Example 1: You wish to write a file on disk called "MYDATA.SCF.txt" containing a score-to-measure table for the complete test.

SCOREFILE=MYDATA.SCF.txt

Example 2: You want a score-to-measure file for items with known difficulties.

```
ITEM1=1   ; start of response string
NAME1=1
NI=10    ; number of items
CODES=01   ; valid item codes
IAFILE=*
; known item difficulties here
1 0.53
.......
10 -0.34
*
SAFILE=*
; known structure "step" calibrations here, if rating scale or partial credit items
*
SCOREFILE=sm.txt  ; the score-to-measure file - also see Table 20
&END
END LABELS
0101010101  ; two dummy data records
1010101010  ; give every item a non-extreme score
```

Example 3: Produce a cumulative percentage plot of raw scores:

1) Output the Scorefile= to Excel
2) Scatterplot with lines between points
3) x-axis: SCORES
4) y-axis: Cumulative Frequency %

For the inverse cumulative percentage plot (percentage point plot), switch the x-axis and the y-axis.

Example 4: more exact relationship between raw scores and Rasch measures.

1) "Output Files" menu, SCOREFILE= to Excel.
2) Excel scatterplot the measures against the scores
3) On the Excel scatterplot, a cubic trendline: display formula.

Example 5. Rasch measures and raw scores corresponding to Angoff Ratings.

For each item Angoff value this can give you the nearest person measure and raw score on all the items. The item conditional p-values are the right-most columns in the SCOREFILE=.

Judges' Use of Examinee Performance Data in an Angoff Standard-Setting Exercise for a Medical Licensing Examination: An Experimental Study. Brian E. Clauser, Janet Mee, Su G. Baldwin, Melissa J. Margolis and Gerard F. Dillon. Journal of Educational Measurement. Vol. 46, No. 4 (Winter 2009), pp. 390-407

A Latent Trait Method for Determining Intrajudge Inconsistency in the Angoff and Nedelsky Techniques of Standard Setting

Wim J. Van Der Linden. Journal of Educational Measurement. Vol. 19, No. 4 (Winter, 1982), pp. 295-308

Example. 6: You want PFILE=, Table 20 and SCOREFILE= to report exactly the same person measures (thetas) to 4 decimal places.

The PFILE= output uses the thetas estimated during the Winsteps main data analysis. Arithmetical precision and output are controlled by CONVERGE=, LCONV=, RCONV=, UDECIMALS= . For precision to 4 decimal places, we need LCONV= 0.00003 and maybe even smaller. Suggestion: set USCALE=10000 so that you can see what is happening beyond the 4th decimal place.

Winsteps Table 20 and SCOREFILE= compute the theta values based on the values of the item difficulties (deltas) and Andrich thresholds (taus, for polytomies) saved from the data analysis (IFILE=, SFILE=). The arithmetic precision of the theta computation is much higher LCONV*0.001 and RCONV*0.001 - this is at the request of users who build item banks with the IFILE item difficulties and wish to compare their item banking software to Winsteps. To perform a Winsteps main data analysis to this higher precision would require many iterations, during which the item difficulties would also change slightly.

You could try this:

Do the main analysis, output IFILE=if.txt and SFILE=sf.txt using your settings of CONVERGE=B, LCONV=lvalue, RCONV=rvalue, UDECIMALS=5

Reanalyze the data with anchored values IAFILE=if.txt and SAFILE=sf.txt with LCONV=lvalue/100, RCONV=rvalue/100, UDECIMALS=5, then produce Table 20 and SCOREFILE=

11.172 SCREEN= screen log file

SCREEN=filename (with no spaces) must be on the command line or in the short cut. Everything written to the Analysis window is also written to the screen file.

Example:
c:\> "C:\winsteps\winsteps.exe" controlfile.txt outputfile.txt SCREEN=screenfile.txt

The screen log file can be displayed from the Edit menu.

11.173 SDELQU= delete category structure interactively

This is better performed with IREFER= and IVALUE=. SDELQU= is not supported in this version of Winsteps.

11.174 SDFILE= category structure deletion file

This is better performed with IREFER= and IVALUE=. SDFILE= is not supported in this version of Winsteps.

11.175 SEPARATOR= or DELIMITER= data field delimiters

See DELIMITER=

11.176 SFILE= category structure-threshold output file

If SFILE=filename is specified, a file is output which contains the item and category information needed for anchoring structures. It has 4 heading lines (unless HLINES=N or ROW1HEADING=N), and has the format:

Example for dichotomous items:

```
; STRUCTURE-THRESHOLD MEASURE ANCHOR FILE
; CATEGORY  Rasch-Andrich threshold
 1     .00 ; this is a dummy threshold to tell Winsteps that 0 is the bottom category
 2     .00
```

Example for the Andrich Rating Scale model:

```
; STRUCTURE-THRESHOLD MEASURE ANCHOR FILE
; CATEGORY  Rasch-Andrich threshold
 0     .00 ; this is a dummy threshold to tell Winsteps that 0 is the bottom category
 1    -.86
 2     .86
```

Example for the Partial Credit model with ISGROUPS= 0

```
 STRUCTURE-THRESHOLD MEASURE ANCHOR FILE
; ACT CATEGORY  Rasch-Andrich threshold MEASURE
   1  0     .00 ; this is a dummy threshold to tell Winsteps that 0 is the bottom category
   1  1   -1.64
   1  2    1.64
   2  0     .00 ; this is a dummy threshold to tell Winsteps that 0 is the bottom category
   2  1    -.30
   2  2     .30
   3  0     .00  ; this is a dummy threshold to tell Winsteps that 0 is the bottom category
   3  1   -1.13
   3  2    1.13
....
```

Example with CMLE=Yes with Rating Scale Model.

```
; STRUCTURE-THRESHOLD MEASURE ANCHOR FILE
```

; CATEGORY Rasch-Andrich threshold
 0   .00 ;   .00 ; CMLE
 1 -.86 ;   -.80
 2   .86 ;   .80
......
JMLE threshold estimates are shown in the second column.
CMLE threshold estimates are shown in the third column. CMLE estimates are usually slightly more central than JMLE estimates.

Example with CMLE= Yes and null (unobserved) category with ISGROUPS= 0

```
; STRUCTURE-THRESHOLD MEASURE ANCHOR FILE FOR ....
; ACT CATEGORY  Rasch-Andrich threshold MEASURE
     1  0      .00 ;      .00  ; CMLE
     1  1    -3.94 ;    -3.62
     1  2     -.92 ;     -.74
     1  3     3.65 ;     3.65
     1  4    40.74 ;    40.67  ; NULL
     1  5   -39.52 ;   -39.96
```

Columns:
1. The item sequence number (I6), if required.
Shown only if there are multiple groupings in ISGROUPS= or SAITEM=Yes, otherwise this is omitted.

2. The category number (I3) (STRU) - the higher numbered of the pair of categories on each side of the Andrich threshold.

3. Andrich threshold value (structure calibration) (F7.2) (user-rescaled by USCALE=) (number of decimals by UDECIM=) (MEASURE)
Use this for anchoring, together with IFILE=

If CSV=Y, these values are separated by commas. When CSV=T, the commas are replaced by tab characters.

SFILE=? opens a Browse window

Andrich Thresholds for Unobserved Categories

When STKEEP=YES and there are intermediate null categories, i.e., with no observations, then the Rasch-Andrich thresholds are infinite. To approximate infinite Andrich thresholds in computer arithmetic, the Andrich threshold into the unobserved category is set 40 logits above the highest threshold calibration. The Rasch-Andrich threshold out of the unobserved category, and into the next category, is set down by the same amount. Thus:

Category Structure Calibration Rasch-Andrich Threshold		
Category	Table 3.2	In SFILE
0	NULL	0
1	-3	-3
2	NULL	40 + 2 = 42
3	1	1 - 40 - 2 = -41
4	2	2
TOTAL:	0	0

This is also an attempt to model unobserved categories for the next time, when they may be observed.

If categories will not be observed next time, then please specify STKEEP=NO, which automatically drops the category from the rating (or partial credit) scale.

If categories may be observed next time, then it is better to include a dummy data record in your data file which includes an observation of the missing category, and reasonable values for all the other item responses that accord with that missing category. This one data record will have minimal impact on the rest of the analysis.

Example for high-stakes examination:

We have a 12-category rating scale, 1-12, and are using the Partial Credit Model. Some items were not observed in the low categories (1-5). Consequently a standard PCM analysis treats these as items with a shorter rating scale. We don't want this. We want every item to have the full range of categories.

We apply some Bayesian-style thinking: There must be some severe cases somewhere who we may meet later, so let's include them now. An approach is to add two dummy data records that look like this:
12121212......12 dummy-1
21212121......21 dummy-2

give them a small weight so they don't mess up other statistics:
IWEIGHT=*
entry-number-for-dummy-1 .001
entry-number-for-dummy-2 .001
*

and keep unobserved intermediate categories:
STKEEP=Yes

Now, every item will be reported with the full range of categories 1-12. The easy items (originally without the low categories) will be reported correctly as the easiest items.

If we want to rerun the analysis without the dummy persons, then, from the analysis with the dummy persons:
SFILE= thresholds.txt

Remove the dummy persons:
SAFILE= threshold.txt ; anchor the thresholds
and reanalyze everything.

11.177 SFUNCTION= function to model Andrich thresholds with polynomials

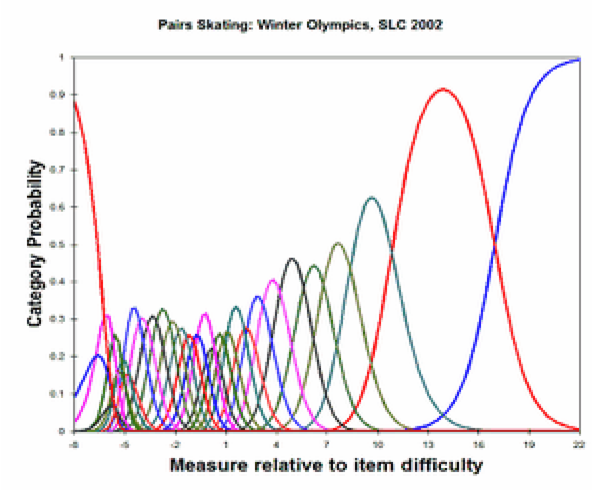
By default, the structure or a rating scale (polytomy) is estimated from the data, and expressed as Rasch-Andrich thresholds. When the data are sparse, or the rating scale is long, there may not be enough observations to estimate every threshold securely. SFUNCTION= defines a smoothing function for estimating all the rating scale thresholds. If all the categories are not observed in the data, ISRANGE= defines the range of the category numbers.

Alternative approaches are described at Null or unobserved categories: structural and incidental zeroes, also at Unobserved and dropped categories.

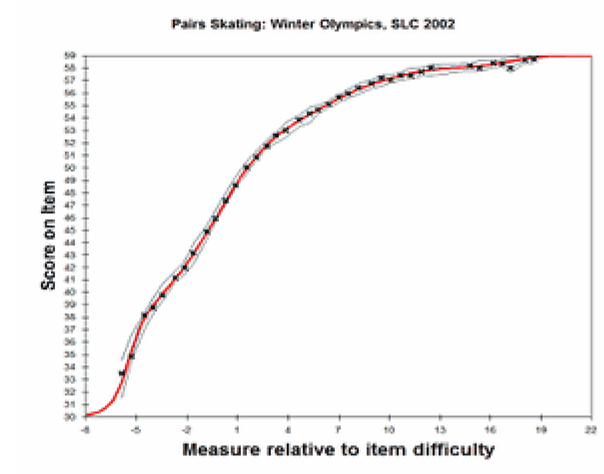
Modeling Rasch-Andrich Thresholds for unobserved and sparse categories
Example: Olympic Ice-Skating, Exam15.txt. The rating-scale is from 0.0 to 6.0, renumbered 00 to 60 for Rasch analysis. The empirical data are from the Pairs Figure-Skating at the Salt Lake City Olympics. Category frequencies: Possible categories: 0-60 = 61 categories Observed categories: 29, 30-59 = 30 categories Unobserved categories: 00-28, 30, 60 = 31 categories

Analysis 1: Categories 29, 31-59 observed, renumbered 30-59. Estimated using the method of Wright, Masters (1982).
`CODES=      " 29 31 32 33 34 35 36 37 38 39 40 41 42 43 44+`
`            + 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59"`

```
NEWSCORE = " 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44+
           + 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59"
STKEEP=NO
```



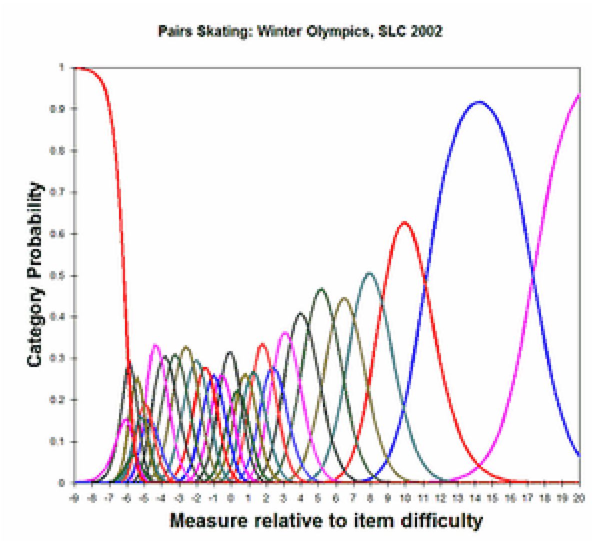
Category Probability Curves

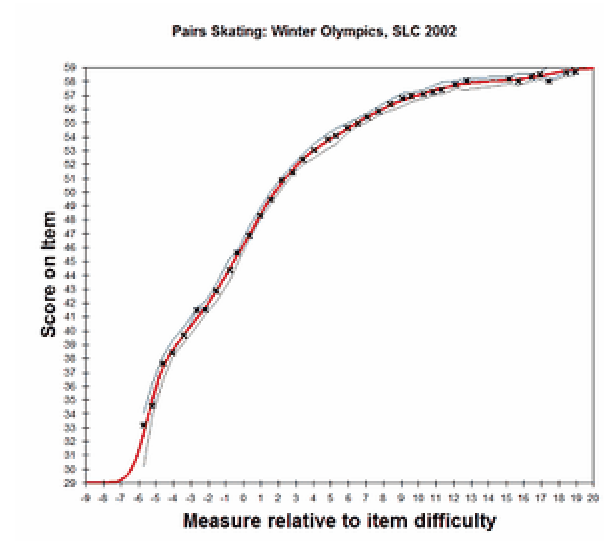


Item Characteristic Curves
Red: Model, Blue: Empirical (with confidence bands)

Analysis 2: Categories 29, 31-59 observed. Category 30 interpolated with Wilson (1991).

```
CODES= " 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44+
       + 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59"
or
CODERANGE= 29 - 59
STKEEP=YES
```





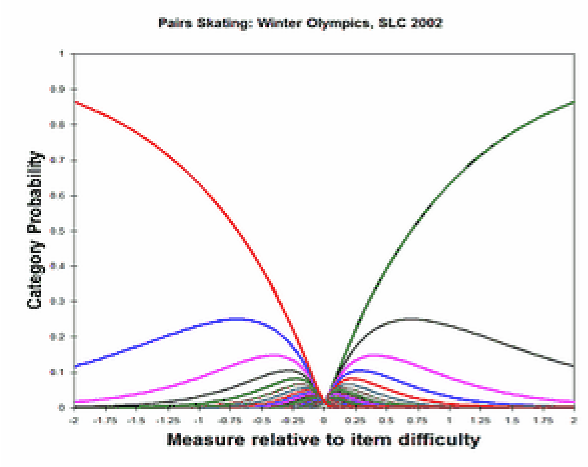
Analysis 3: 1st moment (thresholds at central location). All thresholds have the same estimate. Categories 0-60.

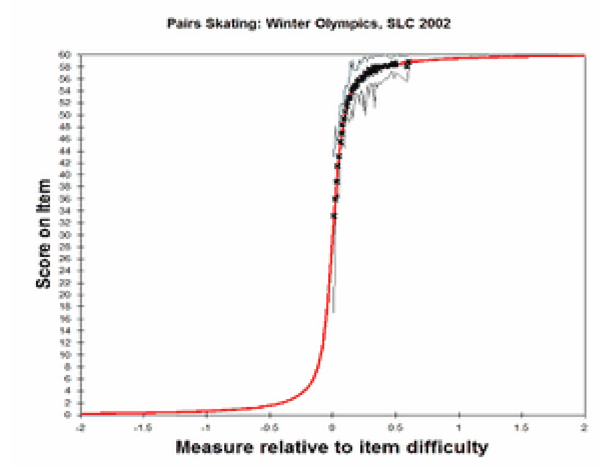
```
CODERANGE= 0 - 60
SFUNCTION=1 ; item thresholds are at item location. Threshold dispersion = 0.
ISRANGE=*
1 0 60 ; 1 is item in the item-group: category range 0-60
*
```

or

```
SAFILE=*
```

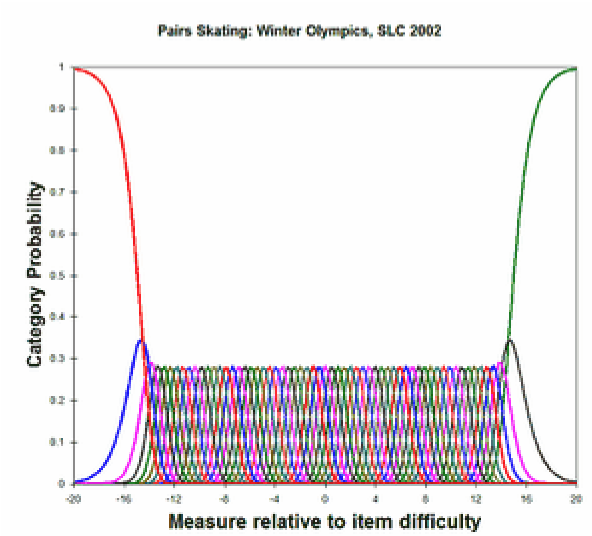
```
0-60 0 ; all thresholds anchored at 0
*
```

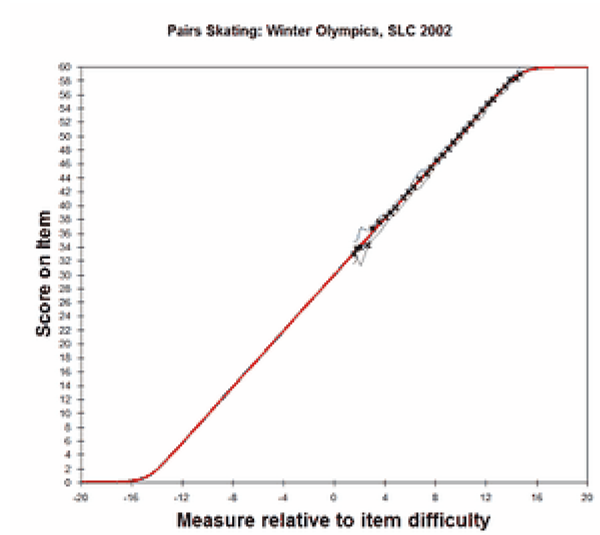




Analysis 4: 2nd moment (thresholds with uniform dispersion) . Thresholds have a linear relationship. Categories 0-60 with Andrich, Luo (2003), Pedler (1987)

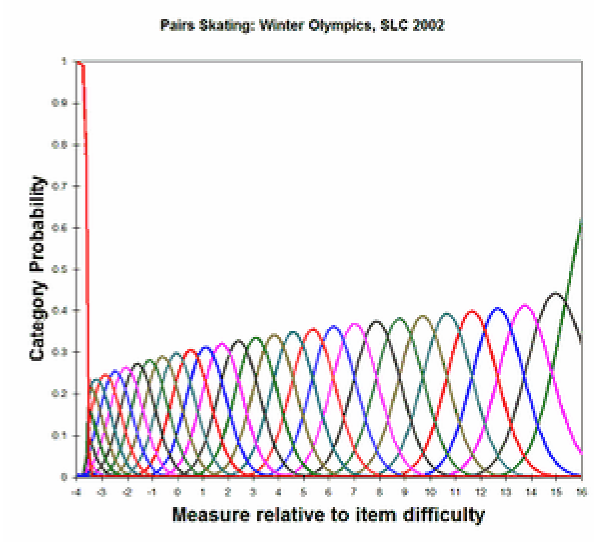
```
CODERANGE= 0 - 60
SFUNCTION=2
ISRANGE=*
1 0-60
*
```

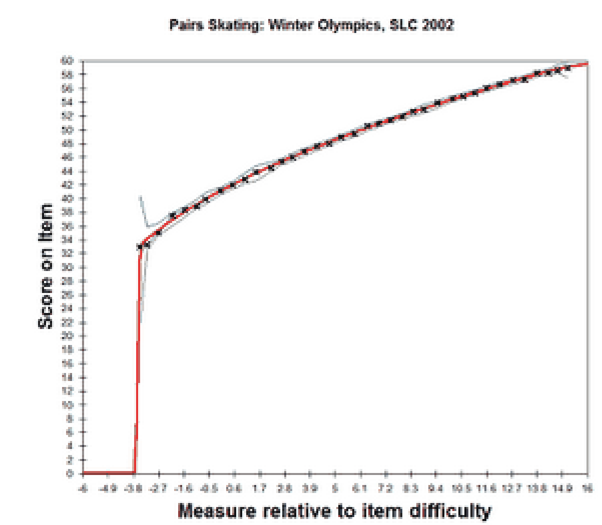




Analysis 5: 3rd moment (thresholds with dispersion and skewness). Thresholds have a quadratic relationship. Categories 0-60 with Andrich, Luo (2003), Pedler (1987)

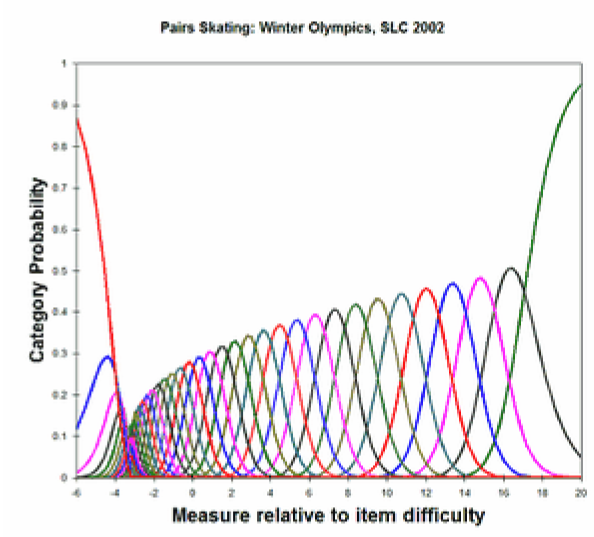
```
CODERANGE= 0 - 60
SFUNCTION=3
ISRANGE=*
1 0-60
*
```

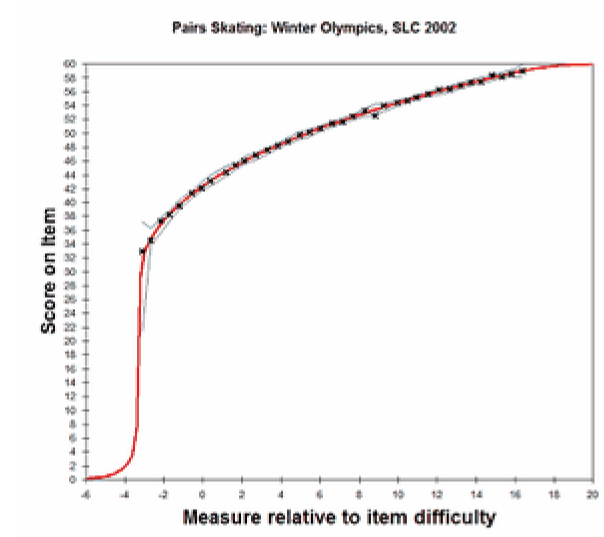




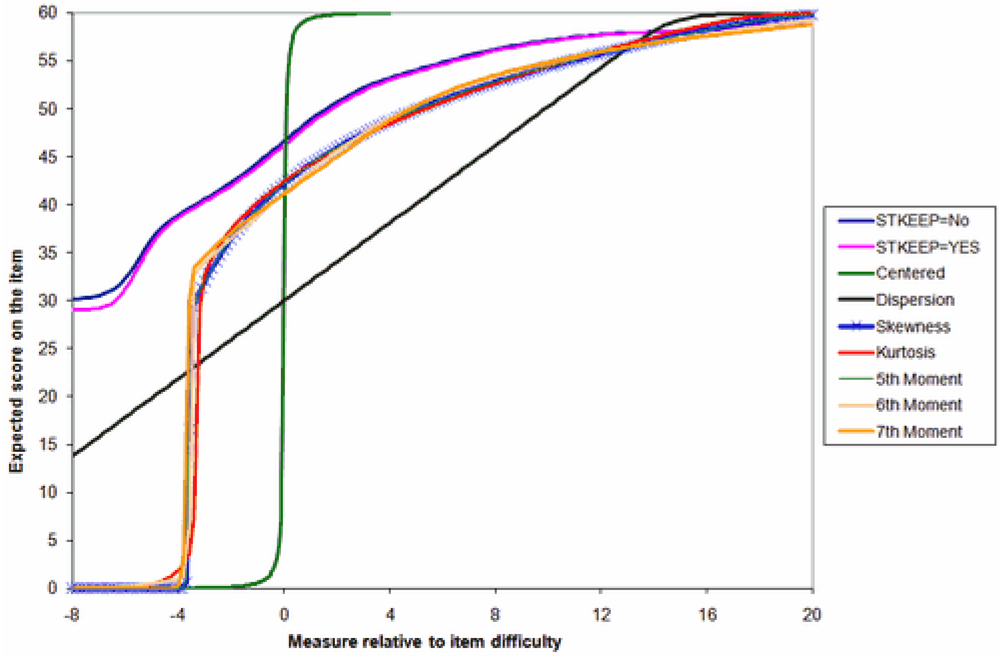
Analysis 6: 4th moment (thresholds with dispersion, skewness and kurtosis). Thresholds have a cubic relationship. Categories 0-60 with Andrich, Luo (2003), Pedler (1987)

```
CODERANGE= 0 - 60
SFUNCTION=4
ISRANGE=*
1 0-60
*
```





<table>
<tr><td>ICCs for these and higher moments

The 4th moment (kurtosis, red line, quartic) models the smoothest ICC for the full range of the rating scale 0-60. The higher moments (SFUNCTION=5,6,...) do not add meaningfully to the red line of the 4th moment (kurtosis, SFUNCTION=4).</td><td>
</td></tr>
<tr><td colspan="2">Andrich, D. & Luo, G. (2003). Conditional Pairwise Estimation in the Rasch Model for Ordered Response Categories using Principal Components. Journal of Applied Measurement, 4(3), 205-221.
Pedler, P.J. (1987) Accounting for psychometric dependence with a class of latent trait models. Ph.D. dissertation. University of Western Australia.
Wilson M. (1991) Unobserved or Null Categories. Rasch Measurement Transactions, 5:1, 158 - www.rasch.org/rmt/rmt51b.htm
Wright B.D., Masters G.N. (1982) Rating Scale Analysis. MESA Press.</td></tr>
</table>

11.178 SICOMPLETE= simulate complete data

Data simulated with SIFILE= . See simulated data file. When simulating a data file SIFILE= the missing-data pattern in the originating data may be copied or ignored.

SICOMPLETE = Yes
generate a complete rectangular data set from the generating values.

SICOMPLETE = No
generate a rectangular data set with missing values where the originating data set has missing values. This has no effect if the originating data set is complete, without missing responses.

Example: For a CAT dataset, we want to simulate responses only where responses were made:
SICOMPLETE = No

11.179 SIEXTREME= simulate extreme scores

Data are simulated with SIFILE= . See simulated data file. Simulated data files may contain extreme scores (zero, minimum possible and perfect, maximum possible scores) by chance.

SIEXTREME = Yes
allow extreme score to be part of the simulated data.

SIEXTREME = No
avoid generating extreme scores in the simulated data. This may not be possible. This option may also produce measures which are more central than the generating values.

Example: In a study of differential item functioning extreme scores are not wanted:
SIEXTREME = No

11.180 SIFILE= simulated data file

Data are simulated with SIFILE= . See simulated data file.

SIFILE = file name SIFILE=? opens a Browse window	name of output file to hold simulated data the format of the simulated file is controlled by the filename suffix. If there is more than one simulated file specified with SINUMBER= then the file name is automatically incremented by one for each simulated data file.

The simulated data file has the same format as the original data. It may be accessed from the original control file by using DATA= at the Extra Specifications prompt.

Other control variables for simulated data files are SICOMPLETE=, SIEXTREME=, SIMEASURE=, SINUMBER=, SIRESAMPLE=, SISEED=

11.181 SIMEASURE= measure or data

Data simulated with SIFILE= . See simulated data file.

SIMEASURE = Yes	Simulate data from the Rasch measures
SIMEASURE = No	Simulate data by re-sampling from observed response strings.

11.182 SINUMBER= number of simulated data files

Data simulated with SIFILE= . See simulated data file. More than one simulated data file SIFILE= can be generated.

SINUMBER = 1 produce one simulated data file
SINUMBER > 1 produce more than one simulated data file.

For the first simulated data file, its name is given by SIFILE= (or a temporary file) and the random number seed is given by SISEED=.

For the second and subsequent simulated data files when SINUMBER>1, then the data file name increments from SIFILE= and the seed number increments from SISEED, unless the seed is based on the system clock.

Example. Produce 3 simulated files with seed starting at 101.
 SIFILE = mysimulation.txt
 SINUMBER = 3
 SISEED = 101

The three output files will be:
 mysimulation.txt with seed 101
 mysimulation2.txt with seed 102
 mysimulation3.txt with seed 103

11.183 SIRESAMPLE= number of persons resampled

Data can be simulated with SIFILE= . See simulated data file.

SIRESAMPLE= 0	The simulated corresponds exactly with the original data
SIRESAMPLE= number	The simulated data file contains *number* person records. These are produced by: 1. SIMEASURE=Yes - re-sampling the person measures. 2. SIMEASURE=No - re-sampling the person response strings.

11.184 SISEED= simulated data seed

Data simulated with SIFILE= . See simulated data file. Simulated data files are constructed using a random number generator for selecting the responses. The random generator number uses a seed value to initiate its pseudo-random sequence of numbers. The seed value can either be set by the user, or be the current value of the system clock.

SISEED = 0 or 1 means use the system clock to seed the random number generator.
SISEED = 2 or above (integer) means use this value to seed the random number generator.

If more than one simulated data file is produced with SINUMBER= then
if SISEED = 0 or 1, the new current setting of the system clock is used for each simulated file
if SISEED > 1, the user-specified seed is advanced by 1 for each simulated file

Example: You want to simulate the same data set several times, so you choose the seed:
SISEED = 237 ; 237 is any number.

11.185 SORTABLE= webpage has sortable columns

SORTABLE= Yes	When webpage output is produced, the data columns are sortable by clicking on the column headings. Example at www.winsteps.com/a/webtable.html
SORTABLE= No	Webpage output does not have sortable columns

11.186 SPFILE= supplementary control file

There is often a set of control instructions that you wish to make a permanent or temporary part of every control file. Such files can be specified with SPFILE=. Multiple SPFILE= specifications can be included in one control file. Supplemental files called with SPFILE= can also include SPFILE= specifications.

SPFILE= file name	file containing details
SPFILE = *	in-line list (useful for testing)
SOFILE = ?	opens a Browser window to find the file

Example 1: The analyst has a standard set of convergence criteria and other control instructions to include in every control file.
a) Enter these into a standard DOS TEXT/ASCII file, e.g, SUPPL.TXT
The analyst's SUPPL.TXT contains:
LCONV=.01
ITEM=TASK
PERSON=CLIENT
TABLES=101110011

b) Specify this supplemental file in the main control file, say, MAIN.TXT
TITLE='NEW YORK CLIENTS'
SPFILE=SUPPL.TXT
ITEM1=37
NI=100

Example 2: The analyst has a set of control instructions that are used only for the final run. These are coded in a separate DOS TEXT file called FINAL.txt
C:>Winsteps CONTROL.txt OUTPUT.txt SPFILE=FINAL.txt

Example 3: KEYn= is a particularly useful application of SPFILE=.
Put the KEY1= instruction for each test form in its own DOS TEXT file, then reference that file rather than including the key directly in the control file.

Here is FORMA.KEY:
NI=23
CODES=ABCD
KEY1=ABCDDADBCDADDABBCAADBBA

Here is the control file:
TITLE='FORM A READING RASCH ANALYSIS'
ITEM1=20
SPFILE=FORMA.KEY
TABLES=111011011
|

11.187 STBIAS= correct for estimation bias

STBIAS=Y causes an approximate correction for estimation bias in JMLE estimates to be applied to measures and calibrations. This is only relevant if an exact probabilistic interpretation of logit differences is required for short tests or small samples. Set STBIAS=NO when using IWEIGHT=, PWEIGHT=, anchoring, IAFILE=, PAFILE=, SAFILE= or artificially lengthened tests or augmented samples, e.g., by replicating item or person response strings.

Fit statistics are computed without this estimation-bias correction. Estimation-bias correction makes the measures more central, generally giving a slight overfit condition to Outfit and Infit. Correct "unbiased" computation of INFIT and OUTFIT needs not only unbiased measures, but also probabilities adjusted for the possibility of extreme score vectors (which is the cause of the estimation bias).

STBIAS=YES instructs Winsteps to compute and apply statistical-bias-correction coefficients to the item difficulties and to the person measures - based on the current data. This becomes complicated for anchor values and scoring tables. With STBIAS=YES, the item anchor values are assumed to be bias-corrected. Consequently bias is applied to make them compatible with JMLE computations for the current data. The resulting person measures are JMLE person estimates, which are biased. So a person bias correction is applied to them.

For the special case of two items for each person, or two persons for each item, please use PAIRED=Yes to correct for bias.

With **STBIAS=No,** there is no statistical bias correction, so the internal and reported values are the same. The process is

For unanchored item values,
data + internal person estimates => internal item estimates => reported item estimates
For anchored item values,
anchored item values => internal item estimates => reported item estimates

For unanchored person values,
data + internal item estimates => internal person estimates => reported person estimates
For anchored person values,
anchored person values => internal person estimates => reported person estimates

For a scoring table
reported item estimates => internal item estimates => internal person estimates => reported person estimates

With **STBIAS= YES**, the internal and reported values differ. The process is

Compute bias correction coefficients for item estimates and for person estimates based on the current data.

For unanchored item values,
current data + internal person estimates => internal item estimates => item bias correction => reported item estimates
For anchored item values,
anchored item values => undo item bias correction => internal item estimates => item bias correction => reported item estimates

For unanchored person values,

data + internal item estimates => internal person estimates => person bias correction => reported person estimates
For anchored person values,
anchored person values => undo person bias correction => internal person estimates => person bias correction => reported person estimates

For a scoring table, the process is
reported item estimates => undo item bias correction => internal item estimates => internal person estimates => person bias correction => reported person estimates.

Note: it is seen that this process can result in estimates that are worse than uncorrected JMLE estimates. Consequently it may be advisable not to use STBIAS=YES unless the bias correction is clearly required.

Question: Are JMLE estimates always biased?

Answer: Yes, but the bias becomes inconsequential (less than the standard errors) for tests with more than 20 persons and more than 20 items - www.rasch.org/memo45.htm

Question: Are person estimates in JMLE biased as well as the item difficulty estimates?

Answer: The Rasch model does not know what is a person and what is an item. Smaller person samples for a given test length and shorter tests for a given person sample size generally make the estimation bias worse. Winsteps is constructed so that transposing the rows and columns of the data matrix (with dichotomous items or the Andrich rating scale model) produces statistically the same item and person measures (apart from a change of sign). CMLE and MMLE do not have this property. This transposition property is convenient in those types of analysis where it is not clear what is a "person" and what is an "item" - e.g., a matrix of street intersections and calendar dates with "0" for no traffic accident and "1" for traffic accident. It also enables analysis with a person-based "Partial Credit" model, where each person has a unique rating scale.

Question: Are person estimates obtain from known or anchored item difficulties statistically biased?

Answer: Under these circumstances, estimation is no longer "Joint" (persons and items), but becomes the AMLE (Anchored Maximum Likelihood Estimation) used to estimate person abilities from item difficulties in other estimation methods (CMLE, MMLE, PMLE, etc.)

Question: What is the bias correction used by Winsteps?

Assuming dichotomous, complete data:
Unbiased item estimate = biased estimate * (number of items - 1) / number of items
Unbiased person estimate = biased estimate * (number of persons - 1) / number of persons

However, Winsteps does more than this because it also has to process missing data and polytomies. Consequently Winsteps bias correction became more and more complicated. Work on refining JMLE bias correction in Winsteps ceased when we realized that bias correction rarely made any practical difference, and in those situations where bias-correction matters (small, high-stakes datasets), CMLE is readily available.

Question: what about other data?
An empirical solution is to estimate the Rasch measures from your data. Note down the person S.D.
Then use the Winsteps "Output Files" "simulate data" option to simulate 10 datasets.
Analyze these, and average the person S.D.s
(This process can be automated using Winsteps "BATCH=" capability)
Compare the average with the original estimate person S.D. - this will tell you the size of the bias.
Then apply USCALE= bias correction to the original analysis to obtain unbiased estimates. The unbiased estimates will always be more central (smaller range) than the biased estimates.

Example 1: I have a well-behaved test of only a few items, but I want to correct for statistical estimation bias because I want to me to make exact probabilistic inferences based on differences between logit measures:
STBIAS=Y

Example 2: I have a set of item difficulties from RUMM (or ConQuest or OPLM or ...) and want to construct a score-table that matches the RUMM person measures.

```
 IAFILE = (RUMM item difficulties)
 STBIAS = No ; don't change the estimates - use the values RUMM uses
 TFILE=*
 20  ; Table 20 is the score table
 *
...
END LABELS
01010101010101010  ; Dummy data records
10101010101010101 ; so that Winsteps will run
```

11.188 STEPT3= include category structure summary in Table 3.2 or 21

The structure summary statistics usually appear in Table 3. For grouped analysis this part of Table 3.2 can become long, in which case it can be moved to Table 21.

Example: Don't output partial credit structure summaries in Table 3.2. Move them to Table 21:

```
  ISGROUPS=0 ; each item has own rating scale
  STEPT3=N ; report scale statistics in Table 21
```

11.189 STKEEP= keep unobserved intermediate categories in structure

Unobserved categories can be dropped from rating (or partial credit) scales and the remaining category recounted during estimation. For intermediate categories only, recounting can be prevented and unobserved categories retained in the analysis. This is useful when the unobserved categories are important to the rating (or partial credit) scale logic or are usually observed, even though they happen to have been unused this time. Category Rasch-Andrich thresholds for which anchor calibrations are supplied are always maintained wherever computationally possible, even when there are no observations of a category in the current data set.

Use STKEEP=YES when there may be intermediate categories in your rating (or partial credit) scale that aren't observed in this data set, i.e., incidental or sampling zeroes.

Use STKEEP=NO when your category numbering deliberately skips over intermediate categories, i.e., structural zeroes.

Use IVALUE= to rescore each item independently to keep or eliminate unobserved categories.

STKEEP=N Eliminate unused categories and close up the observed categories.

STKEEP=Y Retain unused non-extreme categories in the ordinal categorization.

When STKEEP=Y, missing categories are retained in the rating (or partial credit) scale, so maintaining the raw score ordering. But missing categories require locally indefinite structure calibrations. If these are to be used for anchoring later runs, compare these calibrations with the calibrations obtained by an unanchored analysis of the new data. This will assist you in determining what adjustments need to be made to the original calibrations in order to establish a set of anchor calibrations that maintain the same rating (or partial credit) scale structure.

To remind yourself, STKEEP=YES can be written as STRUCTUREKEEP=YES, STRKEEP=YES or STEPKEEP=YES and other similar abbreviations starting STK, STR and STEPK.

Example 1: Incidental unobserved categories. Keep the developmentally important rating (or partial credit) scale categories, observed or not. Your small Piaget rating scale goes from 1 to 6. But some levels may not have been observed in this data set.

```
  STKEEP=Y
```

Example 2: Structural unobserved categories. Responses have been coded as "10", "20", "30", "40", but they really mean 1,2,3,4

```
  CODES = "10203040"
```

XWIDE = 2
STKEEP=NO
; if STKEEP=YES, then data are analyzed as though categories 11, 12, 13, 14, etc. could exist, which would distort the measures.
; for reporting purposes, multiply Winsteps SCORE by 10 to return to the original 10, 20, 30 categorization.

Example 3: Some unobserved categories are structural and some incidental. Rescore the data and use STKEEP=YES.
Possible categories are 2,4,6,8 but only 2,6,8 are observed this time.
(a) Rescore 2,4,6,8 to 1,2,3,4 using IVALUE= or NEWSCORE=
(b) Set STKEEP=YES, so that the observed 1,3,4 and unobserved 2 are treated as 1,2,3,4
(c) For reporting purposes, multiply the Winsteps SCORE by 2 using Excel or similar software.
CODES=2468
NEWSCORE=1234
STKEEP=YES

Example 4: There are both dichotomous items(0/1) and polytomous items(0/1/2) in the same test. Items 1-5 are dichotomies, and 6-10 are polytomies with the same rating scale:
ISGROUPS = DDDDDPPPPP ; items 1-5, the dichotomies, are in one item-group, items 6-10, the polytomies, in another.
CODES = 012 ; has all valid codes in the data file.
; For dichotomies, STKEEP= has no effect.
; For polytomies: If the data contain 0/1/2 then STKEEP= has no effect.
; If the data contain 0/2 (but no 1's), what is to be done?
STKEEP = No ; 0/2 is to be automatically recoded 0/1
STKEEP = Yes ; 0/2 is to be analyzed as 0/1/2

Incidental and Structural Zeroes: Extreme and Intermediate

For missing intermediate categories, there are two options.

If the categories are missing because they cannot be observed, then they are "structural zeroes". Specify "STKEEP=NO". This effectively recounts the observed categories starting from the bottom category, so that 1,3,5,7 becomes 1,2,3,4.

If they are missing because they just do not happen to have been observed this time, then they are "incidental or sampling zeros". Specify "STKEEP=YES". Then 1,3,5,7 is treated as 1,2,3,4,5,6,7.

Categories outside the observed range are always treated as structural zeroes.

When STKEEP=Y, unobserved intermediate categories are imputed using a mathematical device noticed by Mark Wilson. This device can be extended to runs of unobserved categories.

Idiosyncratic rating scales: the Barthel Index

Winsteps has two ways of analyzing rating scales such as 0,2,5,8,10 in the Barthel Index.
1. STKEEP=No. Unobserved rating-scale categories are structural zeroes. This converts 0,2,5,8,10 into 0,1,2,3,4
2. STKEEP=Yes (the default). Unobserved rating-scale categories are sampling zeroes. This converts 0,2,5,8,10 into 0,1,2,3,4,5,6,7,8,9,10

It appears that the Barthel Index is using weighted categories, so its scoring implies:
0,2,5,8,10 = 0, 2x1, 2.5x2, 2.66x3, 2.5x4
Winsteps does not support different weighting of different categories. This can be done in *Facets*, but *Facets* does not output KeyForms.
An approximation in Winsteps could be:
0,2,5,8,10 ≈ 0, 2.5x1, 2.5x2, 2.5x3, 2.5x4 = (STKEEP=No) 0,1,2,3,4 with an item weight of IWEIGHT= 2.5
then edit the KeyForm from 0,1,2,3,4 to become 0,2,5,8,10

11.190 SUBSETS= perform subset detection

When there are missing data, subsets of the observations may not be measurable with other subsets. For instance, Person sample A responds to Test Form A, and Person sample B responds to Test Form B. If there are no common items nor common persons, combining these two datasets into one analysis will produce two disconnected subsets of responses.

SUBSETS= Yes performs subset and connectivity detection.

SUBSETS = No bypasses subset detection.

When subset detection is activated, "Probing Data Connection" displays in the Winsteps analysis window. Here is an analysis of Examsubs.txt

```
PROBING DATA CONNECTION: to skip out: Ctrl+F - to bypass: subset=no
>====================================<
Consolidating 8 potential subsets pairwise ...
>====================================<
Consolidating 8 potential subsets indirectly pairwise ...
>====================================<
Warning: Data are ambiguously connected into 8 subsets. Measures may not be comparable across subsets.
Subsets details are in Table 0.4
```

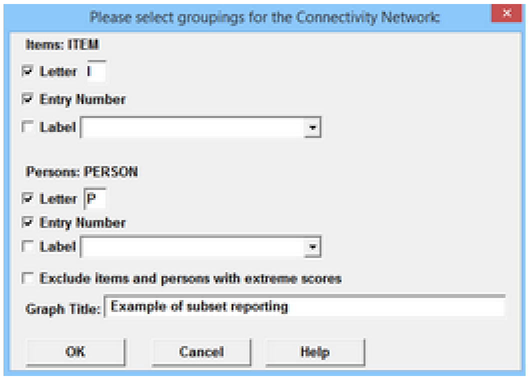
Subsets are reported In Table 0.4 if any are discovered.

```
TABLE 0.4 Example of subset reporting

SUBSET DETAILS

SUBSET 1 OF 2 ITEM AND 2 PERSON
 ITEM: 2-3
 PERSON: 2-3
SUBSET 2 OF 2 ITEM AND 2 PERSON
 ITEM: 4-5
 PERSON: 4-5
SUBSET 3 OF 1 PERSON
 PERSON: 6
SUBSET 4 OF 2 ITEM AND 2 PERSON
 ITEM: 7-8
 PERSON: 7-8
SUBSET 5 OF 2 ITEM AND 2 PERSON
 ITEM: 9-10
 PERSON: 9-10
SUBSET 6 OF 2 PERSON
 PERSON: 11-12
SUBSET 7 OF 3 PERSON
 PERSON: 13-15
SUBSET 8 OF 1 ITEM
 ITEM: 6
```

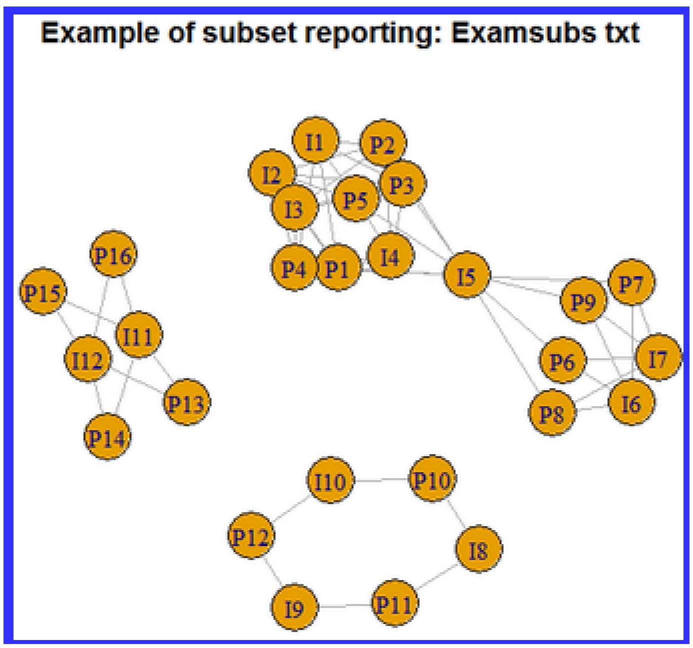
Subsets are also shown to the right of the measure tables, Table 14.1, Table 18.1, etc.

```
| PERSON                   |
+--------------------------|
| 01 Extreme  11111        |
| 02 Subset 1 01111        | SUBSET 1
| 03 Subset 1 10111        | SUBSET 1
| 04 Subset 2 00101        | SUBSET 2
| 05 Subset 2 00011        | SUBSET 2
| 06 Subset 3     011      | SUBSET 3
| 07 Subset 3     011      | SUBSET 3
| 08 Subset 4     001      | SUBSET 4
| 09 Subset 4     010      | SUBSET 4
| 10 Subset 5        0x1   | SUBSET 5
| 11 Subset 5        10x   | SUBSET 5
| 12 Subset 5        x10   | SUBSET 5
| 13 Subset 6           01| SUBSET 6
| 14 Subset 6           10| SUBSET 6
| 15 Subset 6           23| SUBSET 6
| 16 Subset 6           32| SUBSET 6
+--------------------------|
```

and here from the Plots menu



is the Connectivity Network Graph. Notice that the Network Graph does not detect Guttman splits in the data, such as between "Extreme" and subset 1, also subsets 2 and 3, but the graph does show that item 5 is the only connection between subsets 2 and 3.



11.191 SVDEPOCHS= maximum epochs for SVD estimation

SVDEPOCHS= sets the maximum number of epochs (iterations through the data) for estimating each SVD factor.

See SVDFILE=.

11.192 SVDFACTORS= singular-value decomposition factors

SVDFACTORS= sets the number of factors to estimate. Factor processing can be forced to conclude with Ctrl+F, "finish factoring".

See SVDFILE=.

11.193 SVDFILE= singular-value decomposition file

Singular-value decomposition (SVD) is a technique for factoring a data matrix. Here it is used to look for patterns in the Rasch residuals which may indicate multidimensionality. SVD values are estimated by iterating through the residual data matrix. Each residual is explained, as much as possible, by a value attributed to the person (row) and a value attributed to the item (column). These values are multiplied.

The SVD estimation method implemented in Winsteps uses randomization for speed and flexibility, so the results reported for each estimation run are slightly different. For a description of the algorithm, see "Finding structure with randomness: Probabilistic algorithms for constructing approximate matrix decompositions. Nathan Halko, Per-Gunnar Martinsson, Joel A. Tropp. SIAM Rev., Survey and Review section, Vol. 53, num. 2, pp. 217-288, June 2011. https://arxiv.org/pdf/0909.4061.pdf

SVDFILE=? opens a Browse window

The general form of the Rasch-SVD model is:

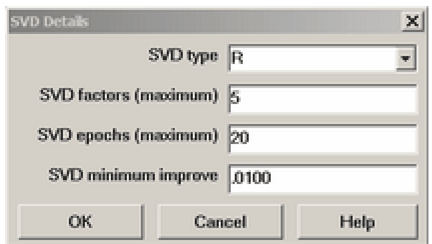
$$X_{ni} = E_{ni} + V_n{*}U_i \pm \varepsilon$$

where X_{ni} is the observation when person *n* meets item *i*. E_{ni} is the Rasch-expected value. V_n is the SVD value for the person. U_i is the SVD value for the item. ε is the unexplained part of the residual.

After the first set of SVD values have been estimated, the process can be continued deeper down to further levels:

$$X_{ni} = E_{ni} + V_{1n}{*}U_{1i} + V_{2n}{*}U_{2i} \; ... \pm \varepsilon$$

SVD control settings. These can be in the control file, or from the Output file menu, SVDFILE option.



Control	Default	Explanation
SVDFACTORS=	5	is the number of SVD terms (factors) to be estimated for each residual. SVD computation can be concluded with Ctrl+F.
SVDEPOCHS=	20	is the maximum number of epochs (iterations through the data) for estimating each SVD factor
SVDMIN=	.01	is the minimum improvement of the root-mean-square residuals based on the current SVD estimates at the end of an SVD iteration (epoch) through the data matrix of residuals in order for SVD estimation to finish for that SVD factor.
SVDTYPE=	R	is the type of residual to be decomposed. R = the raw residual or S = the standardized residual.
SVDFILE=		name of the output file for the SVD values.

SVD file format:

```
; SVD FILE FOR LIKING FOR SCIENCE (Wright & Masters p.18) SVDTYPE= S SVDFACTORS= 4 SVDMIN= .0010 KID= 75 ACT= 25
;     RMSR     .5422     .4793     .4595     .4244     .4027
;     RMSS    1.0404     .8715     .8133     .7424     .6983
;      KID   MEASURE         1         2         3         4       ACT   MEASURE         1         2         3
         1     .6099    -.0607     .2212    -.4504    -.1882         1    -.3960    -.2002    -.9116     .1108
         2    6.0751         0         0         0         0         2    -.7086    -.7039     .2789   -1.1431
         3    1.0973     .0243    -.1957    -.2856     .0619         3     .4174    -.3841     .0428     .0975
         4     .2611     .0999     .1702     .2774     .2440         4    1.7504     .3857    -.9536     .9610
         5    -.6731     .8925    -.0656    -.2772    -.3505         5    2.4183    2.5783    3.3365   -1.1817
```

The first four lines are heading lines. To omit them, specify HLINES=NO or in the Output Files specifications dialog box. ROW1HEADING=N to omit the first line only.

RMSR = Root-mean-square-residual corresponding to the column of Rasch measures or SVD factors.

RMSS = Root-mean-square-standardized-residual corresponding to the column of Rasch measures or SVD factors.
MEASURE = Rasch measure in Table 14 etc.
1 2 3 4 ... are the columns of SVD values. For each SVD factor, every person and every item has an SVD value.

SVD factors corresponding to extreme scores have 0 values.

11.194 SVDMIN= singular-value decomposition minimum improvement

SVDMIN= sets the change in root-mean-square (RMS) at which an SVD factor is deemed to have converged. If the change in the RMS at the end of an epoch (iteration through the data) is less than SVDMIN=, then estimation advances to the next SVD factor.

Factor convergence can be forced with Ctrl+E, "end epochs".

See SVDFILE=.

11.195 SVDTYPE= singular-value decomposition residual type

SVDTYPE= sets the type of residual to factor.
SVDTYPE=R is the raw residual: (observation - Rasch expectation)
SVDTYPE=S is the standardized residual: (observation - Rasch expectation) / √(model variance)

See SVDFILE=.

11.196 T1CAT= show category number

In Tables 1.5, 1.6, 1.7, 1.8, 1.9, 12.5, 12.6, 12.7, 12.8, 12.9

T1CAT=	Category numbers in column headings are
(blank)	as in earlier versions of Winsteps
Scored	Category value after specified scoring with NEWSCORE=, etc. (if any)
Recounted	Category score counting up from lowest observed value
Zero	Category score counting up from zero

11.197 T1I#= number of items summarized by "#" symbol in Table 1

For ease in comparing the outputs from multiple runs, force consistent x-axis scaling by using MRANGE=, T1I#= and T1P#=. Choose T1I#= to be the largest number of items summarized by one "#" from any of the separate runs.

Example: In one run, the bottom of Table 1 (or Table 16) states that
EACH "#" IN THE ITEM COLUMN IS 20 ITEMS
In another run: EACH "#" IN THE ITEM COLUMN IS 15 ITEMS
To make the runs visually comparable, specify the bigger value:
T1I#=20

11.198 T1MWE= mean and S.D. with extreme measures in Tables 1, 12, 16

T1MWE= controls the computations of the Mean (M), 1 and 2 Standard Deviations from the mean (S,T) in Tables 1, 12, 16. If PWEIGHT= or IWEIGHT= then weighting is applied.	Do Means and S.D.s in Tables 1, 12, 16 include items or persons with extreme scores (measures)?

T1MWE= Yes (the default)	Item and person M,S,T in Tables 1, 12, 16 include the measures for persons and items with extreme scores.
T1MWE= Items	Item M,S,T in Tables 1, 12, 16 include the measures for items with extreme scores. Person with extreme scores are excluded from the person M,S,T.
T1MWE= Persons	Person M,S,T in Tables 1, 12, 16 include the measures for persons with extreme scores. Items with extreme scores are excluded from the item M,S,T.
T1MWE= No	M,S,T in Tables 1, 12, 16 exclude the measures for persons and items with extreme scores.

11.199 T1P#= number of persons summarized by "#" symbol in Table 1

For ease in comparing the outputs from multiple runs, and to force consistent x-axis scaling by using MRANGE=, T1I#= and T1P#=. Choose T1P#= to be the largest number of persons summarized by one "#" from any of the separate runs.

T1P#= can increase the number of persons for each # above the value computed by Winsteps.

Example: In one run, the bottom of Table 1 (or Table 12) states that
EACH "#" IN THE PERSON COLUMN IS 250 PERSONS
In another run: EACH "#" IN THE PERSON COLUMN IS 300 PERSON
To make the runs visually comparable, specify the bigger value:
T1P#=300

11.200 T1SCORE= show raw score in Tables 1,12,16

For Tables 1, 12, 16: T1SCORE=Yes shows the raw score on all active items alongside the measures:

To make T!SCORE=Yes permanent, add it to Edit Initial Settings

<table>
<tr><td>T1SCORE=No

No raw score</td><td>

```
TABLE 1.1 LIKING FOR SCIENCE (Wright & Masters p ZOU35
INPUT: 76 KID  25 ACT  REPORTED: 76 KID  25 ACT  80 CA
------------------------------------------------------

MEASURE                                  |
  <more> --------------------- KID      -+- ACT
    3                                    +
                                        T|
                                     X   |
                                   XXX   |T
                                    XX   |
                                         |
    2                                X   +
```

</td></tr>
<tr><td>T1SCORE=Yes

Raw score on all the active items displayed</td><td>

```
TABLE 1.1 LIKING FOR SCIENCE (Wright & Masters p ZOU35
INPUT: 76 KID  25 ACT  REPORTED: 76 KID  25 ACT  80 CA
------------------------------------------------------

SCORE  MEASURE                                  |
         <more> --------------------- KID      -+- ACT
   82      3                                    +
   80                                          T|
   77                                       X   |
   75                                     XXX   |T
   73                                      XX   |
```

</td></tr>
</table>

	71 | 69 2 x +

11.201 T1WEIGHT= show items and persons by weight in Tables 1, 12, 16

Weighting	T1WEIGHT= No	T1WEIGHT= Yes
IWEIGHT=0, PWEIGHT=0	Items, persons not shown in Tables 1, 12, 16	Not shown in Tables 1, 12, 16
IWEIGHT=, PWEIGHT=	Items, persons shown in Tables 1, 12, 16	Items, persons shown once each in Tables 1, 12, 16
IWEIGHT=weighting , PWEIGHT=weighting	Items, persons shown once in Tables 1, 12, 16	Items, persons shown by weight in Tables 1, 12, 16

11.202 T2SELECT= selects Table 2 subtables

T2SELECT= specifies which sub-tables in Tables 2 are to display. "1" to display the subtable. "0" to omit the subtable. Formerly included with CURVES=

T2SELECT=1010111 displays subtables 2.1, 2.3, 2.5, 2.6, 2.7, when Table 2 is selected.

T2SELECT=	Table 2 displays	
10000000	2.1, 2.11	Modal categories (most probable)
01000000	2.2, 2.12	Mean categories (average or expected: Rasch-half-point thresholds)
00100000	2.3, 2.13	Median categories (cumulative probabilities: Rasch-Thurstonian thresholds)
0001000	2.4, 2.14	Structure calibrations (Rasch model parameters: rating scale, partial credit, "restricted", "unrestricted": Rasch-Andrich thresholds)
0000100	2.5, 2.15	Observed average measures of persons for scored categories (empirical averages)
0000010	2.6, 2.16	Observed average measures of persons (empirical averages)
0000001	2.7, 2.17	Expected average measures of persons

11.203 T30PAIRSMAX= maximum pairs to display in Tables 30.1, 31.1

Table 30.1 lists pairwise Differential Item Functioning of the person DIF classes for each item. Table 31.1 lists pairwise Differential Person Functioning of the item DPF classes for each person.

T30P = 0	list all pairwise comparisons
T30P= 100	list 100 comparisons (default)
T30P= number	list at most this number of comparisons

11.204 T45OPTIONS= field choices for Table 45

See Table 45

11.205 T7OPTIONS = selects Table 7.1 and 11.1 detail lines

T7OPTIONS= specifies which detail lines are shown in Table 7.1 and Table 11.1 . The default is T7OPTIONS=OZ, display *Observations* and *Z-standardized* residuals

T7OPTIONS= some or all of	Table 7.1 and Table 11.1 display:
O	Observations
E	Expected values of the observations
R	Residual = Observation - Expectation
Z	Z-standardized residual = Residual / square-root(Model variance of observation around its expectation)

Example: Table 7.1 with T7OPTIONS = OERZ in an analysis of Example0.txt:

```
TABLE OF POORLY FITTING KID   (ACT IN ENTRY ORDER)
NUMBER - NAME -- POSITION ------ MEASURE - INFIT (MNSQ) OUTFIT

     72  M Jackson, Solomon        -1.32     2.0   A    5.2
  OBSERVED:      1:  1    0    0    1    0     0    0    1    0    0    <- T7OPTIONS= O
  EXPECTED:          0.6  0.7  0.3  0.1  0.1   0.4  0.2  0.1  0.3  1.1  <- T7OPTIONS= E
  RESIDUAL:          0.4 -0.7 -0.3  0.9 -0.1  -0.4 -0.2  0.9 -0.3 -1.1  <- T7OPTIONS= R
Z-RESIDUAL:                         2                    2              <- T7OPTIONS= Z
```

11.206 TABLES= output tables

For more flexibility, use the Output Tables pull-down menu.

Tables= causes the specified Tables to be written into the report output file. It is has no effect on the pull-down menus.

A character string that tells Winsteps which output tables to prepare for printing. The sequence number of the "1" or "0" in the TABLES= string matches the table number. For more elaborate table selection, use TFILE=.

"1" means prepare the corresponding table.
"0" or anything else means do not prepare the corresponding table.

TABLES= is processed after TFILE= so that control variables in TFILE= are active for TABLES=

TABLE 0 is appended to the end of the TABLES= output except if TFILE= is also specified.

Example 1: You want only Tables 2,4,6,8,10 and 20 to be prepared
  TABLES=01010101010000000001000

This is the same as specifying:
TFILE=*
2
4
6
8
10
20
*

Example 2: You want only Tables 1-4.
  TABLES=1111

Example 3. To save all the tables at one time, here are three ways to do this:

A. Temporary way:

1. In your Winsteps control file, include the line:
TABLES=1111111111111111111111111111111111111111

2. When you launch Winsteps, press Enter to the "Report Output File name" option. (A temporary report output file will be produced.)

3. Press Enter to "Extra Specifications"

4. Winsteps will run and write all the tables to the temporary report output file.

5. Click on "Edit" menu
Click on "Report output file"

6. A file containing all the tables displays.

7. "Save As" to make this a permanent file.

B. Permanent way:

1. In your Winsteps control file, include the line:
TABLES=1111111111111111111111111111111111111111

2. When you launch Winsteps, press enter a file name at the "Report Output File name" option. (Press Ctrl+O if you want a file dialog box)

3. Press Enter to "Extra Specifications"

4. Winsteps will run and write all the tables to the temporary report output file.

5. Click on "Edit" menu
Click on "Report output file"

6. The permanent file containing all the tables displays.

C. Use TFILE=

11.207 TARGET= estimate using information-weighting

Exploratory only: not recommended for reporting measures.

TARGET=Y down-weights off-target observations. This lessens the effect of guessing on the measure estimates, but can reduce reliabilities and increase reported misfit. A big discrepancy between the measures produced by TARGET=N and TARGET=Y indicates much anomalous behavior disturbing the measurement process.

Unwanted behavior (e.g. guessing, carelessness) can cause unexpected responses to off-target items. The effect of responses on off-target items is lessened by specifying TARGET=Y. This weights each response by its statistical information during estimation. Fit statistics are calculated as though the estimates were made in the usual manner. Reported displacements show how much difference targeting has made in the estimates.

Example: Some low achievers have guessed wildly on a MCQ test. You want to reduce the effect of their lucky guesses on their measures and on item calibrations.
TARGET=Y

How Targeting works:
a) for each observation:
 calculate probability of each category (0,1 for dichotomies)
 calculate expected score (= probability of 1 for dichotomy)
 calculate variance = information

= probability of 1 * probability of 0 for dichotomies,
so maximum value is 0.25 when person ability measure = item difficulty measure

b) for targeting:
weighted observation = variance * observation
weighted expected score = variance * expected score

c) sum these across persons and items (and structures)

d) required "targeted" estimates are obtained when, for each person, item, structure sum (weighted observations) = sum (weighted expected scores)

e) for calculation of fit statistics and displacement, weights of 1 are used but with the targeted parameter estimates. Displacement size and excessive misfit indicate how much "off-target" aberrant behavior exists in the data.

For targeting, there are many patterns of responses that can cause infinite measures, e.g. all items correct except for the easiest one. The convergence criteria limit how extreme the reported measures will be.

Polytomous items: look at the Item Information function from the Graphs menu to see the weighting. With TARGET=Y, responses are weighted by their information.

11.208 TCCFILE= Test Characteristic Curve and Test Information Function

TCCFILE= specifies the file to hold the coordinates for the Test Characteristic Curve and the Test Information Function. See Test Characteristic Curve and the Test Information Function in the Graph Window, also Table 20. Also the accumulated probabilities across rating-scale categories for all items.

For customized range and increments, use TCCHIGH=, TCCLOW=, TCCINCR=. Decimal places: UDECIM=

``; TCC + TIF CURVES``
``MEASURE  SCORE  INFO   SEM     0    1    2``
``  -8.00    .05   .05  4.31 24.95  .05  .00``
``  -7.98    .06   .05  4.27 24.94  .05  .00``
``  -7.97    .06   .06  4.24 24.94  .06  .00``
``  -7.95    .06   .06  4.20 24.94  .06  .00``
``  -7.94    .06   .06  4.17 24.94  .06  .00``
``  -7.92    .06   .06  4.14 24.94  .06  .00``
``  -7.90    .06   .06  4.11 24.94  .06  .00``
	The contents of the TCCFILE=

MEASURE	The person ability measure (theta in logits or user-scaled USCALE= units)
SCORE	Test Characteristic Curve, TCC: the expected score on the test for the MEASURE
INFO	Test Information Function, TIF: the statistical information in the score
SEM	Standard Error of Measurement for the MEASURE when estimated from the SCORE = 1 / √ INFO
0	Cumulative probability of lowest category (with lowest category numbered 0)
...	Cumulative probability of intermediate categories
Highest	Cumulative probability of highest category
NORMED, FREQUENCY, CUM.FREQ, PERCENTILE	See SCOREFILE=

Example 1: www.rasch.org/memo1.htm Figure 2 shows the TCC for two person groups on the same plot. How can I do this?

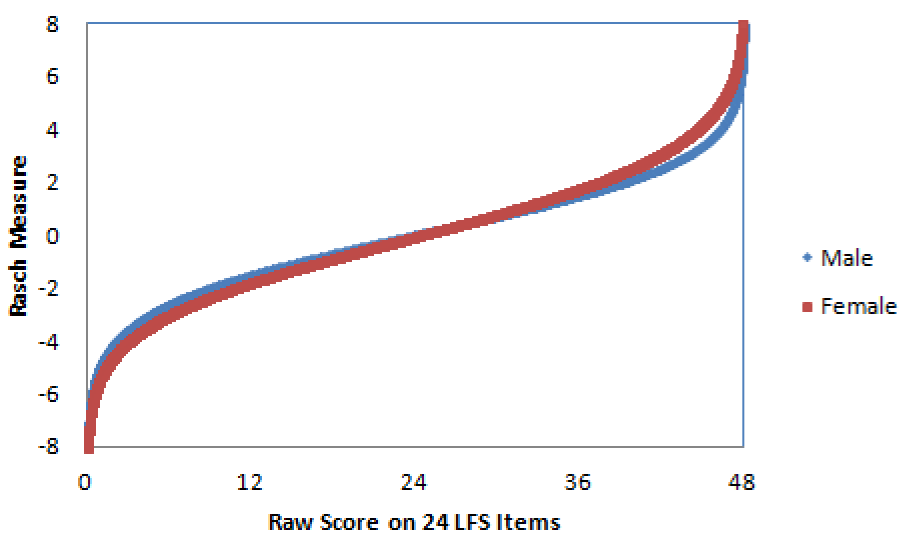
These needs two analyses, but only one control file and data file. Put the group code in column 1 of the person label. Then, here is the procedure with Example0.txt - since item 19 is extreme for one group, it is omitted with IDELETE=19 from both groups

analysis 1: at the Extra Specification prompt, type the person group code for the first group:
PSELECT=F
do the analysis, then
Output Files menu:
Ouput TCCFILE= to Excel temporary file

analysis 2: at the Extra Specification prompt, type the person group code for the second group:
PSELECT=M
do the analysis, then
Output Files menu:
Ouput TCCFILE= to Excel

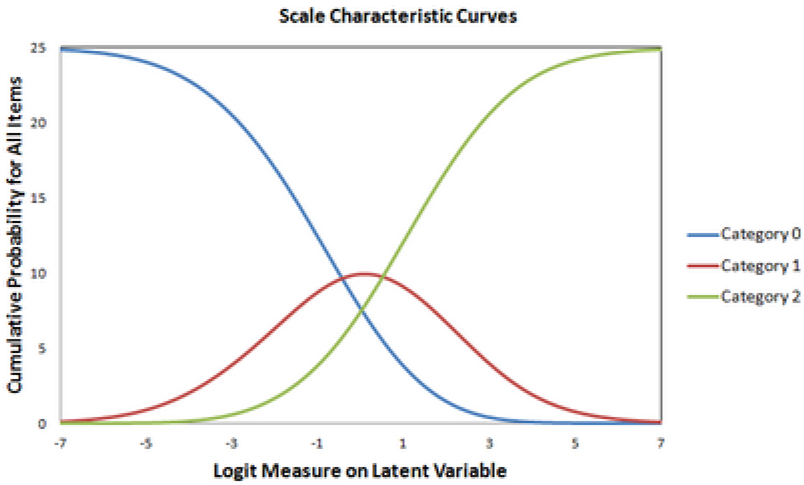
Excel plot:
copy the first two columns of both Excel files into one worksheet.
scatterplot the MEASURE columns against the matching SCORE columns

Here is what I see:



Example 2: The *Scale Characteristic Curves* in Dogan (2018) *"An Application of the Partial Credit IRT Model in Identifying Benchmarks for Polytomous Rating Scale Instruments", PARE, 23:7.*

Output the TCCFILE= to Excel and plot the cumulative probability curves against the measures. Here they are for Example0.txt using the Rating Scale Model:



11.209 TCCHIGH= highest value of TCC

Defines the highest (or lowest) value of the TCC output with TCCFILE=
If TCCHIGH=0 and TCCLOW=0, then they are ignored
TCCINCR= gives the increment along the TCC measurement scale, unless TCCINCR=0

11.210 TCCINCR= increment on TCC measurement scale

TCCHIGH= and TCCLOW= define the extremes of the TCC output with TCCFILE=
If TCCHIGH=0 and TCCLOW=0, then they are ignored.
TCCINCR= gives the increment along the TCC measurement scale, unless TCCINCR=0

11.211 TCCLOW= lowest value of TCC

Defines the lowest (or highest) value of the TCC output with TCCFILE=
If TCCHIGH=0 and TCCLOW=0, then they are ignored.
TCCINCR= gives the increment along the TCC measurement scale, unless TCCINCR=0

11.212 TFILE= input file listing tables to be output

TFILE= causes the specified Tables to be written into the report output file. It is has no effect on the Output Tables menus.

TFILE= file name	file containing details
TFILE = *	in-line list which ends with *
TFILE = ?	opens a Browser window to find the TFILE= file

TFILE= contents	
Table number, such as 22	All standard subtables for the Table are output. Table 0 is the iteration report
Table and subtable number, such as 3.1	Only the specified subtable is output. Every subtable can be reported individually.
Table and subtable range, such as 23.11-33 (which means 23.11 - 23.33)	All subtables in the specified range of subtables are output
Table and subtable open-ended range, such as 23.11+ 21.0+	All subtables numbered equal to, or higher than the specified subtable are output

Control instruction = value, such as OFILE=report1.txt PSELECT={MF}	All instructions active in the Specification menu dialog box can be included. These instructions become active when Winsteps reaches them in processing TFILE= after estimation has completed.
Control instruction = output file name with suffix, such as SCOREFILE = myscorefile.txt IADD=Yes GRFILE = mygraphfile.rdata	The output files are created but not displayed. They can be displayed from the Edit menu. These instructions become active when Winsteps reaches them in processing TFILE= after estimation has completed.

Example 1: In this example, 3 report output files will be written. These include two versions of Table 2.2.

```
TFILE=*
OFILE=table1report.txt
1  ; output Table 1
OFILE=table2.2report.txt
2.2  ; output Table 2,2
OFILE=table2.2breport.txt
MRANGE=5
2.2  ; output Table 2.2
MRANGE=  ; to cancel the MRANGE=5 instruction
*
```

Example 2: A DIF subtable is output in a format more suitable for processing by other software

```
TFILE=*
DIF=$S1W2
BOXSHOW=No
HEADER=No
OFILE=difoutput.txt
30.1
*
```

TABLES= selects the tables in a fixed sequence, and prints only one copy. TFILE= allows the analyst to print multiple copies of tables to different specifications. TFILE= specifies the name of an input ASCII file. Each line of the file contains a table number or table number.sub-table and other control parameters, separated by blanks or commas. Unused control values are specified with "-". The list may be entered directly into the control file with TFILE=* (see Example 2).

TFILE= Parameters:

Control variable = Value	The Control Variables allowed in the Specification Menu dialog box are can be entered here for immediate action. Example: TITLE="My Report"

Output Table selection: (enter unused parameters with "-" or ".")

1: Table number. subtable	2	3	4	5	6	7	8
Distribution map 1.0, 1.1	Lowest measure	Highest measure	Rows per unit	-	Persons per '#'	Items per '#'	
Response plot 2, 7.2	Lowest measure	Highest measure	Columns per tick mark	Reference category for sorting	High rating adjustment	Low rating adjustment	Unexpected only
Person fit plots 4, 5	Lowest measure	Highest measure	Columns per tick mark				

Person/Item list: 6, 10, 13, 14, 15, 17, 18, 19	Low fit bar	High fit bar					
Item fit plots 8, 9, 23	Lowest measure	Highest measure	Columns per tick mark				
Item map 12, 1.2	Lowest measure	Highest measure	Rows per unit	Sort column within item name	-	Items per '#'	
Item list alphabetical 15	-	-	-	Sort column within item name			
Person map 16, 1.3	Lowest measure	Highest measure	Rows per unit	Sort column within person name	Persons per '#'		
Person list alphabetical 19	-	-	-	Sort column within person name			
Score table 20	-	-	Columns per tick mark				
Category curves 21	-	-	Columns per tick mark				

TFILE= Table number selection		
Table number, for example 15	selects the Table and all its Subtables	
Table number.Subtable number For example: 6.4	selects only the Table's Subtable	For each Subtable request, Winsteps regenerates all the required Table information. For example, TFILE=* 23.3 ; performs Table 23 PCA analysis then reports Table 23.3 23.4 ; performs Table 23 PCA analysis then reports Table 23.4
Table number.Subtable number+ For example: 18.3+	select the specified Subtable and all following Subtables, if any.	
6.2, 10.2, 13.2, 14.2, 15.2, 17.2, 18.2, 19.2, 25.2, 26.2	selects the specified Subtable with CHART=Yes	
10.3, 13.3, 14.3, 15.3, 25.3, 26.3	selects the specified Subtable with DISTRACTORS=YES	
3.3	STEPT3.NE.'Y'	

Example 1: The analyst wishes to select and print several tables:

TFILE=TABLES.TF

TABLES.TF is a DOS (ASCII) file with the following lines:					
; Table number	Low Range	High Range	Columns per unit	Sort on column	
2					; print Tables 2.1, 2.2, 2.3
10.2	0.5	1.5			; print Table 10.2 with fit bars at 0.5 and 1.5
8	-5	5			; print Table 8 with range -5 to +5 logits
9	-2	7			; range -2 to +7 logits, 10 columns per logit
9	-5	5	10		; print Table 9 again, different range
15	-	-	10	4	; print Table 15, sorted on column 4 of item name

or enter directly into the control file,

```
 TFILE=*
 2
 10.2
 8 -5 5
 9 -2 7 10
 9 -5 5 10
15 - - - 4
 *
```

Example 2: Analyst wishes to specify on the DOS control line, Table 15 sorted on item name column 4. Values are separated by commas, because blanks act as end-of-line separators.
C:>Winsteps SF.TXT SFO.TXT TFILE=* 15,-,-,-,4 *

Example 3: To output the empirical Keyforms in Table 17.3, etc.:
TFILE=*
17.3
*

Example 4: multiple tables from one line in SAS or similar:
a="TFILE=";
output
a="0.3,1,3.1,10.1,13.1,14.1,20,25.1";
b = tranwrd(a,',','0d0a'x);
output
a="*";
output

Example 5: Multiple Wright maps showing different subsets of items:
TFILE=*
; MTOP= and other Wright map control instructions here
LINELENGTH = 30 ; to keep each map narrow
IMAP=1W3 ; first 3 characters of the item label
ISELECT=W ; select item labels starting with W
1.2 ; output Table 1.2
ISELECT=R ; select item labels starting with R
1.2 ; output Table 1.2
*

11.213 TITLE= title for output listing

Use TITLE= to label output distinctly and uniquely.

Up to 60 characters of title. This title will be printed at the top of each page of output.

Example: You want the title to be: Analysis of Math Test
TITLE="Analysis of Math Test"

Quote marks " " or ' ' are required if the title contains any blanks.

11.214 TOTALSCORE= show total scores with extreme observations

TOTALSCORE=No
Winsteps uses an adjusted raw score for estimation, from which observations that form part of extreme scores or CUTLO= or CUTHI= have been dropped. Scored responses are transformed (re-counted) so that the lowest response is zero. This is displayed in Table 13.1, PFILE=, IFILE=, TABLE 20, SCOREFILE= etc.

TOTALSCORE=Yes
The total raw score from the data file, after any recoding and weighting, is shown. This usually matches the numbers used in raw-score analysis and the counts in Table 13.3 TABLE 20, SCOREFILE= etc.

This can be changed from the *Specification* pull-down menu.

Example: KCT.txt with TOTALSCORE=No. This shows scores on 15 non-extreme items.

```
+-----------------------------------------------------------------------+----------+
|ENTRY    RAW                           |   INFIT   |  OUTFIT   |SCORE|     |          |
|NUMBER  SCORE  COUNT  MEASURE   ERROR|MNSQ   ZSTD|MNSQ   ZSTD|CORR.|WEIGH| KID      |
|-------------------------------------+----------+----------+-----+-----+----------|
|    24     12     15     3.50     .91|1.81    1.4| .79     .0|  .52| 1.00| Rick     M|
|     7     11     15     2.68     .90|1.64    1.1|1.49     .1|  .59| 1.00| Susan    F|
|    15     11     15     2.68     .90| .35   -1.7| .15    -.4|  .76| 1.00| Frank    M|
```

With TOTALSCORE=Y. This shows scores on all 18 items.

```
+-----------------------------------------------------------------------+----------+
|ENTRY    TOTAL                         |   INFIT   |  OUTFIT   |SCORE|     |          |
|NUMBER  SCORE  COUNT  MEASURE   ERROR|MNSQ   ZSTD|MNSQ   ZSTD|CORR.|WEIGH| KID      |
|-------------------------------------+----------+----------+-----+-----+----------|
|    24     15     18     3.50     .91|1.81    1.4| .79     .0|  .52| 1.00| Rick     M|
|     7     14     18     2.68     .90|1.64    1.1|1.49     .1|  .59| 1.00| Susan    F|
|    15     14     18     2.68     .90| .35   -1.7| .15    -.4|  .76| 1.00| Frank    M|
```

11.215 TRPOFILE= transposing the data matrix

To transpose the rows and columns of the data matrix, select Transpose on the Output Files menu or include TRPOFILE= in your control file. Details are given at Transpose file specifications.

TRPOFILE= file name. This is the name of the transposed file.
This operates in association with TRPOTYPE= control characters. This controls what is written to the transposed file.

TRPOFILE=? opens a Browse window

Example 1: You want to "rack" the data in exam12lo.txt and exam12hi.txt, so that each person record contains the ratings from both files:

1. Analyze exam12.txt with data=exam12lo.txt
Transpose this data file only to exam12lod.txt
The "lo" items are now rows

2. Analyze exam12.txt with data=exam12hi.txt
Transpose this data only to exam12hid.txt
The "hi" items are now rows
Transpose the control file only to exam12tran.txt
The person labels are now shown as item labels

3. Analyze exam12tran.txt with data=exam12lod.txt+exam12hid.txt
The columns are the original persons. The rows are all the original items, "lo" and "hi".
Transpose this control and data file to exam12rack.txt
The persons return to the rows.
The columns are now all the original items, "lo" and "hi".

4. Analyze exam12rack.txt with Winsteps. This is the desired control and data file.

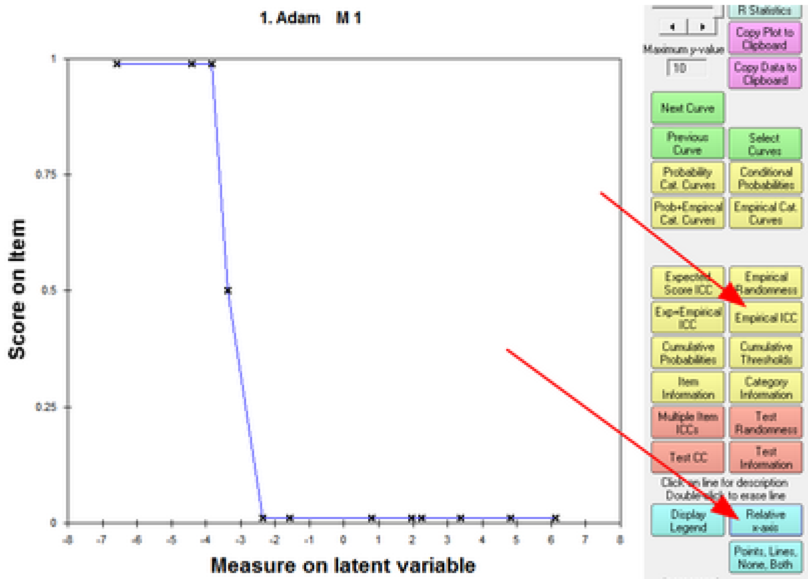
Example 2: We want to see if one group of persons have a different response "style" than another group of persons on a 6-category rating scale. To do this,
1. Transpose the Winsteps control-and-data file so that the rows become columns: Winsteps output file menu: Transpose.
2. In the transposed Winsteps control-and-data file,
GROUPS = 12112111.... to match the person groups.
3. Save the transposed file and analyze it with Winsteps.
4. Look at Table 3.2. There will be one rating scale for Group 1 and another rating scale for Group 2.

Example 3: We want Cronbach Alpha for the items.
Cronbach Alpha is designed for persons, but there is no reason why the same computation cannot be applied to items. In Winsteps, transpose the data (use the Output Files menu), analyze the transposed dataset, and report Table 3. Its Cronbach Alpha applies to the original items. If Alpha for the items is too low, then the likely reason is that the person sample size is too small. More persons -> higher item Alpha. More items -> higher person Alpha.

Empirical Person Response Function

Using example file Exam1.txt.
Step 1. Standard analysis
Step 2. Output files menu: Transposed
Step 3. Select the options you want
Step 4. Click on permanent or temporary file
Step 5. Click on Launch Winsteps
Step 6. Winsteps analysis of transposed file
Step 7. Graphs Window: "Empirical ICC."
Step 8. Click on "Absolute x-axis"

Here's the person response function for the first person in Exam1.txt:



11.216 TRPOTYPE= transposing specifications

TRPOTYPE= controls the format of the transposed file written to TRPOFILE=. Details are given at Transpose file specifications.
Transposing switches around the rows and the columns in the Winsteps control and data file.

TRPOTYPE= has three characters:

First Character: The response-level data are:
O = Original data: data codes are those in the data file.
S = Scored data: data after applying NEWSCORE=, IVALUE=, KEY=, etc.
R = Recounted data: the data recounted upwards from 0 after applying STKEEP=No, etc.

Second Character: Deleted and deselect persons and items are: (IDFILE=, IDELETE=, ISELECT=, PDFILE=, PDELETE=, PSELECT=)
S = Squeezed out: deleted and deselected items and persons are omitted from the transposed file.
M = Missing data: deleted and deselected items and persons remain in the transposed file, but all their responses are indicated as missing data, "."

Third Character: Output:
B = Both Control and Data file: the transposed file can be analyzed. Additional control instructions may be required in the control section in order for the analysis to proceed correctly.
C = Control file only: Only the control file for the transposed data is output. The transposed data are not output.
D = Data file only: Only the transposed data are output. The control instructions are not.

Example: Transpose the multiple choice data after rescoring.
TRPOFILE = transposed-file.txt
TRPOTYPE = SMD ; Scored data, Missing data codes for deletions, Data only

Example: Use transposed files to display person response functions (= model and empirical ICCs).
Emons WHM, Sijtsma K, Meijer RR (2004). "Testing Hypotheses About the Person-Response Function in Person-Fit Analysis." Multivariate Behavioral Research, 39(1), 1–35. doi: 10.1207/s15327906mbr3901_1.

11.217 UAMOVE= move all anchor values a pre-set amount

Anchor (fixed) values for the persons are specified by PAFILE= and for the items by IAFILE=. All the anchor values can be increased or decreased by the same amount using UAMOVE=. The value is applied before any rescaling with UASCALE= or USCALE=. UIMEAN= and UPMEAN= are ignored.

Reported values = USCALE= * (UAMOVE= + anchor value)/UASCALE=

Example 1: All anchor values are to be increased by 1.5 units for this analysis:
IAFILE = *
12 2.5 ; the anchor value for item 12 is 2.5 units
*
UAMOVE = 1.5 ; the amount by which to increase the anchor values
Item 12 will be reported in Table 14 with an anchor value "A" of 2.5 + 1.5 = 4.0 logits.

Example 2: Anchor values in logits centered on 0. Report values to be user-scaled 100 units per logit, centered on 500.
UASCALE=1
USCALE=100
UAMOVE = 500/100 = 5
IAFILE=*
1 0.5 ; 0.5 logits
*
Reported value for item 1 anchor value = 0.5 logits = 100 * (5 + 0.5) = 550 user-units

11.218 UANCHOR= anchor values supplied in user-scaled units

For backwards compatibility only.

UANCHOR= simplifies conversion from previously computed logit measures to user-scaled measures.

If UASCALE<>0.0 then UANCHOR=A is forced.
If UASCALE=0.0 then UANCHOR=N is forced.

UANCHOR=A or N or L specifies that the anchor values are in UASCALE= units per logit. Reported measures will be user-rescaled by UMEAN= (or UIMEAN= or UPMEAN=) and USCALE=.

Logit measure = anchored measure/UASCALE - UMEAN/USCALE

UANCHOR=Y specifies that anchor values are in USCALE= units per logit.

Example 1: Your item bank calibrations are user-scaled with 10 units per logits, but you want to report person measures in CHIPS (BTD p.201):
UASCALE=10 ; user-scaling of anchor values
UANCHOR=A
USCALE=4.55

Example 2: Your previous test was in logits, but now you want the user-scaling 100 per logit.
UASCALE=1 ; user-scaling of anchor values: logits
UANCHOR=Logits
USCALE=100

11.219 UASCALE= anchor user-scale value of 1 logit

Specifies the number of units per logit of the anchor values.
UASCALE=0 - the anchor values are in the current output scale set with USCALE=
UASCALE= other value - this is the units per logit of the anchor values.

UIMEAN= and UPMEAN= are ignored when there are anchor values.

Example 1: The anchor values are user-scaled such that 1 logit is 45.5 units, so that differences of -100, -50, 0, +50, +100 correspond to success rates of 10%, 25%, 50%, 75%, 90%:
UASCALE = 45.5 ; 1 logit = 45.4 user-units
USCALE = 1 report in logits

Example 2: The anchor values are on one scaling, but you want the reported values to be on another scaling.

UASCALE= 5	; there are 5 units per logit in the scaled values
USCALE=10	; you want 10 units per logit on the reported values

Example 3: The anchor measures are in logit scaling, the output measures are to be in user-scaling.

UASCALE= 1	; anchor values in logits
USCALE=30	; 30 user-units per logit

Example 4: Anchor measures are in same scaling as the output measures

UASCALE= 0	; anchor values in USCALE= scaling. 0 to ignore (default)
USCALE=user-value	; also used for anchor values

Example 5: Anchor values are scaled in Probits, not Logits

UASCALE = 0.588	; 1 logit = 0.588 probits
USCALE = 1	report in logits

Example 6: Anchor values are to be rescaled with a new range

IAFILE= (values)	the anchor values in anchor-value scaling
UASCALE= value	; anchor value scaling: on input anchor values converted to logits
UIMEAN=0	to set the internal base line
TFILE=*	in control file: done after analysis, but before reporting
USCALE=value	user-rescaling with new range
UIMEAN=value	user-rescaling with new offset
....	any other instructions for TFILE=
*	

11.220 UCOUNT= number of unexpected responses: Tables 6, 10

This sets the maximum number of "most unexpected responses" to report in Tables 6.6, 10.6. Also the maximum number of persons and items to report in the anti-Guttman matrices in Tables 6.4, 6.5, 10.4, 10.5

```
MOST UNEXPECTED RESPONSES
+-------------------------------------------------------------------------------------------+
| DATA  |OBSERVED|EXPECTED|RESIDUAL|ST. RES.| ACT    | KID     | ACT          | KID              |
|------+--------+--------+--------+--------+--------+--------+-------------+-----------------|
|     0 |       0 |    1.93 |   -1.93 |   -7.66 |     18 |      73 | GO ON PICNIC| SANDBERG, RYNE   |
|     2 |       2 |     .07 |    1.93 |    7.57 |     23 |      72 | WATCH A RAT | JACKSON, SOLOMON|
|     2 |       2 |     .07 |    1.93 |    7.57 |     23 |      29 | WATCH A RAT | LANDMAN, ALAN    |
|     0 |       0 |    1.93 |   -1.93 |   -7.40 |     19 |      71 | GO TO ZOO   | STOLLER, DAVE    |
```

Example: Show 100 "Most Unexpected Responses" in Table 10.6:
UCOUNT=100

11.221 UDECIMALS= number of decimal places reported

This is useful for presenting your output measures and calibrations in a clear manner by removing meaningless decimal places from the output. Range is 0 (12345.) to 4 (1.2345).

How small is meaningless? Look at the Standard Error columns. Any value clearly less than a standard error has little statistical meaning.

Use the "Specification" pull-down menu to alter the value of UDECIMALS= for individual reports.

Example 1: You want to report measures and calibrations to the nearest integer:
UDECIMALS = 0

Example 2: You want to report measures and calibrations to 4 decimal places because of a highly precise, though arbitrary, pass-fail criterion level:
UDECIMALS = 4

11.222 UEXTREME= include extreme scores for UIMEAN= or UPMEAN=

In unanchored analyses, the item difficulties are centered by UIMEAN= or the person abilities are centered by UPMEAN=.

UEXTREME = No (the default). Do **not** include items or persons with extreme scores (minimum possible or maximum possible) when computing the centering.

UEXTREME = Yes. Do include items or persons with extreme scores (minimum possible or maximum possible) when computing the centering.

Example: using Exam1..txt

UIMEAN=0 and UEXTREME=No (items with extreme scores **excluded** when setting the local origin at zero)

```
     SUMMARY OF 14 MEASURED (NON-EXTREME) TAP
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT         OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN      16.9      35.0         .00     .71       .96     .0    .68    -.1 |
| P.SD      12.9        .0        3.48     .21       .28     .7    .58     .5 |
| MAX.      32.0      35.0        4.80    1.07      1.56    1.2   2.21    1.1 |
| MIN.       1.0      35.0       -4.40     .45       .59   -1.3    .11    -.6 |
|------------------------------------------------------------------------------|

     SUMMARY OF 18 MEASURED (EXTREME AND NON-EXTREME) TAP
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT         OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN      18.9      35.0        -.76     .96                                   |
| P.SD      14.0        .0        4.26     .51                                   |
| MAX.      35.0      35.0        6.13    1.85                                   |
| MIN.        .0      35.0       -6.59     .45       .59   -1.3    .11    -.6 |
|------------------------------------------------------------------------------|
```

UIMEAN=0 and UEXTREME=YES (items with extreme scores **included** when setting the local origin at zero)

```
     SUMMARY OF 14 MEASURED (NON-EXTREME) TAP
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT         OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN      16.9      35.0         .75     .71       .96     .0    .68    -.1 |
| P.SD      12.9        .0        3.46     .21       .27     .7    .57     .5 |
| MAX.      32.0      35.0        5.53    1.07      1.55    1.2   2.16    1.1 |
| MIN.       1.0      35.0       -3.63     .45       .59   -1.4    .11    -.6 |
|------------------------------------------------------------------------------|
| REAL RMSE    .77 TRUE SD    3.38  SEPARATION  4.40  TAP    RELIABILITY  .95 |
|MODEL RMSE    .74 TRUE SD    3.38  SEPARATION  4.57  TAP    RELIABILITY  .95 |
| S.E. OF TAP MEAN = .96                                                       |
-------------------------------------------------------------------------------

     SUMMARY OF 18 MEASURED (EXTREME AND NON-EXTREME) TAP
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT         OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN      18.9      35.0         .00     .96                                   |
| P.SD      14.0        .0        4.24     .50                                   |
| MAX.      35.0      35.0        6.86    1.84                                   |
| MIN.        .0      35.0       -5.80     .45       .59   -1.4    .11    -.6 |
|------------------------------------------------------------------------------|
```

11.223 UIMEAN=or UMEAN= the mean or center of the item difficulties

Assigns your chosen numerical value to the average measure of the non-extreme items (UEXTREME=No) or all items (UEXTREME=Yes), i.e., a criterion-referenced measure. UMEAN= and UIMEAN= are the same specification. The last UIMEAN= or UPMEAN= values in the control file is actioned.

UIMEAN= and UPMEAN= are ignored when there are anchor values, IAFILE= or PAFILE=. Anchor values are treated according to UASCALE=

Table 20 gives the UMEAN= and USCALE= values for a conversion that gives the measures a range of 0-100.

Example 1: You want to recenter the item measures at 10 logits, and so add 10 logits to all reported measures, to avoid reporting negative measures for low achievers:
UIMEAN = 10

Example 2: You want to recenter and user-rescale the item measures, so that the range of observable measures goes from 0 to 100.
Look at Table 20.1. Beneath the Table are shown the requisite values, e.g.,
UMEAN = 48.3 ; this is the same as UIMEAN=48.3
USCALE = 9.7

For more examples, and how to compute this by hand, see User-friendly rescaling

---

Rescaling with anchor values:

When you do the analysis, you need the anchored values and their scaling:
UASCALE= anchor values per logit
IAFILE=*
1 20
2 34
...
*

Then you have options:

A. Use the "Help" menu scaling USCALE= calculator to discover the new values you want:
UIMEAN= new mean
USCALE= new scaling

B. If you know the rescaling you want, include in the control file:
TFILE=*
UIMEAN= new mean
USCALE= new scaling
*

In both options, use the Output Tables menu or Output Files menu to produce the output you need.

11.224 UMEAN=or UIMEAN= the mean or center of the item difficulties

See UIMEAN=

11.225 UPMEAN= the mean or center of the person abilities

Assigns your chosen numerical value to the average of the non-extreme abilities for persons (UEXTREME=No) or all persons (UEXTREME=Yes), i.e., this provides a norm-referenced user-scaling.

The last UIMEAN= or UPMEAN= values in the control file is actioned.

UIMEAN= and UPMEAN= are ignored when there are anchor values, IAFILE= or PAFILE=. Anchor values are treated according to UASCALE=

Example 1: You want to used conventional IRT norm-referenced user-scaling with person mean of 0 and person S.D. of 1.
UPMEAN = 0
USCALE = 1 / (person S.D. in logits) ; find this from Table 3.1
If there are extreme person scores, see User-friendly rescaling

Example 2: I want to compare the mean performance of random samples of examinees from my database. Will UPMEAN= help in this?

UPMEAN=0 sets the local mean of the persons to zero (excluding extreme scores) regardless of the sampling.
If you wish to investigate the behavior of the person mean for different person samples, then
(1) analyze all persons and items: set UPMEAN=0, for convenience, and write IFILE=. For better comparison, set STBIAS=NO.
(2) anchor the items using IAFILE=
(3) analyze samples of persons with the anchored items.
The person means reported in Table 3.1 now show person means (with or without extreme scores) in the one frame of reference across all analyses defined by the anchored items.

For more examples, and how to compute this by hand, see User-friendly rescaling

Example 3: We want the mean of a target group in our analysis to be 50.

1. Put a code in the person label for the target group (or sort them to be adjacent rows) in the data file.
2. Do a free analysis of everything.
3. In the Specification menu, PSELECT= the target group on the code or PDELETE=+ the target range of rows.
4. Output Table 3.1 - this will give you the mean of the target group
5. Winsteps Specification menu: UPMEAN = - mean of target group
6. Output Table 3.1 - this will give you the mean of the target group which should be 0.
7. If not mean=0, then UPMEAN = - mean of target group from step 4, adjusted by value in step 6.
8. Repeat 5. and 6. if needed.
9. Write down the UPMEAN= value for later, if needed. You can see it in the Control Variables list.
10. Reinstate everyone: PSELECT= or PDELETE=
11. Run your reports.

Item Easiness = Reversed Item Difficulties

The reversal formula for the items on the maps in Tables 1.10, 1.11, 1.12, 1.13, 12.12, and 16.13 is:
Item Easiness = 2*Mean Person Ability - Item Difficulty

For a full set of item easiness statistics, set the Mean Person Ability as the reference point, then reverse the user-scaling . Use the USCALE= Calculator or:

For the person ability statistics:
UEXTREME = Yes
UPMEAN = 0 or preferred reference value
USCALE = current value of USCALE=

For the matching item easiness statistics:
UEXTREME = Yes

UPMEAN = 0 or preferred reference value
USCALE = - current value of USCALE=

11.226 USCALE= the user-scaled value of 1 logit

Specifies the number of reported user-scaled units per logit. When USCALE=1 (or USCALE= is omitted) then all measures are in logits.

Negative USCALE= values, such as USCALE= -10
Higher row score -> lower row measure
Higher column score -> higher column measure
USCALE= does not change the direction of the Andrich thresholds, so
with positive USCALE=, Andrich thresholds are in the direction of items (columns)
with negative USCALE=, Andrich thresholds are in the direction of persons (rows)

Table 20 gives the UMEAN= and USCALE= values for a conversion that gives the measures a range of 0-100.

Example 1: You want to user-rescale 1 logit into 45.5 units, so that differences of -100, -50, 0, +50, +100 correspond to success rates of 10%, 25%, 50%, 75%, 90%:
 USCALE = 45.5

Example 2: You want to reverse the measurement directions, because
a) the data matrix is transposed so that the 'items' are examinees and the 'persons' are test questions:
b) the data are scored "backwards", such as rank orders, where lower score value -> higher ability
USCALE = -1
KEYn=, RESCORE=, ISGROUPS= will still apply to the columns, not the rows, of the data matrix. Centering will still be on the column measures.

Example 3: You want to approximate the "probit" measures used in many statistical procedures.
  UPMEAN = 0 ; set the person sample mean to zero
  USCALE = 0.59 ; probits * 1.7 = logits

but if you want your person sample to approximate N(0,1):

  1. first analysis:
  UPMEAN=0
  USCALE=1
  look at the person S.D. in Table 3.1

  2. second analysis:
  UPMEAN=0
  USCALE=1/person S.D. from 1.

Example 4: You want to report measures in "log-odds units to the base 10" (lods) instead of the standard "logits to the base e".
  USCALE=0.434294482 ; the conversion between "natural" and base-10 logarithms.

For more examples, and how to compute this by hand, see User-friendly rescaling

11.227 UTF8ENC= UTF-8 encoding

UTF8ENC encoding = Yes	This control and data file are encoded with UTF-8
UTF8ENC encoding = No	This control and data file are not encoded with UTF-8
UTF8ENC encoding = ? or anything else	Winsteps determines whether the file is encoded with UTF-8

If the file is encoded with UTF-8, but the UTF-8 code cannot be displayed, then the UTF8SUB= character is displayed

11.228 UTF8SUB= substitute character for multibyte UTF-8

Winsteps replaces multibyte UTF-8 codes with a substitute ASCII code when needed to maintain column-alignment in Tables.

The freeware text-editor NotePad++ https://notepad-plus-plus.org/ displays UTF-8 codes.

Example: UTF8CODE= ~
Table 6.6

```
-----------------------------------------------------------------------------------------------
    -------------------------
| DATA  |OBSERVED|EXPECTED|RESIDUAL|ST. RES.|MEASDIFF| ITEM   | PERSON | ITEM                 |
    PERSON                    |
|------+--------+--------+--------+--------+--------+-------+--------+---------------------
    +--------------------------|
|    2 |       2 |     .39 |    1.61 |    2.04 |    -.71 |      4 |       6 | ~~~~~~               | 馬
    蒔撰
                                                                                  substituting for 四部叢刊
    初編
```

11.229 W300= Output files in Winsteps 3.00 format

New or revised statistics are added as extra or changed columns in IFILE= and PFILE= when they are introduced into Winsteps.

To revert to an earlier format of IFILE= and PFILE=, specify W300=Yes. This produces the PFILE= and IFILE= in the format of Winsteps 3.00 1/1/2000.

Example: IFILE= in current format:

```
;ACT          FILE FOR
;ENTRY MEASURE STTS COUNT    SCORE  ERROR IN.MSQ IN.ZSTD OUT.MS OUT.ZSTD DISPL PTME WEIGHT  DISCR G M NAME
     1    -.89  1    75.0    109.0    .23    .74  -1.97    .67  -1.89    .00   .64   1.00   1.06 0 R WATCH BIRDS
     2    -.61  1    75.0    116.0    .20    .76  -1.54    .56  -1.55    .00   .58   1.00   1.07 0 R READ BOOKS ON ANIMALS
```

IFILE= in W300=Yes format:

```
;ACT     FILE FOR
;ENTRY MEASURE ST COUNT  SCORE  ERROR IN.MSQ IN.ZSTD OUT.MS OUT.ZSTD DISPL CORR G M NAME
     1    -.89  1    75    109    .23    .74  -1.97    .67  -1.89    .00   .64 0 R WATCH BIRDS
     2    -.61  1    75    116    .20    .76  -1.54    .56  -1.55    .00   .58 0 R READ BOOKS ON ANIMALS
```

PFILE= in current format:

```
;PUPIL        FILE FOR
;ENTRY MEASURE STTS COUNT    SCORE  ERROR IN.MSQ IN.ZSTD OUT.MS OUT.ZSTD DISPL PTME WEIGHT  DISCR NAME
     1     .49  1    25.0     30.0    .35    .96   -.15    .84   -.43    .00   .69   1.00    .00 ROSSNER, MARC DANIEL
;    2    5.99  0    25.0     50.0   1.84   1.00    .00   1.00    .00    .00   .00   1.00    .00 ROSSNER, LAWRENCE F.
```

PFILE= in W300=Yes format:

```
;PUPIL  FILE FOR
;ENTRY MEASURE ST COUNT  SCORE  ERROR IN.MSQ IN.ZSTD OUT.MS OUT.ZSTD DISPL CORR NAME
     1     .49  1    25     30    .35    .96   -.15    .84   -.43    .00   .69 ROSSNER, MARC DANIEL
     2    5.99  0    25     50   1.84   1.00    .00   1.00    .00    .00   .00 ROSSNER, LAWRENCE F.
```

Notes:
TOTAL=YES is active for both current and old formats.
";" shown for extreme scores, such as person 2, in current format, but not in old format.
COUNT and SCORE are shown rounded to nearest integer in old format.

11.230 WEBFONT= font of webpages

WEBFONT= is used to specify the font for webpage display with ASCII=Webpage.

A standard font instruction is:

WEBFONT="Lucida Console, Andale Mono, Courier New"

See ASCII= for how this works.

11.231 WHEXACT= Wilson-Hilferty exact normalization

Some early versions of Winsteps have the standard WHEXACT=NO.

ZSTD INFIT is the "t standardized Weighted Mean Square" shown at the bottom of RSA p. 100. ZSTD (standardized as a z-score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic distribution value has been adjusted to a unit normal value.

ZSTD OUTFIT is the "t standardized Unweighted Mean Square" based on the terms on RSA p. 100.

The Wilson-Hilferty transformation converts mean-square values to their equivalent "t standardized" normal deviates. See RSA p. 101

$$t_i = (v_i^{1/3} - 1)(3/q_i) + q_i/3$$

The degrees of freedom are 2/(qi*qi). The Wilson-Hilferty transformation is accurate for d.f.>25. With very small d.f., it becomes misleading, consequently the d.f. are not allowed to fall below 1, so that qi ≤ 1.4142.

Under certain circumstances, it can report the paradoxical finding that the mean-square apparently reports an overfit condition, but the normal deviate an underfit.

To allow this possibility, specify WHEXACT=Y

To suppress it, specify WHEXACT=N. The final q/3 term is omitted from the transformation.

Does not apply if NORMAL=Yes..

Example: A person takes a test of 20 dichotomous items and obtains an unweighted chi-square value of 19.5.

WHEXACT=Y
The OUTFIT mean-square is 0.975, i.e., apparently slightly overfitting. The exact normal deviate is .03, i.e., very slightly underfitting.
WHEXACT=N
The OUTFIT mean-square is 0.975, i.e., apparently slightly overfitting. The reported normal deviate is -.08, i.e., slightly overfitting.

11.232 WMLE = Warm's Mean Likelihood Estimation

WMLE=Yes reports Warm's Weighted Maximum Likelihood estimates in the measure tables. Also called Warm's Weighted Likelihood Estimation (WLE).

For persons, Thomas Warm's exact method is used. Warm's bias corrected estimate, WLE is when (raw score - J / (2 * I)) = Expected score. Where I is the test information for the WLE measure, and J is a function of the density.

For items, Frederick Lord's MLE Bias Correction is used. This approximates WLE. Lord's bias corrected estimate = MLE + (J / (2 * I^2))

See Shudong Wang and Tianyou Wang.(1999) Precision of Warm's Weighted Likelihood Estimation of Ability for a Polytomous Model in CAT.

Example: With WMLE=Yes, using the dataset in Table 4.1 on page 59 of Fischer, G.H. and Molenaar, I.W. (1995) Rasch Models. Foundations, Recent Developments and Applications. Springer, New York.

```
Title= "Fischer & Molenaar Table 4.1"
item1= 1
ni= 5
```

```
name1= 1
namelength= 30
IAFILE=*
1 -1.5 ; item values from Fischer Table 1
2 -0.75
3 0
4 0.75
5 1.5
*
CODES=01
WMLE=YES
LCONV=.0001
RCONV=.01
CONVERGE= Both
TFILE=*
18.1  ; persons in measure order
14.1  ; items in measure order
20.1  ; score table
*
&END
END LABELS
00000 MLE=        WMLE= -2.95
00001 MLE=  -1.70 WMLE= -1.45
00011 MLE=   -.51 WMLE=  -.46
00111 MLE=    .51 WMLE=   .46
01111 MLE=   1.70 WMLE=  1.45
11111 MLE=        WMLE=  2.95
```

Output:

```
Persons: Warm's WLE estimates:
TABLE 18.1 Fischer & Molenaar Table 4.1
         PERSON STATISTICS:  ENTRY ORDER
----------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL    JMLE  |  WARM |                              |
|NUMBER  SCORE  COUNT  MEASURE |  WMLE | PERSON: Fischer's results    |
|------------------------------+-------+------------------------------|
|     1      0      5   -3.20  |  -2.95| 00000 MLE=        WMLE= -2.95|
|     2      1      5   -1.70  |  -1.45| 00001 MLE=  -1.70 WMLE= -1.45|
|     3      2      5    -.51  |   -.46| 00011 MLE=   -.51 WMLE=  -.46|
|     4      3      5     .51  |    .46| 00111 MLE=    .51 WMLE=   .46|
|     5      4      5    1.70  |   1.45| 01111 MLE=   1.70 WMLE=  1.45|
|     6      5      5    3.20  |   2.95| 11111 MLE=        WMLE=  2.95|
|------------------------------+-------+------------------------------|
| MEAN     2.5    5.0     .00  |    .00|                              |
| P.SD     1.7     .0    2.12  |   1.92|                              |
----------------------------------------------------------------------

Items: Lord's MLE Bias Correction approximates Warm's WLE estimates:
TABLE 14.1 Fischer & Molenaar Table 4.1
         ITEM STATISTICS:  ENTRY ORDER
--------------------------------------
|ENTRY   TOTAL  TOTAL    JMLE  |  WARM | <- This is Lord's Approximation
|NUMBER  SCORE  COUNT  MEASURE |  WMLE |
|------------------------------+-------+
|     1      1      6   -1.50A |  -1.24|
|     2      2      6    -.75A |   -.65|
|     3      3      6     .00A |    .00|
|     4      4      6     .75A |    .65|
```

```
|      5       5       6     1.50A |    1.24|
|-----------------------------+-------+
| MEAN      3.0     6.0       .00  |     .00|
| P.SD      1.4      .0     1.06   |     .88|
--------------------------------------
```

11.233 WRFIT = Weighted-residual fit statistics = No

Gao et al. (2025) "propose a new person-fit statistic, WR, specifically designed for polytomous items in CDMs" [Cognitive Diagnostic Models]. As implemented in Winsteps, the fundamental equation is:

$$WRGHWZ_i = \sqrt{\frac{\sum_{n=1}^{N} |\log(P(X_{ni})|(X_{ni} - E(X_{ni})^2}{N}}$$

where i is item i, n=1 to N are the persons, Xni is the observation of category j of the rating scale, j=0,m. |log(P(Xni=j)| is the absolute value of the probability that Xni is j. E(Xni) is the expected value of Xni. There is a similar computation for each person n, where i=1 to L are the items.

When WRFIT=Yes, Winsteps reports the WR-GHWZ statistic. Gao et al. (2025) do not report WR-GHWZ directly. Instead they report significance tests based on bootstrap resampling. Bootstrap resampling can be done in Winsteps using SIMUL=.

WR-GHWZ is the squared residual weighted by the log-probability of the observation. This same weighting can be applied to the usual Infit and Outfit mean-square statistics: Computation of OUTFIT and INFIT Statistics. When WRFIT=Yes, WR-Infit mean-square and WR-Outfit mean-square are also reported.

$$WRinfit_i = \frac{\sum_{n=1}^{N}(|\log(P(X_{ni})|(X_{ni} - E(X_{ni}))^2)}{\sum_{n=1}^{N}\sum_{j=0}^{m}(P(j)|\log(P(j)|(j - E(X_{ni}))^2)}$$

$$WRoutfit_i = \frac{\sum_{n=1}^{N}\frac{|\log(P(X_{ni})|(X_{ni} - E(X_{ni}))^2}{\sum_{j=0}^{m}(P(j)|\log(P(j)|(j - E(X_{ni}))^2)}}{N}$$

Gao X., Hou M., Wang F., Zhou J, (2025) A new person-fit statistic for the detection of aberrant responses in polytomous cognitive diagnostic models. Behavior Research Methods 57:138. https://doi.org/10.3758/s13428-025-02659-6

Example: Table 6 for the data sets in Polytomous Mean-Square Fit Statistics and Dichotomous Infit and Outfit Mean-Square Fit Statistics are shown below. Gao et al.(2025) report that "Overall, WR proved to be an effective tool for detecting person misfit in polytomous scoring CDMs." They investigated "highly competent examinees respond[ing] incorrectly to simple items in a unique and creative way", and "cheating where low-ability examinees use various methods, such as cheating and plagiarism, to provide correct answers to difficult items". These are "noisy outliers" in the polytomous Table below.

```
         POLYTOMOUS MISFIT STATISTICS
----------------------------------------------------------------------------
|INFIT  OUTFIT| GHWZ   INFIT OUTFIT|                                        |
|MNSQ  |MNSQ   |  WR    WR-MS  WR-MS| PERSON                                 |
+------+------+-------------------+----------------------------------------|
| 8.30 | 9.79 |4.5905  20.2  25.1 | 00000000003333333333 extreme reversal    |
| 5.14 | 6.07 |3.4927  11.7  14.9 | 03030303030303030303 extreme flip-flop   |
| 4.00 | 5.58 |3.1322  9.41  13.9 | 00111111112222222233 Guttman reversal    |
| 3.62 | 4.61 |2.8802  7.96  10.8 | 01230123012301230123 rotate categories   |
| 2.11 | 4.14 |1.1708  1.97  3.62 | 22222222223333333333 high reversal       |
| 2.99 | 3.59 |2.5150  6.28  7.63 | 03202002101113311002 random responses    |
| 2.56 | 3.20 |1.8663  3.34  4.36 | 11111111112222222222 central reversal    |
| 1.75 | 2.02 |1.5010  2.16  2.59 | 11111122233222111111 folded pattern      |
| 1.50 | 1.96 |1.4281  1.96  2.65 | 12121212121212121212 central flip-flop   |
| 1.49 | 1.40 |1.3055  1.64  1.51 | 33133330232300101000 noisy progression   |
```

```
| 1.37 | 1.20 |1.0356  1.03   .85 | 33333333330000000000 extreme categories   |
| 1.25 | 1.09 |1.0466  1.08   .87 | 33233332212333000000 erratic transitions  |
|  .94 | 1.22 |1.4783  2.10  2.87 | 32222222201111111130 noisy outliers       |
|  .85 | 1.21 | .8364   .72   .98 | 22222222222222222222 one category         |
| 1.06 |  .97 | .9185   .81   .68 | 33333331122300000000 modelled             |
|  .98 | 1.04 | .9119   .80   .90 | 31332332321220000000 modelled             |
| 1.03 | 1.00 | .8652   .72   .68 | 33333331110010200001 modelled             |
|  .98 |  .99 | .8113   .64   .62 | 33333132210000001011 modelled             |
|  .80 |  .77 | .6819   .45   .41 | 33333333221100000000 high discrimination  |
|  .52 |  .54 | .5558   .30   .29 | 32323232121212101010 tight progression    |
|  .31 |  .36 | .3513   .12   .13 | 33333222221111100000 most likely          |
|  .25 |  .34 | .4018   .15   .21 | 22222222221111111111 2 central categories |
|  .21 |  .26 | .3390   .11   .13 | 32222222221111111110 low discrimination   |
|  .24 |  .24 | .2863   .12   .11 | 33333333332222222222 high (low) categories|
|  .18 |  .22 | .2947   .08   .09 | 33222222221111111100 most expected        |
|  .16 |  .20 | .2687   .08   .08 | 33333322222222211111 only 3 categories    |
+------+------+-------------------+-----------------------------------------|
```

```
         DICHOTOMOUS MISFIT STATISTICS
-----------------------------------------------------------------------------
|INFIT|OUTFIT| GHWZ  INFIT OUTFIT|                                        |
|MNSQ |MNSQ  |  WR   WR-MS  WR-MS| PERSON                                 |
+-----+------+-------------------+----------------------------------------|
|4.75 |8.05  |1.1913  7.85  8.81 | 0000000011111111 Miscode               |
|2.37 |3.31  | .7900  3.45  3.58 | 1010101010101010 Response set/Miskey   |
|1.76 |1.32  | .5620  1.75  1.56 | 1111000011110000 Special knowledge     |
| .87 |1.73  | .4636  1.19  1.67 | 0111111110000000 Carelessness/Sleeping |
| .87 |1.73  | .4636  1.19  1.67 | 1111111000000001 Lucky Guessing        |
|1.59 |1.45  | .5653  1.77  1.59 | 1110101010101000 low discrimination    |
|1.15 | .91  | .4406  1.07   .95 | 1111010110010000 Imputed outliers      |
|1.13 | .95  | .4440  1.09   .99 | 1110110110100000 Modelled/Ideal        |
| .68 | .45  | .2734   .41   .40 | 1111110101000000 high discrimination   |
| .50 | .34 -| .2026   .23   .23 | 1111111010000000 very high discrimination|
| .41 | .29 -| .1593   .14   .14 | 1111111100000000 Guttman/Deterministic |
+-----+------+-------------------+----------------------------------------|
```

```
TITLE='POLYTOMOUS MISFIT STATISTICS
WRFIT=Yes
NI=20
ITEM1=1            ; include response strings in person name
name1=1
namlen=43
CODES=0123
ptbis=no           ; compute point-measure correlation
INUMB=YES          ; no item labels
TFILE=*
6        ; Table 6 - persons in fit order
18       ; table 18 - persons in entry order
*
IAFILE=*           ; item anchor values - uniform
1 -1.9
2 -1.7
3 -1.5
4 -1.3
5 -1.1
6 -0.9
7 -0.7
8 -0.5
9 -0.3
10 -0.1
11 0.1
12 0.3
13 0.5
14 0.7
15 0.9
16 1.1
17 1.3
18 1.5
19 1.7
20 1.9
*
SAFILE=*           ; step anchor values
```

```
0 0
1 -1
2 0
3 1
*
&end
33333132210000001011 modelled
31332332321220000000 modelled
33333331122300000000 modelled
33333331110010200001 modelled
33222222221111111100 most expected
33333222221111100000 most likely
33333333221100000000 high discrimination
32222222221111111110 low discrimination
32323232121212101010 tight progression
33333333332222222222 high (low) categories
22222222221111111111 2 central categories
33333322222222211111 only 3 categories
32222222201111111130 noisy outliers
33233332212333000000 erratic transitions
33333333330000000000 extreme categories
33133330232300101000 noisy progression
22222222222222222222 one category
12121212121212121212 central flip-flop
03202002101113311002 random responses
01230123012301230123 rotate categories
03030303030303030303 extreme flip-flop
11111122233222111111 folded pattern
22222222223333333333 high reversal
11111111112222222222 central reversal
00111111112222222233 Guttman reversal
00000000003333333333 extreme reversal
```

```
Title = DICHOTOMOUS MISFIT STATISTICS
wrfit=yes
ni=16
item1=1
name1=1
namelength=41
codes=01
ptbiserial = measure
iafile=*
1 1
2 2
3 3
4 4
5 5
6 6
7 7
8 8
9 9
10 10
11 11
12 12
13 13
14 14
15 15
16 16
*
uascale = 2.4
tfile=*
6 ; Table 6 - persons in misfit order
*
&end
END LABELS
1110110110100000 Modelled/Ideal
1111111100000000 Guttman/Deterministic
0000000011111111 Miscode
0111111110000000 Carelessness/Sleeping
1111111000000001 Lucky Guessing
1010101010101010 Response set/Miskey
1111000011110000 Special knowledge
1111010110010000 Imputed outliers
1110101010101000 low discrimination
1111110101000000 high discrimination
1111111010000000 very high discrimination
```

11.234 XFILE= analyzed response file

If XFILE=filename is specified in the control file, a file is output which enables a detailed analysis of individual response anomalies.

XFILE=? opens a Browse window

This file contains 4 heading lines (unless HLINES=N or ROW1HEADING=N) followed by one line for each person-by-item response used in the estimation. Each line contains:

Field number	Description	Number Format	Abbreviation
1	Person number	7.0	PERSON
2	Item number	7.0	ITEM
3	Response value (after scoring with KEY=, IVALUE=, etc.)	4.0	OBS
4	Response value (after scoring and recounting. This usually only happens for rating scales with unobserved intermediate categories and STKEEP=NO.)	4.0	ORD
5	Expected response value. For dichotomous items, probability of success. This is computed from the measures without correction by STBIAS=. If you want to see the values with STBIAS=YES, then: 1. Perform the analysis with STBIAS=YES 2. Output IFILE=if.txt PFILE=PF.txt SFILE=sf.txt 3. Perform the analysis again with STBIAS=NO IAFILE=if.txt PAFILE=pf.txt SAFILE=sf.txt	7.3	EXPECT
6	Modeled Variance of observed values around the expected value This is also the statistical information in the observation. √ (modeled variance) is the observation's raw-score standard deviation or S.E.	7.3	VARIAN
7	Standardized residual: (Observed - Expected)/Square root (Variance). This approximates a unit-normal deviate. Values outside ±2 are unexpected.	7.3	ZSCORE
8	Score residual: (Observed - Expected)	7.3	RESIDL
9	Person measure in USCALE= units	7.2*	PERMEA
10	Item measure in USCALE= units	7.2*	ITMMEA
11	Measure difference (Person measure - Item measure) in USCALE= units	7.2*	MEASDF
12	Log-Probability of observed response. These can be summed for the Log-Likelihood Chi-Square, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC), etc.	7.3	L-PROB
13	Predicted person measure from this response alone in USCALE= units. for many purposes, this approximates a linearization of the individual original ordinal observation, but, because the top and bottom categories of a rating scale are ininitely wide, averaging these only approximates the person measure estimated from all the person's observations.	7.2*	PPMEAS
14	Predicted item measure from this response alone in USCALE= units	7.2*	PIMEAS
15	Modeled Kurtosis of the observed values around their expectation	7.3	KURT
16	More Probable of the Responses to be observed	4.0	MPR
17	Response weight (person weight x item weight)	7.3	WEIGHT
18	Response status: 0 = Not scored, 1 = Standard, 2 = in Extreme person score, 3 = in Extreme item score, 4 = in Extreme person and item scores	2.0	ST
19	Response code in data file	A	CODE
20	Person label	A	PLABEL
21	Item label	A	ILABEL
	7.3 means "7 columns with 3 decimal places". 2* means Decimal Places set by the XFILE= dialog box from the Output Files menu or UDECIM= if not set..		

	A means alphanumeric character field

```
; RESIDUAL FILE FOR LIKING FOR SCIENCE (Wright & Masters p.18)  May 22 17:34 2013
    KID    ACT OBS ORD EXPECT VARIAN ZSCORE RESIDL PERMEA ITMMEA MEASDF L-PROB PPMEAS PIMEAS KURTOS MPR WEIGHT C PLABEL                 ILABEL
      1      1   1   1  1.414   .388  -.666  -.414   .483  -.469   .953  -.819  -.469   .483   .360   2  1.000 1  ROSSNER, MARC DANIEL WATCH BIRDS
      1      2   2   2  1.528   .341   .808   .472   .483  -.781  1.264  -.555  1.289 -1.587   .308   2  1.000 2  ROSSNER, MARC DANIEL READ BOOKS ON ANIMALS
      1      3   1   1  1.065   .458  -.096  -.065   .483   .342   .141  -.621   .342   .483   .457   1  1.000 1  ROSSNER, MARC DANIEL READ BOOKS ON PLANTS
      1      4   1   1   .499   .353   .843   .501   .483  1.669 -1.186  -.926  1.669   .483   .321   0  1.000 1  ROSSNER, MARC DANIEL WATCH GRASS CHANGE
      1      5   1   1   .301   .246  1.410   .699   .483  2.331 -1.848 -1.327  2.331   .483   .218   0  1.000 1  ROSSNER, MARC DANIEL FIND BOTTLES AND CANS
      1      6   0   0  1.115   .455 -1.654 -1.115   .483   .232   .251 -1.735 -1.838  2.553   .451   1  1.000 0  ROSSNER, MARC DANIEL LOOK UP STRANGE ANIMAL OR PLANT
      1      7   2   2   .755   .435  1.887  1.245   .483  1.025  -.541 -2.078  3.095 -1.587   .423   1  1.000 2  ROSSNER, MARC DANIEL WATCH ANIMAL MOVE
      1      8   0   0   .528   .365  -.873  -.528   .483  1.589 -1.106  -.835  -.481  2.553   .334   0  1.000 0  ROSSNER, MARC DANIEL LOOK IN SIDEWALK CRACKS
```

Fields can be selected interactively and the default field selection changed at XFILE= dialog box.

If CSV=Y, the values are separated by commas. When CSV=T, the commas are replaced by tab characters. For "non-numeric values in quotation marks", specify QUOTED=Y.

This file enables a detailed analysis of individual response anomalies. The response residual can be analyzed in three forms:
1) in response-level score units, from [(observed value - expected value)].
2) in logits, from [(observed value - expected value)/variance].
3) in standard units, [(observed value - expected value)/(square root of variance)].

Predicted person measure: Imagine that this observation was the only observation made for the person ... this value is the measure we would predict for that person given the item measure.
Predicted item measure: Imagine that this observation is the only observation made for this item ... this value is the measure we would predict for that item given the person measure.
The formulas are the same as for a response string of more than 1 observation. For dichotomies, see www.rasch.org/rmt/rmt102t.htm and for polytomies www.rasch.org/rmt/rmt122q.htm

Example 1: I need the S.D. of the response values for each item
Output the Xfile= to Excel. Sort by Item number. Then compute the S.D. for each item separately or use the Excel SUBTOTAL function:
1. On the Data tab, in the Outline group, click **Subtotal**. The Subtotal dialog box is displayed.
2. In the At each change in box, click the nested subtotal column, item number. ...
3. In the Use function box, click the summary function that you want to use to calculate the subtotals, StDevP. ...
4. Clear the Replace current subtotals check box.
5. Click OK

Example 2: You wish to compute differential item functioning, DIF, for a specific classification group of people:
If Table 30 is not suitable, here is a simple approximation:
Since one item does not have enough information to measure a person, for item bias we have to do it on the basis of a classification group of people.
From the XFILE,
add the "score residuals" (not standardized) for everyone in classification "A" on a particular item.
Add the "modeled variance" for everyone in the classification.
Divide the residual sum by the variance sum. This gives an estimate of the DIF for classification "A" relative to the grand mean measure.
Do the same for classification "B" on the same item.
To contrast classification "A" with classification "B" then
DIF size "AB" =DIF estimate for "A" - DIF estimate for "B"
A significance t-test is t =DIF size "AB" / square root (1/variance sum for classification A + 1/variance sum for classification B))

Example 3: You want to convert lucky guesses into missing data for some items.
Click on Output Files menu
Click on XFILE=
In the XFILE= Fields dialog box, type the Item numbers you want.
Click on OK
Output to Excel (Temporary file)
Sort the Excel file on Residual
The largest positive residuals are the lucky guesses
Rectangular- Copy the person entry numbers and the item entry numbers into your Winsteps control file:

EDFILE=*
person item . ; the . is to indicate "make this response missing data"
person item . ; the . is to indicate "make this response missing data"
person item . ; the . is to indicate "make this response missing data"
*

Save your Winsteps control file.
In the next analysis these unexpected correct responses will be scored as missing. The raw scores will also change.

11.235 XWIDE= columns per response

The number of columns taken up by each response in your data file (1 or 2 or more). If possible, enter your data one column per response. If there are two columns per response, make XWIDE=2. If your data includes responses entered in both 1 and 2 character-width formats, use FORMAT= to convert all to XWIDE=2 format. When XWIDE=2, these control variables require two columns per item or per response code: CODES=, KEYn=, KEYSCR=, NEWSCORE=, IVALUE=. Either 1 or XWIDE= columns can be used for RESCORE=, ISGROUPS=, RESCORE= and IREFER=

See Example 11, Item responses two characters wide.

Example 1: The responses are scanned into adjacent columns in the data records,
```
XWIDE=1 ; Observations 1 column wide
CODES=01
```

Example 2: Each response is a rating on a rating scale from 1 to 10, and so requires two columns in the date record,
```
XWIDE=2 ; 2 columns per datum
CODES=01020304050607080 1011 ; 2 CHARACTERS FOR EACH OBSERVATION
or
CODES=" 1 2 3 4 5 6 7 8 91011" ; 2 CHARACTERS FOR EACH OBSERVATION
```

Example 3: Some responses take one column, and some two columns in the data record. Five items of 1-character width, code "a", "b", "c", or "d", then ten items of 2-character width, coded "AA", "BB", "CC", "DD". These are preceded by person-id of 30 characters.
```
XWIDE=2 Format to two columns per response
FORMAT=(30A1,5A1,10A2)  Name 30 characters, 5 1-chars, 10 2-chars
CODES   ="a b c d AABBCCDD"  "a" becomes "a "
NEWSCORE="1 2 3 4 1 2 3 4 "  response values
RESCORE=2    rescore all items
NAME1=1    person id starts in column 1
ITEM1=31    item responses start in column 31
NI=15     15 items all now XWIDE=2
```

Example 4: Scores are entered as hundreds, but are to be analyzed as incrementing by 1
```
XWIDE = 4
CODES = " 100 200 300 400 500 600 700 800 9001000"
STKEEP = No ; analyze the ascending scores as ordinal levels
```

For more examples, see CODES= and Decimal, percentage and contiuous data.

12 Examples of Control and Data Files

12.1 Example 0: Rating scale data: The Liking for Science data

Rather than attempting to construct a control file from scratch, it is usually easier to find one of these examples that is similar to your analysis, and modify it.

Control and data file, Example0.txt, for the Liking for Science data (see RSA) contains the responses of 75 children to 25 rating-scale items. The responses are 0-dislike, 1-neutral, 2-like. To analyze these data, start Winsteps, then:

Control file name?:
"Files" pull-down menu
"Control file name"

"Examples" folder
Example0.txt
Open

Report output file: **(Enter)**	*press Enter for a temporary file.*
Extra specifications:**(Enter)**	*press Enter because there are no extra specifications*

```
; This is file "example0.txt" - ";" starts a comment
 TITLE= 'LIKING FOR SCIENCE (Wright & Masters p.18)'
 NI=     25  ; 25 items
 ITEM1=  1   ; responses start in column 1 of the data
 NAME1=  30  ; person-label starts in column 30 of the data
 ITEM=   ACT ; items are called "activities"
 PERSON= KID ; persons are called "kids"
 CODES=  012 ; valid response codes (ratings) are 0, 1, 2
 CLFILE= *   ; label the response categories
 0 Dislike   ; names of the response categories
 1 Neutral
 2 Like
 *           ; "*" means the end of a list
 &END        ; this ends the control specifications
; These are brief descriptions of the 25 items
WATCH BIRDS
READ BOOKS ON ANIMALS
READ BOOKS ON PLANTS
WATCH GRASS CHANGE
FIND BOTTLES AND CANS
LOOK UP STRANGE ANIMAL OR PLANT
WATCH ANIMAL MOVE
LOOK IN SIDEWALK CRACKS
LEARN WEED NAMES
LISTEN TO BIRD SING
FIND WHERE ANIMAL LIVES
GO TO MUSEUM
GROW GARDEN
LOOK AT PICTURES OF PLANTS
READ ANIMAL STORIES
MAKE A MAP
WATCH WHAT ANIMALS EAT
GO ON PICNIC
GO TO ZOO
WATCH BUGS
WATCH BIRD MAKE NEST
FIND OUT WHAT ANIMALS EAT
WATCH A RAT
FIND OUT WHAT FLOWERS LIVE ON
TALK W/FRIENDS ABOUT PLANTS
END NAMES   ;this follows the item names: - the data follow:
1211102012222021122021020    ROSSNER, MARC DANIEL
2222222222222222222222222    ROSSNER, LAWRENCE F.
2211011012222122122121111    ROSSNER, TOBY G.
1010010122122111122021111    ROSSNER, MICHAEL T.
1010101001111001122111110    ROSSNER, REBECCA A.
1011211011121010122101210    ROSSNER, TR CAT
2220022202222222222222222    WRIGHT, BENJAMIN
2210021022222020122022022    LAMBERT, MD., ROSS W.
0110100112122001121120211    SCHULZ, MATTHEW
2100010122221121122011021    HSIEH, DANIEL SEB
2220011102222220222022022    HSIEH, PAUL FRED
0100220101210011021000101    LIEBERMAN, DANIEL
1211000102121121122111000    LIEBERMAN, BENJAMIN
2110020212022100022000120    HWA, NANCY MARIE
1111111111111111112211111    DYSON, STEPHIE NINA
2221121122222222222122022    BUFF, MARGE BABY
2222022222222222222222122    SCHATTNER, GAIL
2222021022222221222122022    ERNST, RICHARD MAX
2221011002222211122020022    FONTANILLA, HAMES
1100010002122212122020022    ANGUIANO, ROB
1111011112122111122021011    EISEN, NORM L.
1211111112222121122121121    HOGAN, KATHLEEN
2211112112222121222122122    VROOM, JEFF
1221012102222110122021022    TOZER, AMY ELIZABETH
2221120222222221222122022    SEILER, KAREN
1111111111111111111111111    NEIMAN, RAYMOND
1110011101122111022120221    DENNY, DON
2211102002122121022012011    ALLEN, PETER
1000101001110000022110200    LANDMAN, ALAN
1000000002122000022012100    NORDGREN, JAN SWEDE
```

```
221101111222101112212111    SABILE, JACK
121001001122211012102202    ROSSNER, JACK
221202121222222022202202    ROSSNER, BESS
222212222222222222222212    PASTER, RUTH
111021101112211112201111    RINZLER, JAMES
111020100112211112201111    AMIRAULT, ZIPPY
121001001212211112201202    AIREHEAD, JOHN
221102111222212112222212    MOOSE, BULLWINKLE
222102211222212222212202    SQURREL, ROCKY J.
222101102222222122212202    BADENOV, BORIS
222222222222222222222212    FATALE, NATASHA
212101111212222112201102    LEADER, FEARLESS
222011202222212122202202    MAN, SPIDER
121002101221221102201102    CIANCI, BUDDY
222102222222222222222202    MCLOUGHLIN, BILLY
220002000222200022212201    MULLER, JEFF
111022011221211102201000    VAN DAM, ANDY
222102222222222122212202    CHAZELLE, BERNIE
110011010111011211111121    BAUDET, GERARD
222212122222222222212212    DOEPPNER, TOM
121002102222222112202102    REISS, STEVE
111111111111111112211111    STULTZ, NEWELL
010010101011001102101000    SABOL, ANDREW
111102112112211212202101    BABBOO, BABOO
101001001112211222211111    DRISKEL, MICHAEL
222101201222222222212202    EASTWOOD, CLINT
222002202222222222202202    CLAPP, CHARLIE
122101012222222122202102    CLAPP, DOCENT
222102112222222122202222    CLAPP, LB
122111112222212112212102    SQUILLY, MICHAEL
211101002212211112201102    SQUILLY, BAY OF
222000002222222022202000    BEISER, ED
121101012222212222212201    BECKER, SELWIN
221002211222212122212201    CORLEONE, VITO
121121100222201212212120    CORLEONE, MICHAEL
120101001222212022202202    PINHEAD, ZIPPY
121100100121212122212101    MALAPROP, MRS.
120001010212012002200101    BOND, JAMES
121001012222212222202102    BLOFELD, VILLAIN
222202201222212222202202    KENT, CLARK
220122200122002222022220    STOLLER, DAVE
100100010001101002120020    JACKSON, SOLOMON
201201012221020110220202    SANDBERG, RYNE
222002200222222222202201    PATRIARCA, RAY
120011011212222102202001    PAULING, LINUS
```

When analysis completes, use the "Output Tables"pull-down menu to examine the measures and quality-control fit statistics. Start with Table 1, which gives you a quick summary. Here are the Science Activity items in measure order, Table 13. The hierarchy of item labels, in the right-hand column, defines the construct that has been measured. "Go on picnic" is easiest to like. "Find bottles" is hardest to like.

```
         ACT STATISTICS:  MEASURE ORDER
+----------------------------------------------------------------------------------------------+
|ENTRY    RAW                     MODEL|   INFIT  |  OUTFIT  |PTMEA|                               |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.| ACT                           |
|------------------------------------+----------+----------+-----+-------------------------------|
|     5     35     74    2.42     .22|2.30   5.6|3.62   7.3|  .05| FIND BOTTLES AND CANS         |
|    23     40     74    2.18     .21|2.41   6.3|4.11   9.0|  .00| WATCH A RAT                   |
|    20     48     74    1.83     .20|1.33   2.0|1.82   3.7|  .42| WATCH BUGS                    |
|     4     50     74    1.75     .20| .89   -.7| .91   -.4|  .60| WATCH GRASS CHANGE            |
|     8     52     74    1.67     .20|1.10    .7|1.21   1.2|  .51| LOOK IN SIDEWALK CRACKS       |
|     7     67     74    1.10     .19| .97   -.1|1.01    .1|  .59| WATCH ANIMAL MOVE             |
|     9     78     74     .71     .19|1.18   1.3|1.17   1.0|  .53| LEARN WEED NAMES              |
|    16     81     74     .60     .19| .97   -.2| .95   -.3|  .51| MAKE A MAP                    |
|    25     83     74     .53     .19| .80  -1.5| .74  -1.6|  .66| TALK W/FRIENDS ABOUT PLANTS   |
|     3     86     74     .42     .19| .57  -3.5| .54  -3.0|  .72| READ BOOKS ON PLANTS          |
|    14     86     74     .42     .19| .82  -1.3| .75  -1.4|  .62| LOOK AT PICTURES OF PLANTS    |
|     6     89     74     .31     .19| .81  -1.4| .76  -1.4|  .61| LOOK UP STRANGE ANIMAL OR PLANT|
|    17     93     74     .16     .19| .65  -2.7| .59  -2.4|  .70| WATCH WHAT ANIMALS EAT        |
|    22     95     74     .08     .19| .83  -1.2| .74  -1.4|  .63| FIND OUT WHAT ANIMALS EAT     |
|    24    105     74    -.31     .20| .90   -.6| .79   -.9|  .60| FIND OUT WHAT FLOWERS LIVE ON |
|     1    107     74    -.40     .21| .55  -3.5| .49  -2.5|  .64| WATCH BIRDS                   |
|    15    109     74    -.48     .21| .78  -1.5| .64  -1.6|  .61| READ ANIMAL STORIES           |
|     2    114     74    -.71     .22| .93   -.4| .72  -1.0|  .58| READ BOOKS ON ANIMALS         |
|    21    117     74    -.85     .22| .84   -.9| .65  -1.3|  .58| WATCH BIRD MAKE NEST          |
|    11    119     74    -.96     .23| .63  -2.4| .49  -1.9|  .59| FIND WHERE ANIMAL LIVES       |
|    13    125     74   -1.29     .25|1.22   1.1| .94    .0|  .47| GROW GARDEN                   |
```

```
|    10    128     74   -1.49     .26| .78  -1.1| .57  -1.1|  .50| LISTEN TO BIRD SING            |
|    12    135     74   -2.04     .31| .70  -1.2| .51  -1.0|  .45| GO TO MUSEUM                   |
|    19    139     74   -2.48     .36|1.08    .4|1.10    .4|  .30| GO TO ZOO                      |
|    18    143     74   -3.15     .47|1.50   1.2|1.23    .5|  .14| GO ON PICNIC                   |
|------------------------------------+----------+----------+-----+--------------------------------|
| MEAN    93.0   74.0     .00     .23|1.02   -.2|1.08    .0|     |                                |
| P.SD    30.9     .0    1.41     .06| .45   2.3| .87   2.8|     |                                |
+-------------------------------------------------------------------------------------------------+
```

12.2 Example 1: Dichotomous data: Simple control file with data included

A control file, EXAM1.TXT, for an analysis of the Knox Cube Test (see BTD) a test containing 18 items, each item is already scored dichotomously as 0,1. The person-id data begins in column 1 and the item string begins in column 11. No items will be deleted, recoded, or anchored. The number of data lines is counted to determine how many children took the test. use the pull-down "Diagnosis" and "Output Table" menus to see the output tables. For an explanation of the output obtained, see later in the manual. Run this example with:

Control file: **EXAM1.TXT**
Report output file: **(Enter)**
Extra specifications: **(Enter)**

```
; This file is EXAM1.TXT - (";" starts a comment)
 TITLE='KNOX CUBE TEST'  ; Report title
 NAME1=1                 ; First column of person label in data file
 ITEM1=11                ; First column of responses in data file
 NI=18                   ; Number of items
 CODES=01                ; Valid response codes in the data file
 CLFILE=*                ; Labels the observations
 0 Wrong                 ; 0 in data is "wrong"
 1 Right                 ; 1 in data is "right"
 *                       ; "*" is the end of a list
 PERSON=KID              ; Person title: KID means "child"
 ITEM=TAP                ; Item title: TAP means "tapping pattern"
 &END                    ; Item labels for 18 items follow
1-4                      ; tapping pattern of first item: cube 1 then cube 4 are tapped.
2-3
1-2-4
1-3-4
2-1-4
3-4-1
1-4-3-2
1-4-2-3
1-3-2-4
2-4-3-1
1-3-1-2-4
1-3-2-4-3
1-4-3-2-4
1-4-2-3-4-1
1-3-2-4-1-3
1-4-2-3-1-4
1-4-3-1-2-4
4-1-3-4-2-1-4            ; last tapping pattern: 7 actions to remember!
END NAMES                ; END NAMES or END LABELS must come at end of list
Richard M 111111100000000000    ; Here are the 35 person response strings
Tracie  F 111111111100000000
Walter  M 111111111001000000
Blaise  M 111100101000000000
Ron     M 111111111100000000
William M 111111111100000000
Susan   F 111111111111101000
Linda   F 111111111100000000
Kim     F 111111111100000000
Carol   F 111111111110000000
Pete    M 111011111000000000
Brenda  F 111110101100000000
Mike    M 111110011111000000
Zula    F 111111111110000000
Frank   M 111111111111100000
Dorothy F 111111111010000000
Rod     M 111101111100000000
Britton F 111111111100100000
Janet   F 111111111000000000
David   M 111111111100100000
Thomas  M 111111111110100000
```

```
Betty   F 111111111111000000
Bert    M 111111111100110000
Rick    M 111111111110100110    ; best performance
Don     M 111011000000000000
Barbara F 111111111100000000
Adam    M 111111100000000000
Audrey  F 111111111010000000
Anne    F 111111001110010000
Lisa    F 111111111000000000
James   M 111111111100000000
Joe     M 111111111110000000
Martha  F 111100100100000000
Elsie   F 111111111101010000
Helen   F 111000000000000000    ; worst performance:  last data line - just stop!
```

12.3 Example 2: Control and anchor files

A control file, EXAM2.TXT, for the analysis of a test containing 18 items, each item already scored dichotomously as 0,1. The person-id data begins in column 1 and the item-response string begins in column 11. The standard tables will be appear in the printout. There is user scaling. Items 2, 4, 6 and 8 are anchored at 400, 450, 550 and 600 units respectively, supplied in file EXAM2IAF.TXT Your data is in file EXAM2DAT.TXT:

```
; This file is EXAM2.TXT
 TITLE='KNOX CUBE TEST - ANCHORED'   ; the title for output
 NI=18               ; the number of items
 ITEM1=11            ; position of first response in data record
 NAME1=1             ; first column of person-id in data record
 PERSON=KID
 ITEM=TAP
 DATA=EXAM2DAT.TXT   ; name of data file
 IAFILE=EXAM2IAF.TXT ; this is item anchor (input) file: it is the IFILE= of an earlier analysis
 CONVERGE=L          ; use only Logits for convergence criterion
 LCONV=.005          ; converged when biggest change is too small to show on any report.
; What follows is equivalent to the IAFILE= above
; IAFILE=*          ; item anchor file list
;2 400              ; item 2 anchored at 400 units
;4 450              ; item 4 anchored at 450 units
;6 550              ; item 6 anchored at 550 units
;8 600              ; item 8 anchored at 600 units
; *

 UIMEAN=500          ; user scaling - item mean
 USCALE=100          ; user scaling - 1 logit = 100 user units
 UDECIM=0            ; print measures without decimals
 &END
1-4                  ; item labels, starting with the first item
  .
4-1-3-4-2-1-4
END NAMES            ; End of this file
```

The anchoring information is contained in file EXAM2IAF.TXT and contains the following lines, starting in column 1:

```
2 400 ; item 2 anchored at 400 units:
      ; if logits are user-rescaled, then anchor values are also expected to be user-rescaled.
      ; for logit anchor values, specify UASCALE=1
4 450 ; item 4 anchored at 450 units
6 550 ; item 6 anchored at 550 units
8 600 ; item 8 anchored at 600 units
```

Item calibration files, IFILE=, from prior runs can be used as item anchor files, IAFILE=, of later runs.

Your data is in the separate file, EXAM2DAT.TXT, with person-id starting in column 1, and item responses starting in column 11:

```
Richard M 111111100000000000
Tracie  F 111111111100000000
   .
Elsie   F 111111111101010000
Helen   F 111000000000000000    End of this file
```

12.4 Example 3: Item recoding and item deletion

The test has 25 items, specified in EXAM3.TXT. The item response string starts in column 12. Person-id's start in column 1 (the standard value). Original item codes are "0", "1", "2" and "X". All items are to be recoded and the original-to-new-code assignments will be 0 0, 1 2, 2 1 and X 3. Items 5, 8, and 20 through 25 are to be deleted from the analysis, and are specified in the control. The misfit criterion for person or item behavior is 3.0. Tables 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, 15, 17, 19, 20 and 21 are to appear in your report output file EXAM3OUT.TXT. Sequence numbers are used as item names. Data are in file EXAM3DAT.TXT.

```
; This file is EXAM3.TXT
 TITLE="A test with 25 recoded items" ; informative title
 NI=25                    ; 25 items
 ITEM1=12                 ; item responses start in column 12
 CODES =012X              ; valid codes
 NEWSCORE=0213            ; corresponding response score
 RESCORE=2                ; specifies rescore all items
 TABLES=1111111110101010101110      ; selected tables to go in output file
 FITP=3.0                 ; person misfit cut-off for reporting
 FITI=3.0                 ; item misfit cut-off for reporting
 DATA=EXAM3DAT.TXT        ; name of data file
 IDFILE=*                 ; list of items to delete: or use IDFILE=file name
 5                        ; delete item entry number 5
 8                        ; delete item entry number 8
 20-25                    ; delete item entry numbers 20 through 25
 *                        ; end of list
 INUMB=Y                  ; use item sequence numbers as names
 &END                     ; end of control specifications
 first-item-label
 second-item-label
 ....
 END LABELS
```

The data is in file EXAM3DAT.TXT

```
101F20FJDP 21XX2XXXXX111X1200001X2X
102M20PFNP X22101222112222112221 20X2
   .
175F  FBDP 1X00X00000200012X02220100
176F23FEDP 21121022012002121 2202000      person id's contain demographic information
```

12.5 Example 4: Selective item recoding

The test has 18 items, specified in file EXAM4.TXT. The response string starts in column 1. Person-id's start in column 41. Original codes are 0,1 in data file EXAM4DAT.TXT. Items 2, 3, and 4 are to be recoded as 1,0. All tables are to appear in report file EXAM4OUT.TXT, in a standardized form.

```
TITLE="An example of selective item recoding"    ; page title
NI=18                    ; 18 items
ITEM1=1                  ; item responses start in column 1
NAME1=41                 ; person-id starts in column 41
NAMLEN=9                 ; person-id has 9 characters: Richard M
PSELECT= ????????M       ; select M in position 9 of person name
NAMLMP=7                 ; 7 characters to appear on maps: "Richard"
CODES=01                 ; the observed response codes
CLFILE=*                 ; the code label list
0 Incorrect              ; the observed response codes
1 Correct
*                        ; end of list
IREFER=ABBBAAAAAAAAAAAAAA      ; can be letters or numbers
IVALUEA=01               ; A-type items keep original scoring (this line can be omitted)
IVALUEB=10               ; B-type items have reverse scoring

DATA=EXAM4DAT.TXT        ; name of data file
MRANGE=5                 ; plots and maps have half-range of 5 logits
LINELENGTH=0                 ; allow maximum line length
MAXPAGE=0                 ; no maximum page length
TABLES=1111111111111111111111111111111111      ; output all Tables to the Output file
&END
1-4
R2-3                     ; R reminds us item coding was reversed
R1-2-4
2-1-4
  .
4-1-3-4-2-1-4
END NAMES
```

The data file, EXAM4DAT.TXT, is

```
100011100000000000                  Richard M
100011111100000000                  Tracie  F
    .
100100000000000000                  Helen   F
```

12.6 Example 5: Scoring key for items, also CAT responses

A multiple-choice-question (MCQ) computer-adaptive test (CAT), in file EXAM5.TXT with responses "a", "b", "c", "d" and a scoring key for 69 items. Your data are in the control file. This was administered as a CAT test, then the response file formatted into a "flat" file with one row per person and one column per item.

```
; This file is EXAM5.TXT
TITLE="An MCQ Test" ; the title
NI=69       ; 69 items
ITEM1=10    ; response string starts in column 10
NAME1=1     ; person-id starts in column 1
CODES=abcd  ; valid response codes
MISSCORE=-1 ; standard scoring of missing data, means that blanks are ignored
KEY1 = dcbbbbadbdcacacddabadbaaaccbddddcaadccccdbdcccbbdbcccbdcddbacaccbcddb
            ; scoring key of correct answers
ITEM=TOPIC  ; items are topics
PERSON=STDNT  ; respondents are students
NAMLMP=2      ; first 2 characters on maps, e.g., nl
PFILE=EXAM5PF.TXT ; write out person measures
CSV=Y       ; separate values by commas in PFILE=
HLINES=N    ; write out no heading lines in PFILE=
; Many spreadsheets and statistics programs expect a file of numbers separated by commas.
; Use IFILE= or PFILE= with CSV=Y and HLINES=N.
MJMLE=0     ; allow as many JMLE iterations as necessary
EXTRSC=0.5  ; most conservative (central) extreme measures wanted
XFILE=EXAM5XF.TXT ; write out individual response residual file
&END
nl01  Month
nl02  Sign
  .
sb02  newspaper
sb03  newspaper
END NAMES
IM  CAT                         a          dcacc   ccabbcaa
NM  KAT     b badad accaaba aa c dd   ab   c
   .
NH  RIC  ddb  b dbdcbcaadba ba acd bad  db     c   d    cc
IL  HOL        a      a  da d   d ccbddd bcd  dc ca
```

12.7 Example 6: Keys in data record FORMAT

Do not use FORMAT= unless there is no other way. It is tricky to set up correctly. MFORMS= is much easier.

A test of 165 multiple-choice items with multiple data lines per data record. The scoring key is formatted in the same way as the data lines:

```
; This file is EXAM6.TXT
 TITLE='Demonstration of KEY1 record' title
 FORMAT=(1X,10A,T23,50A,/,T23,50A,/,T23,50A,/,T23,15A)
; The first character is ignored,
; then 10 characters in first record are person id,
; then starting in column 23,
; 50 columns in first 3 records,
; and 15 responses in fourth record.

;  Using MFORMS= to reformat the same data record
;  MFORMS=*
;  Data= filename ; put the input data in a separate file
;  L=4           ; 4 data input lines per output record
```

```
;  P1-10=2       ; person label characters 1-10 start in column 2 of line 1 of input data
;  I1-50=23      ; responses to items 1-50 start in column 23 of line 1 of input data
;  I51-100=2:23  ; responses to items 51-100 start in column 23 of line 2 of input data
;  I101-150=3:23 ; responses to items 101-150 start in column 23 of line 3 of input data
;  I151-165=4:23 ; responses to items 151-165 start in column 23 of line 4 of input data
;  *   ; end of MFORMS=
;      ; Note this does not reformat the Keyfrm=, so use KEY1=

; In the reformatted record
 NAME1=1  ; Person-id starts in column 1
 ITEM1=11 ; Item responses start in column 11 of reformatted record
 NI=165   ; There are 165 items
 CODES="ABCD " ; The raw responses are ABCD and BLANK.
          ; Put character strings in " " if blanks are to be included.
 MISSCORE=0  ; Blanks and invalid codes scored wrong=0
 KEYFRM=1 ; There is a KEY1 record after &END which is formatted
          ; exactly like a data record specifying the correct responses.
RFILE=exam6rf.txt ; this shows effect of reformatting and scoring
PTBISERIAL=YES ; Raw score point-biserial excluding extremes
TFILE=*   ; List of desired tables
1.0       ; Subtable 0 of Table 1
3         ; Table 3.1, 3.2, etc.
6
10
20
*         ; end of list

 &END     ; KEY1= formatted like your data follows:
Key 1 Record          CDABCDBDABCADCBDBCADBABDDCDABCBABDCACBADACBADBAACD
after &END            CCBDACABDADCBDCABBCACDBAABCDADCDCADBCABCDCADABACDA
in FORMAT= format     BADCDBADCBADCDBACBADBCAADBCBBDCBACDBACBADCDADBACDB
before item names     ABDACDCDBADBCAB
A1   First item name
A2
  .
A164
A165
END NAMES
090111000102   10001  BDABADCDACCDCCADBCBDBCDDACADDCACCCBCCADBDABADCAADD
                      ABDDDCABDADCBDACDBCACADABCDCCDCBDBCCABBCDCADDCDCDA
                      BDCCDBABCDCDDDCBADCACBDCBDBACBCBCADBABAADCDCBABAAC
                      DCBCCACABCDDCBC
090111000202   10002  BDCDCDCDADCBCCBDBDCABCBDACDABCAABCAACBBBACAADDAACA
                      ACBCACBBDADCBDCBBBCDCCDACCBCADCACCAACDBCCDADDBACDA
                      BADCDCBDBDCDCCBACCCBBAABDBCDBCCBAADBABBADBDDABDCAA
                      DCDBCDCDBADBCCB

   .

090111008402   10084  CDABCDADDDCDDDDCBDCCBCCDACDBBCACDBCCCBDDACBADCAACD
                      ACBDCCDBDADCCBCDDBBDCABACCBDBDCBCCACCBACDCADABACDA
                      BABBDCADBDDBCDADDDCDDBCABCBDCCCAACDBACBDDBDBCCAACB
                      DBACDBCDBADDCBC
090111008502   10085  CDABADADABCADCDDBDADBBCBACDABCCABACCCDAAACBADAAACD
                      ACBCDCBBDADCDDCADBCCCDBADDBBBDCACAABCBDDDCADABACDA
                      BADABBADBBADCADACDABBAACACAABDCBACDBADBACCDBACBADA
                      BCABCBCDBADDCCC
```

or, using continuation lines for the key:

```
 CODES="ABCD " ; The raw responses are ABCD and BLANK
;KEYFRM=  ; omit this, not needed
 KEY1 = CDABCDBDABCADCBDBCADBABDDCDABCBABDCACBADACBADBAACD+
```

```
+CCBDACABDADCBDCABBCACDBAABCDADCDCADBCABCDCADABACDA+
+BADCDBADCBADCDBACBADBCAADBCBBDCBACDBACBADCDADBACDB+
+ABDACDCDBADBCAB
; "+" are continuation characters
```

12.8 Example 7: A partial credit analysis

A 30 item MCQ Arithmetic Test is to be analyzed in which credit is given for partial solutions to the questions. Each item is conceptualized to have its own response structure, as in the Masters' Partial Credit model. Estimation for the Partial Credit model is described in RSA, p. 87.

In this example, item 1 has 3 scoring levels. "C" is correct, worth 2 points. "A" and "D" are partially correct, worth 1 point. "B" is incorrect, worth 0 points. CODES= identifies all possible valid responses. In this example, KEY1= identifies responses worth 2 points. KEY2= and KEY3= identify responses worth 1 point. The values of KEY1=, KEY2= and KEY3= are set by KEYSCR=. So for item 1, KEY1=C..., KEY2=A..., and KEY3=D. Response B is not in a KEY= and so is scored 0. Here, invalid responses are treated as not-administered. If invalid responses are to be treated as "wrong", specify MISSCORE=0.

```
; This file is EXAM7.TXT
TITLE="A Partial Credit Analysis" page heading
NAME1=1  ; Person-id starts in column 1
ITEM1=23  ; Item responses start in column 23
NI=30   ; There are 30 items

; USING KEY1= (an alternative is to use IREFER=)
CODES=ABCD  ; Scores entered as A through D
;    0        1         2         3
;    123456789012345678901234567890
KEY1=CDABCDBDABCADCBDBCADBABDDCDABC ; Fully correct
KEY2=ABCDABCCBADDABACABBBACCCCDABAB ; Partially correct
KEY3=DABABAAACC*CCABAC************* ; Some partially correct
   ; if no matching response, use a character not in CODES=, e.g., *
   ; the keys are matched in sequence, "B" for item 15 matches Key1=, and Key3= is ignored
KEYSCR=211  ; KEY1 fully correct (2 points),
   ; KEY2, KEY3 partially correct (1 point each)

ISGROUPS=0  ; Each item is its own grouping, i.e., the Partial Credit model
MODELS=R  ; Each item has its own Andrich rating scale
STKEEP=Y  ; Keep all intermediate categories in analysis, even if never observed
CURVES=111  ; Print all 3 item curves in Tables 2 and 21
CATREF=2  ; Use category 2 for ordering in Table 2
&END
0.7  A1  ; item labels
1.1  A2
  .
3.1  A29
2.7  A30
END NAMES
090111000102   10001  BDABADCDACCDCCADBCBDBCDDACADDC
090111000202   10002  BDCDCDCDADCBCCBDBDCABCBDACDABC
  .
090111005302   10053  BDABCDDDCCCDDCDBACBABABCMCDBDC
090111005402   10054  BDADCDCCDACBCCABBDADBBCBBDDDDC
```

12.9 Example 8: Items with various rating scale models

A 4 item test in which each item has a 9-level scoring rubric. We suspect that there are not really 9 levels of competence. After several Winsteps analyses, we choose to recode the rating scale or partial credit items by collapsing categories in order to increase measurement effectiveness (separation) and increase parameter stability. An objection to collapsing is that it violates the Rasch model. This is only true if the uncollapsed data strictly accord with the model. In fact, the collapsed data may fit the Rasch model better than the uncollapsed. We have to compare the collapsed and uncollapsed analyses to decide.

```
; This file is EXAM8.TXT
 TITLE="Success and Failure Items"
 NAME1=6
 ITEM1=1
 NI=4   ; 4 items
 ISGROUPS=1234 ; one item per grouping, same as ISGROUPS=0
 IREFER=ABCD  ; the 4 items are to be recoded differently. Item 1 is type "A", etc.
  CODES=123456789 ; the codes in the data file
IVALUEA=333456666 ; the recoding for A-type items in IREFER=, i.e., Item 1
IVALUEB=333455555
IVALUEC=333444444
IVALUED=444456777
 &END
Maze
Passengers
Blocks
Egg race
END NAMES
5536 M Richard
4545 F Tracie
4345 M Walter
3454 M Blaise
4435 M Ron
....
```

Table 14.3 shows the recoding:

```
         ITEMS CATEGORY/OPTION/Distractor FREQUENCIES:  ENTRY ORDER
+------------------------------------------------------------------------+
|ENTRY   DATA  SCORE |     DATA    |     USED      AVERAGE OUTF|           |
|NUMBER  CODE  VALUE |  COUNT    % |  COUNT    %   MEASURE MNSQ|  ITEM     |
|--------------------+-------------+---------------------------+-----------|
|    1   2         3 |      1    3 |      1    3     -2.39   .3|Maze       |
|        3         3 |      7   22 |      6   19     -1.57   .7|           |
|        4         4 |     10   31 |     10   32      -.54   .5|           |
|        5         5 |     10   31 |     10   32      1.23   .6|           |
|        6         6 |      3    9 |      3   10      2.42   .7|           |
|        7         6 |      1    3 |      1    3      2.78   .5|           |
```

12.10 Example 9: Grouping and modeling items

A 20 item test. Items 1, 2 are dichotomous items, coded "Y", "N". Item 3 is a "Partial Credit" item. Items 4-10 are all ratings on one Andrich scale or test-level partial-credit scale (Grouping 1), and items 11-20 are all ratings on another Andrich scale or test-level partial-credit scale (Grouping 2). These are grouped with ISGROUPS=. Winsteps discovers from the data what the item structure is. Items 3-20 have response codes "A", "B", "C", "D", "E" or "a", "b", "c", "d", "e".

```
; This file is EXAM9.TXT
TITLE="Grouping and Modeling"
ITEM1=11   ; Item responses start in column 11
NI=20   ; There are 20 items
ISGROUPS=DD011111112222222222 ; The groupings in item order
IREFER=DDAAAAAAAAAAAAAAAAAA ; for recoding
CODES   = 10ABCDEabcde  ; Response codes to all items
IVALUED= 10**********  ; for Items 1 & 2
IVALUEA= **1234512345  ; for Items 3-20
DATA=EXAM9DAT.TXT   ; Location of data file
IWEIGHT=*    ; Item weighting file list
3 2.5     ; Item 3 has weight of 2.5
*
&END
RD Prompt 1 ; Item id's remind us of MODELS= and ISGROUPS=
RD Prompt 2 ; MODELS= and ISGROUPS= are shown in item measure Tables 10, 13, 14, 15
S0 Logic
```

```
R1 Grammar 1
R1 Grammar 2
R1 Grammar 3
R1 Grammar 4
R1 Grammar 5
R1 Grammar 6
R1 Grammar 7
R2 Meaning 1
R2 Meaning 2
R2 Meaning 3
R2 Meaning 4
R2 Meaning 5
R2 Meaning 6
R2 Meaning 7
R2 Meaning 8
R2 Meaning 9
R2 Meaning 10
END NAMES
```

The data is in file EXAM9DAT.TXT:

```
Richard M 00bCDCDddCDddddCDccE
Tracie  F 00BcBABBccbBbbBbBBBb
  .
James   M 00ccaBbabBAcbacbaBbb
Joe     M 10BdBBBBccBccbbccbcC
```

12.11 Example 10: Combining tests with common items

This uses MFORMS=, but it can also be done, more awkwardly, with FORMAT=

Test A, in file EXAM10A.TXT, and TEST B, in EXAM10B.TXT, are both 20 item tests. They have 5 items in common, but the distractors are not necessarily in the same order. The responses must be scored on an individual test basis. Also the validity of each test is to be examined separately. Then one combined analysis is wanted to equate the tests and obtain bankable item measures. For each file of original test responses, the person information is in columns 1-11, the item responses in 41-60.

The combined data file specified in EXAM10C.TXT, is to be in RFILE= format. It contains

Person information of 11 characters: Columns 1-30 (always), but only 1-11 are active.
Item responses to 35 items: Columns 31-64

The identification of the common items is:

Test Item Number (=Location in item string)							
Bank	1	2	3	4	5	6-20	21-35
A:	3	1	7	8	9	2, 4-6, 10-20	
B:	4	5	6	2	11		1, 3, 7-10, 12-20

I. From Test A, make a response (RFILE=) file..

```
; This file is EXAM10A.TXT
TITLE="Analysis of Test A"
RFILE=EXAM10AR.TXT ; The constructed response file for Test A
NI=20    ; 20 items
ITEM1=41   ; Items start in column 41 of data record
NAME1=1   ; Start of person label
NAMELEN=11   ; Length of person label
CODES="ABCD# " ; Beware of blanks and # meaning wrong!
```

```
   ; Blanks are included in CODES=, but they are scored incorrect, because never keyed correct
KEY1=CCBDACABDADCBDCABBCA    ; the MCQ key
&END
BANK 2   TEST A 1 ; first item name
BANK 6   TEST A 2
BANK 1   TEST A 3
 .
BANK 20  TEST A 20
END NAMES
Person 01 A                             BDABCDBDDACDBCACBDBA
 .
Person 12 A                             BADCACADCDABDDDCBACA
```

The RFILE= file, EXAM10AR.TXT, is:

```
0        1         2         3         4         5
12345678901234567890123456789012345678901234567890
Person 01 A                   00000000110010001001
.........
Person 12 A                   00001110000001001011
```

II. From Test B, make a response (RFILE=) file.

```
; This file is EXAM10B.TXT
TITLE="Analysis of Test B"
RFILE=EXAM10BR.TXT ; The constructed response file for Test B
NI=20
ITEM1=41  ; Items start in column 26 of reformatted record
NAME1=1  ; Start of person label
NAMELEN=11  ; Length of person label
CODES="ABCD# " ; Beware of blanks meaning wrong!
KEY1=CDABCDBDABCADCBDBCAD  ; Key in data record format
&END
BANK 21  TEST B 1
BANK 4   TEST B 2
BANK 22  TEST B 3
  .
BANK 35  TEST B 20
END NAMES
Person 01 B                             BDABDDCDBBCCCCDAACBC
  .
Person 12 B                             BADABBADCBADBDBBBBBB
```

The RFILE= file, EXAM10BR.TXT, is:

```
Person 01 B                   01110101011001000100
...
Person 12 B                   00000001010000101000
```

III. Analyze Test A's and Test B's RFILE='s together:

```
; This file is EXAM10C.TXT
TITLE="Analysis of Tests A & B (already scored)"
NI=35   ; 35 items in total
ITEM1=31  ; reformatted data record
CODES=01  ; scored right-wrong.
   ; Blanks ignored as "not administered"
MFORMS=*         ; multiple data files in different formats
DATA=EXAM10AR.txt ; first file
L=1              ; one line per data record
P1-11 = 1        ; person id starts in column 1 of input file
I1=33            ; item 1 is Test A's item 3 in Test A's column 33
I2=31            ; item 2 is Test A's item 1 in column 31
```

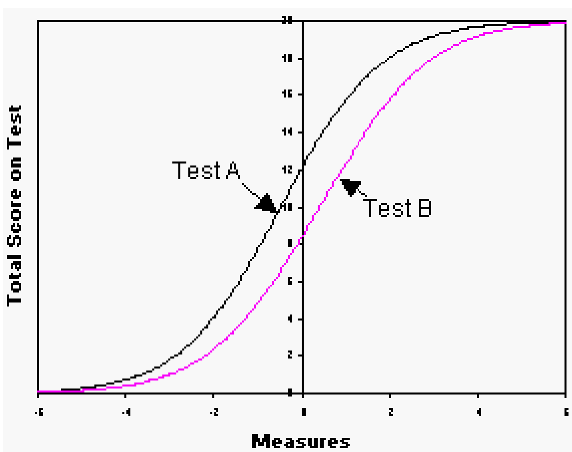
```
I3-5=37          ; items 3-5 are Test A's items 7-9 starting in column 37
I6=32
I7-9=34
I10-20=40
#
DATA=EXAM10BR.txt ; second data file
L=1
P1-11 = 1        ; person id starts in column 1 of input file
I1-3 = 34        ; items 1-3 are Test B's items 4-6 starting in Test B's column 34
I4 = 32          ; item 4 is Test B's item 2 in column 32
I5 = 41          ; items 5 in Test B's item 11 in column 41
I21 = 31
I22 = 33
I23-26 = 37
I27-35 = 42
*
&END
BANK 1   TEST A 3 B 4
...
BANK 35  TEST B 20
END NAMES
```

The combined data file (which can be accessed from the **Edit** pull-down menu) is:

```
Person 01 A                 00001000010010001001
...
Person 12 A                 00100001100001001011
Person 01 B                 10111              010101001000100
...
Person 12 B                 00000              000101000101000
```

After running EXAM10C, I want to see two ICCs: One for test A and another Test B. How do I do this?

This graph is not produced directly by Winsteps, but can be produced in Excel.



After the Exam10C analysis,

use the "Specification" pull-down menu to delete items not in Test A: Use IDELETE=21-35
Display the Test Characteristic Curve
Select "Copy data to clipboard".
Paste into an Excel worksheet

Use the "Specification" pull-down menu to reinstate all items: IDELETE=+1-35

Use the "Specification" pull-down menu to delete items not in Test B: Use IDELETE=6-20
Display the Test Characteristic Curve
Select "Copy data to clipboard".

Paste into an Excel worksheet

In Excel, scatterplot the pasted columns.

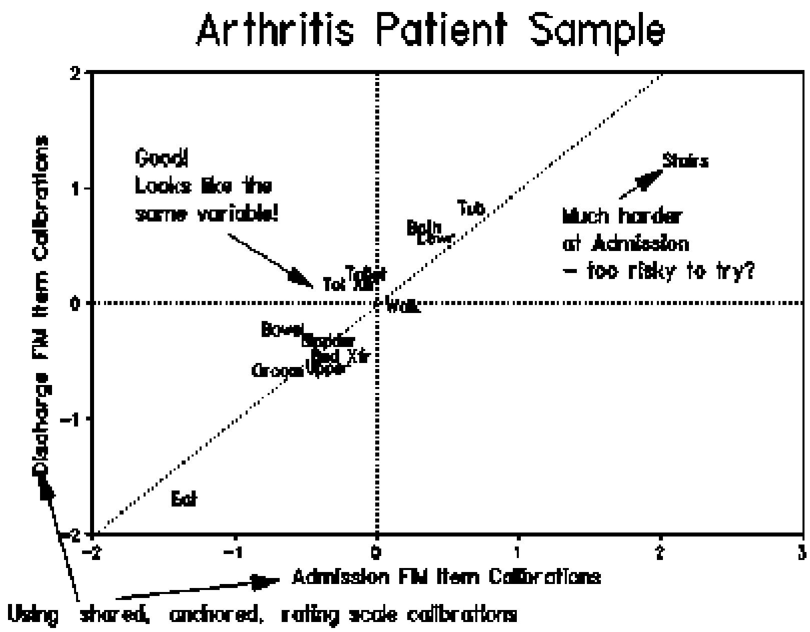
12.12 Example 11: Item responses two characters wide

The "Liking for Science" data (see RSA) is in file EXAM11.TXT. Each observation is on a rating scale where 0 means "dislike", 1 means "don't care/don't know" and 2 means "like". The data has been recorded in two columns as 00, 01 and 02. XWIDE= is used.

```
; This file is EXAM11.TXT
 TITLE='LIKING FOR SCIENCE (Wright & Masters p.18)'
 XWIDE=2 ; Responses are 2 columns wide
 CODES=000102  ; Codes are 00 01 and 02
 CLFILE=*  ; Category label filelist
 00 Dislike  ; Category 00 in data file means "Dislike"
 01 Neutral
 02 Like
 *   ; End of category list
 ITEM1=1  ; Items start in column 1
 NI=25   ; 25 Items
 NAME1=51  ; Person id starts in column 51
 NAMLMP=20  ; Show 20 characters of id on maps
 TABLES=111111111111111111111111111111 ; All Tables
 CURVES=111  ; Print all curves in Tables 2 and 21
 IFILE = EXAM11IF.TXT  ; Output item measure file
 PFILE = EXAM11PF.TXT ; Output person measure file
 SFILE = EXAM11SF.TXT ; Output structure calibration file
 RFILE = EXAM11RF.TXT ; Output reformatted response file
 XFILE = EXAM11XF.TXT ; Output observation and residual file
 UIMEAN = 455  ; User scaling: mean 455
 USCALE = 94  ; 94 user units per logit
 LINELENGTH = 0  ; Print with minimum of split lines
 MAXPAGE = 0  ; Print with no page breaks in long tables
 &END
WATCH BIRDS
READ BOOKS ON ANIMALS
   .
FIND OUT WHAT FLOWERS LIVE ON
TALK W/FRIENDS ABOUT PLANTS
END NAMES
01020101010002000102020202000201010202000201000200ROSSNER, MARC DANIEL
02020202020202020202020202020202020202020202020202ROSSNER, LAWRENCE F.
  .
02020200000202000002020202020202020202000202000102PATRIARCA, RAY
01020000010100010102010202020201000202000200000100PAULING, LINUS
                                                  BLANK RECORD
```

12.13 Example 12: Comparing high and low samples with rating scales

Rasch estimates are constructed to be as sample independent as is statistically possible, but you must still take care to maintain comparability of measures across analyses. For instance, if a rating scale or partial credit structure is used, and a high-low measure split is made, then the low rating scale (or partial credit) categories may not appear in the data for the high measure sample and vice versa. To compare item calibrations for the two samples requires the response structure to be calibrated on both samples together, and then the response structure calibrations to be anchored for each sample separately. Comparison of patient measures from separate analyses requires both the response structure calibrations and the item calibrations to share anchor calibrations. 35 arthritis patients have been through rehabilitation therapy. Their admission to therapy and discharge from therapy measures are to be compared. They have been rated on the 13 mobility items of the Functional Independence Measure (FIM™). Each item has seven levels. At admission, the patients could not perform at the higher levels. At discharge, all patients had surpassed the lower levels (Data courtesy of C.V. Granger & B. Hamilton, ADS). A generic control file is in EXAM12.TXT. The admission ratings are in EXAM12LO.TXT and the discharge ratings in EXAM12HI.TXT. Three analyses are performed: 1) joint analysis of the admission (low) and discharge (high) data to obtain response structure calibrations, 2 & 3) separate runs for the admission (low) and discharge (high) data to obtain item calibrations. For a more complex situation, see Example 17.




```
; This common control file is EXAM12.TXT
TITLE='GENERIC ARTHRITIS FIM CONTROL FILE'
ITEM1=7   ; Responses start in column 7
NI=13    ; 13 mobility items
CODES=1234567   ; 7 level rating scale
CLFILE=*   ; Defines the rating scale
1 0% Independent
2 25% Independent
3 50% Independent
4 75% Independent
5 Supervision
6 Device
7 Independent
*
&END
A. EATING
B. GROOMING
C. BATHING
D. UPPER BODY DRESSING
E. LOWER BODY DRESSING
F. TOILETING
G. BLADDER
H. BOWEL
I. BED TRANSFER
J. TOILET TRANSFER
K. TUB, SHOWER
L. WALK/WHEELCHAIR
M. STAIRS
END NAMES
```

The admission data is in file EXAM12LO.TXT:

```
21101 5523133322121  Patient number in cols 1-5, ratings in 7-19
21170 4433443345454
 |
22618 4433255542141
```

```
22693 3524233421111
```

The discharge data is in file EXAM12HI.TXT:

```
21101 5734366655453  Ratings generally higher than at admission
21170 6466677777676
 |
22618 7667656666565
22693 7776677676677
```

The batch file to run this under Windows is EXAM12.CMD (see BATCH=), :

```
REM  COMPARISON OF ITEM CALIBRATIONS FOR HIGH AND LOW SAMPLES
START /WAIT ..\Winsteps  EXAM12.TXT EXAM12OU.TXT DATA=EXAM12LO.TXT+EXAM12HI.TXT
        TITLE=ADMIT+DISCHARGE SFILE=EXAM12SF.TXT BATCH=Y
START /WAIT ..\Winsteps EXAM12.TXT EXAM12LU.TXT DATA=EXAM12LOF.TXT TITLE=ADMIT
        SAFILE=EXAM12SF.TXT IFILE=EXAM12LI.TXT BATCH=Y
START /WAIT ..\Winsteps EXAM12.TXT EXAM12HU.TXT DATA=EXAM12HIF.TXT TITLE=DISCHARGE
        SAFILE=EXAM12SF.TXT IFILE=EXAM12HI.TXT BATCH=Y
```

under WINDOWS-98, EXAM12BAT.BAT: (not Windows-9 nor 3.1)

```
REM  COMPARISON OF ITEM CALIBRATIONS FOR HIGH AND LOW SAMPLES
START /w ..\Winsteps EXAM12.TXT EXAM12OU.TXT DATA=EXAM12LO.TXT+EXAM12HI.TXT
        TITLE=ADMIT+DISCHARGE SFILE=EXAM12SF.TXT BATCH=Y
START /w ..\Winsteps EXAM12.TXT EXAM12LU.TXT DATA=EXAM12LO.TXT TITLE=ADMIT SAFILE=EXAM12SF.TXT
        IFILE=EXAM12LIF.TXT BATCH=Y
START /w ..\Winsteps EXAM12.TXT EXAM12HU.TXT DATA=EXAM12HI.TXT TITLE=DISCHARGE
        SAFILE=EXAM12SF.TXT IFILE=EXAM12HIF.TXT BATCH=Y
```

Under WINDOWS-NT (early versions), EXAM12NT.BAT:

```
REM  COMPARISON OF ITEM CALIBRATIONS FOR HIGH AND LOW SAMPLES
..\Winsteps EXAM12.TXT EXAM12OU.TXT DATA=EXAM12LO.TXT+EXAM12HI.TXT TITLE=ADMIT&DISCHARGE
        SFILE=EXAM12SF.TXT BATCH=Y
..\Winsteps EXAM12.TXT EXAM12LU.TXT DATA=EXAM12LO.TXT TITLE=ADMIT SAFILE=EXAM12SF.TXT
        IFILE=EXAM12LIF.TXT  BATCH=Y
..\Winsteps EXAM12.TXT EXAM12HU.TXT DATA=EXAM12HI.TXT TITLE=DISCHARGE SAFILE=EXAM12SF.TXT
        IFILE=EXAM12HIF.TXT  BATCH=Y
```

To run this, select "Run batch file" from "Batch" pull-down menu, and right-click on "Exam12bat.bat" or "Exam12cmd.cmd" in the dialog box, then left-click on "open".

The shared structure calibration (Andrich threshold) anchor file is EXAM12SF.TXT:

```
; structure measure FILE FOR
; ADMIT&DISCHARGE
; May 23 13:56 1993
; CATEGORY  structure measure
  1    .00
  2  -2.11
  3  -1.61
  4  -1.25
  5    .06
  6   1.92
  7   2.99
```

The item calibrations measures for admission and discharge are written into IFILE= files, with comma-separated values (CSV=Y), so that they can easily be imported into a spreadsheet.

12.14 Example 13: Paired comparisons as the basis for measurement

Paired comparisons can be modeled directly with the Facets computer program. For Winsteps a dummy facet of "occasion" or "pairing" must be introduced. On each occasion (in this example, each column), there is a winner '1', a loser '0', or a draw 'D' recorded for the two players. The data can be set up with the paired objects as rows and the pairings as columns, or the paired objects as columns or the pairings as rows. Analytically it makes no differences, so do it the way that is easier for your.

In this example, the paired objects are the rows, and the pairings are the columns. In column 1 of the response data in this example, Browne (1) defeated Mariotti (0). In column 2, Browne (D) drew with Tatai (D). Specifying PAIRED=YES adjusts the measures for the statistical bias introduced by this stratagem. Each player receives a measure and fit statistics. Occasion measures are the average of the two players participating. Misfitting occasions are unexpected outcomes. Point-biserial correlations have little meaning. Check the occasion summary statistics in Table 3.1 to verify that all occasions have the same raw score.

```
; This common control file is EXAM13.TXT
TITLE = 'Chess Matches at the Venice Tournament, 1971'
Name1 = 1  ; Player's name
Item1 = 11  ; First match results
PERSON = PLAYER
ITEM   = MATCH ; Example of paired comparison
CODES  = 0D1  ; 0 = loss, D = draw (non-numeric), 1 = win

; if you wish to just consider won-loss, and ignore the draws, omit the following line:
NEWSCORE = 012 ; 0 = loss, 1 = draw, 2 = win

CLFILE=*
0 Loss
D Draw
1 Win
*
NI     = 66  ; 66 matches (columns) in total
PAIRED = YES  ; specify the paired comparison adjustment
INUMBER = YES  ; number the matches in the Output
&END
Browne    1D 0  1   1    1     1      D       D        1         1
Mariotti  0 1 D  0   1    1     1      D       1        D         1
Tatai      D0  0  1   D    D     1      1       1        1         D
Hort         1D1   D   D    1     D      D       D        1         0
Kavalek         010D    D    D     1      D       1        1         D
Damjanovic          00DDD     D     D      D       1        D         1
Gligoric                 00D0DD      D      1       1        1         0
Radulov                        000D0DD       D       1        D         1
Bobotsov                              DD0DDD0D        0        0         1
Cosulich                                      D00D00001         1         1
Westerinen                                             0D000D0D10          1
Zichichi                                                         00D1D010000
```

Part of the output is:

```
         PLAYER STATISTICS:  MEASURE ORDER
+---------------------------------------------------------------------+
|ENTRY   RAW                               |   INFIT  |  OUTFIT  |          |
|NUMBR  SCORE  COUNT  MEASURE  ERROR|MNSQ  ZSTD|MNSQ  ZSTD| PLAYER     |
|-----------------------------------+----------+----------+-----------|
|    1     17     11     1.09     .35|1.10    .2|1.02    .1| Browne     |
|    2     15     11      .68     .32|1.02    .0| .96   -.1| Mariotti   |
|    3     14     11      .50     .31| .86   -.4| .83   -.5| Tatai      |
|    4     14     11      .50     .31|1.34    .9|1.54   1.3| Hort       |
|    5     13     11      .33     .31| .81   -.6| .80   -.6| Kavalek    |
```

```
|    6     11     11       .00      .30| .35   -2.8| .37   -2.6| Damjanovic|
|    7     10     11      -.17      .30| .90    -.3| .91    -.3| Gligoric  |
|    8      9     11      -.34      .31| .52   -1.8| .52   -1.7| Radulov   |
|    9      8     11      -.51      .31|1.00     .0|1.00     .0| Bobotsov  |
|   10      8     11      -.51      .31|1.18     .5|1.15     .4| Cosulich  |
|   11      7     11      -.69      .32| .95    -.1| .89    -.3| Westerinen|
|   12      6     11      -.88      .33|1.86    1.8|1.90    1.7| Zichichi  |
|--------------------------------------+-----------+-----------+-----------|
| MEAN     11.    11.      .00      .32| .99    -.2| .99    -.2|           |
+--------------------------------------------------------------------------+
```

12.15 Example 14: Multiple rescorings, response structures and widths

Introductory example: A test has 30 multiple choice question (keyed A, B, C, D) and 5 essay questions, each has its own rating scale definition (scored 0, 1, or 2), i.e., they accord with the partial credit model. ISGROUPS= is used to identify the partial credit items. IREFER= and IVALUE= are used for scoring the questions

```
; This control file is EXAM14.TXT
TITLE = "AN EXAMPLE OF MULTIPLE ITEM TYPES"
; THIS PART DEFINES THE ANALYTICAL MODEL
; MCQ ARE ONE GROUPING, WHICH WE WILL CALL "M" - PARTIAL CREDIT ITEMS ARE GROUPED AS "0"
; "0" MEANS EACH ITEM IS IN A GROUPING BY ITSELF, i.e., partial credit
ISGROUPS = MMMMMMMMMMMMMMMMMMMMMMMMMMMMMM00000

; THIS PART DEFINES THE RESPONSE SCORING
; The MCQ key is: ABCAAACBAAABABABBAAABABBAAABAB
IREFER = ABCAAACBAAABABABBAAABABBAAABAB00000 ; REFERENCE THE MCQ ITEMS BY THEIR SCORING KEY
CODES   = ABCD012; ALL VALID CODES IN THE DATA FILE
IVALUE0= 0000012; THESE ARE THE ESSAY ITEMS
IVALUEA= 1000000 ; MCQ ITEMS WITH A AS THE CORRECT ANSWER
IVALUEB= 0100000 ; B IS CORRECT
IVALUEC= 0010000 ; C IS CORRECT
IVALUED= 0001000 ; D IS CORRECT
MISSING-VALUES-SCORED = 0 ; SO ALL 9'S (OR ANYTHING ELSE NOT IN CODES=) ARE SCORED 0

ITEM1 = 1 ; START OF ITEM STRING
NI    = 35 ; NUMBER OF ITEM RESPONSES
NAME1 = 37 ; START OF PERSON IDENTIFICATION
&END
; ITEM LABELS HERE
END LABELS
ACAACBAA9DC9AB9C9DCC9ABBA9AACB00102  1     ; DATA ARE HERE
A9D9AAAB9DA999AA9BBD999999B9AA12100  2
A9C9AACD9AB9AB9B99D9DB9ACBD9AB10120  3
A9C9AACB9AD99999CA9ABD999999900120  4
A9C9AAAB9AA99999CD9ABB999999910120  5
A9C9ADCBBAA9CDABD9DACCABBA9ABC21212  6
B9D9AAAB9CB99999DB9ABC999999900100  7
A9D9BAAB9AA99999BA9ABB999999900101  8
A9D9BACB9DC99999CA9DBB999999921201  9
A9A9AACD9BA99999AD9ABB999999910120 10
A9C9AACB9AA99999DC9ABD999999900120 11
A9C9AAAB9CA99999BA9CBB999999921201 12
A9C9CACB9AC99999CB9ABD999999910120 13
A9D9AACB9AA99999AA9ABD999999D900000 14
A9C9DDCB9AA99999CB9ABD99999C9D21201 15
A9C9AABB9AD9999CD9ABC9999ABDAB11110 16
A9CAACB9ABBC9ADBB9ABDABBA9ADCB00120 17
CBBAB9CAAC9BBBC9BCBACDD9ADDCAB10120 18
A9C9BAAB9AD99CB9BBBA9ABDACDD9A00120 19
C9D9BDDB9BBBB9ACBADBC9AADBBCBC21201 20
```

```
A9C9AABB9DABA9ABDDABCABBA9AACB00120 21
A9D9BDCB9DCAC9DBBADBBACBA9ABAC00001 22
A9C9BACB9DADA9DBBDABBACBA9ABBB21201 23
A9D9BACC9AADC9DBBAABBADBC9ABCB10012 24
A9D9BAAB9ABCC9ABBDABBACBB9ABBB21201 25
```

Example 14: A test comprises multiple-choice questions (MCQ), true-false, and two different response structure formats. These are combined in one data file. The MCQ scoring key, and also the True-False scoring key are used as item cluster references in the IREFER= and IVALUE= specifications to simplify key checking.

EXAM14DT.TXT data format is:	
Cols 1-5	Person id.
Cols 6-10	5 MCQ items (A,B,C,D, # = missing, wrong. Some items may be miskeyed
Cols 11-15	5 True-False items, responses (S, N). For some of these S="True" is correct, for others "N"=False is correct
Cols 16-25	10 Rating scale items (N=0,P=1,M=2,S=3). Some items may be reversed.
Cols 26-29	2 Evaluation items (0-12). - (See exam14b.txt) - *second analysis only.*

First analysis: all responses one column wide

The control file, EXAM14.TXT, is:

```
; This file is EXAM14.TXT
TITLE="Multiple Response Formats, Same Response Width"
DATA=exam14dt.txt
;EXAM14DT.TXT data format is
;Cols 1-5  Person id.
;Cols 6-10 5 MCQ items (A,B,C,D, # = missing, wrong)
;  Some items may be miskeyed
;Cols 11-15 5 True-False items, responses (S, N)
;  For some of these S="True" is correct, for others "N"=False is correct
;Cols 16-25 10 Rating scale items (N=0,P=1,M=2,S=3)
;  Some items may be reversed.
;Cols 26-29 2 Evaluation items (0-12). - (See exam14b.con)
NAME1=1
ITEM1=6
NI=20

; THESE CODES LINE UP WITH THE ITEM COLUMNS
;         0         1         2
;         12345678901234567890

; TO DEFINE RESPONSE STRUCTURE CLUSTERS
ISGROUPS  = 11111222223333333333

; TO DEFINE RESCORING CLUSTERS
IREFER  = BACDCSNSNSRRRRRRRRRR
; IREFER = X MATCHES IVALUEX=

; IVALUE?= MATCHES WITH CODES=
CODES    = ABCD#SNPM ; CODES IN ORIGINAL DATA FILE
IVALUEA = 10000**** ; MCQ RESPONSE A IS CORRECT
IVALUEB = 01000**** ; MCQ RESPONSE B IS CORRECT
IVALUEC = 00100**** ; MCQ RESPONSE C IS CORRECT
IVALUED = 00010**** ; MCQ RESPONSE D IS CORRECT
IVALUES = *****10** ; "S" IS THE CORRECT ANSWER
IVALUEN = *****01** ; "N" IS THE CORRECT ANSWER
IVALUER = *****3012 ; "NPMS" RATING SCALE
STKEEP=YES  ; KEEP UNUSED INTERMEDIATE CATEGORIES IN RATING SCALES
INUMBER=YES ; NO ITEM INFORMATION AVAILABLE
&END
```

Second analysis: responses one and two columns wide

Including the last two items with long numeric response structures and 2-column format, the control file becomes EXAM14B.TXT. Since some responses are in 2 column format, XWIDE=2. FORMAT= is used to transform all responses into XWIDE=2 format.

EXAM14B.TXT is:

```
&INST
TITLE="Multiple Response Formats, Same Response Width"
DATA=EXAM14DT.TXT
;EXAM14DT.TXT data format is
;Cols 1-5  Person id.
;Cols 6-10 5 MCQ items (A,B,C,D, # = missing, wrong)
;  Some items may be miskeyed
;Cols 11-15 5 True-False items, responses (S, N)
;  For some of these S="True" is correct, for others "N"=False is correct
;Cols 16-25 10 Rating scale items (N=0,P=1,M=2,S=3)
;  Some items may be reversed.
;Cols 26-29 2 Evaluation items (0-12)
NAME1=1
ITEM1=6
NI=22     ;20-1 COLUMN + 2 2-COLUMN ITEMS
XWIDE=2   ;XWIDE FOR WIDEST FIELD
FORMAT=(5A1, 20A1,2A2) ; PERSON LABEL & FIRST 20 ITEMS 1 CHARACTER COLUMNS
;                        ; LAST 2 ITEMS ARE 2 CHARACTER COLUMNS
; THESE ARE SET UP FOR XWIDE=2

; FOR RESPONSE STRUCTURE DEFINITIONS
; TO DEFINE RATING SCALE CLUSTERS
ISGROUPS   = 1111122222333333333344
IREFER   = BACDCSNSNSRRRRRRRRRREE
; IREFER = X MATCHES IVALUEX=

; IVALUE?= MATCHES WITH CODES=
; CODES ARE 2 CHARACTERS WIDE
CODES    = "A B C D # S N P M 121110 9 8 7 6 5 4 3 2 1 0"; CODES IN DATA
IVALUEA = "1 0 0 0 0 * * * *  * * * * * * * * * * * * *"; MCQ A IS CORRECT
IVALUEB = "0 1 0 0 0 * * * *  * * * * * * * * * * * * *"; MCQ B IS CORRECT
IVALUEC = "0 0 1 0 0 * * * *  * * * * * * * * * * * * *"; MCQ C IS CORRECT
IVALUED = "0 0 0 1 0 * * * *  * * * * * * * * * * * * *"; MCQ D IS CORRECT
IVALUES = "* * * * * 1 0 * *  * * * * * * * * * * * * *"; "S" IS CORRECT
IVALUEN = "* * * * * 0 1 * *  * * * * * * * * * * * * *"; "N" IS CORRECT
IVALUER = "* * * * * 3 0 1 2  * * * * * * * * * * * * *"; "NPMS" RATING SCALE
IVALUEE = "* * * * * * * * * 121110 9 8 7 6 5 4 3 2 1 0"; 0-12 RATING SCALE
STKEEP=YES  ; KEEP UNUSED INTERMEDIATE CATEGORIES IN RATING SCALES
INUMBER=YES ; NO ITEM INFORMATION AVAILABLE
&END
```

This can also be done with MFORMS=

EXAM14C.TXT is:

```
; This file is EXAM14C.TXT
&INST
TITLE="Multiple Response Formats, Same Response Width"
;EXAM14DT.TXT data format is
;Cols 1-5  Person id.
;Cols 6-10 5 MCQ items (A,B,C,D, # = missing, wrong)
;  Some items may be miskeyed
;Cols 11-15 5 True-False items, responses (S, N)
;  For some of these S="True" is correct, for others "N"=False is correct
```

```
;Cols 16-25 10 Rating scale items (N=0,P=1,M=2,S=3)
;  Some items may be reversed.
;Cols 26-29 2 Evaluation items (0-12)

; Reformatted data record is:
;Cols 1-5 Person id
;Cols 6-7 Item 1 = original Col. 6
;Cols 8-9 Item 2 = original Col. 7
;.....
;Cols 48-49 Item 22

NAME1=1
ITEM1=6
NI=22    ;20-1 COLUMN + 2 2-COLUMN ITEMS
XWIDE=2  ;XWIDE FOR WIDEST FIELD

mforms=*
data=exam14dt.txt ; the name of an input data file
L = 1   ; the are 2 lines in input data file for each data record
P1-5 = 1  ; person label characters 1 through 5 start in column 1
; in the following "C" is used because "I" uses XWIDE=2
C6 = 6  ; original item 1 in column 6 goes in column 6
C8 = 7  ; original item 2 in column 7 goes in column 8
C10 = 8
C12 = 9
C14 = 10
C16 = 11
C18 = 12
C20 = 13
C22 = 14
C24 = 15
C26 = 16
C28 = 17
C30 = 18
C32 = 19
C34 = 20
C36 = 21
C38 = 22
C40 = 23
C42 = 24
C44 = 25  ; original item 20 in column 25 goes in column 44-45
I21-22 = 26  ; two-character items 21 and 22 start in column 26
*   ; end of mforms= command

; THESE ARE SET UP FOR XWIDE=2 FOR RESPONSE STRUCTURE DEFINITIONS
; TO DEFINE RATING SCALE CLUSTERS
ISGROUPS  = 1111122222333333333344
IREFER  = BACDCSNSNSRRRRRRRRRREE
; IREFER = X MATCHES IVALUEX=

; IVALUE?= MATCHES WITH CODES=
; CODES ARE 2 CHARACTERS WIDE
CODES    = "A B C D # S N P M 121110 9 8 7 6 5 4 3 2 1 0"; CODES IN DATA
IVALUEA = "1 0 0 0 0 * * * *  * * * * * * * * * * * * * *"; MCQ A IS CORRECT
IVALUEB = "0 1 0 0 0 * * * *  * * * * * * * * * * * * * *"; MCQ B IS CORRECT
IVALUEC = "0 0 1 0 0 * * * *  * * * * * * * * * * * * * *"; MCQ C IS CORRECT
IVALUED = "0 0 0 1 0 * * * *  * * * * * * * * * * * * * *"; MCQ D IS CORRECT
IVALUES = "* * * * * 1 0 * *  * * * * * * * * * * * * * *"; "S" IS CORRECT
IVALUEN = "* * * * * 0 1 * *  * * * * * * * * * * * * * *"; "N" IS CORRECT
IVALUER = "* * * * * 3 0 1 2  * * * * * * * * * * * * * *"; "NPMS" RATING SCALE
IVALUEE = "* * * * * * * * * 121110 9 8 7 6 5 4 3 2 1 0"; 0-12 RATING SCALE
STKEEP=YES  ; KEEP UNUSED INTERMEDIATE CATEGORIES IN RATING SCALES
INUMBER=YES ; NO ITEM INFORMATION AVAILABLE
&END
```

12.16 Example 15: Figure skating: Multidimensionality, DIF or Bias

The Pairs Skating competition at the 2002 Winter Olympics in Salt Lake City was contentious. It resulted in the awarding of Gold Medals to both a Russian and a Canadian pair, after the French judge admitted to awarding biased scores. Multidimensionality, differential item functioning, and item bias are all manifestations of disparate subdimensions within the data. In judged competitions, judge behavior can introduce unwanted subdimensions.

The data comprise 4 facets: skaters + program + skill + judges → rating

For a four-facet Rasch analysis of this model and these data, see www.winsteps.com/facetman/olympics.htm

For this analysis, each pair is allowed to have a different skill level, i.e., different measure, on each skill of each performance. The judges are modeled to maintain their leniencies across all performances.

In this judge-focused rectangular 2-facet analysis: (skaters + program + skill = rows) + (judges = columns) → rating

The rating scale is very long, 0-60. Alternative methods of analysis are shown in SFUNCTION=.

The control file and data are in **exam15.txt**.

```
; This file is EXAM15.TXT
Title  = "Pairs Skating: Winter Olympics, SLC 2002"
Item   = Judge
Person = Pair
NI     = 9        ' the judges
Item1  = 14       ' the leading blank of the first rating
Xwide  = 3        ' Observations are 3 CHARACTERS WIDE for convenience
NAME1  = 1        ' start of person identification
NAMELENGTH = 13   ' 13 characters identifiers

; CODES NEXT LINE HAS ALL OBSERVED RATING SCORES
CODES= " 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44+
       + 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60"

STEPKEEP=YES      ; maintain missing intermediate scores in the hierarchy

@order = 1-2  ; pair order number at finish of competition in person label columns 1-2
@program = 11 ; program in person label column 11: Short or Free
@skil = 13    ; skill in person label column 13: Technical or Artistic
PSUBTOT = @order
DIF = @order  ; judge "DIF" across skating pairs
tfile=*
30    ; produce Table 30 for judge-by-pairs "DIF"
28    ; produce Table 28 for skater-pair summary statistics
*
&END
1 Rus ;Mrs. Marina SANAIA : RUSSIA
2 Chn ;Mr. Jiasheng YANG : CHINA
3 USA ;Mrs. Lucy BRENNAN : USA
4 Fra ;Miss Marie Reine LE GOUGNE : FRANCE
5 Pol ;Mrs. Anna SIEROCKA : POLAND
6 Can ;Mr. Benoit LAVOIE : CANADA
7 Ukr ;Mr. Vladislav PETUKHOV : UKRAINE
8 Ger ;Mrs. Sissy KRICK : GERMANY
9 Jap ;Mr. Hideo SUGITA : JAPAN

; Description of Person Identifiers
; Cols.  Description
; 1-2   Order immediately after competition (@order)
; 4-5   Skaters' initials
; 7-9   Nationality
; 11    Program: S=Short  F=Free
```

```
; 13   Skill: T=Technical Merit, A=Artistic Impression
END LABELS
 1 BS-Rus S T 58 58 57 58 58 58 58 58 57 ;  1 BEREZHNAYA Elena / SIKHARULIDZE Anton : RUS
 1 BS-Rus S A 58 58 58 58 59 58 58 58 58 ;  2 BEREZHNAYA Elena / SIKHARULIDZE Anton : RUS
 1 BS-Rus F T 58 58 57 58 57 57 58 58 57 ;  3 BEREZHNAYA Elena / SIKHARULIDZE Anton : RUS
 1 BS-Rus F A 59 59 59 59 59 58 59 58 59 ;  4 BEREZHNAYA Elena / SIKHARULIDZE Anton : RUS
 2 SP-Can S T 57 57 56 57 58 58 57 58 56 ;  5 SALE Jamie / PELLETIER David : CAN
 2 SP-Can S A 58 59 58 58 58 59 58 59 58 ;  6 SALE Jamie / PELLETIER David : CAN
 2 SP-Can F T 58 59 58 58 58 59 58 59 58 ;  7 SALE Jamie / PELLETIER David : CAN
 2 SP-Can F A 58 58 59 58 58 59 58 59 59 ;  8 SALE Jamie / PELLETIER David : CAN
 3 SZ-Chn S T 57 58 56 57 57 57 56 57 56 ;  9 SHEN Xue / ZHAO Hongbo : CHN
 .....
```

From this data file, estimate judge severity. In my run this took 738 iterations, because the data are so thin, and the rating scale is so long.

Here is some of the output of **Table 30,** for Judge DIF, i.e., Judge Bias by skater pair order number, @order = $S1W2.

Pair CLASS	DIF ADDED	DIF S.E.	Pair CLASS	DIF ADDED	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	Judge Number	Name
13	-.93	.40	18	1.50	.39	-2.43	.56	-4.35	9	9 Jap
14	-1.08	.36	18	1.50	.39	-2.58	.53	-4.83	9	9 Jap

The most significant statistical bias is by the Japanese judge on skater pairs 13 and 14 vs. 18. These pairs are low in the final order, and so of little interest.

Table 23, the principal components/contrast analysis of Judge residuals is more interesting. Note that Judge 4, the French judge, is at the top with the largest contrast loading. The actual distortion in the measurement framework is small, but crucial to the awarding of the Gold Medal!

```
STANDARDIZED RESIDUAL CONTRAST PLOT
       -1                              0                             1
       ++------------------------------+------------------------------++
   .6 +                     4          |                               +
      |                                |                               |
   .5 +                                | 5      7                      +
C     |                                |                               |
O  .4 +                    1           |                               +
N     |                                |                               |
T  .3 +                                |                               +
R     |                                |                               |
A  .2 +                                |                               +
S     |                                |                               |
T  .1 +                                |                               +
      |                                |                               |
1  .0 +--------------------------------|-------------------------------+
      |                 2              |                               |
L -.1 +                                |                               +
O     |                                |                               |
A -.2 +                                |                               +
D     |                                |                               |
I -.3 +                                |                               +
N     |                                |  9                            |
G -.4 +                                |        8                      +
      |                                |       6                       |
  -.5 +                                |  3                            +
      |                                |                               |
       ++------------------------------+------------------------------++
       -1                              0                             1
Judge MEASURE
```

Table 23 variance table also shows a very high explained variance by the measures, 97%, and the estimates require many iterations to converge. Why is this?

The Olympic Ice-skating data is problematic. This is because the judges' ratings are edited prior to display to the public. The ISU (International Skating Union) feel that disagreement among the judges about a skater's performance would look bad. So the head judge instructs disagreeing judges to redo their ratings. All this goes on while we are waiting for the judges' ratings to display. Sometimes there is quite a long wait! The result is that the data are too Guttman-like. Hence the large explained variance :-(

In fact, the large explained variance indicates that we may have lost measurement accuracy and precision. Rasch uses the randomness in the data to construct the variable. There is little randomness, particularly among high-performing skaters, so the variable definition is weak.

Another flaw in the ratings is that smart judges can game the system. They know that the data will be almost Guttman, so if they make very small tweaks to bias the ratings, the head judge won't catch them, but their effects can be profound - even altering the Gold Medal winners.

Analysts have pointed out these and other flaws to the ISU. Their response has been to make the rating process even more obscure :-(

12.17 Example 16: Disordered categories - thresholds and person anchoring

This example illustrates two types of disordering in rating scale structures: category disordering and Rasch-Andrich threshold disordering. For further discussion, see disordering. It also illustrates anchor values in the person labels and category labeling.

The control file and data are in **exam16.txt**.

```
; This control file is EXAM16.TXT    Revised November 8, 2021
title = "Attitude Survey illustrating two types of disordering"
ni    = 3  ; three items
item1 = 1  ; item responses start in column 1
xwide = 2  ; data codes are two columns wide
codes = "1 2 3 " ; valid two character codes
name1 = 9  ; person label starts in column 9
namelength = 3 ; length of person labels
; pafile = $s1w3 ; person anchor values in columns 1-3 of person labels
@panchors = 1-3 ; person anchor field is in columns 1 to 3 of person labels
pafile = @panchors ; person anchors in field @panchors
ISGROUPS = 0  ; allow each item to have its own rating scale (the partial credit model)
clfile = *  ; category labels: item+category
1+1 Never  ; item 1 category 1 is "Never"
1+2 Sometimes  ; well-behaved rating scale
1+3 Often
2+1 Car  ; categories as ordered in frequency in 1930
2+2 Ship  ; now these categories are disordered
2+3 Plane  ; ship travel now rarer than planes
3+1 No
3+2 Neutral  ; very few in this narrow intermediate category
3+3 Yes
*
&END  ; item labels follow
Smooth advance everywhere - probability curves a "range of hills"
Disordered categories - disordered empirical average measures for categories
Low middle frequency - high discrimination - disordered Rasch-Andrich thresholds
END LABELS ; end of item labels, data follow ...
1 2 1   0.0   ; person anchor logits in person labels
1 3 1   0.1   ; advancing anchored person measures
2 1 1   0.2   ; but not advancing categories for item 2
2 3 1   0.3
2 2 2   0.4   ; only one observation of category 2 for item 3, but in the correct place = high
    discrimination
```

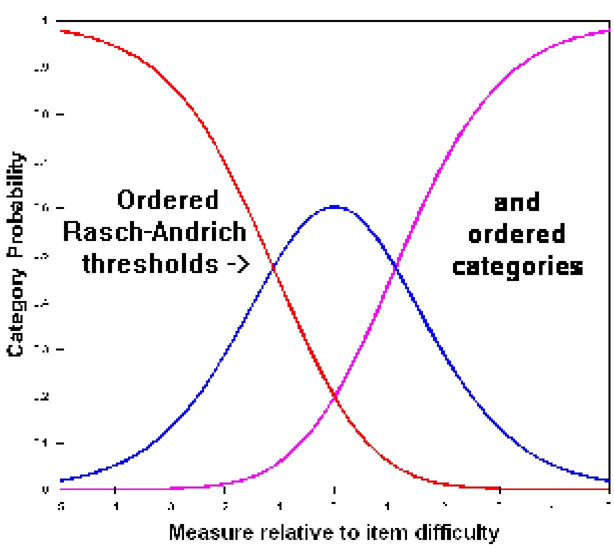
```
2 1 3   0.5
2 2 3   0.6
3 2 3   0.7
3 2 3   0.8   ; last data record
```

On the Diagnosis Menu: Empirical Item-Category Measures:

```
TABLE 2.5 Attitude Survey
OBSERVED AVERAGE MEASURES FOR PERSONS (BY OBSERVED CATEGORY)
0     1     2     3     4     5
+-----+-----+-----+-----+-----|  NUM   ITEM
|     1     2     3           |    1  Smooth advance everywhere
|     1     3 2               |    2  Disordered categories
|        1  2  3              |    3  Low middle frequency - high discrimination
+-----+-----+-----+-----+-----|  NUM   ITEM
```

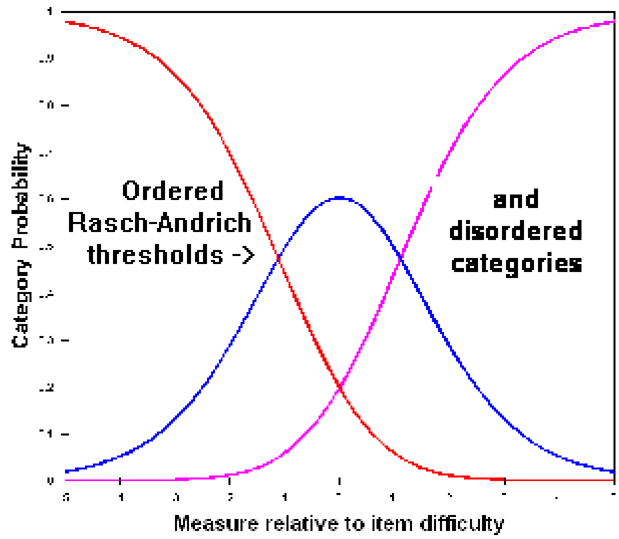
On the Diagnosis Menu: Category Function:

```
TABLE 3.2 Attitude Survey
FOR GROUPING "0" ITEM NUMBER: 1  Smooth advance everywhere - probability curves a "range of
        hills"

ITEM DIFFICULTY MEASURE OF 2.00 ADDED TO MEASURES
+------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------+
|  1   1       2  22|  1.00  1.62|   .49   .52||  NONE   |(  -.29)| 1 1 Never
|  2   2       5  56|  2.00  2.00|   .00   .00||   -1.11 |   2.00 | 2 2 Sometimes <- Ordered
        Rasch-Andrich thresholds
|  3   3       2  22|  3.00  2.38|   .49   .52||    1.11 |(  4.29)| 3 3 Often <- Ordered
        categories
+------------------------------------------------------------------
```

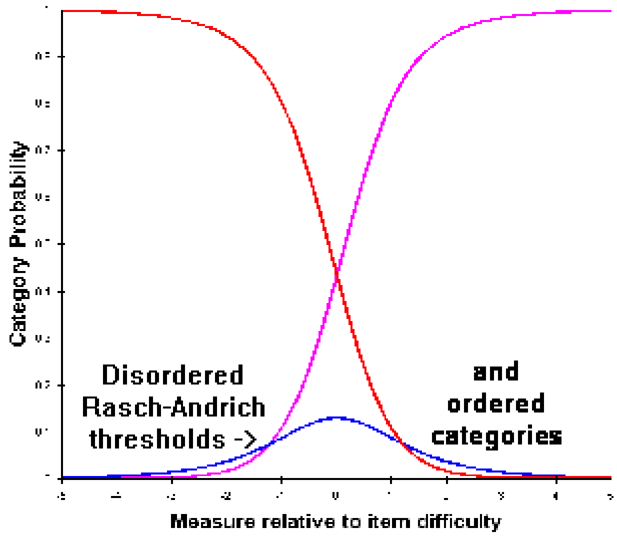


```
TABLE 3.3 Attitude Survey
FOR GROUPING "0" ITEM NUMBER: 2  Disordered categories - disordered empirical average measures
        for categories
```

```
ITEM DIFFICULTY MEASURE OF 2.00 ADDED TO MEASURES
+------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------+
|  1   1       2  22|  1.00  1.62|   .49   .52||  NONE   |(  -.29)| 1 1 Car
|  2   2       5  56|  2.40  2.00|  1.01  1.01||   -1.11 |   2.00 | 2 2 Ship <- Ordered Rasch-
        Andrich thresholds
|  3   3       2  22|  2.00* 2.38|  1.28  1.23||    1.11 |(  4.29)| 3 3 Plane <- Disordered
        categories
+------------------------------------------------------------------
```




```
TABLE 3.4 Attitude Survey
FOR GROUPING "0" ITEM NUMBER: 3  Low middle frequency - high discrimination - disordered Rasch-
        Andrich thresholds

ITEM DIFFICULTY MEASURE OF 2.00 ADDED TO MEASURES
+------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------+
|  1   1       4  44|  1.50  1.65|   .74   .64||  NONE   |(   .86)| 1 1 No
|  2   2       1  11|  2.00  2.00|   .00   .00||    1.21 |   2.00 | 2 2 Neutral <- Disordered
        Rasch-Andrich thresholds
|  3   3       4  44|  2.50  2.35|   .74   .64||   -1.21 |(  3.14)| 3 3 Yes  <- Ordered
        categories
+------------------------------------------------------------------
```



12.18 Example 17: Rack, stack, principal components

Comparisons of measures at two time-points or in two situations can become complicated. Example 12 illustrates a straightforward situation. It uses the 13 motor items of the FIM®. This example uses the 18 items of the FIM, 13 motor and 5 cognitive, at two time points. There is a 7-level rating scale that is intended to operate in the same way across all items.

In exam17s.txt, the data have been **stacked.** The items are modeled to maintain their difficulties across the two time points, and the 52 patients are entered twice, once at admission to rehabilitation and once at discharge from it, so there 104 data records. Changes in patient independence can be identified by cross-plotting the admission and discharge measures for each patient, as in Example 12. This can be done by using the Plots menu to plot the measures against themselves, and then, in Excel, pasting the discharge measures over the top of the admission measures for the y-axis. Here is the procedure:

Easier:
Arrange time 1 and time 2 person records in the same order. All Time 1 then all Time 2.
1. you have your time 1 + time 2 data file
2. also create a time 2 + time 1 data file (simply move time 1 data lines after time 2 data lines)
3. analyze time 2 + time 1 data file: output PF2.txt - delete time time 1 lines from PF2.txt ((second half of the file)
4. analyze time 1 + time 2 data file
5. scatterplot this analysis (which is still running) and PF2.txt - PF2 (time 2) will match time 1 in this analysis.

---

1. Do the analysis with all time 1 data above all time 2 data, and the persons in the same order at both time-points.
2. Output Files menu: PFILE=pf.txt
3. Edit pf.txt
4. Place time 1 persons in pf1.txt
5. Place time 2 persons in pf2.txt
6. Make sure that the person labels match (put in blank rows to make them align)
7. Winsteps Plots menu: Scatterplot
8. x-axis file is pf1.txt
9. y-axis file is pf2.txt
10. Plot the measures
11. Plot is produced in Excel

In exam17r.txt, the data have been **racked.** The persons are modeled to maintain their abilities across the two time points, and the 18 FIM items are entered twice, once at admission to rehabilitation and once at discharge from it, so there 36 items. (To rack datasets from several time points follow the Transpose procedure.) Average changes in patient performance on individual items can be identified by cross-plotting the admission and discharge measures for each item.

This can be done by using the Plots menu to plot the measures against themselves, and then, in Excel, pasting the discharge measures over the top of the admission measures for the y-axis.

A further feature is the contrasts in the Principal Components Analysis of Residuals, Tables 23 and 24. The 13 motor items and 5 cognitive items are probing different aspects of patient independence. Do they function as one variable in this sample? See Principal components/contrast. Patients also have different impairments. Are their measures comparable? See Differential Item Function.

```
; This control file is EXAM17S.TXT
TITLE='Example 17S: 18-item FIM control file: stacked admission then discharge'
ITEM1=1  ; Responses start in column 7
NI=18  ; 13 motor items + 5 cognitive items
NAME1=20 ; start of person label
; variables in person label
@SETTING=$S1W1 ; setting: A=Admission, D=Discharge
@SEX=$S3W1 ; Gender: 1=Male, 2=Female
@IGC=$S5W2 ; Impairment Group Code: 8=Orthopedic, 9=Cardiac, 10=Pulmonary, 11=Burns,
12=Congenital, 13=Other
@ID=$S8W2 ; Patient sequence number

; variables in item label
@SUBTEST=$S1W1  ; subtest: M=Motor, C=Cognitive
@ILETTER=$S3W1 ; code letter of item

CODES=1234567 ; 7 level rating scale
CLFILE=* ; Defines the rating scale
1 0% Independent
2 25% Independent
3 50% Independent
4 75% Independent
5 Supervision
6 Device
7 Independent
*
&END
M A. EATING
....
C R. MEMORY
END NAMES
334412312331123112 A 1  8  1
432322442223134444 A 2  8  2
....

; This control file is EXAM17R.TXT
TITLE='Example 17: 18-item FIM control file: racked admission and discharge'
ITEM1=1  ; Responses start in column 7
NI=37  ; 13 motor items + 5 cognitive items: admission and discharge
NAME1=39 ; start of person label

; variables in person label
@SEX=$S1W1 ; Gender: 1=Male, 2=Female
@IGC=$S3W2 ; Impairment Group Code: 8=Orthopedic, 9=Cardiac, 10=Pulmonary, 11=Burns,
12=Congenital, 13=Other
@ID=$S5W2 ; Patient sequ. number

; variable in item label
@SETTING=$S1W1 ; setting: A=Admission, D=Discharge
@SUBTEST=$S3W1  ; subtest: M=Motor, C=Cognitive
@ILETTER=$S5W1 ; code letter of item

CODES=1234567 ; 7 level rating scale
```

```
CLFILE=* ; Defines the rating scale
1 0% Independent
2 25% Independent
3 50% Independent
4 75% Independent
5 Supervision
6 Device
7 Independent
*
&END
A M A. EATING
....
A C R. MEMORY
-      Blank for ease of seeing
D M A. EATING
....
D C R. MEMORY
END NAMES
334412312331123112 554535546665345545 1  8  1
432322442223134444 777677777666567777 2  8  2
....
```

12.19 Example 18: Maximum size dataset

This demonstrates the maximum data set size which Winsteps can analyze: 9,999,999 persons (rows) and 64,000 items (columns). Here, 20MB responses. Maximum with this version of Winsteps is 2GB observed responses out of 640GB possible responses. Please email mike@winsteps.com if you need larger capacity.

```
; This control file is EXAM18.TXT
; 9,999,999 persons and 64,000 items: uses 160GB temporary disk storage
; this analysis takes 9+ hours
TITLE='Example 18: Demonstration of maximum size dataset in outline'
ITEM1=11      ; Responses start in column 11
NI=64000      ; maximum number of items
NAME1=1              ; start of person label
NAMELENGTH = 10 ; length of person label
CODES=01      ; dichotomous data

; FOR LARGE DATA SETS
CMLE=No              ; CMLE=Yes only works to about NI=300 items. Results of CMLE the same as
    JMLE from about NI=100 items
SUBSETS=No    ; only check for subsets once, if in doubt
DISTRACTORS=No       ; do distractors only in the final analysis run
MPROX=1              ; minimum PROX iterations
CONVERGE=B    ; set reasonable convergence limits
RCONV=0.1     ; this maximum residual is probably much too small - use Ctrl+F to stop JMLE
    iterations
LCONV=0.01    ; set at smallest visible logit change
; ESTMULT=    ; set this from the Diagnosis menu if changes in estimates are too small at each
    iteration

; Exam18.txt dataset is the outline of a 9,999,999 persons x 64,000 items dataset
; Exam18.txt has 20MB non-missing observations
;        | 1        18| 19-32000 |32001-64000|
;        -------------------------------------
; 1      | data below | 0......0 | 1........1|
; 35     | data below | 0        |          1|
; 36     | 0.........0           |          1|
; 5000000| 0                     |          1|
```

```
;        |----------------------------------|
; 5000001| 1                     |          0|
; 9999999| 1...................1 | 0........0|
;         -------------------------------------

EDFILE=*
;     persons       items   responses
;     1-35          1-18    is dataset below
      1-35         19       0
     36             1-18    0
      1            19-32000 0
      1         32001-63999 1
     36-5000000     1       0
      1-5000000 64000       1
5000001-9999998     1       1
5000001-9999998 64000       0
9999999             1-32000 1
9999999         32001-64000 0
*

;PLFILE= no more person names in this demonstration file
;ILFILE= no more item names in this demonstration file

&END
Item 1 label
; no more item names in this demonstration file
END NAMES
Adam    M 111111100000000000
Anne    F 111111111100000000
Audrey  F 111111111100100000
Barbara F 111100100100000000
Bert    M 111110101100000000
Betty   F 111111111000000000
Blaise  M 111111111111100000
Brenda  F 111111111100000000
Britton F 111011111000000000
Carol   F 111100101000000000
David   M 111111111110100000
Don     M 111111111001000000
Dorothy F 111111111100000000
Elsie   F 111101111100000000
Frank   M 111000000000000000
Helen   F 111111111100000000
James   M 111111111110000000
Janet   F 111111111100000000
Joe     M 111110011111000000
Kim     F 111111111100100000
Linda   F 111011000000000000
Lisa    F 111111111100000000
Martha  F 111111111100000000
Mike    M 111111111111101000
Lud     M 111111001110010000
Richard M 111111100000000000
Rick    M 111111111010000000
Rod     M 111111111111000000
Ron     M 111111111110000000
```

```
Susan    F 111111111000000000
Thomas   M 111111111010000000
Tracie   F 111111111110100110
Walter   M 111111111101010000
William  M 111111111110000000
Zula     F 111111111100110000
```

12.20 Example of subset reporting

You see: **Warning:** Data are ambiguously connected into 6 subsets. Measures may not be comparable across subsets.

Quick (but arbitrary) solution:
Let's assume your data are scored 0 or 1. Then:
a. if subsets of items have the same average difficulty
Add two dummy persons with scored response strings:
10101010....
01010101....

b. if subsets of persons have the same average ability
Add two dummy items (columns) with scored response strings:
01
10
01
10
..

Subsets: are these because different persons were administered non-overlapping subsets of items?
If so, can we assume that each subset of items is equally difficult on average?
If so, we only need 2 dummy persons, because the subsetting is independent of the sample size.
The easiest two dummy persons have response strings for all the items:
101010....
010101...
So the two dummy persons will have about the same ability and about the same success rate on all the subsets of items.
They will tie the subsets together.
The estimation may converge faster if you have more pairs of dummy persons, but then they will start to reduce the spread of the item difficulties in each subset.

More detail: add to the data file two dummy person records so that all persons and items become directly comparable.

Dichotomous data:
```
Dummy person 1: responses: 010101010...
Dummy person 2: responses: 101010101...
```

This says: "the middle level of performance for all subsets of persons is the same."

Rating scale data, where "1" is the lowest category, and "5" is the highest category:
```
Dummy person 1: responses: 1212121212...
Dummy person 2: responses: 2121212121...
```

This says: "the bottom level of performance for all subsets of persons is the same."

If you are concerned the dummy persons or items will skew your statistics, give them very small weights: PWEIGHT= or IWEIGHT=

Explanation: Connectivity (or subsetting) is a concern in any data analysis involving missing data. In general,

nested data are not connected.
fully-crossed data (also called "complete data") are connected.
partially-crossed data may or may not be connected.

Winsteps examines the responses strings for all the persons. It verifies that every non-extreme response string is linked into one network of success and failure on the items. Similarly, the strings of responses to the items are linked into one network of success and failure by the persons.

If person response string A has a success on item 1 and a failure on item 2, and response string B has a failure on item 1 and a success on item 2, then A and B are connected. This examination is repeated for all pairs of response strings and all pairs of items. Gradually all the persons are connected with all the other persons, and all the items are connected with all the other items. But it some persons or some items cannot be connected in this way, then Winsteps reports a "connectivity" problem, and reports which subsets of items and persons are connected.

Mathematics: connectivity is part of Graph Theory. The person/item/judge/... parameters of the Rasch model are the vertices and the observations are the edges. In an undirected graph, we need every vertex to be connected directly or indirectly to every other vertex. A connection is established between two vertices when one vertex is observed to have both a higher observation and a lower observation than another vertex in the same context, or when both both vertices have the same intermediate category of a rating scale in the same context.

Thus there are two situation for failure to connect:
1) there is no direct or indirect link between two vertices, e.g., two different datasets analyzed together with no common parameters. This is detected by the Winsteps/Facets subset routine.

2) the vertices are connected by observations, but the observations do not meet the requirements, e.g., all the person respond to all the items, but half the persons score in the upper half of the rating scale on every item, and the other half of the persons score in the lower half of the rating scale on every item. This is called a "Guttman split" in the data. This is usually obvious in the reported estimates as a big gap on the Wright maps between the two halves of the person distribution.

Example 1: Connection problems and subsets in the data are shown in this dataset. It is **Examsubs.txt.**

```
Title = "Example of subset reporting"
Name1 = 1
Namelength = 24 ;  include response string in person label
Item1 = 13
NI = 12
CODES = 0123 ; x is missing data
ISGROUPS = DDDDDDDDDDRR ; items 1-10 are dichotomies; items 11-12 share a rating scale
MUCON = 3 ; Subsetting can cause very slow convergence
TFILE=*
18.1
14.1
0.4
*
&End
01 Subset 1
02 Subset 1
03 Subset 2
04 Subset 2
05 Subset 7
06 Subset 4
07 Subset 4
08 Subset 5
09 Subset 5
10 Subset 5
11 Subset 6
12 Subset 6
END LABELS
01 Extreme  11111
02 Subset 1 01111
03 Subset 1 10111
04 Subset 2 00101
05 Subset 2 00011
06 Subset 3     011
07 Subset 3     011
08 Subset 4     001
09 Subset 4     010
10 Subset 5        0x1
11 Subset 5        10x
12 Subset 5        x10
13 Subset 6           01
14 Subset 6           10
15 Subset 6           23
16 Subset 6           32
```

The Iteration Screen reports:

```
                              CONVERGENCE TABLE
-Control: \HOLDW95\examples\examsubs.txt Output: \examples\ZOU571WS.TXT
|    PROX          ACTIVE COUNT       EXTREME 5 RANGE      MAX LOGIT CHANGE  |
| ITERATION  PERSON    ITEM  CATS     PERSON    ITEM      MEASURES  STRUCTURE|
>=====================================<
|        1       15      12     8       2.00    1.06       -2.0794           |
>=====================================<
|        2       15      12     6       2.38    1.84        2.6539   -1.6094 |
>=====================================<
```

```
|        3       14       12      6       2.67    1.60        2.7231     .0000 |
>=======================================<
|        4       14       12      6       2.68    2.33       -2.3912     .0000 |
>=======================================<
|        5       14       12      6       2.97    1.77        2.3246           |
>=======================================<
|        6       14       12      6       2.97    2.54       -2.2191           |
>=======================================<
|        7       14       12      6       3.22    2.10        2.0372           |
Probing data connection: to skip out: Ctrl+F - to bypass: subset=no
Processing unanchored persons ...
>=======================================<
Consolidating 9 potential subsets pairwise ...
>==================================
Consolidating 9 potential subsets indirectly pairwise ...
>=======================================<
Consolidating 8 potential subsets pairwise ...
>==================================
Consolidating 7 potential subsets pairwise ...
>==================================
Consolidating 7 potential subsets indirectly pairwise ...
>=======================================<
Warning: Data are ambiguously connected into 7 subsets. Measures may not be comparable
   across subsets.
 Subsets details are in Table 0.4
```

Table 18.1

```
         PERSON STATISTICS:  ENTRY ORDER

---------  ---------------------------
|ENTRY     |                          |
|NUMBER    | PERSON                   |
|--------  +-------------------------|
|     1    | 01 Extreme  11111        | MAXIMUM MEASURE
                                               < Guttman split here >
|     2    | 02 Subset 1 01111        | SUBSET 1
|     3    | 03 Subset 1 10111        | SUBSET 1
                                               < Guttman split here >
|     4    | 04 Subset 2 00101        | SUBSET 2
|     5    | 05 Subset 2 00011        | SUBSET 2
                                               < Guttman split here >
|     6    | 06 Subset 3     011      | SUBSET 3
|     7    | 07 Subset 3     011      | SUBSET 3
                                               < Guttman split here >
|     8    | 07 Subset 4     001      | SUBSET 4
|     9    | 09 Subset 4     010      | SUBSET 4
                                               < Subset split here >
|    10    | 10 Subset 5        0x1   | SUBSET 5
|    11    | 11 Subset 5        10x   | SUBSET 5 < Indirect connection >
|    12    | 12 Subset 5        x10   | SUBSET 5
                                               < Subset split here>
|    13    | 13 Subset 6           01| SUBSET 6
|    14    | 14 Subset 6           10| SUBSET 6
                                               < undetected Guttman split here:
   Winsteps failed! >
|    15    | 15 Subset 6           23| SUBSET 6
|    16    | 16 Subset 6           32| SUBSET 6
|--------  +-------------------------|
```

In Tables and Notes:	***Explanation:***
`< Guttman split here >`	The persons above the split performed an unknowable amount different from the persons below the split. There is no item on which this subset succeeded

	and another subset failed, and also this subset failed and the other subset succeeded. The data are not "well-conditioned" (Fischer G.H., Molenaar, I.W. (eds.) (1995) Rasch models: foundations, recent developments, and applications. New York: Springer-Verlag. p. 41-43).
`< Subset split here >`	The persons in this subset responded to different items than persons in other subsets. We don't know if these items are easier or harder than items in other subsets.
`< Indirect connection >`	The persons responded to different items, but they are connected by a loop of successes and failures.
`< undetected Guttman split here >`	Winsteps subset-detection did ***not*** report than persons 13 and 14 always score lower than persons 15 and 16, causing a Guttman split. We do not know how much better persons 15 and 16 are than persons 14 and 15. Winsteps subset-detection may fail to report subsets. Unreported subsets usually cause big jumps in the reported measures.
`Data are ambiguously connected`	Measures for persons in different subsets are not comparable. Winsteps always reports measures, but these are only valid within subsets. We do not know how the measures for persons in one subset compare with the measures for persons in another subset. Reliability coefficients are accidental and so is Table 20, the score-to-measure Table. Fit statistics and standard errors are approximately correct.
`Measures may not be comparable across subsets`	Please always investigate when Winsteps reports subsets, even if you think that all your measures are comparable.
MAXIMUM MEASURE, MINIMUM MEASURE, DROPPED, INESTIMABLE	Persons and items with special features are not included in subsets. Extreme scores (zero, minimum possible and perfect, maximum possible scores) imply measures that are beyond the current frame of reference. Winsteps uses Bayesian logic to provide measures corresponding to those scores.
SUBSET 1, 2, 4	These are directly connected subsets. Within each subset, a person has succeeded on an item and failed on an item, and *vice-versa*. The person performances are directly pairwise comparable within the subset. The persons in this subset have either succeeded on items in other subsets, or failed on items in other subsets, or have missing data on items in other subsets.
SUBSET 3	These two persons have the same responses, so they are in the same subset. No one succeeded on their failed items item, and also failed on their successful item.
SUBSET 5	This is an indirectly connected subset. There is a loop of successes and failures so that the performances of all three persons are connected indirectly pairwise.
SUBSET 6	Persons 13 and 14 are directly comparable using categories 0 and 1 of the rating scale. Persons 15 and 16 are directly comparable using categories 2 and 3 of the rating scale. Winsteps has ***not*** detected that persons 13 and 14 always rate lower than persons 15 and 16, causing a Guttman split.
SUBSET 7 (Table 14.1)	No person is in the same subset as this item. There is no subset in which persons both succeeded and failed on this item.
Connecting SUBSETs	Here are approaches: 1. Collect more data that links items across subsets. Please start Winsteps analysis as soon as you start data collection. Then subset problems can be remedied before data collection ends. 2. Dummy data. Include data for imaginary people in the data file that connects the subsets. 3. Anchor persons or items. Anchor equivalent items (or equivalent persons) in the different subsets to the same values - or juggle the anchor values to make the mean of each subset the same (or whatever)

	4. Analyze each subset of persons and items separately. In Table 0.4, Winsteps reports entry numbers for each person and each item in each subset, so that you can compare their response strings. To analyze only the items and persons in a particular subset, such as subset 4 above, specify the items and persons in the subset: IDELETE= +9-10 PDELETE= +10-11
Memory was not allocatable to probe connectivity	If the data are complete, ignore this message. If the data are sparse, add dummy data records. They will have little influence on connected data, but will connected up data with subsets. See also Memory

Table 14.1

```
---------  -----------------
|ENTRY     |               |
|NUMBER    | ITEM        G |
|--------  +---------------|
|      1   | 01 Subset 1 D | SUBSET 1
|      2   | 02 Subset 1 D | SUBSET 1
                                   < Guttman split here >
|      3   | 03 Subset 2 D | SUBSET 2
|      4   | 04 Subset 2 D | SUBSET 2
                                   < Guttman split here >
|      5   | 05 Subset 7 D | SUBSET 7
                                   < Guttman split here >
|      6   | 06 Subset 4 D | SUBSET 4
|      7   | 07 Subset 4 D | SUBSET 4
                                   < Guttman split here >
|      8   | 08 Subset 5 D | SUBSET 5
|      9   | 09 Subset 5 D | SUBSET 5
|     10   | 10 Subset 5 D | SUBSET 5
                                   < Guttman split here >
|     11   | 11 Subset 6 R | SUBSET 6
|     12   | 12 Subset 6 R | SUBSET 6
|--------  +---------------|
```

Table 0.4 reports

```
SUBSET DETAILS

Subset 1 of 2 ITEM and 2 PERSON
 ITEM: 1-2
 PERSON: 2-3
Subset 2 of 2 ITEM and 2 PERSON
 ITEM: 3-4
 PERSON: 4-5
Subset 3 of 2 PERSON
 PERSON: 6-7
Subset 4 of 2 ITEM and 2 PERSON
 ITEM: 6-7
 PERSON: 8-9
Subset 5 of 3 ITEM and 3 PERSON
 ITEM: 8-10
 PERSON: 10-12
Subset 6 of 2 ITEM and 4 PERSON
 ITEM: 11-12
 PERSON: 13-16
Subset 7 of 1 ITEM
 ITEM: 5
```

Example 2: Analyzing two separate datasets together.
Dataset 1. The Russian students take the Russian items. This is connected. All the data are in one subset.
Dataset 2. The American students take the American items. This is connected. All the data are in one subset.
Dataset 3. Datasets 1 and 2 are put into one analysis. This is not connected. The data form two subsets: the Russian one and the American one. The raw scores or Rasch measures of the Russian students cannot be compared to those of the American students. For instance, if the Russian students score higher than the American students, are the Russian students more able or are the Russian items easier? The data cannot tell us which is true.

Winsteps attempts to estimate an individual measure for each person and item within one frame of reference. Usually this happens. But there are exceptions.

The initial implimentation used the algorithm of David L. Weeks Donald R. Williams Technometrics 6:3 p.319-324 8/1964, but this fails for indirect linking.

12.21 Examples on www.winsteps.com

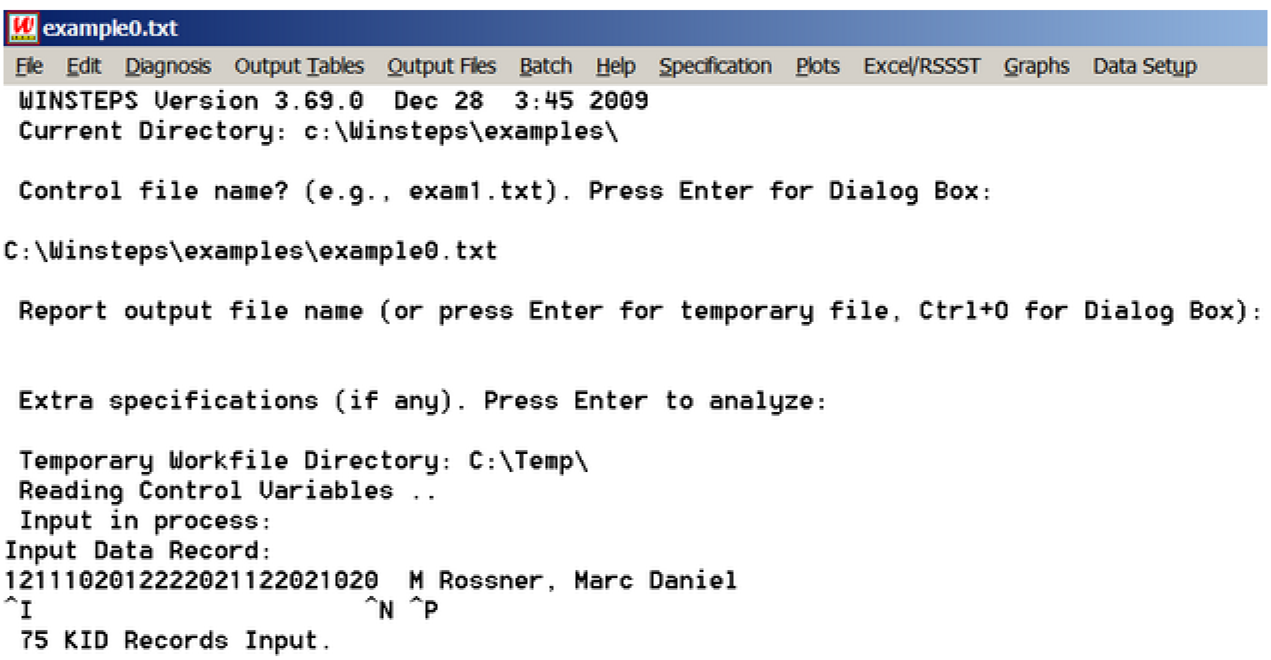
www.winsteps.com has other examples of Winsteps control and data files. For example:

1. The Languages of Love - www.winsteps.com/languages.htm
2. Masterchef Australia 2017 - www.winsteps.com/masterchef.htm
3. Masterchef Australia 2018 - www.winsteps.com/masterchef-2018.htm

13 Analysis Window

13.1 The Analysis Window

While Winsteps is running, information about the analysis is displayed on the screen. The iterative estimation process is by logistic curve-fitting. Here is an example based on the "Liking for Science" data, example0.txt



The Winsteps analysis window can display:

WINSTEPS Version: 5.10.1
program running - shows version number

Reading Control Variables .. Processing your control variables
Input in process ...... Reading in your data: each . is 1,000 persons

```
1211102012222021122021020  M Rossner, Marc Daniel
^I                        ^N ^P
```

^I where item response string starts, ITEM1=
^N last item response, NI=
^P where person label starts, NAME1=

75 person records input Total person records found

```
                               CONVERGENCE TABLE
-Control: \examples\example0.txt         Output: \examples\ZOU706WS.TXT
|    PROX          ACTIVE COUNT       EXTREME 5 RANGE      MAX LOGIT CHANGE  |
| ITERATION     KID      ACT  CATS         KID      ACT      MEASURES  STRUCTURE|
>=====================================<
|        1        75       25      3        3.78     3.20        3.8918     .0740 |
>=====================================<
|        2        74       25      3        4.59     3.71         .8258    -.6158 |
>=====================================<
|        3        74       25      3        4.83     3.92         .2511    -.1074 |
PROBING DATA CONNECTION: to skip: subset=no
>=====================================<
|Control: \examples\example0.txt         Output: \examples\ZOU706WS.TXT
|    JMLE      MAX SCORE   MAX LOGIT     LEAST CONVERGED    CATEGORY STRUCTURE|
| ITERATION   RESIDUAL*     CHANGE     KID      ACT     CAT    RESIDUAL   CHANGE|
>=====================================<
|       1          2.84      -.1955      60      22*      2          .01     .0076|
>=====================================<
|       2           .71      -.0335      53      15*      0          .01     .0144|
>=====================================<
|       3          -.43       .0297      53       5*      1          .01     .0101|
>=====================================<
|       4           .32       .0237      18      11*      1          .01     .0079|
>=====================================<
|       5           .24       .0184      18      11*      0          .01     .0060|
>=====================================<
|       6           .19       .0141      18      11*      0          .00     .0045|
>=====================================<
|       7           .14       .0108      18      11*      0          .00     .0035|
>=====================================<
|       8           .11       .0082      18      11*      0          .00     .0026|
>=====================================<
|       9           .08       .0062      18      11*      0          .00     .0020|
>=====================================<
|      10           .06       .0048      18      11*      0          .00     .0015|
 -----------------------------------------------------------------------------
-
```

To stop iterations: press Ctrl+S
To cancel the analysis: press Ctrl+F

If Winsteps detects that the iterative process is not converging (the maximum residual and maximum change are not becoming smaller) then this message appears:
"Estimation may have diverged. Press Ctrl-F to stop iterations."
Reasons for this include:
1. Incorrect values in the data. Look at CODES= in your Winsteps control file, and Table 3.2.
2. The data form disconnected subsets.

CONVERGENCE TABLE: See Table 0.2

PROBING DATA CONNECTION: See SUBSETS=

PROX and JMLE: See Estimation methods
Check that values diminish, and become near 0. See convergence considerations

When CMLE=Yes, CMLE estimation is done:

```
 Calculating CMLE Estimates
>=====================================<
|      11          .51        .0285       0       5*       1        7.88     .0202|
>=====================================<
|      12          .33        .0193       0       5*       1        3.99     .0102|
>=====================================<
|      13          .18        .0102       0       5*       1        2.75     .0071|
>=====================================<
|      14          .12        .0068       0       5*       1        1.55     .0040|
>=====================================<
|      15          .07        .0039       0       5*       1         .99     .0025|
 Calculating CMLE Fit Statistics
>=====================================<
```

JMLE estimation continues .....

```
 Calculating Fit Statistics
>=====================================<
Standardized Residuals N(0,1)  Mean: .06 S.D.: 1.04
Time for estimation: 0:0:0.750
LIKING FOR SCIENCE (Wright & Masters p.18)
-----------------------------------------------------------------------------
| KID      75 INPUT      75 MEASURED                INFIT         OUTFIT    |
|          TOTAL     COUNT     MEASURE  REALSE    IMNSQ   ZSTD  OMNSQ   ZSTD|
| MEAN      31.7      25.0         .97     .43      .99    -.2   1.08     .1|
| S.D.       8.6        .0        1.35     .20      .50    1.6   1.04    1.9|
| REAL RMSE    .47 TRUE SD    1.26  SEPARATION  2.66  KID    RELIABILITY  .88|
|---------------------------------------------------------------------------|
| ACT      25 INPUT      25 MEASURED                INFIT         OUTFIT    |
|          TOTAL     COUNT     MEASURE  REALSE    IMNSQ   ZSTD  OMNSQ   ZSTD|
| MEAN      95.0      75.0         .00     .25     1.02    -.2   1.08     .0|
| S.D.      30.9        .0        1.41     .08      .45    2.3    .87    2.8|
| REAL RMSE    .26 TRUE SD    1.38  SEPARATION  5.32  ACT    RELIABILITY  .97|
-----------------------------------------------------------------------------
Output written to C:\Winsteps\examples\ZOU280WS.TXT
CODES= 012
Measures constructed: use "Diagnosis" and "Output Tables" menus
```

CALCULATING FIT STATISTICS
During this iteration through the data, the person and item fit statistics are computed. The exact formulas are in the book Rating Scale Analysis, p. 100 - also at Fit Equations.

Summary statistics are extracted from Table 3.1 with REALSE=Yes and including extreme scores.

14 Output Tables

14.1 Table 0 Analysis Report

14.1.1 Table 0.1 Analysis identification

Winsteps Table 0 is not always produced automatically.
If you need to see it once only:
Output Tables menu:

Request Subtables (top left of menu)
OK

If you need to see it every time:
Insert in your Winsteps control file before &END:
TFILE=*
0
*

Table 0.1 Analysis Identification
Table 0.2 Convergence report
Table 0.3 Control file
Table 0.4 Subset details
Table 0 is in the Report Output File in the Edit menu. In the Output Table menu, request it from Subtable, 0.

```
TABLE 0.1 LIKING FOR SCIENCE (Wright & Masters p ZOU838WS.TXT  Jul  8 2021  9: 1
INPUT: 76 PUPIL  25 ACT  REPORTED: 75 PUPIL  25 ACT  3 CATS     WINSTEPS 5.0.1.0
--------------------------------------------------------------------------------

------------------------------------------------------------------------------
|                                                                            |
|                     * * * *  W I N S T E P S  * * * *                      |
|                     ---------------------------------                      |
|                                                                            |
|                 -  RASCH ANALYSIS FOR TWO-FACET MODELS  -                  |
|                                                                            |
|        PERSON, ITEM & RESPONSE STRUCTURE MEASUREMENT AND FIT ANALYSIS      |
|                                                                            |
|                     WINSTEPS(R)      www.winsteps.com                      |
|                                                                            |
|                COPYRIGHT  (C)JOHN MICHAEL LINACRE, 1991-2021               |
|            Permission to copy output and documentation is granted.        |
|                    July 7, 2021       VERSION 5.0.1.0                      |
------------------------------------------------------------------------------
      TITLE= LIKING FOR SCIENCE (Wright & Masters p.18)
CONTROL FILE: C:\ANALYSIS\NEW5010\sf.txt
OUTPUT FILE: C:\ANALYSIS\NEW5010\ZOU838WS.TXT
       DATE: Jul  8 2021  9: 1
76 PUPIL Records Input
```

This shows the Title, Control file, Output report file, date and time of this analysis. This page contains the authorship and version information.

Winsteps is updated frequently. Please refer to the web page for current version numbers and recent enhancements at www.winsteps.com

If the output file name has the form ZOU???ws.txt, then it is a temporary file which will be erased when Winsteps terminates. You can "Save As" as a permanent file. This output file is on the Edit menu.

14.1.2 Table 0.2 Convergence report

(controlled by LCONV=, RCONV=, CONVERGE=, MPROX=, MJMLE=, CUTLO=, CUTHI=)

Table 0.1 Analysis Identification
Table 0.2 Convergence report
Table 0.3 Control file
Table 0.4 Subset details
Table 0 is in the Report Output File in the Edit menu. In the Output Table menu, request it from Subtable, 0.

```
                             CONVERGENCE TABLE

+----------------------------------------------------------------------------+
```

```
|    PROX          ACTIVE COUNT       EXTREME 5 RANGE      MAX LOGIT CHANGE  |
| ITERATION   PUPILS  ACTS    CATS     PUPILS  ACTS       MEASURES  STRUCTURE|
|----------------------------------------------------------------------------|
|        1       76      25     3        3.59    1.62        3.1355    -.1229 |
|        2       74      12     3        4.03    1.90         .3862    -.5328 |
|        3       74      12     3        4.19    1.96         .1356    -.0783 |
WARNING: DATA ARE AMBIGUOUSLY CONNECTED INTO 6 SUBSETS. MEASURES ACROSS SUBSETS ARE NOT COMPARABLE
 see Connection Ambiguities
----------------------------------------------------------------------------|
|    JMLE     MAX SCORE   MAX LOGIT    LEAST CONVERGED     CATEGORY STRUCTURE|
| ITERATION   RESIDUAL*    CHANGE    PUPIL  ACT      CAT   RESIDUAL   CHANGE |
|----------------------------------------------------------------------------|
|       1        -2.04       .2562       7      5*      2       -.72    .0003|
+----------------------------------------------------------------------------+
Time for estimation: 0:0:0.166
```

The meanings of the columns are:
PROX normal approximation algorithm - for quick initial estimates
ITERATION number of times through your data to calculate estimates

ACTIVE COUNT number of parameters participating in the estimation process after elimination of deletions, and perfect (maximum possible) and zero (minimum possible) scores:
PERSONS person parameters
ITEMS item parameters
CATS rating scale categories - shows 2 for dichotomies

These counts may reduce because persons, items or categories may have been

1. deleted
2. dropped because they have no responses
3. dropped from standard estimation because they are unanchored and have extreme scores. These will be reported with Bayesian estimates.

EXTREME 5 RANGE
PERSONS The current estimate of the spread between the average measure of the top 5 persons and the average measure of the bottom 5 persons.
ITEMS The current estimate of the spread between the average measure of the top 5 items and the average measure of the bottom 5 items.
MAX LOGIT CHANGE
MEASURES maximum logit change in any person or item estimate. This i expected to decrease gradually until convergence, i.e., less than LCONV=.
STRUCTURE maximum logit change in any Andrich Threshold estimate - for your information - need not be as small as MEASURES.

JMLE JMLE joint maximum likelihood estimation - for precise estimates
ITERATION number of times through your data to calculate estimates
It is unusual for more than 100 iterations to be required
MAX SCORE RESIDUAL maximum score residual (difference between integral observed core and decimal expected score) for any person or item estimate - used to compare with RCONV=. This number is expected to decrease gradually until convergence acceptable.
*   indicates to which person or item the residual applies.

MAX LOGIT CHANGE maximum logit change in any person or item estimate - used to compare with LCONV=. This number is expected to decrease gradually until convergence is acceptable.

LEAST CONVERGED element numbers are reported for the person, item and category farthest from meeting the convergence criteria.
*   indicates whether the person or the item is farthest from convergence.
the CAT (category) may not be related to the ITEM to its left. See Table 3.2 for details of unconverted categories.

CATEGORY RESIDUAL maximum count residual (difference between integral observed count and decimal expected count) for any response structure category - for your information. This number is expected to decrease gradually. Values less than 0.5 have no substantive meaning.

STRUCTURE CHANGE maximum logit change in any structure calibration (usually Rasch-Andrich Threshold). Not used to decide convergence, but only for your information. This number is expected to decrease gradually.

Look for scores and residuals in the last iteration to be close to 0,

14.1.3 Table 0.3 Control file

Table 0.1 Analysis Identification
Table 0.2 Convergence report
Table 0.3 Control file
Table 0.4 Subset details
Table 0 is in the Report Output File in the Edit menu. In the Output Table menu, request it from Subtable, 0.

Table 0.3 shows the control file used in the analysis. It includes the extra specifications and expands SPFILE= commands. This is also appended to the LOGFILE=, when specified.

A complete listing of control variables is obtained using "Control variable file=" from the Output Files pull-down menu, which is also Table 32.

"Extra Specifications" are listed after &END.

```
&INST
TITLE='LIKING FOR SCIENCE +
    +(Wright & Masters p.18)'  ;demonstrates continuation line
ITEMS=ACT
PERSONS=PUPIL
ITEM1=1
NI=25
NAMLMP=20
XWIDE=2
NAME1=51
isubtot=$s1W1
psubtot=$s2W1
pweight=$s2w1
iweight=$s3w1
dif=$s3W1
dpf=$s4W1
CODES=000102
; ISGROUPS=0
CFILE=*
00 dislike
01 neutral
02 like
*
idfile=*
 13 GROW GARDEN                   |
 10 LISTEN TO BIRD SING           |
  2 READ BOOKS ON ANIMALS         |
 12 GO TO MUSEUM                  |
 21 WATCH BIRD MAKE NEST          |
 18 GO ON PICNIC                  |
 24 FIND OUT WHAT FLOWERS LIVE ON |
 19 GO TO ZOO                     |
 15 READ ANIMAL STORIES           |
 11 FIND WHERE ANIMAL LIVES       |
  3 READ BOOKS ON PLANTS          |
 14 LOOK AT PICTURES OF PLANTS    |
 17 WATCH WHAT ANIMALS EAT        |
*

EXTRSC=0.3
; TABLES=00000011111111111111111111111111
; CURVES=111
CSV=Y
; ISGROUPS=0
; IFILE = SFIF.txt
; PFILE = SFPF.txt
; XFILE = SFXF.txt
; RFILE = SFRF.txt
; SFILE = SFSF.txt
; ISFILE = SFIS.txt
&END
MJMLE=1  ; this is an Extra Specification
```

14.1.4 Table 0.4 Subset details

Table 0.1 Analysis Identification
Table 0.2 Convergence report
Table 0.3 Control file
Table 0.4 Subset details
Table 0 is in the Report Output File in the Edit menu. In the Output Table menu, request it from Subtable, 0.

Table 0.4 reports the details of the disjoint subsets discovered in the subset analysis.

```
TABLE 0.4 Example of subset reporting

SUBSET DETAILS

Subset 1 of 2 ITEM and 2 PERSON
 ITEM: 1-2
 PERSON: 2-3
Subset 2 of 2 ITEM and 2 PERSON
 ITEM: 3-4
 PERSON: 4-5
Subset 3 of 1 PERSON
 PERSON: 6
Subset 4 of 2 ITEM and 2 PERSON
 ITEM: 6-7
 PERSON: 7-8
Subset 5 of 2 ITEM and 2 PERSON
 ITEM: 8-9
 PERSON: 9-10
Subset 6 of 1 ITEM
 ITEM: 5
Warning: Data are ambiguously connected into 6 subsets. Measures may not be comparable
    across subsets.
```

14.2 Table 1 Wright item-person maps of the latent variable

controlled by T1SCORE=, IPEXTREME=, MTICK=, NAMLMP=, IMAP=, PMAP=, ISORT=, PSORT. There are more options at TFILE=, see also MTOP=
For size: MAXPAGE=, LINELENGTH=, MRANGE=

Ben Wright usually drew his maps vertically with item and person labels (like Winsteps Table 1). Ben's maps were intended to tell us about what it means to be at a specific location on the latent variable in terms of what you can do and who can do it.

Table 1.0 Wright map - person and item labels on one page

```
MEASURE                                        KID - MAP - TAP
                                                <more>|<rare>
   5                                                  +  1-3- 1-4- 1-4- 4-1-
                                                      |
   4                                                 T+
                                            Mik Tra  |S 1-4-
   3                                            Bla  +
                                                      |
   2                                    Dav Rod Wal Zul S+  1-3- 1-4-
                                                      |
   1                                Aud Jam Kim Ron Wil  +  1-3-
                                                      |
   0                                                 M+M
     Ann Bre Don Dor Hel Jan Joe Lis Mar Pet Ric Tho  |
  -1                                                  +
                                           Bet Els Sus  |  2-4-
  -2                                           Ber Bri S+
                                                      |  1-4-
  -3                                           Ada Ric  +
                                               Bar Car  |S 1-3- 3-4-
  -4                                                 T+  1-4- 2-1-
```

Table 1.0 is printed, if person and item maps can be squeezed into one page. MAXPAGE= controls height of table (number of lines for each logit). LINELENGTH= controls width of table. Typical defaults are MAXPAGE=50, LINELENGTH=80. Use the Specification menu dialog box to try different values.

Left-hand column locates the person ability measures along the variable. The persons often have a normal distribution.

Right-hand column locates the item difficulty measures along the variable. Table 12 has the full item labels. Items arranged by measure: look for the hierarchy of item names to spell out a meaningful construct

```
                                                       Lin  |  1-3-
   -5                                                  Fra  +  1-2- 1-4  2-3
                                                     <less>|<freq>
```

Column Labels for Tables 1.0, 1.1, 1.2, 1.4

PERSON=	MAP	ITEM=
MORE=	⊤	RARE=
	|	
LESS=	⊥	FREQ= frequent

from easiest at the bottom to hardest at the top.

M,S,T are the Mean, 1 and 2 Standard Deviations from the Mean for the persons and items. With IPEXTREME=Yes (the default), persons and items with extreme scores are placed at the ends of the map and are excluded from M,S,T. With IPEXTREME=No, persons and items with extreme scores are placed at their measures on the map and are included in M,S,T.

For dichotomous items, look for an even spread of items along the variable (the y-axis) with no gaps. Gaps can indicate poorly defined or poorly tested regions of the variable. Good tests usually have the items targeted (lined up with) the persons.

For polytomous items, Table 2.2 shows the operational range of the item with its rating scale.

You can use IMAP= and PMAP= to choose parts of labels to show. NAMLMP= limits the number of characters of each name reported. LINELENGTH= changes the available space on the line. MAXPAGE= controls the length of the Table. MRANGE= controls the displayed range of measures. ISORT= and PSORT= control the sort order within rows.

For the full person labels, please use Table 16.
For the full item labels, please use Table 12.

Table 1.1 Wright map - person and item distributions

```
SCORE  MEASURE                                 |                               MEASURE
         <more> --------------------- KID     -+- TAP     ----------------- <rare>
           5                                   +  X                                5
   15                                          |  XXX
                                               |
           4                                   +                                   4
   14                                      XX T|
                                               |S X
   13      3                                X  +                                   3
                                               |
                                               |  X
   12      2                             XXXX  +  X                                2
                                              S|
                                               |
   11      1                            XXXXX  +                                   1
                                               |  X
                                               |
           0                                   +M                                  0
   10                           XXXXXXXXXXXX M|
                                               |
          -1                                   +                                  -1
    9                                     XXX  |
                                               |  X
          -2                                  S+                                  -2
    8                                      XX  |  X
                                               |
    7     -3                               XX  +                                  -3
                                               |S XX
    6                                      XX  |  XX
          -4                                  T+                                  -4
    5                                       X  |  X
                                               |
          -5                                X  +  XXX                             -5
         <less> --------------------- KID     -+- TAP     ----------------- <freq>
```

This table shows the distribution of the persons and items. The variable is laid out vertically with the most able persons, and most difficult items at the top.

Left-hand columns locate the person raw scores and ability measures along the variable.

Right-hand column locates the item difficulty measures along the variable.

SCORE (raw score on active items) shown in Table 1 sub-tables when T!SCORE=Yes

Table 1.2 Wright map - person distribution + item labels

```
MEASURE        KID - MAP - ACT
                <more>|<rare>
    5                .  +
                     .  |
                        |
    4                .  +
                     .  |
                     . T|
    3                .  +
                     .  |T
                    ##  |  FIND BOTTLES AND   WATCH A RAT
    2              .## S+
                    ##  |  LOOK IN SIDEWALK   WATCH BUGS          WATCH GRASS CHANG
                  .###  |S
    1            .#### M+  WATCH ANIMAL MOVE
                   .##  |  LEARN WEED NAMES   MAKE A MAP          TALK W/FRIENDS AB
               #######  |  LOOK AT PICTURES   LOOK UP STRANGE A   READ BOOKS ON PLA
    0           .#####  +M FIND OUT WHAT ANI  WATCH WHAT ANIMAL
                     # S|  FIND OUT WHAT FLO  READ ANIMAL STORI   WATCH BIRDS
                     #  |  READ BOOKS ON ANI
   -1                #  +  FIND WHERE ANIMAL  WATCH BIRD MAKE N
                     #  |S GROW GARDEN        LISTEN TO BIRD SI
                     . T|
   -2                   +  GO TO MUSEUM
                        |  GO TO ZOO
                        |T
   -3                   +  GO ON PICNIC
                <less>|<freq>
EACH "#" IS 2: EACH "." IS 1
```

Left-hand column locates the person ability measures along the variable. The persons often have a normal distribution.

Right-hand column locates the item difficulty measures along the variable. The item labels are abbreviated to fit on one page. Table 12 has the full item labels.

Effective operational range of an instrument with dichotomous items.
Table 1.2 is enough if the data are dichotomies. Then each item has an operational range of about 1.5 logits up and down from the item difficulty. For an ability at 1.5 logits from the difficulty of a dichotomous item, the response to the item contain about 60% of the statistical information of a response for an ability equal to the item difficulty.

In Table 1.2 the X's are located at the point where there is a 50% chance of being observed in the bottom category and a 50% chance of being observed in the top category. For dichotomies, there are only 2 categories, so this is the whole story.

Table 1.3 Wright map - item distribution + person labels

```
MEASURE ACT - MAP - KID
        <rare>|<more>
    5         +  M
              |  F
              |
    4         +  F
              |  F
              |T M
    3         +  F
             T|  M
          XX  |  F   F   F   M
    2         +S F   M   M   M   M
         XXX  |  F   M   M   M
             S|  F   F   M   M   M   M   M
    1      X  +M F   F   M   M   M   M   M   M   M
         XXX  |  M   M   M   M   M
         XXX  |  F   F   M   M   M   M   M   M   M   M   M   M   M   M
    0     XX M+  M   M   M   M   M   M   M   M   M   M   M
         XXX  |S F   M
           X  |  F   M
   -1     XX  +  F   M
          XX S|  M   M
              |T M
   -2      X  +
           X  |
             T|
   -3      X  +
        <freq>|<less>
```

Left-hand column shows the item difficulty distribution measures along the variable.

Right-hand column locates the person ability measures along the variable. The persons often have a normal distribution. The person labels are abbreviated to fit on one page. Table 16.3 shows the full person labels

Column Labels

```
  ITEM=     MAP    PERSON=
  RARE=      T     MORE=
             |
  FREQ=      ⊥     LESS=
```

Table 1.4 Wright map - person and item distributions + polytomous item range

```
MEASURE                  | BOTTOM P=50%  | MEASURE         | TOP P=50%       MEASURE
 <more> ----- KID      -+- ACT         -+- ACT          -+- ACT             <rare>
   5                  . +               +                +                    5
                      . |               |                |
                        |               |                |
   4                  . +               +                +                    4
                      . |               |                |
```

Table 1.4 is only produced when there are polytomous items. Table 1.4 shows the distribution of the person MEASUREs and items. The variable is laid out vertically with the most able persons, and most difficult items at the top. Each person or polytomous item is indicated by an "X", or, when there are too many "X"s to display on one line, several

```
                  . |               |               | XX
  3               . + D             + D             + D                3
                  . |               |               | XXX
                 ## |               | XX            |
  2             .## +               +               + X                2
                 ## |               | XXX           | XXX
               .### | XX            |               | XXX
  1           .#### +               + X             + XX               1
                .## | XXX           | XXX           | XXX
            ####### |               | XXX           | X
  0          .##### + X             + XX            + XX               0
                  # | XXX           | XXX           | XX
                  # | XXX           | X             |
 -1               # + XX            + XX            + X               -1
                  # | XXX           | XX            | X
                  . | X             |               |
 -2                 + XX            + X             + X               -2
                    | XX            | X             |
                    |               |               |
 -3                 + X             + X             +                 -3
                    | X             |               |
                    |               |               |
 -4                 + X             +               +                 -4
                    |               |               |
                    |               |               |
 -5                 +               +               +                 -5
 <less> ----- KID   -+- ACT         -+- ACT         -+- ACT          <freq>
EACH "#" IN THE KID COLUMN IS 2 KID: EACH "." IS 1
```

persons or items are represented by a "#". Less than that number by ".". So that if "#" represents 4, then "." represents 1 to 3.

Each item is shown three times in Table 1.4. Dichotomous items, "D", have only one location, the same in all three item columns.

In the center item column, "MEASURE", each item is placed at its item difficulty measure (in Table 13.1, etc).

In the left-hand item column,"BOTTOM", the item is shown at the measure level (Rasch-Thurstonian threshold) corresponding to a probability of .5 of exceeding (or being rated in) the bottom rating (or partial credit) scale category.

In the right-hand item column, "TOP", the item is shown at the measure level corresponding to a probability of .5 of being rated in (or falling below) the top rating (or partial credit) scale category.

The plotted values are in the ISFILE=. These locations are also shown in Table 2.3.

The left-hand column locates the person ability measures along the variable. Observe that the top pupil (top . in left column and green band) is well above the top category of the most difficult act items (top XX in right-most column and top red band), but that all pupils are above the top category of the easiest item (bottom X in right-most column and blue band). "Above" here means with greater than 50% chance of exceeding.

Effective operational range of an instrument with polytomous items.

In Table 1.4, everyone between the extreme Rasch-Thurstonian thresholds = 50% cumulative thresholds (red bands in the Figure) has a more than 50% chance of being rated *above* the bottom category of at least one item and *below* the top category of at least one item. Here we have polytomies (rating scale, partial credit), so each item has a range from the bottom category of the rating scale (2nd column in Table 1.4) through the overall item difficulty (3rd column in Table 1.4) to the top category of the rating scale (4th column Table 1.4).

In Table 1.4, the X's in the 2nd column are located at the points on the latent variable where a person would have a 50% chance of being observed in the bottom category and a 50% chance of being observed in a higher category. So this is like the "item difficulty" of the bottom category.

In Table 1.4, the X's in the 4th column are located at the points on the latent variable where a person would have a 50% chance of being observed in the top category and a 50% chance of being observed in a lower category. So this is like the "item difficulty" of the top category.

So the item difficulty of each item covers the whole range in Table 1.4 from its X in the 2nd column to its X in the 4th column.

Polytomies: Tables 1.5 - 1.8 - which to report? Think: what is my message to my audience? See Category Boundaries and Thresholds

Table 1.5 - Rasch-half-point thresholds work best when you need to show average ratings at each point on the rating scale. This works well with people familiar with conventional statistical analysis.

Table 1.6 - Rasch-Thurstonian thresholds are best when you need the equivalent of dichotomizing the rating scale at each category boundary = is the person above or below this boundary? - www.rasch.org/rmt/rmt233e.htm - This is used in reporting to parents in Australia.

Table 1.7 - Andrich-Thresholds are best when you need to show which individual category is most probable at each point along the latent variable. They become confusing when thresholds are disordered. This is often used in clinical situations when the user needs to know what behavior is more likely to be seen.

Table 1.8 - Category centers. The locations on the latent variable at which each category is most probable = points at which the expected score on the item is the category value = a center of each category. This is useful when you need to report how the rating scale categories "step up" the latent variable.

Table 1.5 Item map with expected score zones

```
MEASURE       KID - MAP - ACT - Expected score zones (Rasch-half-point thresholds)
               <more>|<rare>  Neutral                     Like
    5             #  +
                     |
    4             .  +
                  . T|                                     FIND BOTTLES AND CANS         .15
    3             #  +T                                    WATCH A RAT                   .15
                                                           WATCH BUGS                    .15
                                                           WATCH GRASS CHANGE            .15
                .##  |                                     LOOK IN SIDEWALK CRACKS       .15
    2          .### S+                                     WATCH ANIMAL MOVE             .15
                ###  |S FIND BOTTLES AND CANS         .05  LEARN WEED NAMES              .15
                                                           LOOK AT PICTURES OF PLANTS    .15
                                                           LOOK UP STRANGE ANIMAL OR PLAN.15
                                                           MAKE A MAP                    .15
                                                           READ BOOKS ON PLANTS          .15
                                                           TALK W/FRIENDS ABOUT PLANTS   .15
    1        ###### M+  WATCH A RAT                   .05  FIND OUT WHAT ANIMALS EAT     .15
                        WATCH BUGS                    .05  WATCH WHAT ANIMALS EAT        .15
         .#########  |  LOOK IN SIDEWALK CRACKS       .05  FIND OUT WHAT FLOWERS LIVE ON .15
                        WATCH GRASS CHANGE            .05  READ ANIMAL STORIES           .15
                                                           READ BOOKS ON ANIMALS         .15
                                                           WATCH BIRDS                   .15
    0        ######  +M WATCH ANIMAL MOVE             .05  FIND WHERE ANIMAL LIVES       .15
                                                           WATCH BIRD MAKE NEST          .15
                 .# S|  LEARN WEED NAMES              .05  GROW GARDEN                   .15
                        LOOK AT PICTURES OF PLANTS    .05  LISTEN TO BIRD SING           .15
                        LOOK UP STRANGE ANIMAL OR PLAN.05
                        MAKE A MAP                    .05
                        READ BOOKS ON PLANTS          .05
                        TALK W/FRIENDS ABOUT PLANTS   .05
```

Table 1.5 is only produced when there are polytomous items.

The right-hand column shows the items positioned at the lower edge of each expected score zone (the half-point thresholds). The half-point threshold for category *c* is indicated by .c5 when ASCII=Yes or .c½ when ASCII=No or ASCII=Web. The expected score zone above item-label .05 extends from expected category score 0.5 to 1.5 at item-label .15. Lower than item-label .05 is the zone from 0 to 0.5. These correspond to the thresholds on the Expected Score ICC.

If you put the item number at the start of the item labels after &END, you can show only the

```
  -1            #  +  FIND OUT WHAT ANIMALS EAT     .05   GO TO MUSEUM                  .15
                      WATCH WHAT ANIMALS EAT        .05
               .# T|S FIND OUT WHAT FLOWERS LIVE ON .05   GO TO ZOO                     .15
                      READ ANIMAL STORIES           .05
                      READ BOOKS ON ANIMALS         .05
                      WATCH BIRDS                   .05
  -2               +  FIND WHERE ANIMAL LIVES       .05   GO ON PICNIC                  .15
                      WATCH BIRD MAKE NEST          .05
                   |  GROW GARDEN                   .05
                      LISTEN TO BIRD SING           .05
  -3               +T GO TO MUSEUM                  .05
                   |  GO TO ZOO                     .05
  -4               +  GO ON PICNIC                  .05
                   |
  -5               +
            <less>|<freq>  Dislike                        Neutral
```

item numbers on this plot by using NAMLMP= or IMAP=. Column headings are the category labels that match the (rescored) category numbers in CFILE= or CLFILE=.

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance and is left blank. The plotted values are in the ISFILE=.

Left-hand column shows the distribution of person ability measures along the variable.

Column labels in Tables 1.5, 1.6, 1.7, 1.8

PERSON=	MAP	ITE
MORE=	T	RA
	|	
LESS=	⊥	FR

Table 1.6 Item map with 50% cumulative probabilities (Rasch-Thurstonian thresholds)

```
MEASURE      KID - MAP - ACT - 50% Cumulative probabilities (Rasch-Thurstonian thresholds)
              <more>|<rare>  Neutral                      Like
   5            #  +
                   |
   4            .  +
                .  T|                                     FIND BOTTLES AND CANS          .2
   3            #  +T                                     WATCH A RAT                    .2
                                                          WATCH BUGS                     .2
                                                          WATCH GRASS CHANGE             .2
              .##  |                                      LOOK IN SIDEWALK CRACKS        .2
   2         .### S+                                      WATCH ANIMAL MOVE              .2
              ###  |S FIND BOTTLES AND CANS           .1  LEARN WEED NAMES               .2
                                                          LOOK AT PICTURES OF PLANTS     .2
                                                          LOOK UP STRANGE ANIMAL OR PLANT.2
                                                          MAKE A MAP                     .2
                                                          READ BOOKS ON PLANTS           .2
                                                          TALK W/FRIENDS ABOUT PLANTS    .2
   1       ###### M+  WATCH A RAT                     .1  FIND OUT WHAT ANIMALS EAT      .2
                      WATCH BUGS                      .1  WATCH WHAT ANIMALS EAT         .2
        .#########  | LOOK IN SIDEWALK CRACKS         .1  FIND OUT WHAT FLOWERS LIVE ON  .2
                      WATCH GRASS CHANGE              .1  READ ANIMAL STORIES            .2
                                                          READ BOOKS ON ANIMALS          .2
                                                          WATCH BIRDS                    .2
   0       ######  +M WATCH ANIMAL MOVE               .1  FIND WHERE ANIMAL LIVES        .2
                                                          WATCH BIRD MAKE NEST           .2
               .# S|  LEARN WEED NAMES                .1  GROW GARDEN                    .2
                      LOOK AT PICTURES OF PLANTS      .1  LISTEN TO BIRD SING            .2
                      LOOK UP STRANGE ANIMAL OR PLANT.1
                      MAKE A MAP                      .1
                      READ BOOKS ON PLANTS            .1
                      TALK W/FRIENDS ABOUT PLANTS     .1
  -1            #  +  FIND OUT WHAT ANIMALS EAT       .1  GO TO MUSEUM                   .2
                      WATCH WHAT ANIMALS EAT          .1
               .# T|S FIND OUT WHAT FLOWERS LIVE ON   .1  GO TO ZOO                      .2
                      READ ANIMAL STORIES             .1
                      READ BOOKS ON ANIMALS           .1
                      WATCH BIRDS                     .1
  -2               +  FIND WHERE ANIMAL LIVES         .1  GO ON PICNIC                   .2
                      WATCH BIRD MAKE NEST            .1
                   |  GROW GARDEN                     .1
                      LISTEN TO BIRD SING             .1
```

Table 1.6 is only produced when there are polytomous items.

The right-hand column shows the items positioned at median 50% cumulative probability (the Rasch-Thurstonian thresholds) at the lower edge of each rating probability zone. Above label.1, categories 1 and above are more probable. Below label.2, categories 1 and below are most probable. Between label.1 and label.2 is the zone which can be thought of as corresponding to a rating of 1. These correspond to the Cumulative Probability thresholds.

If you put the item number at the start of the item labels after &END, you can show only the item numbers on this plot by using NAMLMP= or IMAP=. Columns are headed by the (rescored) categories in CFILE=.

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance

```
   -3              +T GO TO MUSEUM                     .1
                    | GO TO ZOO                        .1
   -4              +  GO ON PICNIC                     .1
                    |
   -5              +
              <less>|<freq>  Dislike                     Neutral
EACH "#" IS 2: EACH "." IS 1
```

and is left blank. The plotted values are in the [ISFILE=](#).

Left-hand column shows the distribution of person ability measures along the variable.

Table 1.7 Item map with Andrich thresholds (modal categories if ordered)

```
MEASURE       KID - MAP - ACT - Andrich thresholds (modal categories if ordered)
               <more>|<rare>  Neutral                    Like
    5             .  +
                  .  |
                     |
    4             .  +
                  .  |
                  . T|                                     FIND BOTTLES AND CANS          .2
    3             .  +                                     WATCH A RAT                    .2
                  .  |T                                    LOOK IN SIDEWALK CRACKS        .2
                                                           WATCH BUGS                     .2
                                                           WATCH GRASS CHANGE             .2
                 ##  |
    2           .## S+                                     WATCH ANIMAL MOVE              .2
                 ##  |  FIND BOTTLES AND CANS          .1  LEARN WEED NAMES               .2
               .###  |S WATCH A RAT                    .1  LOOK AT PICTURES OF PLANTS     .2
                                                           MAKE A MAP                     .2
                                                           READ BOOKS ON PLANTS           .2
                                                           TALK W/FRIENDS ABOUT PLANTS    .2
    1         .#### M+  WATCH BUGS                     .1  FIND OUT WHAT ANIMALS EAT      .2
                        WATCH GRASS CHANGE             .1  LOOK UP STRANGE ANIMAL OR PLANT.2
                                                           WATCH WHAT ANIMALS EAT         .2
                .##  |  LOOK IN SIDEWALK CRACKS        .1  FIND OUT WHAT FLOWERS LIVE ON  .2
            #######  |  WATCH ANIMAL MOVE              .1  READ ANIMAL STORIES            .2
                                                           WATCH BIRDS                    .2
    0        .#####  +M LEARN WEED NAMES               .1  FIND WHERE ANIMAL LIVES        .2
                                                           READ BOOKS ON ANIMALS          .2
                                                           WATCH BIRD MAKE NEST           .2
                  # S|  LOOK AT PICTURES OF PLANTS     .1  GROW GARDEN                    .2
                        MAKE A MAP                     .1
                        READ BOOKS ON PLANTS           .1
                        TALK W/FRIENDS ABOUT PLANTS    .1
                  #  |  FIND OUT WHAT ANIMALS EAT      .1  LISTEN TO BIRD SING            .2
                        LOOK UP STRANGE ANIMAL OR PLANT.1
                        WATCH WHAT ANIMALS EAT         .1
   -1             #  +
                  #  |S FIND OUT WHAT FLOWERS LIVE ON  .1  GO TO MUSEUM                   .2
                        READ ANIMAL STORIES            .1
                        WATCH BIRDS                    .1
                  . T|  FIND WHERE ANIMAL LIVES        .1  GO TO ZOO                      .2
                        READ BOOKS ON ANIMALS          .1
                        WATCH BIRD MAKE NEST           .1
   -2                +  GROW GARDEN                    .1
                     |  LISTEN TO BIRD SING            .1  GO ON PICNIC                   .2
                     |T
   -3                +  GO TO MUSEUM                   .1
                     |  GO TO ZOO                      .1
                     |
   -4                +  GO ON PICNIC                   .1
                     |
                     |
   -5                +
               <less>|<freq>  Dislike                      Neutral
EACH "#" IS 2: EACH "." IS 1
```

Table 1.7 is only produced when there are polytomous items.

The right-hand column shows the items positioned at their Andrich thresholds (points of equal probability of adjacent categories) at the lower edge of each rating probability zone. When the thresholds are ordered, above label.2, the most probable category is 2. Below label.1, the most probable category is 0. Between label.1 and label.2 is the zone which can be thought of as corresponding to a rating of 1.

If you put the item number at the start of the item labels after &END, you can show only the item numbers on this plot by using [NAMLMP=](#) or [IMAP=](#). Columns are headed by the (rescored) categories in [CFILE=](#).

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance and is left blank. The plotted values are in the [ISFILE=](#).

Left-hand column shows the distribution of person ability measures along the variable.

Table 1.8 Item map of measures for category scores (maximum probability of observing a category)

```
MEASURE    KID - MAP - ACT - Measures for category scores
                                                     (maximum probability of observing a
     category)
            <more>|<rare>  Dislike    Neutral          Like
    5          X  +
               X  |
                  |
```

Table 1.8 is only produced when there are polytomous items.

The right-hand column shows the items positioned at the measures where the expected score on the item = the category number. This is also the

```
               |                                    Find bottles .2
               |                                    Watch a rat  .2
 4          X  +                                    Watch bugs   .2
               |                                    Look in side .2
                                                    Watch grass  .2
            X  |
              T|
            X  |                                    Watch animal .2
 3          X  +
            X  |T                                   Learn weed n .2
               |                                    Make a map   .2
                                                    Talk w/frien .2
           XX  |                   Find bottles .1  Look at pict .2
                                                    Look up stra .2
                                                    Read books o .2
         XXXX S|                   Watch a rat  .1  Find out wha .2
                                                    Watch what a .2
 2        XXX  +
           XX  |                   Watch bugs   .1  Find out wha .2
                                   Watch grass  .1
           XX  |                   Look in side .1  Read animal  .2
                                                    Watch birds  .2
         XXXX  |S                                   Read books o .2
          XXX  |                   Watch animal .1  Find where a .2
                                                    Watch bird m .2
 1     XXXXXX  +
        XXXXX M|                   Learn weed n .1  Grow garden  .2
          XXX  |                   Make a map   .1  Listen to bi .2
                                   Talk w/frien .1
     XXXXXXXX  |  Find bottles .0  Look at pict .1
                                   Look up stra .1
                                   Read books o .1
   XXXXXXXXXX  |  Watch a rat  .0  Watch what a .1
 0    XXXXXXX  +M                  Find out wha .1  Go to museum .2
            X  |  Watch bugs   .0
            X S|  Look in side .0  Find out wha .1  Go to zoo    .2
                  Watch grass  .0  Read animal  .1
                                   Watch birds  .1
           XX  |
               |                   Read books o .1
                                   Watch bird m .1
-1         XX  +  Watch animal .0  Find where a .1  Go on picnic .2
               |                   Grow garden  .1
           XX  |S Learn weed n .0  Listen to bi .1
                  Make a map   .0
            X T|  Look at pict .0
                  Read books o .0
                  Talk w/frien .0
               |  Look up stra .0
-2             +  Find out wha .0  Go to museum .1
                  Watch what a .0
               |
               |  Find out wha .0  Go to zoo    .1
                  Watch birds  .0
               |  Read animal  .0
               |T Read books o .0
-3             +  Find where a .0
                  Watch bird m .0
               |                   Go on picnic .1
               |  Grow garden  .0
               |  Listen to bi .0
               |
-4             +
               |  Go to museum .0
               |
               |  Go to zoo    .0
               |
-5             +
               |  Go on picnic .0
               |
               |
               |
-6             +
         <less>|<freq>  Dislike    Neutral          Like
```

measure at which the category has its highest probability. Extreme categories are shown at measures corresponding to the category score adjustedby .25 score points (or LOWADJ= and HIADJ=) .

If you put the item number at the start of the item labels after &END, you can show only the item numbers on this plot by using NAMLMP= or IMAP=. Columns are headed by the (rescored) categories in CFILE=.

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance and is left blank. The plotted values are in the ISFILE=.

Left-hand column shows the distribution of person ability measures along the variable.

Table 1.9 Item map of average person measure for each category score

Table 1.9 is only produced when there are polytomous items.

```
MEASURE  PUPIL - MAP - PUPIL - Average Measures for category scores
            <more>|<more>          like                   3                   4
    5          X  +
               X  |
                  |
                  |
                  |
    4          X  +
                  |
               X  |
                 T|
               X  |
    3          X  +                                          WATCH GRASS CHAN.4
                                                             LOOK IN SIDEWALK.4
               X  |T
                  |
              XX  |                                                WATCH BUGS.4
                                                             WATCH ANIMAL MOV.4
            XXXX S|                                          READ BOOKS ON PL.4
                                                             TALK W/FRIENDS A.4
    2        XXX  +                                          LOOK AT PICTURES.4
                                                                   MAKE A MAP.4
                                                             WATCH WHAT ANIMA.4
                                                             LEARN WEED NAMES.4
                                                              LOOK UP STRANGE.4
              XX  |                                          FIND OUT WHAT AN.4
                                                                  WATCH BIRDS.4
              XX  |                                          READ ANIMAL STOR.4
                                                             FIND OUT WHAT FL.4
                                                             FIND WHERE ANIMA.4
                                                             READ BOOKS ON AN.4
                                                              WATCH BIRD MAKE.4
            XXXX  |S                                         LISTEN TO BIRD S.4
                                                             FIND BOTTLES AND.4
             XXX  |                                               GROW GARDEN.4
                                                                 GO TO MUSEUM.4
                                                                    GO TO ZOO.4
    1     XXXXXX  +         GO TO ZOO.2  WATCH GRASS CHAN.3      GO ON PICNIC.4
                          WATCH A RAT.2        WATCH A RAT.3
                     FIND BOTTLES AND.2         WATCH BUGS.3
           XXXXX M|                      FIND BOTTLES AND.3       WATCH A RAT.4
                                         WATCH ANIMAL MOV.3
             XXX  |  LOOK IN SIDEWALK.2         MAKE A MAP.3
                           WATCH BUGS.2  LOOK IN SIDEWALK.3
                                          LOOK UP STRANGE.3
                                         LEARN WEED NAMES.3
                                         LOOK AT PICTURES.3
                                         TALK W/FRIENDS A.3
                                         READ BOOKS ON PL.3
        XXXXXXXX  |      GO ON PICNIC.2  WATCH WHAT ANIMA.3
                                         FIND OUT WHAT AN.3
                                         FIND OUT WHAT FL.3
      XXXXXXXXXX  |  WATCH GRASS CHAN.2        WATCH BIRDS.3
                     LEARN WEED NAMES.2  READ ANIMAL STOR.3
                     WATCH ANIMAL MOV.2
    0    XXXXXXX  +M       MAKE A MAP.2  READ BOOKS ON AN.3
                                         LISTEN TO BIRD S.3
                                             GO ON PICNIC.3
                                         FIND WHERE ANIMA.3
                                              GROW GARDEN.3
                                          WATCH BIRD MAKE.3
               X  |  TALK W/FRIENDS A.2
                     LOOK AT PICTURES.2
               X S|  FIND OUT WHAT AN.2      GO TO MUSEUM.3
                      LOOK UP STRANGE.2
                     READ BOOKS ON PL.2
                     READ ANIMAL STOR.2
                     FIND OUT WHAT FL.2
                      WATCH BIRD MAKE.2
                     READ BOOKS ON AN.2
                     WATCH WHAT ANIMA.2
              XX  |       GROW GARDEN.2         GO TO ZOO.3
                  |  FIND WHERE ANIMA.2
                          WATCH BIRDS.2
   -1         XX  +
                  |
              XX  |S LISTEN TO BIRD S.2
               X T|
                  |
   -2             +
```

The right-hand column shows the categories of the items positioned by the average of the measures of the persons who responded in each category.

If you put the item number at the start of the item labels after &END, you can show only the item numbers on this plot by using NAMLMP= or IMAP=. Columns are headed by the (rescored) categories in CFILE=.

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance and is left blank. The plotted values are in the ISFILE=.

Left-hand column shows the distribution of person ability measures along the variable.

```
             <less>|<freq>  Dislike    Neutral          Like
```

Table 1.10 Wright map - person and item (by easiness) labels on one page

```
MEASURE                                                 KID - MAP - ACT
                                                         <more>||<freq>
    5                                                     M R  ++
                                                          F F  ||
                                                               ||
    4                                                     F P  ++
                                                          F S  ||
                                                          M D T||
    3                                                     F M  ++  Go
                                                          M W  ||T
                                              F B F C F S M C  ||  Go
    2                                     F C M E M E M S M V S++  Go
                                              F R M B M K M M  ||
                                  F C F H M C M H M M M P M S  ||S Gro Lis
    1                     F L F T M B M B M F M L M R M R M S M++  Fin Wat
                                          M B M C M P M R M S  ||  Rea
      F D F M M A M A M B M C M D M E M H M R M R M S M S M S  ||  Fin Rea Wat
    0             M A M A M D M L M M M N M P M R M R M S M V  ++M Fin Wat
                                                      F H M B S||  Loo Loo Rea
                                                      F R M B  ||  Lea Mak Tal
   -1                                                 F N M L  ++  Wat
                                                      M J M L  ||S
                                                          M S T||  Loo Wat Wat
   -2                                                          ++
                                                               ||  Fin Wat
                                                               ||T
   -3                                                          ++
                                                         <less>||<rare>
```

Left-hand column locates the person labels according to ability measures along the latent variable.

Right-hand column locates the item labels by their easiness measures along the latent variable. These are the difficulty measures reversed around the mean person difficulty "M". The item labels are abbreviated to fit on one page. Table 12.12 has the full item labels.

Column Labels

PERSON=	MAP	ITEM=
MORE=	┬	FREQ=
	|	
LESS=	┴	RARE=

Table 1.11 Wright map - person and item (by easiness) distributions

```
MEASURE                                 ||                              MEASURE
  <more> --------------------- KID     -++- TAP     ----------------- <freq>
    5                                   ++  XXX                               5
                                        ||  X
    4                                  T++  XX                                4
                                    XX  ||S XX
    3                                X  ++                                    3
                                        ||  X
    2                             XXXX S++                                    2
                                        ||  X
    1                            XXXXX  ++                                    1
                                        ||
    0                                  M++M                                   0
                          XXXXXXXXXXXX  ||
   -1                                   ++  X                                -1
                                   XXX  ||
   -2                               XX S++  XX                               -2
                                        ||
   -3                               XX  ++                                   -3
                                    XX  ||S X
   -4                                  T++                                   -4
                                     X  ||
   -5                                X  ++  XXXX                             -5
  <less> --------------------- KID     -++- TAP     ----------------- <rare>
```

This table shows the distribution of the persons and items. The variable is laid out vertically with the most able persons, and most difficult items at the top.

Left-hand column shows the distribution of person ability measures along the variable.

Right-hand column locates the item labels by their easiness measures along the latent variable. These are the difficulty measures reversed around the mean person difficulty "M" .

Column Labels

PERSON=	MAP	ITEM=
MORE=	┬	FREQ=
	|	
LESS=	┴	RARE=

Table 1.12 Wright map - person distribution + item (by easiness) labels

```
MEASURE       KID - MAP - ACT
               <more>||<freq>
    5             .  ++
                  .  ||
                     ||
    4             .  ++
                  .  ||
                  . T||
    3             .  ++  Go on picnic
                  .  ||T
                 ##  ||  Go to zoo
    2           .## S++  Go to museum
```

Left-hand column displays the distribution of person ability measures along the latent variable. The persons often have a normal distribution.

Right-hand column locates the item labels by their easiness measures along the latent variable. These are the difficulty measures reversed around the mean person difficulty "M" . The item labels are abbreviated to fit on

```
               ##  ||
             .###  ||S Grow garden        Listen to bird si
    1       .#### M++  Find where animal  Watch bird make n
              .##  ||  Read books on ani
         #######   ||  Find out what flo  Read animal stori  Watch birds
    0      .#####  ++M Find out what ani  Watch what animal
                # S||  Look at pictures   Look up strange a  Read books on
      pla
                #  ||  Learn weed names   Make a map         Talk w/friends
      ab
   -1           #  ++  Watch animal move
                #  ||S
                . T||  Look in sidewalk   Watch bugs         Watch grass
      chang
   -2              ++
                   ||  Find bottles and   Watch a rat
                   ||T
   -3              ++
             <less>||<rare>
EACH "#" IS 2. EACH "." IS 1.
```

one page. Table 12.12 has the full item labels.

Column Labels

PERSON= MAP ITEM=

MORE= ┬ FREQ=

|

LESS= ┴ RARE=

Table 1.13 Wright map - item (by easiness) distribution + person labels

```
MEASURE TAP - MAP - KID
        <freq>||<more>
    5      XXX  ++
             X  ||
    4       XX  ++T
            XX S||  Ric  Sus
    3           ++  Fra
             X  ||
    2           ++S Ber  Bet  Els  Tho
             X  ||
    1           ++  Bri  Car  Dav  Joe  Zul
                ||
    0          M++M
                ||  Ann  Aud  Bar  Dor  Jam  Kim  Lin  Mik  Ron  Tra  Wal  Wil
   -1        X  ++
                ||  Jan  Lis  Rod
   -2       XX  ++S Bre  Pet
                ||
   -3           ++  Ada  Ric
             X S||  Bla  Mar
   -4           ++T
                ||  Don
   -5     XXXX  ++  Hel
        <rare>||<less>
```

Left-hand column locates the item labels by their easiness measures along the latent variable. These are the difficulty measures reversed around the mean person difficulty "M" .

Right-hand column locates the person ability measures along the variable. The persons often have a normal distribution. The person labels are abbreviated to fit on one page. Table 16 has the full person labels

Column Labels

ITEM= MAP PERSON=

FREQ= ┬ MORE=

|

RARE= ┴ LESS=

On Plot:	*Description:*
SCORE	raw score on all active items when T1SCORE=Yes. Includes extreme items when TOTALSCORE=Yes
MEASURE	Location of person or item on the unidimensional latent variable, in logits or USCALE= units
<more>	higher person "ability" = higher raw score with complete data
<less>	lower person "ability" = lower raw score with complete data
<rare>	higher item "difficulty" = lower item "easiness" = lower score on the item with complete data: PVALUE=
<frequ> <frequent>	lower item "difficulty" = higher item "easiness" = higher score on the item with complete data: PVALUE=
M	Mean of person or item distribution
S	One "sample is the population" standard deviation from the person or item mean
T	Two standard deviations from the person or item mean
X	one person or item
#	several persons or items, e.g., EACH "#" = 4. The value for # can be changed with T1I#= for items, T1P#= for persons.
.	between 1 and (# - 1) persons or items, e.g., if # = 4, then "." = 1 to 3
|	Variable advances. Lines without "|" have the same measure as the nearest "|" above.
||	The double line || indicates the two sides have opposite orientations: person ability and item easiness. The item difficulties are reversed.This is useful if the items and persons are being compared to the

	responses.

Example: How can we use a Wright item-person map to investigate a test of multiple-choice (MCQ) items?

Please look at your item map. Rasch item maps show the distribution of the item difficulties in logits (equivalent to item p-values) aligned with the distribution of person abilities in logits (equivalent to raw scores). The easiest items are at the bottom (or left-hand side) of the item map. The hardest items are at the top (or right-hand side) of the item map. The most able students are at the top (or right-hand side) of the item map. The least able students are at the bottom (or left-hand side) of the item map.

1. We should have "content" validity for our items. Please put the content-area into the item label for each item, so that you can see the content-areas on the item map. Do the content areas for the items on the item map match your intention such as the curriculum? For example, are there "geography" items in your item map of "arithmetic" items?

2. We should have "construct" validity for our items. When you look at the ordering (hierarchy) of item difficulties, do their content-areas match your intention? For example, in an item map of "arithmetic" items, we expect to see that the "addition" items are the easiest items at the bottom of the map, and the "division" items are the hardest items at the top of the map, with "subtraction" and "multiplication" generally between "addition" and "division".

3. For most sets of items used in school situations, we want the success of most students to be between about 50% and 90%. This is from about 0 logits on the item map (which is the mean difficulty, average difficulty, of the items) up to about +2 logits on the item map.
If much of the person ability distribution is below 0 logits, then the set of items is too hard. You need some easier items if you want to measure the persons accurately. If much of the person ability distribution is about +2 logits, then the set of items is too easy. You need some harder items if you want to measure the persons accurately.

4. We want all the items to contribute to useful measurement of the persons. If some items on the item map are more than 1 logit below almost all of the persons, then those items may be too easy. If some items on the map are above almost all of the persons, then those items may be too hard. Items that are too easy or too hard do not contribute to useful measurement, and may provoke the students into guessing or carelessness.

5. We want to measure all the students with good precision. For this we need the item difficulties to have a roughly uniform distribution. If there are gaps of more than 0.5 logits in the distribution of item difficulties, then items are needed to fill these gaps. If there are rows on the item maps with many items, then there are many items with the about the same difficulty. These items may be duplicative.

Prettifying the Wright item-person map

Get the map to look how you want on your screen by adjusting font sizes, type faces, MRANGE=, MAXPAGE=, etc., then use your PrintScreen key to make a copy of the screen. Paste into Word, PowerPoint, etc. These Tables can be copied-and-pasted into Excel spreadsheets, and then Excel "Text to columns" used to beautify the output. A more elaborate procedure is at Excel item map. Or get the map to look how you want on your screen by adjusting font sizes, type faces, MRANGE=, MAXPAGE=, etc., then use your PrintScreen key to make a copy of the screen. Paste into Word, PowerPoint, etc.

Winsteps can plot one group of persons on a Wright map. To plot two groups of persons onto one Wright map,
1. Plot one group of persons on the Wright map.
2. Copy the Wright map into a Word document (courier font)
3. Plot the second group of person on the Wright map.
4. Copy the Wright map into a Word document (courier font)
5. Rectangular-copy (alt+mouse) the person distribution of the second group into the Wright map of the first group.

Example 1. Standard display of Table 1.0
MAXPAGE = 0 ; default page length
MRANGE = 0 ; range controlled by the measures

```
                                     KIDS - MAP - ACTS
                                       <more>|<rare>
 5                                    M Ros  +
                                             |
                                      F Fat  |
                                             |
                                             |
                                             |
                                             |
 4                                    F Pas  +
                                             |
                                             |
                                      F Sch  |
                                             |
                                            T|
                                      M Doe  |
 3                                           +
                                      F Mcl  |
                                             |
                                      M Wri  |
                                F Buf M Cha  |T
                                F Cla F Sei  |
                                             |  Find bot
 2                              M Ern M Squ S+  Watch a
                          F Cla M Eas M Vro  |  Watch gr
                                M Bad M Ken  |  Watch bu
                                F Ros M Moo  |  Look in
                                M Man M Pat  |
                                M Cor M Squ  |S
                          F Cla F Hog M Hsi  |
 1                        M Bec M Rei M Ros  +  Watch an
                          M Blo M Lam M Sto M|
                          F Lea F Toz M Fon  |
                                M Cor M Sab  |  Learn we
        F Mal M All M Bab M Pin M Ros M Squ  |  Make a m Talk w/f
              M Bei M Cia M Eis M Hsi M San  |  Look at  Read boo
        F Dys M Air M Den M Rin M Ros M Stu  |  Look up
 0                  M Ang M Mul M Pau M Ros  +M Find out Watch wh
  M Ami M Dri M Lie M Nei M Ros M Sch M Van  |
                                      F Hwa  |  Find out
                                            S|
                                      M Bau  |  Read ani Read boo
                                F Ros M Bon  |
                                             |  Grow gar Watch bi Watch bi
-1                                    M Lie  +
                                      F Nor  |  Go to mu
                                             |S
                                M Jac M Lan  |  Find whe
                                             |  Listen t
                                      M Sab T|
                                             |
-2                                           +
                                             |  Go to zo
                                             |  Go on pi
                                             |T
                                             |
                                             |
                                             |
-3                                           +
                                       <less>|<frequ>
```

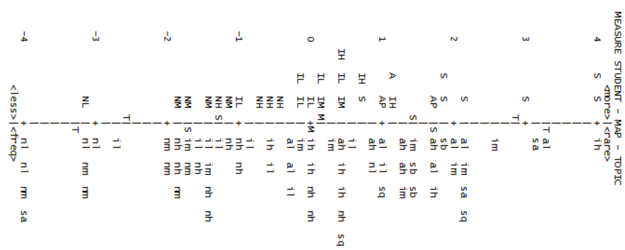
Example 2. Symmetric display around the item mean of Table 1.0
MAXPAGE = 0 ; default page length
MRANGE = -3 ; range away from item mean

```
                                            KIDS - MAP - ACTS
                                              <more>|<rare>
 3         F Fatal F Paste F Schat M Doepp M Rossn  +
                                           F Mclou  |
                                                    |
                                                    |
                                           M Wrigh  |
                                                    |T
                                   F Buff, M Chaze  |
                                                    |
                                   F Clapp F Seile  |  Find bott
                                                    |
 2                                 M Ernst M Squrr S+
                           F Clapp M Eastw M Vroom  |  Watch a r
                                                    |  Watch gra
                                   M Baden M Kent,  |  Watch bug
                                                    |  Look in s
                                   F Rossn M Moose  |
                                   M Man,  M Patri  |
                                   M Corle M Squil  |
                                                    |S
                           F Clapp F Hogan M Hsieh  |
 1                         M Becke M Reiss M Rossn  +  Watch ani
                           M Blofe M Lambe M Stoll  |
                                                   M|
                           F Leade F Tozer M Fonta  |
                                   M Corle M Sabil  |  Learn wee
                           M Babbo M Pinhe M Rossn  |  Make a ma
                           F Malap M Allen M Squil  |  Talk w/fr
           M Beise M Cianc M Eisen M Hsieh M Sandb  |  Look at p Read book
                                                    |  Look up s
   F Dyson M Aireh M Denny M Rinzl M Rossn M Stult  |
 0                 M Angui M Mulle M Pauli M Rossn  +M Find out  Watch wha
                           M Amira M Drisk M Neima  |
                   M Liebe M Rossn M Schul M Van D  |
                                           F Hwa,   |  Find out
                                                   S|
                                           M Baude  |
                                                    |  Read anim Read book
                                                    |
                                   F Rossn M Bond,  |  Watch bir
                                                    |  Grow gard Watch bir
-1                                         M Liebe  +
                                           F Nordg  |  Go to mus
                                                    |S
                                                    |
                                   M Jacks M Landm  |  Find wher
                                                    |
                                                    |  Listen to
                                           M Sabol T|
                                                    |
                                                    |
-2                                                  +
                                                    ||
                                                    |  Go to zoo
                                                    |  Go on pic
                                                    |
                                                    |T
                                                    |
                                                    |
                                                    |
                                                    |
-3                                                  +
                                              <less>|<frequ>
```

Example 3. Custom display of Table 1.0
MAXPAGE=50 ; pre-set page length
TFILE=* ; in the control file
1 -3 4 ; Table 1 with display from -3 to +4 logits.
*

```
                                                    KIDS - MAP - ACTS
                                                      <more>|<rare>
  4                                            F F F P M R  +
                                                            |
                                                       F S  |
                                                       M D T|
  3                                                         +
                                                   F M M W  |
                                                   F B M C  |T
                                                   F C F S  |  Fin
  2                                                M E M S S+  Wat
                                       F C M B M E M K M V  |  Loo Wat Wat
                                           F R M M M M M P  |
                                                   M C M S  |S
  1                                F C F H M B M H M R M R  +  Wat
                                   F L F T M B M F M L M S M|
                                       M B M C M P M R M S  |  Lea Mak Tal
   F D F M M A M A M B M C M D M E M H M R M R M S M S M S  |  Loo Loo Rea
  0                            M A M A M D M M M N M P M R  +M Fin Wat
                                       F H M L M R M S M V  |  Fin
                                                       M B S|  Rea Rea
                                                   F R M B  |  Wat
 -1                                                    M L  +  Gro Wat
                                                       F N  |S Fin Go
                                                   M J M L  |  Lis
                                                       M S T|
 -2                                                         +
                                                            |  Go  Go
                                                            |T
                                                            |
 -3                                                         +
                                                      <less>|<frequ>
```

Example 4. A horizontal Wright map.
1) Output Table 1.0
2) Copy-and-Paste into a Word document
3) Document "New Section" before and after map
4) Highlight the map:
5) Fixed space font: Consolas, Lucida Console
6) Small font size
7) Alt-F11 to launch VBA
8) in Immediate Window:
   Selection.Orientation = wdTextOrientationVerticalFarEast
9) Press Enter
Text is rotated!



14.3 Table 2 Category plots

14.3.1 Table 2 Multiple-choice distractor plot

(controlled by T2SELECT=, MRANGE=)

The codes for the response options (distractors) are located according to the measures corresponding to them. Each subtable is presented two ways: with the response code itself (or one of them if several would be in the same place), e.g., Table 2.1, and with the score corresponding to the option, e.g. Table 2.11 (numbered 10 subtables higher).

Table 2 for polytomous items.

Table 2.1: shows the most probable response on the latent variable. In this example, for item "al07", "a" (or any other incorrect option) is most probable up to 3.2 logits, when "d", the correct response, becomes most probable according to the Rasch model.

```
TABLE 2.1: MOST PROBABLE RESPONSE: MODE  (BETWEEN "0" AND "1" IS "0", ETC.) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4    -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
a                                                  d    d   55* al07  newspaper
a                                                 c     c   64  sa01  magazine
......
b     a                                                 a   12  nm07  sign on wall
a     d                                                 d   10  nm05  public place
|------+------+------+------+------+------+------+------|  NUM   TOPIC
-4    -3     -2     -1      0      1      2      3      4

      1        11 1111 111 212 3 2 12   12 1     1      2  STUDENTS
      T            S           M           S            T
      0        10   20  30 40 50 60 70  80 90           99  PERCENTILE
```

M = Mean, the average of the person measures, S = One Standard Deviation from the mean, T = Two P.SDs. from the mean. Percentile is percentage below the specified position.

* after the item entry NUMber indicates that the item difficulty is anchored.

Table 2.11 is the same as Table 2.1, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.11: MOST PROBABLE RESPONSE: MODE  (BETWEEN "0" AND "1" IS "0", ETC.) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
0                                                 1    1   55  al07  newspaper
0                                                1     1   64  sa01  magazine
```

Table 2.2: shows the predicted average response on the latent variable. In this example, for item "al07", "a" (or any other incorrect option) is the predicted average response up to 3.2 logits, then "d", the correct response, becomes the average predictions. The ":" is at the transition from an average expected wrong response to an average expected "right" response, i.e., where the predicted average score on the item is 0.5, the Rasch-half-point thresholds. The "a" below "2" is positions where the expected average score on the item is 0.25. Similarly "d" would be repeated where the expected average score on the item is 0.75, according to the Rasch model.

```
TABLE 2.2 EXPECTED SCORE: MEAN  (":" INDICATES HALF-POINT THRESHOLD) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
a                                          a       :    d   55  al07  newspaper
a                                         a       :     c   64  sa01  magazine
```

Table 2.12 is the same as Table 2.2, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.12 EXPECTED SCORE: MEAN  (":" INDICATES HALF-POINT THRESHOLD) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
0                                          0       :    1   55  al07  newspaper
0                                         0       :     1   64  sa01  magazine
```

Table 2.3 shows the Rasch-Thurstonian thresholds = 50% cumulative probability points. The lower category ("a" and other wrong answers) has a greater than 50% probability of being observed up to 3.2 logits, when "d", the correct answer, has a higher than 50% probability.

```
TABLE 2.3 50% CUMULATIVE PROBABILITY (Rasch-Thurstonian THRESHOLD): MEDIAN (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
a                                                 d    d   55  al07  newspaper
a                                                c     c   64  sa01  magazine
```

Table 2.13 is the same as Table 2.3, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.13 50% CUMULATIVE PROBABILITY (Rasch-Thurstonian THRESHOLD): MEDIAN (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
0                                                 1    1   55  al07  newspaper
0                                                1     1   64  sa01  magazine
```

Table 2.4 shows the item difficulties (or more generally the Rasch-Andrich thresholds) coded by the option of the higher category. For item "al07" this is "d", the correct option.

```
TABLE 2.4 STRUCTURE MEASURES (RASCH-ANDRICH THRESHOLDS: equal-adjacent-probability thresholds) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                                 d    |   55  al07  newspaper
|                                                c     |   64  sa01  magazine
```

Table 2.14 is the same as Table 2.4, the Rasch-Andrich thresholds, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.14 STRUCTURE MEASURES (RASCH-ANDRICH THRESHOLDS: equal-adjacent-probability thresholds) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                                  1    |   55  al07  newspaper
|                                                 1     |   64  sa01  magazine
```

Table 2.5 shows the average measures of persons choosing wrong distractors (illustrated by one of the wrong distractors, "a") and the average measures or persons choosing a correct distractor (illustrated by one of the correct distractors, "d").

```
TABLE 2.5 OBSERVED AVERAGE MEASURES FOR STUDENTS (scored) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                a                      d   55  al07  newspaper
|                                           a        c  |   64  sa01  magazine
```

Table 2.15 is the same as Table 2.5, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.15 OBSERVED AVERAGE MEASURES FOR STUDENTS (scored) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                0                      1   55  al07  newspaper
|                                           0        1  |   64  sa01  magazine
```

Table 2.6, shown first from the Diagnosis menu, shows the average measures from Table 14.3 of the persons choosing each distractor. "m" usually indicates the average measure of persons with missing data. Table 2.6 shows the average ability of the group of examinees who chose each option. Table 2.15 (above) shows the average ability of the people who got an item right and wrong. Table 2.5 (above again) has the right and wrong scoring illustrated with specific MCQ options. If there are more than one correct or incorrect option, only one of each is shown.

```
TABLE 2.6 OBSERVED AVERAGE MEASURES FOR STUDENTS (unscored) (BY OBSERVED CATEGORY)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                         m    ab     c                 d   55  al07  newspaper
|                          m                 d        c  |   64  sa01  magazine
```

Code for unidentified missing data: m

Table 2.16 is the same as Table 2.6, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.16 OBSERVED AVERAGE MEASURES FOR STUDENTS (unscored) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                         m    00     0                 1   55  al07  newspaper
|                          m                 0        1  |   64  sa01  magazine
```

Table 2.7 shows the measures that would be predicted to be observed for incorrect and correct responses if the persons responded exactly as the Rasch model predicts. "a" (an incorrect distractor) shows the average measure for persons in the sample who would be predicted to fail the item, and "d" (a correct distractor) shows the average measure for persons in the sample who would be predicted to succeed on the item.

```
TABLE 2.7 EXPECTED AVERAGE MEASURES FOR STUDENTS (scored) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                  a                  d|   55  al07  newspaper
|                                         a             c   64  sa01  magazine
```

Table 2.17 is the same as Table 2.7, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.17 EXPECTED AVERAGE MEASURES FOR STUDENTS (scored) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                  0                  1|   55  al07  newspaper
|                                         0             1   64  sa01  magazine
```

14.3.2 Table 2 Polytomies: Most probable, expected, cumulative, structure, average measures

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.

Each plot answers a different question:
What category is most likely? The maximum probability (mode) plot.
What is the average or expected category value? The expected score (mean) plot.
What part of the variable corresponds to the category? The cumulative probability (median) plot.

The numeric information for these plots is in ISFILE=

Which Table should be used for a standard setting procedure?

Most standard setting is based on "average" or "frequency" considerations. For instance,

"If we observed 1000 candidates whose measures are known to be exactly at the pass-fail point, ...

..., we would expect their average score to be the pass-fail score." If this is how you think, then the Table you want is Table 2.2 (matches Table 12.5)

..., we would expect 50% to pass and 50% to fail the pass-fail score." If this is how you think, then the Table you want is Table 2.3 (matches 12.6)

..., we would expect more to be in the criterion pass-fail category of each item than any other category." If this is how you think, then the Table you want is Table 2.1 (no matching 12.)

"Our current sample is definitive, ...

..., we would expect the next sample to behave in exactly the same way this sample did." If this is how you think, then the Table you want is Table 2.5 (or Table 2.6, if the responses have been rescored.)

..., we would expect the next sample to behave the way this sample should have behaved, if this sample had conformed to the Rasch model." If this is how you think, then the Table you want is Table 2.7.

The left-side of this table lists the items in descending order of measure. Anchored items are indicated by an * between the sequence number and name. A particular category can be used as the reference for sorting the items by specifying the CATREF= variable.

Across the bottom is the logit (or user-rescaled) variable with the distribution of the person measures shown beneath it. An "M" marker represents the location of the mean person measure. "S" markers are placed one standard deviation away from the mean. "T" markers are placed two standard deviations away. An "M" inside a plot indicates the measure corresponding to missing data.

To produce all subtables of Table 2, request Table 2.0

Table 2.1 & **Table 2.11**: The "Most Probable Response" Table, selected with CURVES=001, answers the question "which category is a person of a particular measure most likely to choose?" This is the most likely category with which the persons of logit (or user-rescaled) measure shown below would respond to the item shown on the left. The area to the extreme left is all "0"; the area to the extreme right is at the top category. Each category number is shown to the left of its modal area. If a category is not shown, it is never a most likely response. An item with an extreme, perfect (maximum possible) or zero (minimum possible), score is not strictly estimable, and is omitted here. Blank lines are used to help approximate the placement of the items on the latent variable.

This table presents in one picture the results of this analysis in a form suitable for inference. We can predict for people of any particular measure what responses they would probably make. "M" depicts an "average" person. The left "T" a low performer. The right "T" a high performer. Look straight up from those letters to read off the expected response profiles.

Table 2.1 to 2.7 reports with observed categories, i.e., those in the CODES= statement: (illustrated by an Observed Category).
Table 2.11 to 2.17 report with scored categories, i.e., after IVALUE=, RESCORE=, KEY1=, etc., but only if different from Table 2.1 to 2.7: (by Category Score).

```
Most Probable Response: Mode  (Between "0" and "1" is "0", etc.) (illustrated by an Observed Category)
-6       -4        -2         0         2         4         6
|---------+---------+---------+---------+---------+---------|  NUM   ACT
0                                    1       2             2     5  Find bottles and cans
|                                                          | deliberate space
0                                   1       2              2    23  Watch a rat
|                                                          |
0                                 1       2                2    20  Watch bugs
0                                 1       2                2     4  Watch grass change
0                                1        2                2     8  Look in sidewalk cracks
|                                                          |
0         1        2                                       2    18  Go on picnic
|---------+---------+---------+---------+---------+---------|  NUM   ACT
-6       -4        -2         0         2         4         6

                               1
                    12 2 2117083563422342 111 1 1    1     1  KID
                   T      S      M      S     T
                    0    10  30  50  70  80  90             99  PERCENTILE
```

When there are [disordered Andrich thresholds](), some categories are never most probable:

```
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   ITEM
0             2        4         6        8             8    1   disorder
```

[**Table 2.2**]() & [**Table 2.12**](): In the "Expected Score" Table, the standard output (or selected with [CURVES=]()010) answers the question "what is the average rating that we expect to observer for persons of a particular measure?" This rating information is expressed in terms of expected scores (with ":" at the half-point thresholds). Extreme scores are located at expected scores .25 score points away from the extremes. This plot also indicates the operational range of each item.

```
Expected Score: Mean  (Rasch-score-point threshold, ":" indicates Rasch-half-point threshold) (illustrated by an Observed
            Category)
-6       -4        -2         0         2         4         6
|---------+---------+---------+---------+---------+---------|  NUM   ACT
0                             0    :      1      :    2        2     5  FIND BOTTLES AND CANS
0                            0    :      1      :    2         2    23  WATCH A RAT
0                          0    :      1      :    2           2    20  WATCH BUGS
          Operational range: ^--------------------^
....
0        0     :      1      :    2                            2    12  GO TO MUSEUM
0      0     :      1      :    2                              2    19  GO TO ZOO
0   0    :      1      :    2                                  2    18  GO ON PICNIC
|---------+---------+---------+---------+---------+---------|  NUM   ACT

-6       -4        -2         0         2         4         6
```

In this example of a 5 category rating scale, the operation range of the top item is indicated in red.

```
-5       -3        -1          1         3         5         7
|---------+---------+---------+---------+---------+---------|  NUM   ITEM
1                       1  :    2  : 3 :  4     :   5        5   13  M. STAIRS
|---------+---------+---------+---------+---------+---------|  NUM   ITEM
-5       -3        -1          1         3         5         7
```

[**Table 2.3**]() & [**Table 2.13**](): The "Cumulative Probability" Table: Rasch-Thurstonian thresholds, selected with CURVES=001, answers the question "whereabouts in the category ordering is a person of a particular measure located?" This information is expressed in terms of median cumulative probabilities (the point at which the probability of scoring in or above the category is .5).

```
50% Cumulative Probability: Median (equal-cumulative-probability Rasch-Thurstonian thresholds) (illustrated by an Observed
     Category)
-6       -4        -2         0         2         4         6
|---------+---------+---------+---------+---------+---------|  NUM   ACT
0                                    1         2            2    5  Find bottles and cans
|                                                           |
0                                   1         2             2   23  Watch a rat
|                                                           |
0                                 1         2               2   20  Watch bugs
0                                 1         2               2    4  Watch grass change
0                                1         2                2    8  Look in sidewalk cracks
|                                                           |
0        1         2                                        2   18  Go on picnic
|---------+---------+---------+---------+---------+---------|  NUM   ACT
-6       -4        -2         0         2         4         6
```

[Table 2.4](#) & [Table 2.14](#) show Rasch structure calibrations: Rasch-Andrich thresholds (step parameters, step measures, step difficulties, rating (or partial credit) scale calibrations). These are the relationships between adjacent categories, and correspond to the points where adjacent category probability curves cross, i.e., are equally probable of being observed according to a Rasch model. There are always one less thresholds than categories.

```
Andrich Thresholds (Rasch model parameters: equal-adjacent-probability structure measures) (illustrated by an Observed
     Category)
-6       -4        -2         0         2         4         6
|---------+---------+---------+---------+---------+---------|  NUM   ACT
|                                     1       2             |    5  Find bottles and cans
|                                                           |
|                                    1       2              |   23  Watch a rat
|                                                           |
|                                  1       2                |   20  Watch bugs
|                                 1        2                |    4  Watch grass change
|                                 1        2                |    8  Look in sidewalk cracks
|                                                           |
|         1        2                                        |   18  Go on picnic
|---------+---------+---------+---------+---------+---------|  NUM   ACT
-6       -4        -2         0         2         4         6
```

[Table 2.5](#) & [Table 2.15](#) plot the observed average person measures for each scored category. It reflects how this sample used these categories. The plotted values cannot fall outside the range of the sample.

```
Observed Average Measures for KID (scored) (illustrated by an Observed Category)
-2     -1       0       1       2       3       4       5
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
|                       000102                          |    5  FIND BOTTLES AND CANS
|                                                       |
|                       000102                          |   23  WATCH A RAT
|                                                       |
|                   00  01         02                   |   20  WATCH BUGS
|                 00    01               02             |    4  WATCH GRASS CHANGE
|                   0001                02              |    8  LOOK IN SIDEWALK CRACKS
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
-2     -1       0       1       2       3       4       5

   1 2  11 2 114346533233332222 322 2 1 1 1  1  1      11  PUPILS
    T        S         M         S         T
```

[Table 2.6](#) & [Table 2.16](#) plot the observed [average person measures](#) for each observed category. It reflects how this sample used these categories. The plotted values cannot fall outside the range of the sample. "m" in the plot indicates the average measure of those for whom their observation is missing on this item. This Table is shown first from the Diagnosis pull-down menu.

```
Observed Average Measures for KID (unscored) (by Observed Category)
-2     -1       0       1       2       3       4       5
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
```

```
|                       000102                          |    5  FIND BOTTLES AND CANS
|                                                       |
|                       000102    m                     |   23  WATCH A RAT
|                                                       |
|                   00  01         02                   |   20  WATCH BUGS
|                 00    01               02             |    4  WATCH GRASS CHANGE
|                   0001               02              |    8  LOOK IN SIDEWALK CRACKS
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
-2     -1       0       1       2       3       4       5
  Code for unidentified missing data: m

   1 2  11 2 114346533233332222 322 2 1 1 1  1  1      11  PUPILS
    T        S         M         S         T
```

[Table 2.7](#) & [Table 2.17](#) plot the expected average person measures for each category score. It reflects how this sample were expected to use these categories. The plotted values cannot fall outside the range of the sample. This Table applies the empirical person distribution to Table 2.2.

```
Expected Average Measures for KID (scored) (illustrated by an Observed Category)
-2     -1       0       1       2       3       4       5
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
|                  00      01             02            |    5  FIND BOTTLES AND CANS
|                                                       |
|                  00     01             02             |   23  WATCH A RAT
|                                                       |
|                 00     01           02                |   20  WATCH BUGS
|                 00     01          02                 |    4  WATCH GRASS CHANGE
|                 00     01          02                 |    8  LOOK IN SIDEWALK CRACKS
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
-2     -1       0       1       2       3       4       5

   1 2  11 2 114346533233332222 322 2 1 1 1  1  1      11  PUPILS
    T        S         M         S         T
```

14.3.3 Table 2.1 Modal observed categories (most probable categories)

(controlled by [T2SELECT=](#), [MRANGE=](#), [MTICK=](#), [CATREF=](#))

[Table 2](#) for multiple-choice items.
[Table 2](#) for polytomous items.

Table 2.1: shows the most probable response on the latent variable, relative to each of the other responses. The most probable response for an item (row) is the category number shown to the left of the desired location on the x-axis. The items are shown vertically by difficulty distribution. The person distribution is shown below the plot.

```
MOST PROBABLE RESPONSE: MODE  (BETWEEN "0" AND "1" IS "0", ETC.) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-5   -4    -3    -2    -1     0     1     2     3     4     5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
0                                                          11  15  1-3-2-4-1-3
0                                                          11  16  1-4-2-3-1-4
0                                                          11  17  1-4-3-1-2-4
|                                                           |
|                                                           |
0                                                 1         1  14  1-4-2-3-4-1
|                                                           |
0                                          1                1  12  1-3-2-4-3
0                                         1                 1  13  1-4-3-2-4
|                                                           |
0                                  1                        1  11  1-3-1-2-4
|                                                           |
|                                                           |
0                    1                                      1  10  2-4-3-1
|                                                           |
0               1                                           1   8  1-4-2-3
|                                                           |
0         1                                                 1   6  3-4-1
0         1                                                 1   9  1-3-2-4
0      1                                                    1   5  2-1-4
0      1                                                    1   7  1-4-3-2
0   1                                                       1   4  1-3-4
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
-5   -4    -3    -2    -1     0     1     2     3     4     5
```

```
                            1
1   1   2   2    2    3     2       5     4    1    2          KID
 T            S             M            S            T
0      10       20   30    60      80    90        99          PERCENTILE
```

Multiple-choice items

 this example, for item "al07", "a" (or any other incorrect option) is most probable up to 3.2 logits, when "d", the correct response, becomes most probable according to the Rasch model.

```
TABLE 2.1: MOST PROBABLE RESPONSE: MODE  (BETWEEN "0" AND "1" IS "0", ETC.) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4    -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
a                                                  d    d   55  al07  newspaper
a                                                 c     c   64  sa01  magazine
......
b     a                                                 a   12  nm07  sign on wall
a     d                                                 d   10  nm05  public place
|------+------+------+------+------+------+------+------|  NUM   TOPIC
-4    -3     -2     -1      0      1      2      3      4

      1        11 1111 111 212 3 2 12   12 1     1      2  STUDENTS
      T            S           M           S            T
      0        10  20  30 40 50 60 70  80 90           99  PERCENTILE
```

M = Mean, the average of the person measures, S = One Standard Deviation from the mean, T = Two P.SDs. from the mean. Percentile is percentage below the specified position.

Table 2.11 is the same as Table 1, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.11: MOST PROBABLE RESPONSE: MODE  (BETWEEN "0" AND "1" IS "0", ETC.) (BY CATEGORY SCORE)
-4    -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
0                                                  1    1   55  al07  newspaper
0                                                 1     1   64  sa01  magazine
```

Polytomous items

Tables 2.1, The "Most Probable Response" Table, selected with CURVES=001, answers the question "which category is a person of a particular measure most likely to choose?" This is the most likely category with which the persons of logit (or user-rescaled) measure shown below would respond to the item shown on the left. The area to the extreme left is all "0"; the area to the extreme right is at the top category. Each category number is shown to the left of its modal area. If a category is not shown, it is never a most likely response. An item with an extreme, perfect (maximum possible) or zero (minimum possible), score is not strictly estimable, and is omitted here. Blank lines are used to help approximate the placement of the items on the latent variable.

This table presents in one picture the results of this analysis in a form suitable for inference. We can predict for people of any particular measure what responses they would probably make. "M" depicts an "average" person. The left "T" a low performer. The right "T" a high performer. Look straight up from those letters to read off the expected response profiles.

Table 2.1 to 2.7 reports with observed categories, i.e., those in the CODES= statement.
Table 2.11 to 2.17 report with scored categories, i.e., after IVALUE=, RESCORE=, KEY1=, etc., if any.

```
MOST PROBABLE RESPONSE: MODE  (BETWEEN "0" AND "1" IS "0", ETC.)
NUM  ITEM       -5    -4    -3    -2    -1     0     1     2     3     4     5
                 -------------------------------------------------------------

  5 FIND BOTTLES 0                                      1          2         2
 20 WATCH BUGS   0                                   1          2            2
  8 LOOK IN SIDE 0                                  1          2             2
  7 WATCH ANIMAL 0                              1          2                 2
 17 WATCH WHAT A 0                         1          2                      2
deliberate space |                                                           |
 21 WATCH BIRD M 0                   1          2                            2
 10 LISTEN TO BI 0               1          2                                2
```

```
  12 GO TO MUSEUM 0            1          2                                   2
  18 GO ON PICNIC 0      1          2                                         2
                  -------------------------------------------------------------

                 -5    -4    -3    -2    -1     0     1     2     3     4     5

                  1
PERSON                                1 2 1121 174135336222232221 11 1  1    11
                                       T      S      M       S      T
```

14.3.4 Table 2.2 Mean observed categories (average or expected categories: Rasch-half-point thresholds)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

```
EXPECTED SCORE: MEAN  (Rasch-score-point threshold, ":" indicates Rasch-half-point threshold) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-5   -4    -3    -2    -1     0     1     2     3     4     5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
0                                                   0      :1  15  1-3-2-4-1-3
0                                                   0      :1  16  1-4-2-3-1-4
0                                                   0      :1  17  1-4-3-1-2-4
|                                                           |
|                                                           |
0                                           0     :      1  1  14  1-4-2-3-4-1
|                                                           |
0                                    0     :      1         1  12  1-3-2-4-3
0                                  0      :     1           1  13  1-4-3-2-4
|                                                           |
0                           0      :     1                  1  11  1-3-1-2-4
|                                                           |
|                                                           |
0             0      :     1                                1  10  2-4-3-1
|                                                           |
0        0      :     1                                     1   8  1-4-2-3
|                                                           |
0  0      :     1                                           1   6  3-4-1
0  0      :     1                                           1   9  1-3-2-4
0      :      1                                             1   5  2-1-4
0      :      1                                             1   7  1-4-3-2
0   :     1                                                 1   4  1-3-4
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
-5   -4    -3    -2    -1     0     1     2     3     4     5

                            1
1   1   2   2    2    3     2       5     4    1    2           KID
 T            S             M            S            T
0      10       20   30    60      80    90        99          PERCENTILE
```

Table 2.2 is used for inference:

Past-sample-dependent inference: If you expect the future person to be from a person sample exactly like the past sample (distribution, ability level, misfit, etc.) , then base your decisions on Table 2.7.

Past-sample-distribution-dependent inference: If you expect the future person to be from a person sample similar to the past sample (distribution, ability level, but not misfit) , then base your decisions on Table 2.5.

Past-sample-independent-as-possible: If you have no information about the future person, except that the latent variable will be the same as for the past sample, then base your decisions on Table 2.2.

Does the future repeat the past? Or is the future something entirely new? The truth is usually somewhere between these extremes.

Multiple-choice items

Table 2.2: shows the predicted average response on the latent variable. In this example, for item "al07", "a" (or any other incorrect option) is the predicted average response up to 3.2 logits, then "d", the correct response, becomes the average predictions. The ":" is at the transition from an average expected wrong response to an average expected "right" response, i.e., where the predicted average score on the item is 0.5, the Rasch-half-point thresholds. The "a" below "2" is positions where the expected average score on the item is 0.25. Similarly "d" would be repeated where the expected average score on the item is 0.75, according to the Rasch model.

```
TABLE 2.2 EXPECTED SCORE: MEAN  (":" INDICATES HALF-POINT THRESHOLD) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
a                                          a      :    d   55  al07  newspaper
a                                         a      :     c   64  sa01  magazine
```

Table 2.12 is the same as Table 2, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.12 EXPECTED SCORE: MEAN  (":" INDICATES HALF-POINT THRESHOLD) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
0                                          0      :    1   55  al07  newspaper
0                                         0      :     1   64  sa01  magazine
```

Polytomous items

Tables 2.2 & 2.12: In the "Expected Score" Table, the standard output (or selected with CURVES=010) answers the question "what is the average rating that we expect to observer for persons of a particular measure?" This rating information is expressed in terms of expected scores (with ":" at the half-point thresholds). Extreme scores are located at expected scores .25 score points away from the extremes. This plot also indicates the operational range of each item.

```
EXPECTED SCORE: MEAN  (Rasch-score-point threshold, ":" indicates Rasch-half-point threshold)
             (ILLUSTRATED BY AN OBSERVED CATEGORY)
-6        -4        -2         0         2         4         6
|---------+---------+---------+---------+---------+---------|  NUM   ACT
0                              0   :         1     :    2      2    5  Find bottles and cans
|                                                           |
0                             0   :         1     :    2       2   23  Watch a rat
|                                                           |
0                           0   :      1     :    2            2   20  Watch bugs
          Operational range: ^---------------------^
....
0   0   :     1     :     2                                     2   18  Go on picnic
|---------+---------+---------+---------+---------+---------|  NUM   ACT
-6        -4        -2         0         2         4         6       Item hierarchy
                                 Expected profile of person at 1.6 logits
                               1  Person distribution
                      12 2 2117083563422342 111 1 1    1     1  KID
                      T      S       M      S     T
                       0    10  30  50  70  80  90           99  PERCENTILE
```

In this example of a 5 category rating scale, the operation range of the top item is indicated in red.

```
-5        -3        -1         1         3         5         7
|---------+---------+---------+---------+---------+---------|  NUM   ITEM
1                         1  :   2  : 3 :  4    :   5        5   13  M. STAIRS
    Operational range: ^-------------------------^
|---------+---------+---------+---------+---------+---------|  NUM   ITEM
-5        -3        -1         1         3         5         7
```

Example: From a paper by B.D. Wright - www.rasch.org/rmt/rmt141a.htm

```
WINSTEPS TABLE 2.2 Measuring Gout from 3 Blood Tests
      96 PATIENTS, 4 ITEMS, 32 UNIFORM CATEGORIES
----------------------------------------------------------------------------

EXPECTED SCORE: MEAN  (":" INDICATES HALF-SCORE POINT)
10    20     30     40     50     60     70     80     90    100
|-----+------+------+------+------+------+------+------+------|   BLOOD TEST
0   1 :    2       :      3     :(4):5:6: 7: 8   :    9     9  Urea Nitrogen
|                                                           |
0    1    :    2    :  3   :   4 :(5) 6   :   7   : 8   : 9    9  Uric Acid
|                                                           |
|                                                           |
0    0    :          1      :    (2)  : 3:45:67:8   : 9     9  Creatinine

0                   NO     :    (YES)                      1     GOUT?

|-----+------+------+------+------+------+------+------+------|
10    20     30     40     50     60     70     80     90    100

    1              1      3   5 65 87 31121 21 1           PATIENTS WITH GOUT
                   T      S      M       S      T

                   1
       2   3    2  0    5 9   8 51  11 1                  PATIENTS WITHOUT GOUT
           T      S     M      S     T
```

Figure 2. The Complete Story on One Page

Here is what Ben Wright did:
1. Put a code for Gout/No-Gout in every person record
2. Do the Winsteps analysis for everyone.
3. In the Specification menu box, PSELECT= Gout
produce Table 2.2
4. In the Specification menu box, PSELECT=
to restore everyone
5. In the Specification menu box, PSELECT= No-Gout
produce Table 2.2
6. Copy-and-paste the person distribution from 5. onto the bottom of 3.

14.3.5 Table 2.3 Median observed categories (cumulative category probabilities: Rasch-Thurstone thresholds)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

Multiple-choice items

Table 2.3 shows the 50% cumulative probability points, the Rasch-Thurstonian thresholds. The lower category ("a" and other wrong answers) has a greater than 50% probability of being observed up to 3.2 logits, when "d", the correct answer, has a higher than 50% probability.

```
TABLE 2.3 50% CUMULATIVE PROBABILITY (Rasch-Thurstonian THRESHOLD) (ILLUSTRATED BY AN OBSERVED CATEGORY)
      -4     -3     -2     -1      0      1      2      3      4
      |------+------+------+------+------+------+------+------|  NUM   TOPIC
      a                                                d    d   55  al07  newspaper
      a                                               c     c   64  sa01  magazine
```

Table 2.13 is the same as Table 3, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.13 50% CUMULATIVE PROBABILITY (Rasch-Thurstonian THRESHOLD) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
0                                                1    1   55  al07  newspaper
0                                               1     1   64  sa01  magazine
```

Polytomous items

Tables 2.3 & 2.13: The "Cumulative Probability" Table: Rasch-Thurstonian thresholds, selected with CURVES=001, answers the question "whereabouts in the category ordering is a person of a particular measure located?" This information is expressed in terms of median cumulative probabilities (the point at which the probability of scoring in or above the category is .5).

```
50% CUMULATIVE PROBABILITY: MEDIAN (equal-cumulative-probability Rasch-Thurstonian thresholds) (ILLUSTRATED BY AN OBSERVED
            CATEGORY)
      -6        -4        -2         0         2         4         6
       |---------+---------+---------+---------+---------+---------|  NUM   ACT
       0                                    1         2            2    5  FIND BOTTLES AND CANS
       |                                                           |
       0                                   1         2             2   23  WATCH A RAT
       |                                                           |
       0                                 1         2               2   20  WATCH BUGS
       0                                 1         2               2    4  WATCH GRASS CHANGE
       0                                1         2                2    8  LOOK IN SIDEWALK CRACKS
       |---------+---------+---------+---------+---------+---------|  NUM   ACT
      -6        -4        -2         0         2         4         6

                                      1
                             12 2 2117083563422342 111 1 1   1     1  KID
                            T      S      M      S     T
                             0    10 30 50 70 80 90               99  PERCENTILE
```

14.3.6 Table 2.4 Andrich thresholds (structure calibrations)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

Multiple-choice items

Table 2.4 shows the item difficulties (or more generally the Rasch-Andrich thresholds) coded by the option of the higher category. For item "al07" this is "d", the correct option.

```
Andrich Thresholds (Rasch model parameters: equal-adjacent-probability structure measures) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4    -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                                  d    |   55  al07  newspaper
|                                                 c     |   64  sa01  magazine
```

Polytomous items

Table 2.4 shows the Rasch structure calibrations which are the Rasch-Andrich thresholds, also called step parameters, step measures, step difficulties, rating (or partial credit) scale calibrations. These are the relationships between adjacent categories, and correspond to the points where adjacent category probability curves cross, i.e., are equally probable of being observed according to a Rasch model. There are always one less thresholds than categories. In Table 2.4, "1" is the Andrich threshold between categories 0 and 1. "2" is the Andrich threshold between categories 1 and 2.

```
Andrich Thresholds (Rasch model parameters: equal-adjacent-probability structure measures) (ILLUSTRATED BY AN OBSERVED CATEGORY)
      -6        -4        -2         0         2         4         6
       |---------+---------+---------+---------+---------+---------|  NUM   ACT
       |                                     1       2             |    5  FIND BOTTLES AND CANS
       |                                                           |
       |                                    1       2              |   23  WATCH A RAT
       |         1        2                                        |   18  GO ON PICNIC
       |---------+---------+---------+---------+---------+---------|  NUM   ACT
      -6        -4        -2         0         2         4         6

                                      1
                             12 2 2117083563422342 111 1 1   1     1  KID
                            T      S      M      S     T
                             0    10 30 50 70 80 90               99  PERCENTILE
```

14.3.7 Table 2.5 Observed average measures of persons by scored category (empirical averages)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

```
OBSERVED AVERAGE MEASURES FOR KID (scored) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-5    -4    -3    -2    -1     0     1     2     3     4     5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
|                          0                        1        |   15  1-3-2-4-1-3
|                          0                        1        |   16  1-4-2-3-1-4
|                          0                        1        |   17  1-4-3-1-2-4
|                                                            |
|                                                            |
|                          0         1                        |   14  1-4-2-3-4-1
|                                                            |
|                        0              1                    |   12  1-3-2-4-3
|                       0                   1                |   13  1-4-3-2-4
|                                                            |
|                     0               1                      |   11  1-3-1-2-4
|                                                            |
|                                                            |
|               0                1                           |   10  2-4-3-1
|                                                            |
|         0                      1                           |    8  1-4-2-3
|                                                            |
|         0                    1                             |    6  3-4-1
|    0                          1                           |    9  1-3-2-4
|      0                       1                            |    5  2-1-4
|            0                 1                            |    7  1-4-3-2
|   0                          1                            |    4  1-3-4
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
-5    -4    -3    -2    -1     0     1     2     3     4     5

                            1
1   1   2   2    2    3     2       5     4    1    2          KID
 T            S             M             S            T
0      10        20   30    60      80    90        99         PERCENTILE
```

Table 2.5 is used for inference:

Past-sample-dependent inference: If you expect the future person to be from a person sample exactly like the past sample (distribution, ability level, misfit, etc.) , then base your decisions on Table 2.7.

Past-sample-distribution-dependent inference: If you expect the future person to be from a person sample similar to the past sample (distribution, ability level, but not misfit) , then base your decisions on Table 2.5.

Past-sample-independent-as-possible: If you have no information about the future person, except that the latent variable will be the same as for the past sample, then base your decisions on Table 2.2.

Does the future repeat the past? Or is the future something entirely new? The truth is usually somewhere between these extremes.

To plot Table 2.5 in Excel:
The numbers for the Y-axis are in IFILE= (MEASURE)
The number for the X-axis are in DISFILE= (AVGE MEAS)

Multiple-choice items

Table 2.5 shows the average measures of persons choosing wrong distractors (illustrated by one of the wrong distractors, "a") and the average measures or persons choosing a correct distractor (illustrated by one of the correct distractors, "d").

```
TABLE 2.5 OBSERVED AVERAGE MEASURES FOR STUDENTS (scored) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                 a                     d  55   al07  newspaper
|                                            a        c  |  64   sa01  magazine
```

Table 2.15 is the same as Table 5, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.15 OBSERVED AVERAGE MEASURES FOR STUDENTS (scored) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                 0                     1  55   al07  newspaper
|                                            0        1  |  64   sa01  magazine
```

Polytomous items

Tables 2.5 & 2.15 plot the observed average person measures for each scored category. It reflects how this sample used these categories. The plotted values cannot fall outside the range of the sample.

The rating-scale categories, such as 0, 1 and 2, are plotted for each item (y-axis) at the average measure of the persons who responded in that category (x-axis).

```
OBSERVED AVERAGE MEASURES BY SCORED CATEGORY FOR PUPILS
-2     -1       0       1       2       3       4       5
|-------+-------+-------+-------+-------+-------+-------| NUM   ACT
|                       000102                          |    5  FIND BOTTLES AND CANS
|                                                       |
|                       000102                          |   23  WATCH A RAT
|                                                       |
|                   00  01         02                   |   20  WATCH BUGS
|                 00    01               02             |    4  WATCH GRASS CHANGE
|                   0001                02              |    8  LOOK IN SIDEWALK CRACKS
|-------+-------+-------+-------+-------+-------+-------| NUM   ACT
-2     -1       0       1       2       3       4       5

   1 2  11 2 114346533233332222 322 2 1 1 1  1  1      11  PUPILS
    T        S         M         S         T
```

14.3.8 Table 2.6 Observed average measures of persons (empirical averages)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

```
OBSERVED AVERAGE MEASURES FOR KID (unscored) (BY OBSERVED CATEGORY)
-5   -4    -3    -2    -1     0     1     2     3     4     5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----| NUM   TAP
|                          0                        1       |  15  1-3-2-4-1-3
|                          0                        1       |  16  1-4-2-3-1-4
|                          0                        1       |  17  1-4-3-1-2-4
|                                                           |
|                                                           |
|                          0         1                      |  14  1-4-2-3-4-1
|                                                           |
|                        0              1                   |  12  1-3-2-4-3
|                       0                   1               |  13  1-4-3-2-4
|                                                           |
|                     0               1                     |  11  1-3-1-2-4
|                                                           |
|                                                           |
|               0                1                          |  10  2-4-3-1
|                                                           |
|         0                      1                          |   8  1-4-2-3
|                                                           |
|         0                    1                            |   6  3-4-1
|    0                         1                            |   9  1-3-2-4
|      0                      1                             |   5  2-1-4
|            0                1                             |   7  1-4-3-2
|   0                         1                             |   4  1-3-4
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----| NUM   TAP
-5   -4    -3    -2    -1     0     1     2     3     4     5

                            1
1   1   2   2    2    3     2       5     4    1    2         KID
 T            S             M            S            T
0     10        20   30    60      80    90       99          PERCENTILE
```

In Table 2, when Winsteps discovers that two or more category numbers display in the same place, it places the first category number correctly, then it places the next category numbers in the nearest empty print positions. This can be misleading to the eye.
Suggestion: spread the observed averages in Table 2 using the instruction, say,
LINELENGTH=120
so that there is less chance that category numbers will display in the same place.

Table 2.6, shown first from the Diagnosis menu, shows the average measures from [Table 14.3] of the persons choosing each distractor. "m" usually indicates the average measure of persons with missing data. Table 2.6 shows the average ability of the group of examinees who chose each option. Table 2.15 (above) shows the average ability of the people who got an item right and wrong. Table 2.5 (above again) has the right and wrong scoring illustrated with specific MCQ options. If there are more than one correct or incorrect option, only one of each is shown.

```
TABLE 2.6 OBSERVED AVERAGE MEASURES FOR STUDENTS (unscored) (BY OBSERVED CATEGORY)
-4    -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                         m    ab     c                 d  55  al07  newspaper
|                          m                d        c  |  64  sa01  magazine
```

Code for unidentified missing data: m

Table 2.16 is the same as Table 6, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.16 OBSERVED AVERAGE MEASURES FOR STUDENTS (unscored) (BY CATEGORY SCORE)
-4    -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                         m    00     0                 1  55  al07  newspaper
|                          m                0        1  |  64  sa01  magazine
```

Polytomous items

Tables 2.6 & Table 2.16 plot the observed average person measures from Table 14.3 for each observed category. It reflects how this sample used these categories. The plotted values cannot fall outside the range of the sample. "m" in the plot indicates the average measure of those for whom their observation is missing on this item. This Table is shown first from the Diagnosis pull-down menu.

```
OBSERVED AVERAGE MEASURES BY OBSERVED CATEGORY FOR PUPILS
-2     -1       0       1       2       3       4       5
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
|                       000102                          |    5  FIND BOTTLES AND CANS
|                                                       |
|                       000102    m                     |   23  WATCH A RAT
|                                                       |
|                   00  01         02                   |   20  WATCH BUGS
|                 00    01                02            |    4  WATCH GRASS CHANGE
|                   0001                 02             |    8  LOOK IN SIDEWALK CRACKS
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
-2     -1       0       1       2       3       4       5
  Code for unidentified missing data: m

   1 2   11 2 114346533233332222 322 2 1 1 1  1  1      11  PUPILS
    T        S         M         S         T
```

14.3.9 Table 2.7 Expected average measures of persons

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

```
EXPECTED AVERAGE MEASURES FOR KID (scored) (ILLUSTRATED BY AN OBSERVED CATEGORY)
-5   -4    -3    -2    -1     0     1     2     3     4     5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
|                          0                  1             |   15  1-3-2-4-1-3
|                          0                  1             |   16  1-4-2-3-1-4
|                          0                  1             |   17  1-4-3-1-2-4
|                                                           |
|                                                           |
|                         0                 1               |   14  1-4-2-3-4-1
|                                                           |
|                        0                1                 |   12  1-3-2-4-3
|                       0                1                  |   13  1-4-3-2-4
|                                                           |
|                     0               1                     |   11  1-3-1-2-4
|                                                           |
|                                                           |
|               0                1                          |   10  2-4-3-1
```

```
|                                                            |
|            0                  1                            |    8  1-4-2-3
|                                                            |
|        0                     1                             |    6  3-4-1
|        0                     1                             |    9  1-3-2-4
|       0                     1                              |    5  2-1-4
|       0                     1                              |    7  1-4-3-2
|    0                        1                              |    4  1-3-4
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
-5    -4    -3    -2    -1     0     1     2     3     4     5

                             1
1   1   2   2    2    3     2       5     4    1    2          KID
 T           S              M            S            T
0      10       20   30    60      80    90         99         PERCENTILE
```

Table 2.7 is used for description, but can be used for inference:

Past-sample-dependent inference: If you expect the future person to be from a person sample exactly like the past sample (distribution, ability level, misfit, etc.) , then base your decisions on Table 2.7.

Past-sample-distribution-dependent inference: If you expect the future person to be from a person sample similar to the past sample (distribution, ability level, but not misfit) , then base your decisions on Table 2.5.

Past-sample-independent-as-possible: If you have no information about the future person, except that the latent variable will be the same as for the past sample, then base your decisions on Table 2.2.

Does the future repeat the past? Or is the future something entirely new? The truth is usually somewhere between these extremes.

Multiple-choice items

Table 2.7 shows the measures that would be predicted to be observed for incorrect and correct responses if the persons responded exactly as the Rasch model predicts. "a" (an incorrect distractor) shows the average measure for persons in the sample who would be predicted to fail the item, and "d" (a correct distractor) shows the average measure for persons in the sample who would be predicted to succeed on the item. Compare this with Tables 2.5 and 2.6 for the empirical locations, and Table 2.2 for the sample-free locations.

```
TABLE 2.7 EXPECTED AVERAGE MEASURES FOR STUDENTS (scored) (ILLUSTRATED BY AN OBSERVED CATEGORY)
      -4     -3     -2     -1      0      1      2      3      4
      |------+------+------+------+------+------+------+------|  NUM   TOPIC
      |                                  a                  d|   55  al07  newspaper
      |                                         a             c   64  sa01  magazine
```

Table 2.17 is the same as Table 7, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.17 EXPECTED AVERAGE MEASURES FOR STUDENTS (scored) (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
|                                  0                  1|   55  al07  newspaper
|                                         0             1   64  sa01  magazine
```

Polytomous items

Tables 2.7 & 2.17 plot the expected average person measures for each category score. It reflects how this sample were expected to use these categories. The plotted values cannot fall outside the range of the sample. Compare this with Tables 2.5 and 2.6 for the empirical locations, and Table 2.2 for the sample-free locations.

```
EXPECTED AVERAGE MEASURES BY CATEGORY FOR PUPILS
-2      -1       0       1       2       3       4       5
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
|                 00      01            02              |    5  FIND BOTTLES AND CANS
|                                                       |
|                 00     01            02               |   23  WATCH A RAT
|                                                       |
|                00     01           02                 |   20  WATCH BUGS
|                00     01          02                  |    4  WATCH GRASS CHANGE
|                00     01          02                  |    8  LOOK IN SIDEWALK CRACKS
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
-2      -1       0       1       2       3       4       5
```

```
  1 2   11 2 114346533233332222 322 2 1 1 1  1  1      11  PUPILS
   T        S         M         S         T
```

14.3.10 Table 2.11 Modal categories by category score (most probable)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

```
MOST PROBABLE RESPONSE: MODE  (BETWEEN "0" AND "1" IS "0", ETC.)  (BY CATEGORY SCORE)
      -5    -4     -3    -2    -1     0     1     2     3     4     5
       |-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
       0                                                          11   15  1-3-2-4-1-3
       0                                                          11   16  1-4-2-3-1-4
       0                                                          11   17  1-4-3-1-2-4
       |                                                           |
       |                                                           |
       0                                                 1         1   14  1-4-2-3-4-1
       |                                                           |
       0                                          1                1   12  1-3-2-4-3
       0                                         1                 1   13  1-4-3-2-4
       |                                                           |
       0                                  1                        1   11  1-3-1-2-4
       |                                                           |
       |                                                           |
       0                    1                                      1   10  2-4-3-1
       |                                                           |
       0               1                                           1    8  1-4-2-3
       |                                                           |
       0         1                                                 1    6  3-4-1
       0         1                                                 1    9  1-3-2-4
       0      1                                                    1    5  2-1-4
       0      1                                                    1    7  1-4-3-2
       0   1                                                       1    4  1-3-4
       |-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
      -5    -4     -3    -2    -1     0     1     2     3     4     5

                                   1
       1   1   1   2   2    2    3     2       5     4    1    2          KID
        T            S             M            S            T
       0      10        20   30    60      80    90        99          PERCENTILE
```

Multiple-choice items

Table 2.11 shows the most probable response on the latent variable. Table 2.11 is the same as Table 2.1, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.11: MOST PROBABLE RESPONSE: MODE  (BETWEEN "0" AND "1" IS "0", ETC.)  (BY CATEGORY SCORE)
-4     -3     -2     -1      0      1      2      3      4
|------+------+------+------+------+------+------+------|  NUM   TOPIC
0                                                  1   1   55  al07  newspaper
0                                                 1    1   64  sa01  magazine
|------+------+------+------+------+------+------+------|  NUM   TOPIC
-4     -3     -2     -1      0      1      2      3      4

      1        11 1111 111 212 3 2 12    12 1      1       2  STUDENTS
      T             S           M           S             T
      0        10   20   30 40 50 60 70   80 90            99  PERCENTILE
```

M = Mean, the average of the person measures, S = One Standard Deviation from the mean, T = Two P.SDs. from the mean. Percentile is percentage below the specified position.

Polytomous items

Tables 2.1 & 2.11: The "Most Probable Response" Table, selected with CURVES=001, answers the question "which category is a person of a particular measure most likely to choose?" This is the most likely category with which the persons of logit (or user-rescaled) measure shown below would respond to the item shown on the left. The area to the extreme left is all "0"; the area to the extreme right is at the top category. Each category number is shown to the left of its modal area. If a category is not shown, it is never a most likely response. An item with an extreme, perfect (maximum possible) or zero (minimum possible), score is not strictly estimable, and is omitted here. Blank lines are used to help approximate the placement of the items on the latent variable.

This table presents in one picture the results of this analysis in a form suitable for inference. We can predict for people of any particular measure what responses they would probably make. "M" depicts an "average" person. The left "T" a low performer. The right "T" a high performer. Look straight up from those letters to read off the expected response profiles.

Table 2.1 to 2.7 reports with observed categories, i.e., those in the CODES= statement.
Table 2.11 to 2.17 report with scored categories, i.e., after IVALUE=, RESCORE=, KEY1=, etc., if any.

```
MOST PROBABLE RESPONSE: MODE  (BETWEEN "0" AND "1" IS "0", ETC.) (BY CATEGORY SCORE)
-6       -4        -2         0         2         4         6
|---------+---------+---------+---------+---------+---------|  NUM   ACT
0                                     1       2             2    5  FIND BOTTLES AND CANS
|                                                           |
0                                    1       2              2   23  WATCH A RAT
|                                                           |
0                                  1       2                2   20  WATCH BUGS
0                                  1       2                2    4  WATCH GRASS CHANGE
0                                 1        2                2    8  LOOK IN SIDEWALK CRACKS
|                                                           |
0         1        2                                        2   18  GO ON PICNIC
|---------+---------+---------+---------+---------+---------|  NUM   ACT
-6       -4        -2         0         2         4         6

                               1
                      12 2 2117083563422342 111 1 1   1     1  KID
                     T      S      M      S     T
                      0    10 30 50 70 80 90               99  PERCENTILE
```

14.3.11 Table 2.12 Mean categories by category score (average or expected: Rasch-half-point thresholds)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

```
EXPECTED SCORE: MEAN  (Rasch-score-point threshold, ":" indicates Rasch-half-point threshold) (BY CATEGORY SCORE)
       -5   -4    -3    -2    -1     0     1     2     3     4     5
       |-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
       0                                                   0      :1   15  1-3-2-4-1-3
       0                                                   0      :1   16  1-4-2-3-1-4
       0                                                   0      :1   17  1-4-3-1-2-4
       |                                                           |
       |                                                           |
       0                                           0     :      1  1   14  1-4-2-3-4-1
       |                                                           |
       0                                    0     :      1         1   12  1-3-2-4-3
       0                                  0      :     1           1   13  1-4-3-2-4
       |                                                           |
       0                           0      :     1                  1   11  1-3-1-2-4
       |                                                           |
       |                                                           |
       0             0      :     1                                1   10  2-4-3-1
       |                                                           |
       0        0      :     1                                     1    8  1-4-2-3
       |                                                           |
       0  0      :     1                                           1    6  3-4-1
       0  0      :     1                                           1    9  1-3-2-4
       0      :      1                                             1    5  2-1-4
       0      :      1                                             1    7  1-4-3-2
       0   :     1                                                 1    4  1-3-4
       |-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
       -5   -4    -3    -2    -1     0     1     2     3     4     5

                                   1
       1   1   2   2    2    3     2       5     4    1    2          KID
        T            S             M            S            T
       0      10       20   30    60      80    90        99          PERCENTILE
```

Table 2.12 is used for inference:

Past-sample-dependent inference: If you expect the future person to be from a person sample exactly like the past sample (distribution, ability level, misfit, etc.) , then base your decisions on Table 2.7.

Past-sample-distribution-dependent inference: If you expect the future person to be from a person sample similar to the past sample (distribution, ability level, but not misfit) , then base your decisions on Table 2.5.

Past-sample-independent-as-possible: If you have no information about the future person, except that the latent variable will be the same as for the past sample, then base your decisions on Table 2.2.

Does the future repeat the past? Or is the future something entirely new? The truth is usually somewhere between these extremes.

Multiple-choice items

Table 2.2: shows the predicted average response on the latent variable. In this example, for item "al07", "a" (or any other incorrect option) is the predicted average response up to 3.2 logits, then "d", the correct response, becomes the average predictions. The ":" is at the transition from an average expected wrong response to an average expected "right" response, i.e., where the predicted average score on the item is 0.5, the Rasch-half-point thresholds. The "a" below "2" is positions where the expected average score on the item is 0.25. Similarly "d" would be repeated where the expected average score on the item is 0.75, according to the Rasch model.

```
TABLE 2.2 EXPECTED SCORE: MEAN  (":" INDICATES HALF-POINT THRESHOLD) (ILLUSTRATED BY AN OBSERVED CATEGORY)
       -4     -3     -2     -1      0      1      2      3      4
       |------+------+------+------+------+------+------+------|  NUM   TOPIC
       a                                          a       :     d   55  al07  newspaper
       a                                         a       :      c   64  sa01  magazine
```

Table 2.12 is the same as Table 2, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.12 EXPECTED SCORE: MEAN  (":" INDICATES HALF-POINT THRESHOLD) (BY CATEGORY SCORE)
       -4     -3     -2     -1      0      1      2      3      4
       |------+------+------+------+------+------+------+------|  NUM   TOPIC
       0                                          0       :     1   55  al07  newspaper
       0                                         0       :      1   64  sa01  magazine
```

Polytomous items

Tables 2.2 & 2.12: In the "Expected Score" Table, the standard output (or selected with CURVES=010) answers the question "what is the average rating that we expect to observer for persons of a particular measure?" This rating information is expressed in terms of expected scores (with ":" at the half-point thresholds). Extreme scores are located at expected scores .25 score points away from the extremes. This plot also indicates the operational range of each item.

```
EXPECTED SCORE: MEAN  (Rasch-score-point threshold, ":" indicates Rasch-half-point threshold) (ILLUSTRATED BY AN OBSERVED
            CATEGORY)
       -6        -4        -2         0         2         4         6
       |---------+---------+---------+---------+---------+---------|  NUM   ACT
       0                              0   :     1     :   2        2    5  Find bottles and cans
       |                                                           |
       0                             0   :     1     :   2         2   23  Watch a rat
       |                                                           |
       0                           0   :     1     :    2          2   20  Watch bugs
                 Operational range: ^--------------------^
       ....
       0   0   :     1     :    2                                  2   18  Go on picnic
       |---------+---------+---------+---------+---------+---------|  NUM   ACT
       -6        -4        -2         0         2         4         6      Item hierarchy

                                      1  Person distribution
                             12 2 2117083563422342 111 1 1    1      1  KID
                            T      S      M      S     T
                             0    10 30 50 70 80 90              99  PERCENTILE
```

In this example of a 5 category rating scale, the operation range of the top item is indicated in red.

```
       -5        -3        -1         1         3         5         7
       |---------+---------+---------+---------+---------+---------|  NUM   ITEM
       1                        1  :   2  : 3 :  4    :    5        5   13  M. STAIRS
```

```
        Operational range: ^-------------------------^
|---------+---------+---------+---------+---------+---------|  NUM   ITEM
-5       -3        -1         1         3         5         7
```

14.3.12 Table 2.13 Median categories by category score (cumulative probabilities: Rasch-Thurstone thresholds)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

Multiple-choice items

Table 2.13 shows the 50% cumulative probability points, the Rasch-Thurstonian thresholds. The lower category ("a" and other wrong answers) has a greater than 50% probability of being observed up to 3.2 logits, when "d", the correct answer, has a higher than 50% probability.

```
TABLE 2.3 50% CUMULATIVE PROBABILITY (Rasch-Thurstonian THRESHOLD) (ILLUSTRATED BY AN OBSERVED CATEGORY)
      -4     -3     -2     -1      0      1      2      3      4
      |------+------+------+------+------+------+------+------|  NUM   TOPIC
      a                                                 d    d   55  al07  newspaper
      a                                                c     c   64  sa01  magazine
```

Table 2.13 is the same as Table 2.3, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.13 50% CUMULATIVE PROBABILITY (Rasch-Thurstonian THRESHOLD) (BY CATEGORY SCORE)
      -4     -3     -2     -1      0      1      2      3      4
      |------+------+------+------+------+------+------+------|  NUM   TOPIC
      0                                                 1    1   55  al07  newspaper
      0                                                1     1   64  sa01  magazine
```

Polytomous items

Tables 2.3 & 2.13: The "Cumulative Probability" Table: Rasch-Thurstonian thresholds, selected with CURVES=001, answers the question "whereabouts in the category ordering is a person of a particular measure located?" This information is expressed in terms of median cumulative probabilities (the point at which the probability of scoring in or above the category is .5).

```
50% CUMULATIVE PROBABILITY: MEDIAN (equal-cumulative-probability Rasch-Thurstonian thresholds) (BY CATEGORY SCORE)
      -6        -4        -2         0         2         4         6
      |---------+---------+---------+---------+---------+---------|  NUM   ACT
      0                                    1         2            2    5  FIND BOTTLES AND CANS
      |                                                           |
      0                                   1         2             2   23  WATCH A RAT
      |                                                           |
      0                                 1         2               2   20  WATCH BUGS
      0                                 1         2               2    4  WATCH GRASS CHANGE
      0                                1         2                2    8  LOOK IN SIDEWALK CRACKS
      |                                                           |
      0        1         2                                        2   18  GO ON PICNIC
      |---------+---------+---------+---------+---------+---------|  NUM   ACT
      -6        -4        -2         0         2         4         6

                                   1
                          12 2 2117083563422342 111 1 1    1     1  KID
                         T      S      M      S      T
                          0    10 30 50 70 80 90             99  PERCENTILE
```

14.3.13 Table 2.14 Andrich thresholds (structure calibrations)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

Multiple-choice items

Table 2.14 shows the item difficulties (or more generally the Rasch-Andrich thresholds) coded by the option of the higher category. For item "al07" this is "d", the correct option.

```
TABLE 2.4 STRUCTURE MEASURES (Rasch model parameters: equal-adjacent-probability thresholds) (ILLUSTRATED BY AN OBSERVED
            CATEGORY)
      -4     -3     -2     -1      0      1      2      3      4
       |------+------+------+------+------+------+------+------|  NUM   TOPIC
       |                                                  d    |   55  al07  newspaper
       |                                                 c     |   64  sa01  magazine
```

Table 2.14 is the same as Table 4, the Rasch-Andrich thresholds, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.14 STRUCTURE MEASURES (Rasch model parameters: equal-adjacent-probability thresholds) (BY CATEGORY SCORE)
      -4     -3     -2     -1      0      1      2      3      4
       |------+------+------+------+------+------+------+------|  NUM   TOPIC
       |                                                  1    |   55  al07  newspaper
       |                                                 1     |   64  sa01  magazine
```

Polytomous items

Tables 2.4 & 2.14 show Rasch structure calibrations: Rasch-Andrich thresholds (step parameters, step measures, step difficulties, rating (or partial credit) scale calibrations). These are the relationships between adjacent categories, and correspond to the points where adjacent category probability curves cross, i.e., are equally probable of being observed according to a Rasch model.

```
STRUCTURE MEASURES (Rasch model parameters: equal-adjacent-probability Rasch-Andrich thresholds) (BY CATEGORY SCORE)
      -6        -4        -2         0         2         4         6
       |---------+---------+---------+---------+---------+---------|  NUM   ACT
       |                                     1       2             |    5  FIND BOTTLES AND CANS
       |                                                           |
       |                                    1       2              |   23  WATCH A RAT
       |         1        2                                        |   18  GO ON PICNIC
       |---------+---------+---------+---------+---------+---------|  NUM   ACT
      -6        -4        -2         0         2         4         6

                                      1
                             12 2 2117083563422342 111 1 1   1     1  KID
                            T      S      M      S     T
                             0    10 30 50 70 80 90               99  PERCENTILE
```

14.3.14 Table 2.15 Observed average measures of persons for scored categories (empirical averages)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

```
       OBSERVED AVERAGE MEASURES FOR KID (scored) (BY CATEGORY SCORE)
      -5    -4    -3    -2    -1     0     1     2     3     4     5
       |-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
       |                          0                        1       |   15  1-3-2-4-1-3
       |                          0                        1       |   16  1-4-2-3-1-4
       |                          0                        1       |   17  1-4-3-1-2-4
       |                                                           |
       |                                                           |
       |                          0         1                      |   14  1-4-2-3-4-1
       |                                                           |
       |                        0              1                   |   12  1-3-2-4-3
       |                       0                   1               |   13  1-4-3-2-4
       |                                                           |
       |                     0               1                     |   11  1-3-1-2-4
       |                                                           |
       |                                                           |
       |               0                1                          |   10  2-4-3-1
       |                                                           |
       |         0                      1                          |    8  1-4-2-3
       |                                                           |
       |         0                    1                            |    6  3-4-1
```

```
|    0                         1                            |    9  1-3-2-4
|      0                      1                             |    5  2-1-4
|            0                1                             |    7  1-4-3-2
|   0                         1                             |    4  1-3-4
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
-5   -4    -3    -2    -1     0     1     2     3     4     5

                            1
1   1   2   2    2    3     2       5     4    1    2          KID
 T            S             M            S            T
0      10        20   30    60      80    90         99          PERCENTILE
```

Table 2.15 is used for inference:

Past-sample-dependent inference: If you expect the future person to be from a person sample exactly like the past sample (distribution, ability level, misfit, etc.) , then base your decisions on Table 2.7.

Past-sample-distribution-dependent inference: If you expect the future person to be from a person sample similar to the past sample (distribution, ability level, but not misfit) , then base your decisions on Table 2.5.

Past-sample-independent-as-possible: If you have no information about the future person, except that the latent variable will be the same as for the past sample, then base your decisions on Table 2.2.

Does the future repeat the past? Or is the future something entirely new? The truth is usually somewhere between these extremes.

To plot Table 2.5 in Excel:
The numbers for the Y-axis are in IFILE= (MEASURE)
The number for the X-axis are in DISFILE= (AVGE MEAS)

Multiple-choice items

Table 2.5 shows the average measures of persons choosing wrong distractors (illustrated by one of the wrong distractors, "a") and the average measures or persons choosing a correct distractor (illustrated by one of the correct distractors, "d").

```
TABLE 2.5 OBSERVED AVERAGE MEASURES FOR STUDENTS (scored) (ILLUSTRATED BY AN OBSERVED CATEGORY)
      -4     -3     -2     -1      0      1      2      3      4
       |------+------+------+------+------+------+------+------|  NUM   TOPIC
       |                                a                      d   55  al07  newspaper
       |                                           a        c  |   64  sa01  magazine
```

Table 2.15 is the same as Table 5, but the options are shown by their scored values, not by their codes in the data.

```
       TABLE 2.15 OBSERVED AVERAGE MEASURES FOR STUDENTS (scored) (BY CATEGORY SCORE)
       -4     -3     -2     -1      0      1      2      3      4
       |------+------+------+------+------+------+------+------|  NUM   TOPIC
       |                                0                      1   55  al07  newspaper
       |                                           0        1  |   64  sa01  magazine
```

Polytomous items

Tables 2.5 & 2.15 plot the observed average person measures for each scored category. It reflects how this sample used these categories. The plotted values cannot fall outside the range of the sample.

The rating-scale categories, such as 0, 1 and 2, are plotted for each item (y-axis) at the average measure of the persons who responded in that category (x-axis).

```
OBSERVED AVERAGE MEASURES FOR KID (scored) (BY CATEGORY SCORE)
-2     -1       0       1       2       3       4       5
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
|                       000102                          |    5  FIND BOTTLES AND CANS
|                                                       |
|                       000102                          |   23  WATCH A RAT
|                                                       |
|                   00  01          02                  |   20  WATCH BUGS
|                 00    01                02            |    4  WATCH GRASS CHANGE
```

```
|                   0001                02               |    8  LOOK IN SIDEWALK CRACKS
|-------+-------+-------+-------+-------+-------+-------|  NUM   ACT
-2      -1      0       1       2       3       4       5

                               1
                    12 2 2117083563422342 111 1 1   1     1  KID
                   T      S      M      S     T
                    0    10 30 50 70 80 90               99  PERCENTILE
```

14.3.15 Table 2.16 Observed average measures of persons (empirical averages)

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

```
OBSERVED AVERAGE MEASURES FOR KID (unscored) (BY CATEGORY SCORE)
-5    -4    -3    -2    -1     0     1     2     3     4     5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
|                         0                        1        |   15  1-3-2-4-1-3
|                         0                        1        |   16  1-4-2-3-1-4
|                         0                        1        |   17  1-4-3-1-2-4
|                                                           |
|                                                           |
|                         0         1                       |   14  1-4-2-3-4-1
|                                                           |
|                       0              1                    |   12  1-3-2-4-3
|                      0                   1                |   13  1-4-3-2-4
|                                                           |
|                     0               1                     |   11  1-3-1-2-4
|                                                           |
|                                                           |
|               0                1                          |   10  2-4-3-1
|                                                           |
|         0                      1                          |    8  1-4-2-3
|                                                           |
|         0                    1                            |    6  3-4-1
|    0                        1                            |    9  1-3-2-4
|      0                     1                             |    5  2-1-4
|            0               1                             |    7  1-4-3-2
|   0                        1                             |    4  1-3-4
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
-5    -4    -3    -2    -1     0     1     2     3     4     5

                            1
1   1   2   2    2    3     2       5     4    1    2          KID
 T            S             M            S            T
0      10       20   30    60      80    90       99           PERCENTILE
```

Polytomous items

Table 2.6 & Table 2.16 plot the observed average person measures from Table 14.3 for each observed category. It reflects how this sample used these categories. The plotted values cannot fall outside the range of the sample. "m" in the plot indicates the average measure of those for whom their observation is missing on this item. This Table is shown first from the Diagnosis pull-down menu.

```
OBSERVED AVERAGE MEASURES FOR KID (unscored) (BY CATEGORY SCORE)
-6        -4        -2         0         2         4         6
|---------+---------+---------+---------+---------+---------|  NUM   ACT
|                              10 2                         |    5  FIND BOTTLES AND CANS
|                                                           |
|                              201                          |   23  WATCH A RAT
|                                                           |
|                             0 1       2                    |   20  WATCH BUGS
|                           0   1         2                 |    4  WATCH GRASS CHANGE
|                             01          2                 |    8  LOOK IN SIDEWALK CRACKS
|---------+---------+---------+---------+---------+---------|  NUM   ACT
-6        -4        -2         0         2         4         6

                               1
                     12 2 2117083563422342 111 1 1   1     1  KID
                    T      S      M      S     T
                     0    10 30 50 70 80 90               99  PERCENTILE
```

14.3.16 Table 2.17 Expected average measures of persons

(controlled by T2SELECT=, MRANGE=, CATREF=)

Table 2 for multiple-choice items.
Table 2 for polytomous items.

```
EXPECTED AVERAGE MEASURES FOR KID (scored) (BY CATEGORY SCORE)
-5   -4    -3    -2    -1     0     1     2     3     4     5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
|                          0                  1             |   15  1-3-2-4-1-3
|                          0                  1             |   16  1-4-2-3-1-4
|                          0                  1             |   17  1-4-3-1-2-4
|                                                           |
|                                                           |
|                         0                 1               |   14  1-4-2-3-4-1
|                                                           |
|                        0                1                 |   12  1-3-2-4-3
|                       0                1                  |   13  1-4-3-2-4
|                                                           |
|                     0               1                     |   11  1-3-1-2-4
|                                                           |
|                                                           |
|               0                1                          |   10  2-4-3-1
|                                                           |
|            0                  1                           |    8  1-4-2-3
|                                                           |
|        0                     1                            |    6  3-4-1
|        0                     1                            |    9  1-3-2-4
|       0                     1                             |    5  2-1-4
|       0                     1                             |    7  1-4-3-2
|    0                        1                             |    4  1-3-4
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
-5   -4    -3    -2    -1     0     1     2     3     4     5

                            1
1   1   2   2    2    3     2       5     4    1    2         KID
 T            S             M            S            T
0      10       20   30    60      80    90        99         PERCENTILE
```

Table 2.17 is used for description, but can be used for inference:

Past-sample-dependent inference: If you expect the future person to be from a person sample exactly like the past sample (distribution, ability level, misfit, etc.) , then base your decisions on Table 2.7.

Past-sample-distribution-dependent inference: If you expect the future person to be from a person sample similar to the past sample (distribution, ability level, but not misfit) , then base your decisions on Table 2.5.

Past-sample-independent-as-possible: If you have no information about the future person, except that the latent variable will be the same as for the past sample, then base your decisions on Table 2.2.

Does the future repeat the past? Or is the future something entirely new? The truth is usually somewhere between these extremes.

Multiple-choice items

Table 2.7 shows the measures that would be predicted to be observed for incorrect and correct responses if the persons responded exactly as the Rasch model predicts. "a" (an incorrect distractor) shows the average measure for persons in the sample who would be predicted to fail the item, and "d" (a correct distractor) shows the average measure for persons in the sample who would be predicted to succeed on the item. Compare this with Tables 2.5 and 2.6 for the empirical locations, and Table 2.2 for the sample-free locations.

```
TABLE 2.7 EXPECTED AVERAGE MEASURES FOR STUDENTS (scored) (ILLUSTRATED BY AN OBSERVED CATEGORY)
       -4    -3     -2     -1      0      1      2      3      4
       |------+------+------+------+------+------+------+------|  NUM   TOPIC
       |                                  a                   d|   55  al07  newspaper
       |                                         a             c   64  sa01  magazine
```

Table 2.17 is the same as Table 2.7, but the options are shown by their scored values, not by their codes in the data.

```
TABLE 2.17 EXPECTED AVERAGE MEASURES FOR STUDENTS (scored) (BY CATEGORY SCORE)
```

```
-4     -3      -2      -1       0       1       2       3       4
|------+-------+-------+-------+-------+-------+-------+-------|  NUM   TOPIC
|                              0                    1|   55  al07  newspaper
|                                     0              1   64  sa01  magazine
```

Polytomous items

Tables 2.7 & 2.17 plot the expected average person measures for each category score. It reflects how this sample were expected to use these categories. The plotted values cannot fall outside the range of the sample. Compare this with Tables 2.5 and 2.6 for the empirical locations, and Table 2.2 for the sample-free locations.

```
EXPECTED AVERAGE MEASURES FOR KID (scored) (BY CATEGORY SCORE)
-6        -4         -2          0          2          4          6
|---------+---------+---------+---------+---------+---------|  NUM   ACT
|                             0    1        2              |    5  FIND BOTTLES AND CANS
|                                                          |
|                             0   1        2               |   23  WATCH A RAT
|                                                          |
|                            0    1       2                |   20  WATCH BUGS
|                            0    1      2                 |    4  WATCH GRASS CHANGE
|                            0   1       2                 |    8  LOOK IN SIDEWALK CRACKS
|---------+---------+---------+---------+---------+---------|  NUM   ACT
-6        -4         -2          0          2          4          6

                                1
                     12 2 2117083563422342 111 1 1    1     1  KID
                    T      S      M      S     T
                     0    10 30 50 70 80 90              99  PERCENTILE
```

14.4 Table 3.1 Summaries of persons and items

(controlled by REALSE=, UMEAN=, USCALE=, ISUBTOTAL=, PSUBTOTAL=)
This table summarizes the person, item and structure information.

Table 3.1: Gives summaries for all persons and items.
Table 3.2: Summary of rating categories, probability curves and category (confusion) matrix
Table 27.3: Gives subtotal summaries for items, controlled by ISUBTOT=
Table 28.3: Gives subtotal summaries for persons, controlled by PSUBTOT=

```
     SUMMARY OF 34 MEASURED (NON-EXTREME) KID
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      10.0      18.0        -.18    1.01      1.00   -.15    .67   -.10 |
|  SEM        .4        .0         .34     .02       .17    .20    .22    .12 |
| P.SD       2.1        .0        1.94     .10       .95   1.14   1.25    .68 |
| S.SD       2.1        .0        1.97     .10       .96   1.16   1.27    .69 |
| MAX.      14.0      18.0        3.72    1.11      4.16   2.49   6.06   2.23 |
| MIN.       5.0      18.0       -4.29     .81       .18  -1.48    .08   -.73 |
|-----------------------------------------------------------------------------|
| REAL RMSE   1.18 TRUE SD    1.54  SEPARATION  1.30  KID    RELIABILITY  .63 |
|MODEL RMSE   1.01 TRUE SD    1.66  SEPARATION  1.63  KID    RELIABILITY  .73 |
| S.E. OF KID MEAN = .34                                                      |
-------------------------------------------------------------------------------
  MINIMUM EXTREME SCORE:      1 KID 2.9%

     SUMMARY OF 35 MEASURED (EXTREME AND NON-EXTREME) KID
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN       9.8      18.0        -.36    1.03                                |
|  SEM        .4        .0         .38     .03                                |
| P.SD       2.3        .0        2.19     .17                                |
| S.SD       2.4        .0        2.22     .18                                |
| MAX.      14.0      18.0        3.72    1.85                                |
| MIN.       3.0      18.0       -6.58     .81                                |
|-----------------------------------------------------------------------------|
| REAL RMSE   1.21 TRUE SD    1.83  SEPARATION  1.51  KID    RELIABILITY  .70 |
|MODEL RMSE   1.05 TRUE SD    1.93  SEPARATION  1.84  KID    RELIABILITY  .77 |
| S.E. OF KID MEAN = .38                                                      |
-------------------------------------------------------------------------------
KID RAW SCORE-TO-MEASURE CORRELATION = 1.00
```

```
CRONBACH ALPHA (KR-20) KID RAW SCORE "TEST" RELIABILITY = .75  SEM = 1.17
STANDARDIZED (50 ITEM) RELIABILITY = .90

     SUMMARY OF 14 MEASURED (NON-EXTREME) TAP
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      16.9      35.0        .00     .71       .96    .05    .67   -.06 |
|  SEM       3.6        .0        .96     .06       .07    .18    .15    .14 |
| P.SD      12.9        .0       3.47     .21       .26    .63    .55    .52 |
| S.SD      13.4        .0       3.60     .22       .27    .66    .57    .54 |
| MAX.      32.0      35.0       4.80    1.07      1.56   1.23   2.06   1.05 |
| MIN.       1.0      35.0      -4.34     .45       .66  -1.03    .11   -.63 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .77 TRUE SD    3.38  SEPARATION  4.40  TAP    RELIABILITY  .95 |
|MODEL RMSE    .74 TRUE SD    3.39  SEPARATION  4.56  TAP    RELIABILITY  .95 |
| S.E. OF TAP MEAN = .96                                                      |
-------------------------------------------------------------------------------
  MAXIMUM EXTREME SCORE:      3 TAP 16.7%
  MINIMUM EXTREME SCORE:      1 TAP 5.6%

     SUMMARY OF 18 MEASURED (EXTREME AND NON-EXTREME) TAP
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      19.0      35.0       -.75     .96                                 |
|  SEM       3.3        .0       1.03     .12                                 |
| P.SD      14.0        .0       4.24     .51                                 |
| S.SD      14.2        .0       4.36     .52                                 |
| MAX.      35.0      35.0       6.12    1.85                                 |
| MIN.        .0      35.0      -6.53     .45                                 |
|-----------------------------------------------------------------------------|
| REAL RMSE   1.10 TRUE SD    4.09  SEPARATION  3.71  TAP    RELIABILITY  .93 |
|MODEL RMSE   1.09 TRUE SD    4.10  SEPARATION  3.76  TAP    RELIABILITY  .93 |
| S.E. OF TAP MEAN = 1.03                                                     |
-------------------------------------------------------------------------------
TAP RAW SCORE-TO-MEASURE CORRELATION = -.98
Global statistics: please see Table 44.
UMEAN=.0000 USCALE=1.0000
```

EXTREME AND NON-EXTREME SCORES	All items with estimated measures
NON-EXTREME SCORES ONLY	Items with non-extreme scores (omits items or persons with 0% and 100% success rates)
ITEM or PERSON COUNT	count of items or persons. "ITEM" is the name assigned with ITEM= : "PERSON" is the name assigned with PERSON=
MEAN MEASURE	average measure of items or persons.
SEM row	standard error of the mean statistic in the row above
REAL/MODEL S.E. column	standard errors of the measures (REAL = inflated for misfit). The S.E. column summarizes the S.E.s in the measurement Table. So S.E. column, S.D. row, is the S.D.s of the S.E.s in the measurement table. It is not the S.E. of the S.D. to its left in this Table.
REAL/MODEL RMSE	statistical "root-mean-square" average of the standard errors. This is the average conditional standard error of measurement CSEM for this sample.
TRUE P.SD (previously ADJ.SD)	The "true" population standard deviation is the observed population S.D. adjusted for measurement error (RMSE). This is an estimate of the measurement-error-free S.D.
REAL/MODEL SEPARATION	the separation coefficient: G = TRUE P.SD / RMSE Strata = (4*G + 1)/3
REAL/MODEL RELIABILITY	the measure reproducibility = ("True" item measure variance / Observed variance) = Separation ² / (1 + Separation ²)
S.E. MEAN	standard error of the mean measure of items or persons

For valid observations used in the estimation, NON-EXTREME persons or items - summarizes persons (or items) with non-extreme scores (omits zero and perfect scores).

EXTREME AND NON-EXTREME persons or items - summarizes persons (or items) with all estimable scores (includes zero and perfect scores). Extreme scores (zero, minimum possible and perfect, maximum possible scores) have no exact measure under Rasch model conditions. Using a Bayesian technique, however, reasonable measures are reported for each extreme score, see EXTRSC=. Totals including extreme scores are reported, but are necessarily less inferentially secure than those totals only for non-extreme scores. Extreme persons and extreme items (minimum possible scores and maximum possible scores) have no infit nor outfit statistics, so those statistics are omitted from "extreme and non-extreme".

RAW SCORE is the raw score (number of correct responses excluding extreme scores, TOTALSCORE=N).

TOTAL SCORE is the raw score (number of correct responses including extreme scores, TOTALSCORE=Y).

COUNT is the number of responses made.

MEASURE is the estimated measure (for persons) or calibration (for items).

REAL/MODEL: REAL is computed on the basis that misfit in the data is due to departures in the data from model specifications. This is the worst-case situation. MODEL is computed on the basis that the data fit the model, and that all misfit in the data is merely a reflection of the stochastic nature of the model. This is the best-case situation.

S.E. is the standard error of the estimate.

INFIT is an information-weighted fit statistic, which is more sensitive to unexpected behavior affecting responses to items near the person's measure level.

MNSQ is the mean-square infit statistic with expectation 1. Values substantially below 1 indicate dependency in your data; values substantially above 1 indicate noise.

ZSTD is the infit mean-square fit statistic t standardized to approximate a theoretical mean 0 and variance 1 distribution. ZSTD (standardized as a z-score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic distribution value has been adjusted to a unit normal value. When LOCAL=Y, then EMP is shown, indicating a local {0,1} standardization. When LOCAL=L, then LOG is shown, and the natural logarithms of the mean-squares are reported.

OUTFIT is an outlier-sensitive fit statistic, more sensitive to unexpected behavior by persons on items far from the person's measure level.

MNSQ is the mean-square outfit statistic with expectation 1. Values substantially less than 1 indicate dependency in your data; values substantially greater than 1 indicate the presence of unexpected outliers.

ZSTD is the outfit mean-square fit statistic t standardized to approximate a theoretical mean 0 and variance 1 distribution. ZSTD (standardized as a z-score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic distribution value has been adjusted to a unit normal value. When LOCAL=Y, then EMP is shown, indicating a local {0,1} standardization. When LOCAL=L, then LOG is shown, and the natural logarithms of the mean-squares are reported.

MEAN is the average value of the statistic.
P.SD is its standard deviation assuming that this sample of the statistic is the entire population. It is not, the corrected sample S.D. = (P.SD / √ (Count of statistic) / (Count of statistic - 1)) 10
P.SD = Population standard deviation (when the sample is the entire population)
S.SD = Sample standard deviation (when the sample represents the population)
MAX. is its maximum value.
MIN. is its minimum value.

MODEL RMSE is computed on the basis that the data fit the model, and that all misfit in the data is merely a reflection of the stochastic nature of the model. This is a "best case" reliability, which reports an upper limit to the reliability of measures based on this set of items for this sample. This RMSE for the person sample is equivalent to the "Test SEM (Standard Error of Measurement)" of Classical Test Theory.

REAL RMSE is computed on the basis that misfit in the data is due to departures in the data from model specifications. This is a "worst case" reliability, which reports a lower limit to the reliability of measures based on this set of items for this sample.

RMSE is the square-root of the average error variance. It is the Root Mean Square standard Error computed over the persons or over the items. Here is how RMSE is calculated in Winsteps:

George ability measure = 2.34 logits. Standard error of the ability measure = 0.40 logits.
Mary ability measure = 3.62 logits. Standard error of the ability measure = 0.30 logits.
Error = 0.40 and 0.30 logits.
Square error = 0.40*0.40 = 0.16 and 0.30*0.30 = 0.09
Mean (average) square error = (0.16+0.09) / 2 = 0.25 / 2 = 0.125
RMSE = Root mean square error = sqrt (0.125) = 0.354 logits

TRUE P.SD is the population standard deviation of the estimates (assumed to be the population) after subtracting the error variance (attributable to their standard errors of measurement) from their observed variance.

(TRUE P.SD)² = (P.SD of MEASURE)² - (RMSE)²

The TRUE P.SD is an estimate of the unobservable exact standard deviation, obtained by removing the bias caused by measurement error.

SEPARATION coefficient is the ratio of the PERSON (or ITEM) TRUE P.SD, the "true" standard deviation, to RMSE, the error standard deviation. It provides a ratio measure of separation in RMSE units, which is easier to interpret than the reliability correlation. (SEPARATION coefficient)² is the signal-to-noise ratio, the ratio of "true" variance to error variance.

RELIABILITY is a separation reliability (separation index). The PERSON (or ITEM) reliability is equivalent to KR-20, Cronbach Alpha, and the Generalizability Coefficient. See much more at Reliability.

Real reliability while you are improving your results. This assumes misfit contradicts the Rasch model.

Model reliability when your results are as good as they can be. This assumes misfit is the randomness predicted by the Rasch model

S.E. OF MEAN is the standard error of the mean of the person (or item) measures for this sample.

MEDIAN is the median measure of the sample (in Tables 27, 28).

Message	Meaning for Persons or Items
MAXIMUM EXTREME SCORE	All non-missing responses are scored correct (perfect score) or in the top categories. Measures are estimated.
MINIMUM EXTREME SCORE	All non-missing responses are scored incorrect (zero score) or in the bottom categories. Measures are estimated.
LACKING RESPONSES	All responses are missing. No measures are estimated.
DELETED	Persons deleted with PDFILE= or PDELETE=. Items deleted with IDFILE= or IDELETE=
IGNORED	Entry numbers higher than highest reported entry number are deleted and not reported
CUTLO= CUTHI=	CUTLO= and CUTHI= values if these are active. They reduce the number of valid responses.

PERSON RAW SCORE-TO-MEASURE CORRELATION is the Pearson correlation between raw scores and measures, including extreme scores. When data are complete, this correlation is expected to be near 1.0 for persons.

CRONBACH ALPHA (KR-20) KID RAW SCORE "TEST" RELIABILITY is the conventional "test" reliability index. It reports an approximate test reliability based on the raw scores of this sample. It is reported for all the data, including persons and items with missing data. For incomplete data, the formula in your email applies exactly in Winsteps. When computing each person and item raw-score variance separately, Winsteps uses the its observed data only. Winsteps does not check whether persons or items are complete or incomplete. See more at Reliability. Cronbach Alpha is an estimate of the person-sample reliability (= person-score-order reproducibility). Classical Test Theory does not usually compute an estimate of the item reliability (= item-value-order reproducibility), but it could. Winsteps reports both person-sample reliability (=person-measure-order reproducibility) and item reliability (= item-measure-order-reproducibility). Cronbach Alpha is computed for both dichotomous and polytomous data. Cronbach Alpha is the same as KR-20 when the data are dichotomous and complete. KR-20 is not defined for polytomous data. Cronbach Alpha is influenced by missing data. Incomplete data are usually less reliable than complete data. Confusingly, CTT "item reliability" is a different reliability. It is the reliability of the person scores based on one item.

High Cronbach Alpha with low Rasch reliability indicates that the raw scores reproduce reliably, but their meaning on the latent variable does not. *Example:* a survey in which 65% of the persons respond "Agree" to every question. The score of "Agree" is reliably predictable. The meaning of "Agree" on the latent variable is fuzzily unreliable.

Lee J. Cronbach in "Essentials of Psychological Testing" (1970) is explicit that his focus is on "persons" and "test scores". Classical Test Theory follows his lead and only computes Cronbach Alpha for persons (or their equivalent). Alpha was originally incorporated into Winsteps following requests by CTT-orientated analysts and reviewers. But there is no reason why the same computation cannot be applied to items. In Winsteps, transpose the data (use the Output Files menu), analyze the transposed dataset, and report Table 3. Its Cronbach Alpha applies to the original items. If Alpha for the items is too low, then the likely reason is that the person sample size is too small. More persons -> higher item Alpha. More items -> higher person Alpha.

SEM this is the "standard error of measurement" (the averaged S.E. of the person raw-scores) reported by Classical Test Theory = raw score S.D. * √(1-Cronbach Alpha)

STANDARDIZED (50 ITEM) RELIABILITY is the reliability of this test for this sample if the test had 50 items, according to the Spearman-Brown Prediction Formula.

ITEM RAW SCORE-TO-MEASURE CORRELATION is the Pearson correlation between raw scores and measures, including extreme scores. When data are complete, this correlation is expected to be near -1.0 for items. This is because higher measure implies lower probability of success and so lower item scores.

Global fit: please see Table 44.

UMEAN=.000 USCALE=1.000 are the current settings of UMEAN= and USCALE=.

14.5 Table 3.2+ Summary of dichotomous, rating scale or partial credit structures

(controlled by STEPT3=, STKEEP=, MRANGE=, MTICK=, DISCRIM=, CMATRIX=)

Table 3.1: Gives summaries for all persons and items.
Table 3.2: Summary of rating categories, probability curves and category (confusion) matrix

The **average measures** and **category fit statistics** are how the response structure worked **"for this sample"** (which might have high or low performers etc.). For each observation in category k, there is a person of measure Bn and an item of measure Di. Then:
average measure = sum(Bn - Di) / count of observations in category. These are **not** estimates of parameters.

The **probability curves** are how the response structure is predicted to work for any **future** sample, *provided it worked satisfactorily for this sample.*

Our logic is that if the average measures and fit statistics don't look reasonable for this sample, why should they in any future sample? If they look OK for this sample, then the probability curves tell us about future samples. If they don't look right now, then we can anticipate problems in the future.

Persons and items with **extreme scores (maximum possible and minimum possible) are omitted** from Table 3.2 because they provide no information about the relative difficulty of the categories. See Table 14.3 for their details

a) For dichotomies,

```
SUMMARY OF CATEGORY STRUCTURE.  Model="R"
FOR GROUPING "0" ACT NUMBER: 12  Go to museum
```

```
ACT DIFFICULTY MEASURE OF -1.14 ADDED TO MEASURES
-------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT| COHERENCE       |ESTIM|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ| M->C C->M  RMSR |DISCR|
|-------------------+------------+------------+-----------------+-----|
|  1   1      13  17|  -.45  -.06|   .83   .52| 100%  23%  .6686|     | 1 Neutral
|  2   2      62  83|  1.06   .98|   .78   .85|  86% 100%  .1725| 1.23| 2 Like
-------------------------------------------------------------------
|MISSING      51  40|  -.54      |            |                 |     |
-------------------------------------------------------------------
OBSERVED AVERAGE is mean of measures in category. It is not a parameter estimate.
M->C = Does Measure imply Category?
C->M = Does Category imply Measure?
```

ITEM MEASURE OF -1.07 ADDED TO MEASURES
When there is only one item in a grouping (the Partial Credit model), the item measure is added to the reported measures.

CATEGORY LABEL is the number of the category in your data set after scoring/keying.
CATEGORY SCORE is the ordinal value of the category used in computing raw scores - and in Table 20.
MISSING are missing responses.

OBSERVED COUNT and % is the count of occurrences of this category. Counts by data code are given in the distractor Tables, e.g., Table 14.3. % is percentage of non-missing data, except for MISSING% which is of all data.

OBSVD AVERGE is the average of the (person measures - item difficulties) that are modeled to produce the responses observed in the category. This excludes observations in extreme response strings. The average measure is expected to increase with category value. Disordering is marked by "*". **This is a description of the sample, not a Rasch parameter. Only observations used for estimating the Andrich thresholds are included in this average (not observations in extreme scores.) For all observations, see Table 14.3** For each observation in category k, there is a person of measure Bn and an item of measure Di. Then: average measure = sum(Bn - Di) / count of observations in category.
Disordered categories: since extreme scores are theoretically at infinity, their inclusion in the observed-average computation would tend to force the top and bottom categories to be ordered. For evaluating category disordering, we need response strings in which categories can be compared with each other, i.e., non-extreme response strings.

SAMPLE EXPECT is the expected value of the average measure for this sample. These values always advance with category. **This is a description of the sample, not a Rasch parameter.**

INFIT MNSQ is the average of the INFIT mean-squares associated with the responses in each category. The expected values for all categories are 1.0. = Category infit mean-square = sum over all observations in the category ((category of response - expected value of the response)^2) / sum (model variance of the expected values)

OUTFIT MNSQ is the average of the OUTFIT mean-squares associated with the responses in each category. The expected values for all categories are 1.0. This statistic is sensitive to grossly unexpected responses which are listed in Tables 6.6, 10.6 and similar.

Note: Winsteps reports the MNSQ values in Table 3.2. An approximation to their standardized values can be obtained by using the number of observations in the category as the degrees of freedom, and then looking at the plot.

COHERENCE: the usefulness of M->C and C->M depends on the inferences you intend to make from your data.
M->C shows what percentage of the measures that were expected to produce observations in this category actually did. Do the measures imply the category?
Some users of Winsteps, particularly in medical applications, need to know
1) how accurately patient measure is predicted from single observations. This is C->M.
C->M is 10% means that we can predict the estimated measure from the observed category about 1 time in 10.
2) how accurately patient measure predicts single observations. This is M->C.
M->C is 50% means that we can predict the observed category from the estimated measure half the time.
In general, the wider the categories on the latent variable (more dispersed thresholds), the higher these percents will be.
Example with two observations:

```
observed category     expected score
1                      1.1             Yes for category 1    Yes for measure 1
```

```
2                       1.1              No for category 2     No for measure 1
C->M  for category 1 = 100%
C->M  for category 2 = 0%
M->C  for category 1 = 50%
```

Guttman's Coefficient of Reproducibility is the count-weighted average of the M->C, i.e., Reproducibility = sum across categories (COUNT * M->C) / sum(COUNT * 100)

C->M shows what percentage of the observations in this category were produced by measures corresponding to the category. Does the category imply the measures?

Computation: For each observation in the XFILE=,
"expected response value" - round this to the nearest category number = expected average category
if "expected average category" = "response value (after scoring and recounting)" then MC = 1, else, MC = 0
Compute average of MC for each observed category across all the relevant data for C->M
Compute average of MC for each expected category across all the relevant data for M->C

RMSR is the root-mean-square residual, summarizing the differences between observations in this category and their expectations (excluding observations in extreme scores).

ESTIM DISCR is an estimate of the local discrimination when the model is parameterized in the form: log-odds = aj (Bn - Di - Fj). Its expected value is 1.0.

RESIDUAL (when shown) is the residual difference between the observed and expected counts of observations in the category. Shown as % of expected, unless observed count is zero. Then residual count is shown. Only shown if residual count is >= 1.0. Indicates lack of convergence, structure anchoring, or large data set.

CATEGORY CODES are shown to the right from on CODES=. The original data code is shown. If several data codes are scored to the same value, only the first data code found in CODES= is shown. Change the reported data code by changing the order of the data codes on CODES= with matching changes in NEWSCORE= and IVALUE=.

CATEGORY LABELS are shown to the extreme right based on CFILE= and CLFILE=. The label from CFILE= is reported, if any. If none, then the label from CLFILE= is reported, if any.

Measures corresponding to the dichotomous categories are not shown, but can be computed using the Table at "What is a Logit?" and LOWADJ= and HIADJ=.

```
        DICHOTOMOUS CURVES
P      -+--------------+--------------+--------------+--------------+-
R  1.0 +                                                             +
O      |                                                             |
B      |0                                                           1|
A      | 000000                                               111111 |
B   .8 +       00000                                     11111       +
I      |            0000                             1111            |
L      |                0000                     1111                |
I      |                    000               111                    |
T   .6 +                       000         111                       +
Y      |                          000   111                          |
    .5 +                             ***                             +
O      |                          111   000                          |
F   .4 +                       111         000                       +
       |                    111               000                    |
R      |                1111                     0000                |
E      |            1111                             0000            |
S   .2 +       11111                                     00000       +
P      | 111111                                               000000 |
O      |1                                                           0|
N      |                                                             |
S   .0 +                                                             +
E      -+--------------+--------------+--------------+--------------+-
       -2             -1              0              1              2
          KID [MINUS] TAP MEASURE
```

Dichotomous category probability curves. The curve for "1" is also the model Item Characteristic Curve (ICC), also called the Item Response Function (IRF). Rasch model dichotomous curves are all the same.

b) For rating scales and partial credit items, the structure calibration table lists:

```
SUMMARY OF CATEGORY STRUCTURE.  Model="R"
FOR GROUPING "0" ACT NUMBER: 1  Watch birds

ACT DIFFICULTY MEASURE OF 1.25 ADDED TO JMLE MEASURES
ACT DIFFICULTY MEASURE OF 1.15 ADDED TO CMLE MEASURES
------------------------------------------------------------------------------
|CATEGORY     OBSERVED|OBSVD SAMPLE|INFIT OUTFIT||  JMLE    |  CMLE   |CATEGORY|
|LABEL   SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD|THRESHOLD| MEASURE|
|--------------------+------------+------------++---------+---------+--------|
|    0   0       3   4| -1.16  -.63|   .73   .73||  NONE    |  NONE   |( -3.83)| 0 Dislike
|    1   1      33  43|  -.12   .05|   .61   .75||   -3.94 |  -3.62  |  -1.19 | 1 Neutral
|    2   2      37  49|  1.19   .85|   .98   .72||    -.92 |   -.74  |   1.90 | 2 Like
|    3   3       1   1|  1.05* 1.70|  1.56  1.90||    3.65 |   3.65  |   2.70 | 3
|    4   4       0   0|            |   .00   .00||  NULL    |  NULL   |   3.16 |
|    5   5       2   3|   .39* 2.53|  2.50  7.38||    1.22 |    .71  |(  3.74)| 4
------------------------------------------------------------------------------
OBSERVED AVERAGE is mean of measures in category. It is not a parameter estimate.
Unobserved category. Consider: STKEEP=NO
```

ITEM MEASURE OF -.89 ADDED TO MEASURES
When there is only one item in a grouping (the Partial Credit model), the item measure is added to the reported measures.

CATEGORY LABEL, the number of the category in your data set after scoring/keying.
CATEGORY SCORE is the value of the category in computing raw scores - and in Table 20.
OBSERVED COUNT and %, the count of occurrences of this category. Counts by data code are given in the distractor Tables, e.g., Table 14.3.

OBSVD AVERGE is the average of the (person measures - item difficulties) that are model led to produce the responses observed in the category. The average measure is expected to increase with category value. Disordering is marked by "*". **This is a description of the sample, not the estimate of a parameter.** For each observation in category k, there is a person of measure Bn and an item of measure Di. Then: average measure = sum(Bn - Di) / count of observations in category.

SAMPLE EXPECT is the expected value of the average measure for this sample. These values always advance with category. **This is a description of the sample, not a Rasch parameter.**

INFIT MNSQ is the average of the INFIT mean-squares associated with the responses in each category. The expected values for all categories are 1.0. Only values greater than 1.5 are problematic. Category infit mean-square = sum over all observations in the category ((category of response - expected value of the response)^2) / sum (model variance of the expected values)

OUTFIT MNSQ is the average of the OUTFIT mean-squares associated with the responses in each category. The expected values for all categories are 1.0. This statistic is sensitive to grossly unexpected responses. Only values greater than 1.5 are problematic.

Note: Winsteps reports the MNSQ values in Table 3.2. An approximation to their standardized values can be obtained by using the number of observations in the category as the degrees of freedom, and then looking at the plot.

ANDRICH THRESHOLD or JMLE THRESHOLD, the calibrated measure of the transition from the category below to this category. **This is an estimate of the Rasch-Andrich model parameter, Fj. Use this for anchoring in Winsteps.** (This corresponds to Fj in the Di+Fj parametrization of the "Rating Scale" model, and is similarly applied as the Fij of the (delta) Dij=Di+Fij of the "Partial Credit" model.) The bottom category has no prior transition, and so that the measure is shown as NONE. **This parameter, sometimes called the Step Difficulty, Step Calibration, Rasch-Andrich threshold, Tau or Delta, indicates how difficult it is to observe a category, not how difficult it is to perform it.** The Rasch-Andrich threshold is expected to increase with category value. Disordering of these estimates (so that they do not ascend in value up the rating scale), sometimes called "disordered deltas", indicates that the category is relatively rarely observed, i.e., occupies a narrow interval on the latent variable, and so may indicate substantive problems with the rating (or partial credit) scale category definitions. These Rasch-Andrich thresholds are relative pair-wise measures of the transitions *between* categories. They are the points at which adjacent category probability curves intersect. They are not the measures *of* the categories. See plots below. NULL indicates that this intermediate category is not observed in the data, but is included in the threshold structure. See Category Widths, Thurstone Thresholds and Andrich Thresholds

CMLE THRESHOLD, the calibrated measure of the transition from the category below to this category. This is an estimate of the Rasch-Andrich model parameter, Fj, using CMLE estimation.

CATEGORY MEASURE, the difficulty of the category. Add the item difficulty to the category measure to obtain the difficulty of the category for each item for comparison with the person ability.

The sample-free measure corresponding to this category. ( ) is printed where the matching calibration is infinite. The value shown corresponds to the measure .25 score points (or LOWADJ= and HIADJ=) away from the extreme. This is the best basis for the inference: **"ratings averaging x imply measures of y" or "measures of y imply ratings averaging x". This is implied by the Rasch model parameters.** These are plotted in Table 2.2 and the Expected Score ICC.

"Category measures" answer the question "If there were a thousand people at the same location on the latent variable and their average rating was the category value, e.g., 2.0, then where would that location be, relative to the item?" This seems to be what people mean when they say "a performance at level 2.0". It is estimated from the Rasch expectation
.
To discover this ability location, we start with the Rasch model, log (Pnij / Pni(j-1)) = Bn - Di - Fj, For known Di, Fj and trial Bn. This produces a set of {Pnij}.
Compute the expected rating score: Eni = sum (jPnij) across the categories.
Adjust Bn' = Bn + (desired category - Eni) / (large divisor), until Eni = desired category, when Bn is the desired category measure.

Here is how to apply this formula. The purpose of this formula is to find the person ability measure corresponding to an expected score on an item.
a) Usually Winsteps has done this for us. Look at ISFILE= - the columns labeled "AT CAT", "BOT+0.25", "Top-0.25" show the person abilities, Bn, corresponding to an expected score equal to each category value of the rating scale, or a reasonable proxy for the extreme categories.

b) If you want to apply the formula yourself to find the expected value corresponding to an expected value of, say, 2.3 on an item with a 1-5 rating scale. Here's what to do.
1) Select the item, i, and the expected value, E, that you want.
2) Look at the Winsteps EFILE= output
If the expected value, E, is not there, then ...

c) set Bn = the ability with the Eni closest to the E you want. Note down Eni, the expected value corresponding to Bn in the EFILE=
3) Look up the item difficulty Di in Table 14, and the Andrich thresholds, {Fj}, in Table 3.2
4) Now start to apply the formula:
Bn' = Bn + (desired category - Eni) / (large divisor)
desired category = your value E
Bn and Eni are from step 2)
(large divisor) = 10 - this produces a small increment along the latent variable. Its size doesn't really matter. If this iterative process does not converge, try again with a ten times larger divisor.
We now have Bn'
5) Using Excel or similar, apply the Rasch model with Bn', Di, {Fj}, to obtain Eni' correspond to Bn'
6) If Eni' is not close enough to your desired E, then back to step 4)
with Bn = value of Bn', and Eni = value of Eni'

```
-------------------------------------------------------------------------------------------------------------
|CATEGORY JMLE STRUCTURE |  CMLE  |  SCORE-TO-MEASURE    | 50% CUM.| COHERENCE         |ESTIM| OBSERVED-EXPECTED |
| LABEL    MEASURE  S.E. | MEASURE| AT CAT. ----ZONE----|PROBABLTY| M->C C->M  RMSR |DISCR|RESIDUAL DIFFERENCE|
|------------------------+--------+---------------------+---------+-----------------+-----+-------------------|
|   0      NONE          | NONE   |( -3.83) -INF   -2.82|         |   0%   0% 1.0236|     |     .1%         .0 | 0 Dislike
|   1       -2.69    .61 |  -2.47 |  -1.19  -2.82    .41|   -2.74 |  68%  79%  .3834| 1.12|     .1%         .0 | 1 Neutral
|   2         .32    .26 |    .41 |   1.90    .41   2.42|     .36 |  74%  68%  .5298| 1.72|     .0%         .0 | 2 Like
|   3        4.90    .68 |   4.80 |   2.70   2.42   2.92|    2.85 |   0%   0% 1.3095|  .74|    -.2%         .0 | 3
|   4      NULL          |  NULL  |   3.16   2.92   3.47|    2.94 |   0%   0%  .0000| 1.00|                 .0 |
|   5        2.47    .83 |   1.86 |(  3.74)  3.47   +INF |    2.94 |   0%   0% 3.5260|-12.8|    -.8%         .0 | 4
-------------------------------------------------------------------------------------------------------------
M->C = Does Measure imply Category?
C->M = Does Category imply Measure?
```

CATEGORY LABEL, the number of the category in your data set after scoring/keying.

JMLE STRUCTURE MEASURE, is the **Rasch-Andrich threshold**, the item measure add to the calibrated measure of this transition from the category below to this category. The bottom category has no prior transition, and so that the measure is shown as NONE. The Rasch-Andrich threshold is expected to increase with category value, but these can be disordered. "Dgi + Fgj" locations are plotted in Table 2.4, where "g" refers to the ISGROUPS= assignment. See Rating scale conceptualization.

For structures with only a single polytomous item, the Partial Credit Model, **this is is the Rasch model parameter δ ij in t**he δ ij parametrization of the "Partial Credit" model.)
Item difficulty: Di = average(δ ij) for all thresholds j of item i.
Andrich threshold relative to the item difficulty: Fij = δ ij - Di
Andrich threshold relative to the latent variable: STRUCTURE MEASURE = δ ij = Di + Fij
When we map the location of Di on the latent variable (or inspect the algebra of the PCM model), we discover that Di is at the location on the latent variable where the highest and lowest categories of the item are equally probable. Conveniently, the sufficient statistic for Di is the item's raw score.

STRUCTURE S.E. is an approximate standard error of the Rasch-Andrich threshold measure.

CMLE MEASURE is the CMLE equivalent of the JMLE STRUCTURE MEASURE

SCORE-TO-MEASURE
These values are plotted in Table 21, "Expected Score" ogives. They are useful for quantifying category measures. **This is implied by the Rasch model parameters.** See Rating scale conceptualization.

AT CAT is the **Rasch-full-point-threshold**, the measure (on an item of 0 logit measure) corresponding to an expected score equal to the category label, which, for the rating (or partial credit) scale model, is where this category has the highest probability. See plot below.

( ) is printed where the matching calibration is infinite. The value shown corresponds to the measure .25 score points (or LOWADJ= and HIADJ=) away from the extreme.

--ZONE-- is the **Rasch-half-point threshold,** the range of measures from an expected score from 1/2 score-point below to the category to 1/2 score-point above it, the **Rasch-half-point thresholds.** Measures in this range (on an item of 0 measure) are expected to be observed, on average, with the category value. See plot below.

50% CUMULATIVE PROBABILITY gives the location of median probabilities, i.e. these are **Rasch-Thurstonian thresholds**, similar to those estimated in the "Graded Response" or "Proportional odds" models. At these calibrations, the probability of observing the categories below equals the probability of observing the categories equal or above. The .5 or 50% cumulative probability is the point on the variable at which the category interval begins. **This is implied by the Rasch model parameters.** See Rating scale conceptualization.

COHERENCE
M->C shows what percentage of the measures that were expected to produce observations in this category actually did. Do the measures imply the category?
For RSM, everything is relative to each target item in turn. So, the 69% for category 1 is a summary across the persons with abilities in the range, "zone", from -2.63 to .85 logits relative to each item difficulty, which are all the observations where (-2.63 ≤ (Bn-Di) ≤ .85). Of these, 69% are in category 1. Depending on the targeting of the persons and the items, there could be many eligible observations or only a few.

Guttman's Coefficient of Reproducibility is the count-weighted average of the M->C, i.e., Reproducibility = sum across categories (COUNT * M->C) / sum(COUNT * 100)

C->M shows what percentage of the observations in this category were produced by measures corresponding to the category. Does the category imply the measures?

RMSR is the root-mean-square residual, summarizing the differences between observations in this category and their expectations (excluding observations in extreme scores).

ESTIM DISCR (when [DISCRIM=Y](#)) is an estimate of the local discrimination when the model is parameterized in the form:
log-odds = aj (Bn - Di - Fj)

OBSERVED - EXPECTED RESIDUAL DIFFERENCE (when shown) is the residual difference between the observed and expected counts of observations in the category. This indicates that the Rasch estimates have not converged to their maximum-likelihood values. These are shown if at least one residual percent >=1%.
residual difference % = (observed count - expected count) * 100 / (expected count)
residual difference value = observed count - expected count
1. Unanchored analyses: These numbers indicate the degree to which the reported estimates have not converged. Usually performing more estimation iterations reduces the numbers.
2. Anchored analyses: These numbers indicate the degree to which the anchor values do not match the current data.
For example,
(a) iteration was stopped early using Ctrl+F or the pull-down menu option.
(b) iteration was stopped when the maximum number of iterations was reached MJMLE=
(c) the convergence criteria LCONV= and RCONV= are not set small enough for this data set.
(d) anchor values (PAFILE=, IAFILE= and/or SAFILE=) are in force which do not allow maximum likelihood estimates to be obtained.

ITEM MEASURE ADDED TO MEASURES, is shown when the rating (or partial credit) scale applies to only one item, e.g., when ISGROUPS=0. Then all measures in these tables are adjusted by the estimated item measure.

```
        CATEGORY PROBABILITIES: MODES - Andrich Thresholds at intersections
P      ++---------+---------+---------+---------+---------+---------++
R  1.0 +                                                             +
O      |                                                             |
B      |00                                                         22|
A      |  0000                                                 2222  |
B   .8 +      000                                           222      +
I      |         000                                     222         |
L      |            00                                 22            |
I      |              00                             22              |
T   .6 +                00                         22                +
Y      |                  00       1111111       22                  |
    .5 +                    0  1111       1111  2                    +
O      |                    1**               **1                    |
F   .4 +                  11   00           22   11                  +
       |               111       00       22       111               |
R      |             11            00   22            11             |
E      |          111                0*2                111          |
S   .2 +       111                  22 00                  111       +
P      |   1111                  222     000                  1111   |
O      |111                  2222           0000                  111|
N      |              2222222                   0000000              |
S   .0 +22222222222222                                 00000000000000+
E      ++---------+---------+---------+---------+---------+---------++
       -3        -2        -1         0         1         2         3
                            PUPIL  [MINUS] ACT    MEASURE
```

Curves showing how probable is the observation of each category for measures relative to the item measure. Ordinarily, 0 logits on the plot corresponds to the item measure, and is the point at which the highest and lowest categories are equally likely to be observed. The plot should look like a range of hills. Categories which never emerge as peaks correspond to disordered Rasch-Andrich thresholds. These contradict the usual interpretation of categories as a being sequence of most likely outcomes.

Null, Zero, Unobserved Categories
STKEEP=YES and Category 2 has no observations:

CATEGORY LABEL	SCORE	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	ANDRICH THRESHOLD	CATEGORY MEASURE
0	0	378	20	-.67	-.73	.96	1.16	NONE	(-2.01)
1	1	620	34	-.11	-.06	.81	.57	-.89	-.23
2	2	0	0			.00	.00	NULL	.63
3	3	852	46	1.34	1.33	1.00	1.64	.89	(1.49)
4		20	1					NULL	

Category 2 is an incidental (sampling)zero. The category is maintained in the response structure.

Category 4 has been dropped from the analysis because it is only observed in extreme scores.

(1) Add one or more dummy person records to the data file with non-extreme scores, but with category 4 for the relevant item or rating scale. Rasch-analysis your data + dummy records, and save the Andrich thresholds: Winsteps "Output Files menu", SFILE=sf.txt
(2) Reanalyze your data. Omit the dummy records. Include SAFILE=sf.txt to anchor the Andrich thresholds at their (1) values. This does an analysis with reasonable Andrich Thresholds for the items, but only uses the actual data for the sufficient statistics used to estimate the Di and the theta values.

STKEEP=NO and Category 2 has no observations:

```
+------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------+
|  0   0     378  20|  -.87 -1.03|  1.08  1.20||  NONE   |( -2.07)|
|  1   1     620  34|   .13   .33|   .85   .69||    -.86 |    .00 |
|  3   2     852  46|  2.24  2.16|  1.00  1.47||     .86 |(  2.07)|
+------------------------------------------------------------------
```

Category 2 is a structural (unobservable) zero. The category is eliminated from the response structure.

Category Matrix : Confusion Matrix : Matching Matrix

```
-------------------------------------------------------------------------------
| Category Matrix : Confusion Matrix : Matching Matrix                        |
|            Predicted Scored-Category Frequency                              |
|Obs Cat Freq|          0           1           2           3 |         Total |
|------------+--------------------------------------------------+--------------|
|          0 |      12.19       10.22        2.57         .02 |         25.00 |
|          1 |      10.53       13.68        6.67         .11 |         31.00 |
|          2 |       1.93        6.57        8.63         .87 |         18.00 |
|          3 |        .33         .52         .15         .00 |          1.00 |
|------------+--------------------------------------------------+--------------|
|      Total |      24.98       30.99       18.03        1.01 |         75.00 |
-------------------------------------------------------------------------------
```

When CMATRIX=Yes, a category matrix (confusion matrix, matching matrix) is produced for each rating scale group defined in ISGROUPS=. In this example, there are four categories, 0, 1, 2, 3 observed in the data for the item. The row totals show the observed frequency of each category. According to the Rasch model, there is a probability that each observation will be in any category. These probabilities are summed for each category, and the model-predicted counts are shown in each column. When the data are strongly deterministic (Guttman-like) , then the major diagonal of the matrix will dominate.

In this matrix, there is one observation of category 3 in the data (see Row Total for category 3). Since category frequencies are sufficient statistics for the maximum likelihood estimates, one observation of category 3 is predicted in these data (see Column Total for category 3). However, the Category Matrix tells us that the observation of 3 is predicted to have been a 1 (Row 3, Column 1). And an observation of category 3 would be predicted to replace an observation of 2 (Row 2, Column 3). We can compare this finding with the report in Table 10.6. The observation of 3 has an expected value near 1.

```
TABLE 10.6
MOST UNEXPECTED RESPONSES
 -----------------------------------------------------
| DATA  |OBSERVED|EXPECTED|RESIDUAL|ST. RES.|MEASDIFF|
|------+--------+--------+--------+--------+--------+
|    3 |       3 |     .83 |    2.17 |    3.23 |   -2.05 |
```

Category Misfit

Usually any MNSQ (mean-square, red box in figure) less than 2.0 is OK for practical purposes. A stricter rule would be 1.5. Overfit (values less than 1.0) are almost never a problem.

```
-------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT||STRUCTURE|CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||CALIBRATN| MEASURE|
|-------------------+------------+------------++---------+--------|
|  0   0      3   4|  -.96  -.44|   .74   .73||  NONE   |( -3.66)|
|  1   1     35  47|   .12   .30|   .70   .52||  -1.64  |   -.89 |
|  2   2     36  49|  1.60  1.38|   .75   .77||   1.64  |(  1.88)|
-------------------------------------------------------------------
```

A bigger problem than category MNSQ misfit is the disordering of the "observed averages" (blue box in Figure). These contradict the Rasch axiom that "higher measure -> higher score on the rating scale".

Also large differences between the "observed average" and the "expected average" (green box in Figure). These indicate that the misfit in the category is systematic in some way.

In principle, an "expected value" is what we would see if the data fit the Rasch model. The "observed" value is what we did see. When the "observed" and "expected" are considerably misaligned, then the validity of the data (as a basis for constructing additive measures) is threatened. However, we can usually take some simple, immediate actions to remedy these defects in the data.

Usually, a 3-stage analysis suffices:
1. Analyze the data. Identify problem areas.
2. Delete problem areas from the data (PDFILE=, IDFILE=, EDFILE=, CUTLO=, etc.). Reanalyze the data. Produce item and rating-scale anchor files (IFILE=if.txt, SFILE=sf.txt) which contain the item difficulties from the good data.
3. Reanalyze all the data using the item and rating-scale anchor files (IAFILE=if.txt, SAFILE=sf.txt) to force the "good" item difficulties to dominate the problematic data when estimating the person abilities from all the data.

Category MnSq fit statistics

For all observations in the data:
Xni is the observed value
Eni is the expected value of Xni
Wni is the model variance of the observation around its expectation
Pnik is the probability of observing Xni=k

Category Outfit statistic for category k:
[sum ((k-Eni)²/Wni) for all Xni=k] / [sum (Pnik * (k-Eni)²/Wni) for all Xni]

Category Infit statistic for category k:
[sum ((k-Eni)²) for all Xni=k] / [sum (Pnik * (k-Eni)²) for all Xni]

Where does category 1 begin?

When describing a rating-scale to our audience, we may want to show the latent variable segmented into rating scale categories:

0-----------------01--------------------12------------------------2

There are 3 widely-used ways to do this:

1. "1" is the segment on the latent variable from where categories "0" and "1" are equally probable to where categories "1" and "2" are equally probably. These are the **Rasch-Andrich thresholds** (ANDRICH THRESHOLD) for categories 1 and 2.

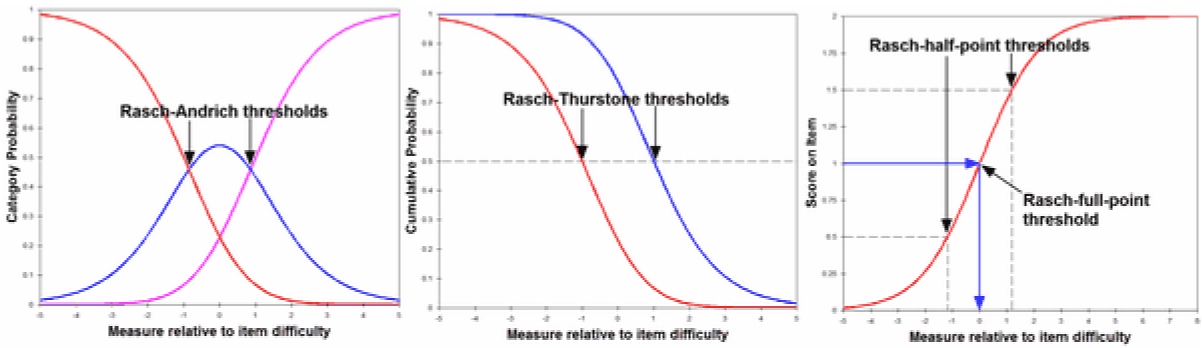
2. "1" is the segment on the latent variable from where categories "0" and "1+2" are equally probable to where categories "0+1" and "2" are equally probably. These are the **Rasch-Thurstonian thresholds** (50% CUM. PROBABILITY) for categories 1 and 2.

3. "1" is the segment on the latent variable from where the expected score on the item is "0.5" to where the expected score is 1.5. These are the **Rasch-half-point thresholds** (ZONE) for category 1.

Alternatively, we may want a point on the latent variable correspond to the category:

----------0-------------------1-----------------------2-----------

4. "1" is the point on the latent variable where the expected average score is 1.0. This is the Rasch-Full-Point threshold (AT CAT.) for category 1.



14.6 Table 4.1 Person infit fit plot

(controlled by FRANGE=, MRANGE=, MTICK=, LOCAL=, MNSQ=, OUTFIT=)

These tables are plots of the t standardized fit statistics, INFIT or OUTFIT, against the parameter estimates. INFIT is a t standardized information-weighted mean square statistic, which is more sensitive to unexpected behavior affecting responses to items near the person's measure level. OUTFIT is a t standardized outlier-sensitive mean square fit statistic, more sensitive to unexpected behavior by persons on items far from the person's measure level. The standardization is approximate. Its success depends on the distribution of persons and items. Consequently, the vertical axis is only a guide and should not be interpreted too rigidly. The NORMAL= variable controls the standardization method used.

Letters on the plot indicate the misfitting person or items. Numbers indicate non-extreme fit or multiple references. The letters appear on Tables 6, 17, 18, 19 for persons, and Tables 10, 13, 14, 15 for items.

Use MNSQ= to change the y-axis to mean-squares.

```
       -4     -3     -2     -1      0      1      2      3      4      5
      |-----------------------------------------------------------------|
P   5 |                             |     B                             |  5
E     |                             |  A                                |
R   4 |                             |                                   |  4
S     |                             |                                   |
O   3 |                    C        |                                   |  3
N     |                       D    I|                                   |
    2 |--------------------------F-G|--Q-M-------------U----------------|  2
I     |                    E       H|                                   |
N   1 |                            J|T                                  |  1
F     |                      R      |1S       11  1      1   1          |
I   0 |------------------K-----1----|1-Z1-21-1--1--12-----------------W-|  0
T     |                        O    2 L1    1 x   y  1          1       |
   -1 |                            1N t22  lnp  r  u       1            | -1
      |                             |vVh     j i     o                  |
S  -2 |-----------------------------|-w--eg--f----k---------------------| -2
T     |                             | b     d                           |
D  -3 |                             | a      c                          | -3
      |-----------------------------------------------------------------|
       -4     -3     -2     -1      0      1      2      3      4      5
                                  PERSON MEASURE

ITEMS         1    1  1   11 111 21  21221  1   21 1 1
                T         S         M         S         T

%TILE         0    10 20   30 40   50   60 70 80 90 99
```

The item distribution and item percentiles are shown beneath the plot.

14.7 Table 5.1 Person outfit fit plot

(controlled by FRANGE=, MRANGE=, MTICK=, LOCAL=, MNSQ=, OUTFIT=)

These tables are plots of the t standardized fit statistics, INFIT or OUTFIT, against the parameter estimates. INFIT is a t standardized information-weighted mean square statistic, which is more sensitive to unexpected behavior affecting responses to items near the person's measure level. OUTFIT is a t standardized outlier-sensitive mean square fit statistic, more sensitive to unexpected behavior by persons on items far from the person's measure level. The standardization is approximate. Its success depends on the distribution of persons and items. Consequently, the vertical axis is only a guide and should not be interpreted too rigidly. The NORMAL= variable controls the standardization method used.

Letters on the plot indicate the misfitting person or items. Numbers indicate non-extreme fit or multiple references. The letters appear on Tables 6, 17, 18, 19 for persons, and Tables 10, 13, 14, 15 for items.

Use MNSQ= to change the y-axis to mean-squares.

```
       -4     -3     -2     -1      0      1      2      3      4      5
      |-----------------------------------------------------------------|
P   5 |                             |     B                             |  5
E     |                             |  A                                |
R   4 |                             |                                   |  4
S     |                             |                                   |
O   3 |                    C        |                                   |  3
N     |                       D    I|                                   |
    2 |--------------------------F-G|--Q-M-------------U----------------|  2
O     |                    E       H|                                   |
U   1 |                            J|T                                  |  1
T     |                      R      |1S       11  1      1   1          |
F   0 |------------------K-----1----|1-Z1-21-1--1--12-----------------W-|  0
I     |                        O    2 L1    1 x   y  1          1       |
T  -1 |                            1N t22  lnp  r  u       1            | -1
      |                             |vVh     j i     o                  |
S  -2 |-----------------------------|-w--eg--f----k---------------------| -2
T     |                             | b     d                           |
D  -3 |                             | a      c                          | -3
      |-----------------------------------------------------------------|
       -4     -3     -2     -1      0      1      2      3      4      5
                                  PERSON MEASURE

TAP    3   1  2  2     1    1             1     11       1       31
       S                        M                         S
%TILE  0 10 20 30 40  50                 60     70              90 99
```

The item distribution and item percentiles are shown beneath the plot.

14.8 Table 5.2 Person infit-outfit fit plot

If both Table 4.1 infit and Table 5.1 outfit plots are requested, then a plot of outfit against infit is also produced to assist with the identification of the different patterns of observations they diagnose. For interpretation of fit statistics, see dichotomous and polytomous fit statistics. The letters on the indicate misfitting persons in Table 6.1. Numbers are the count of persons with that degree of misfit at that location on the plot.

```
      -4   -3   -2   -1    0    1    2    3    4    5    6    7    8    9
      ---------------------------------------------------------------------
    6            |                   |                   .                   6
P                |                   |                 .B
E   5            |                   |              .        A               5
R                |                   |            .
S   4            |                   |         .                             4
O                |                   |       .
N   3            |                   |    .            C                     3
                 |                   |I .         D
I   2  ----------+--------- -U-Q---M-+-------2---------------------------    2
N                |                 . | H          E
F   1            |           T  .    J                                       1
I                |       24   2      |
T   0                   453W       K                                         0
                 |     31.3    PO  L |
S  -1            |   2721       N    |                                      -1
T                |  .3ov    V        |
D  -2  ----------+-2gk-w--- ---------+-----------------------------------   -2
               b d                   |
```

```
-3        a    c|                    |                                      -3
    -----------------------------------------------------------------
   -4    -3    -2    -1     0     1     2     3     4     5     6     7     8     9
                                  PERSON OUTFIT ZSTD
```

14.9 Table 6 Person report in misfit order

14.9.1 Table 6.1 Person statistics in misfit order

(controlled by FITP=, USCALE=, UIMEAN=, UPMEAN=, UDECIM=, LOCAL=, OUTFIT=, PSORT=, TOTAL=)

PERSON STATISTICS: MISFIT ORDER

For details, please see Table 10.1

Example: To eliminate misfitting persons, output Table 6.1. Copy into Notepad++ (freeware) or other software capable of rectangular copy (alt+mouse). Then paste into your Winsteps control file
PDFILE=*
pasted entry numbers - put enough blank lines here first for all the numbers
*

Another approach is to screen out very unexpected answers, rather than whole people. Do this with CUTLO= -2

14.9.2 Table 6.2 Person statistics graphically in misfit order

Please see Table 10.2

14.9.3 Table 6.4 Person most-misfitting response strings

Table 6.4 displays the unexpected responses in the up to 26 most-misfitting person-response strings.

```
MOST MISFITTING RESPONSE STRINGS
KID          OUTMNSQ  |TAP
                      |     111
                      |47568024 <- The list column is Item 14
                  high--------
29 Anne     F    6.07 A|.0..0..1
13 Mike     M    5.28 B|.0.0..1.
 3 Walter   M    1.19 C|......1.
24 Rick     M     .88 D|......0.
34 Elsie    F     .71 E|.......1
23 Bert     M     .67 F|.......1
33 Martha   F     .86 I|.....1..
17 Rod      M     .97 J|..0.....
11 Pete     M     .81 M|0.......
                      |--------low
                      |47568111
                      |     024
```

In this Table, the persons (rows) are sorted:

OUTFIT=Yes	Sorted by Outfit Mean-square descending
OUTFIT=No	Sorted by bigger of Outfit Mean-square and Infit mean-square descending.

The items (columns) are sorted by measure. The easiest item (highest-scoring) is on the left. The item entry-numbers are in each column (vertically). In the Figure, the first is item 18. The items shown are those with the most-unexpected responses according to Table 6.1, but excluding items with no individually misfitting observations on the reported items. UCOUNT= sets the maximum number of items to report. LINELENGTH= controls the width of the table. "high" indicates where we expect to see high observations. "low" indicates where we expect to see low observations. Expected observations are replaced by ".'.

Each row contains:
    Person entry number
    Person label

Person outfit mean-square
Person letter (A-Z) in the Table 6.1.
The responses to the items:

0, 1, 2 and numeric values	Scored unexpected-responses
•	Expected responses, standardized residuals < |2|
(blank)	Missing data

14.9.4 Table 6.5 Person most-unexpected observations

Table 6.5 displays the person response strings with the most-unexpected responses as shown in Table 6.6.

```
MOST UNEXPECTED RESPONSES
PUPIL                     MEASURE  |ACT
                                   |1111112 122 1    22
                                   |89203112542669784035
                               high--------------------
   41 FATALE, NATASHA         4.77  |..................1.
   17 SCHATTNER, GAIL         3.55  |...................0
   71 STOLLER, DAVE            .96 B|.0.10....0.......222
   53 SABOL, ANDREW          -1.59 L|..............1....1
                                   |-----------------low
                                   |11111122122619784225
                                   |8920311 542 6    03
```

In this Table, the persons (rows) are sorted by measure, descending.

The items (columns) are sorted by measure. The easiest item (highest-scoring) is on the left. The item entry-numbers are in each column (vertically). In the Figure, the first is item 18. The items shown are those with the most-unexpected responses as shown in Table 6.6. UCOUNT= sets the maximum number of items to report. LINELENGTH= controls the width of the table. "high" indicates where we expect to see high observations. "low" indicates where we expect to see low observations. Expected observations are replaced by ".'.

Each row contains:
Person entry number
Person label
Person measure
Person letter (A-Z) in the plot in Tables 4 and 5.
The responses to the items:

0, 1, 2 and numeric values	Scored unexpected-responses
•	Expected responses, standardized residuals < |2|
(blank)	Missing data

14.9.5 Table 6.6 Person most-unexpected response list

This shows the most unexpected responses sorted by unexpectedness (standardized residual). Large standardized residuals contribute to large outfit mean-square fit statistics. UCOUNT= sets the maximum number of "most unexpected responses" to report in Tables 6.6, 10.6.

```
MOST UNEXPECTED RESPONSES
+----------------------------------------------------------------------------------------------------+
| DATA |OBSERVED|EXPECTED|RESIDUAL|ST. RES.|MEASDIFF| ACT   | KID     | ACT           | KID              |
|------+--------+--------+--------+--------+--------+-------+---------+---------------+------------------|
|    0 |      0 |   1.93 |  -1.93 |  -7.66 |   3.53 |    18 |      73 | GO ON PICNIC  | SANDBERG, RYNE   |
|    2 |      2 |    .07 |   1.93 |   7.57 |  -3.50 |    23 |      72 | WATCH A RAT   | JACKSON, SOLOMON |
|    2 |      2 |    .07 |   1.93 |   7.57 |  -3.50 |    23 |      29 | WATCH A RAT   | LANDMAN, ALAN    |
|    0 |      0 |   1.93 |  -1.93 |  -7.41 |   3.46 |    19 |      71 | GO TO ZOO     | STOLLER, DAVE    |
```

DATA is the response code in the data file
OBSERVED is the code's value after rescoring
EXPECTED is the predicted observation based on the person and item estimated measures
RESIDUAL is (OBSERVED - EXPECTED), the difference between the observed and expected values
ST. RES. is the standardized residual, the unexpectedness of the residual expressed as a unit normal deviate
MEASDIFF is the difference between the ability and difficulty estimates. This produces the EXPECTED value.
ACT is the item entry number

KID is the person entry number
ACT is the item label
KID is the person label

14.10 Table 7.1 Person misfitting responses

(controlled by FITP=, LINELENGTH=, MNSQ=, OUTFIT=, T7OPTIONS=)

These tables show the persons or items for which the t standardized outfit (or infit, if OUTFIT=N) statistic is greater than the misfit criterion (FITP=). FITP=-10 with MNSQ=No displays all persons. Persons are listed in descending order of misfit. The response codes are listed in their sequence order in your data file. The residuals are standardized response score residuals, which have a model led expectation of 0, and a variance of 1. Negative residuals indicate that the observed response was less correct (or, for rating (or partial credit) scales, lower down the rating scale) than expected. The printed standardized residual is truncated, not rounded, so that its actual value is at least as extreme as that shown. Standardized residuals between -1 and 1 are not printed. For exact details, see XFILE=. "M" indicates a missing response.

"X" indicates that the item obtained an extreme score."X" in Tables 7.1 and 11.1 indicates that the observation is part of an extreme score, and so does not have a standardized residual. All residuals for extreme scores are conceptually zero. Persons with "X" in Item Table 11.1 (because they have extreme scores) do not appear in Table 7.1, and *vice-versa,* because those extreme persons and items are not part of the misfit process. Basically "X" says "this observation is excluded from the misfit computation".

For Table 7, the diagnosis of misfitting persons, persons with a t standardized fit greater than FITP= are reported. Selection is based on the OUTFIT statistic, unless you set OUTFIT=N in which case the INFIT statistic is used.

```
 TABLE OF POORLY FITTING PERSONS     (ITEMS IN ENTRY ORDER)
 NUMBER    NAME     POSITION        MEASURE    INFIT (ZSTD) OUTFIT   MISFIT OVER 2.0

   23 GEORGE                          2.00      5.8    A    8.1
       RESPONSE:     1:  0 2 1 1 1  2 2 0 2 0   0 1 0 1 1  0 1 0 0 0   0 1 1 0 0
     Z-RESIDUAL:           X     2  3     3        2

       RESPONSE:    26:  1 2 0 2 1  M 0 0 1 1   1 0 1 0 0  1 0 0 0 0   0 0 0 2 1
     Z-RESIDUAL:           3   6 2                        -2      -2          4

                                                      / This letter on fit plots
    5 MARY                            2.21      5.2    B    6.5
       RESPONSE:     1:  1 2 0 0 1  2 0 0 1 0   0 2 0 0 1  1 0 0 0 0   0 1 1 0 1
     Z-RESIDUAL:           X     2  4              6          -2
```

Example: Table 7.1 with T7OPTIONS = OERZ in an analysis of Example0.txt:

```
TABLE OF POORLY FITTING KID   (ACT IN ENTRY ORDER)
NUMBER - NAME -- POSITION ------ MEASURE - INFIT (MNSQ) OUTFIT

     72  M Jackson, Solomon        -1.32     2.0   A    5.2
  OBSERVED:      1:  1    0    0    1    0     0    0    1    0    0    <- T7OPTIONS= O
  EXPECTED:          0.6  0.7  0.3  0.1  0.1   0.4  0.2  0.1  0.3  1.1  <- T7OPTIONS= E
  RESIDUAL:          0.4 -0.7 -0.3  0.9 -0.1  -0.4 -0.2  0.9 -0.3 -1.1  <- T7OPTIONS= R
Z-RESIDUAL:                         2                    2              <- T7OPTIONS= Z
```

The OBSERVED value is the scored response, before recounting due to STKEEP=No, if any.
The EXPECTED value is the OBSERVED value - RESIDUAL value.

14.11 Table 8.1 Item infit fit plots

(controlled by FRANGE=, MRANGE=, MTICK=, LOCAL=, MNSQ=, OUTFIT=)

These tables are plots of the t standardized fit statistics, INFIT or OUTFIT, against the parameter estimates. INFIT is a t standardized information-weighted mean square statistic, which is more sensitive to unexpected behavior affecting responses to items near the person's measure level. OUTFIT is a t standardized outlier-sensitive mean square fit statistic, more sensitive to unexpected behavior by persons on items far from the person's measure level. The standardization is approximate. Its success depends on the distribution of persons and items. Consequently, the vertical axis is only a guide and should not be interpreted too rigidly. The NORMAL= variable controls the standardization method used.

Letters on the plot indicate the misfitting person or items. Numbers indicate non-extreme fit or multiple references. The letters appear on Tables 6, 17, 18, 19 for persons, and Tables 10, 13, 14, 15 for items.

Use MNSQ= to change the y-axis to mean-squares.

```
       -4     -3     -2     -1      0      1      2      3      4      5
      |-----------------------------------------------------------------|
    5 |                             |     B                             |  5
      |                             |  A                                |
I   4 |                             |                                   |  4
T     |                             |                                   |
E   3 |                    C        |                                   |  3
M     |                       D    I|                                   |
    2 |--------------------------F-G|--Q-M-------------U----------------|  2
I     |                    E       H|                                   |
N   1 |                            J|T                                  |  1
F     |                      R      |1S       11  1      1   1          |
I   0 |------------------K-----1----|1-Z1-21-1--1--12-----------------W-|  0
T     |                        O    2 L1    1 x   y  1          1       |
   -1 |                            1N t22  lnp  r  u       1            | -1
      |                             |vVh     j i     o                  |
S  -2 |-----------------------------|-w--eg--f----k---------------------| -2
T     |                             | b     d                           |
D  -3 |                             | a      c                          | -3
      |-----------------------------------------------------------------|
       -4     -3     -2     -1      0      1      2      3      4      5
                                  ITEM MEASURE

PERSON 1   1   2   2    2    3     2       5     4    1    2
        T            S             M            S            T

%TILE  0      10       20   30    60      80    90        99
```

The person distribution and person percentiles are shown beneath the plot.

14.12 Table 9.1 Item outfit fit plot

(controlled by FRANGE=, MRANGE=, MTICK=, LOCAL=, MNSQ=, OUTFIT=)

These tables are plots of the t standardized fit statistics, INFIT or OUTFIT, against the parameter estimates. INFIT is a t standardized information-weighted mean square statistic, which is more sensitive to unexpected behavior affecting responses to items near the person's measure level. OUTFIT is a t standardized outlier-sensitive mean square fit statistic, more sensitive to unexpected behavior by persons on items far from the person's measure level. The standardization is approximate. Its success depends on the distribution of persons and items. Consequently, the vertical axis is only a guide and should not be interpreted too rigidly. The NORMAL= variable controls the standardization method used.

Letters on the plot indicate the misfitting person or items. Numbers indicate non-extreme fit or multiple references. The letters appear on Tables 6, 17, 18, 19 for persons, and Tables 10, 13, 14, 15 for items.

Use MNSQ= to change the y-axis to mean-squares.

For Table 9.2 Item infit-outfit fit plot.

```
       -4     -3     -2     -1      0      1      2      3      4      5
      |-----------------------------------------------------------------|
    5 |                             |     B                             |  5
      |                             |  A                                |
I   4 |                             |                                   |  4
T     |                             |                                   |
E   3 |                    C        |                                   |  3
M     |                       D    I|                                   |
    2 |--------------------------F-G|--Q-M-------------U----------------|  2
O     |                    E       H|                                   |
U   1 |                            J|T                                  |  1
T     |                      R      |1S       11  1      1   1          |
F   0 |------------------K-----1----|1-Z1-21-1--1--12-----------------W-|  0
```

```
I        |                                   O     2 L1     1 x    y   1               1          |
T   -1   |                                        1N t22   lnp   r   u          1                 | -1
         |                                          |vVh       j i       o                        |
S   -2   |------------------------------------------|-w--eg--f----k-------------------------------| -2
T        |                                          | b       d                                   |
D   -3   |                                          | a         c                                 |
         |------------------------------------------------------------------------------------------|
          -4        -3        -2        -1         0         1         2         3         4         5
                                                ITEM MEASURE

PERSON 1     1     2     2      2     3      2         5      4     1      2
        T                 S                  M                 S                 T
%TILE  0         10           20    30     60         80     90            99
```

The person distribution and person percentiles are shown beneath the plot.

14.13 Table 9.2 Item infit-outfit fit plot

If both infit and outfit plots are requested, then a plot of outfit against infit is also produced to assist with the identification of the different patterns of observations they diagnose. For interpretation of fit statistics, see dichotomous and polytomous fit statistics. The letters on the indicate misfitting items in Table 10.1. Numbers are the count of items with that degree of misfit at that location on the plot.

```
      -4   -3   -2   -1    0    1    2    3    4    5    6    7    8    9
      ---------------------------------------------------------------------
    6            |                   |                   .                   6
                 |                   |                 .B
    5            |                   |              .        A               5
I                |                   |            .
T   4            |                   |         .                             4
E                |                   |       .
M   3            |                   |    .            C                     3
                 |                   |I .         D
I   2  ----------+--------- -U-Q---M-+-------2---------------------------    2
N                |                 . | H          E
F   1            |           T  .    J                                       1
I                |       24   2      |
T   0                   453W       K                                         0
                 |     31.3    PO  L |
S  -1            |   2721       N    |                                      -1
T                |  .3ov    V        |
D  -2  ----------+-2gk-w--- ---------+-----------------------------------   -2
               b d                   |
   -3       a   c|                   |                                      -3
       -------------------------------------------------------------------
      -4   -3   -2   -1    0    1    2    3    4    5    6    7    8    9
                              ITEM OUTFIT ZSTD
```

14.14 Table 10 Item report in misfit order

14.14.1 Table 10.1 Item statistics in misfit order

(controlled by FITI=, LOCAL=, OUTFIT=, TOTAL=)

ITEMS STATISTICS: MISFIT ORDER

```
PERSON: REAL SEP.: 1.55  REL.: .70 ... ITEM: REAL SEP.: 3.73  REL.: .93
```

Above the Table are shown the "real" separation coefficient and reliability (separation index) coefficients from Table 3.

```
-----------------------------------------------------------------------------------------------
    ----------------------------------------------------
|ENTRY    TOTAL  TOTAL           MODEL|   INFIT  |  OUTFIT  |PTMEASUR-AL|EXACT MATCH|ESTIM|
    ASYMPTOTE |  P-   |      |     |        |                  |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%|DISCR|LOWER
```

```
   UPPER|VALUE| RMSR|WEIGH|DISPLACE| TAP           G |
|------------------------------------+----------+----------+-----------+----------+-----
   +-----------+-----+-----------+--------+-----------------|
|     1     35     35    -6.59A   1.85|1.00    .00|1.00   .04|A .00    .00|100.0 100.0| 1.00|  .00
    1.00| 1.00| .000|  .50|    -.52| 1-4            1 |
|     5     31     35    -3.83     .70|1.04    .19| .52   .12|B .55    .55| 88.2  91.7| 1.01|  .05
    1.00|  .89| .248| 1.00|    -.87| 2-1-4          2 |
|     6     30     35    -3.38     .64| MAXIMUM MEASURE     |  .53    .58|100.0 100.0|     |
         |  .86| .289| 1.00|    -.64| 3-4-1           1 |
|     7     31     35    -3.83     .70| MINIMUM MEASURE     |  .40    .55|100.0 100.0|     |
         |  .89| .281| 1.00|     .57| 1-4-3-2         2 |
|     8     27     35                | DROPPED             |            |           |     |
         |     |     |     |         | 1-4-2-3         1 |
|    10      0     35                | INESTIMABLE: HIGH   |            |           |     |
         |     |     |     |         | 2-4-3-1         3 |
|    11     35     35                | INESTIMABLE: LOW    |            |           |     |
         |     |     |     |         | 1-3-1-2-4       4 |
|     9          DELETED             |          |          |            |           |     |
         |     |     |     |         | 1-3-2-4         2 |
|    12          DESELECTED          |          |          |            |           |     |
         |     |     |     |         | 1-3-2-4-3       1 |
....
|------------------------------------+----------+----------+-----------+----------+-----
   +-----------+-----+-----+-----+--------+-----------------|
| MEAN    18.5   35.0    -.59      .94| .96    .04| .68  -.11|           | 89.9  90.0|     |
         |     |     |     |      .32|                    |
| P.SD    13.9     .0    4.21      .49| .28    .71| .58   .53|           |  6.3   5.3|     |
         |     |     |     |      .27|                    |
-----------------------------------------------------------------------------------------------
   --------------------------------+------------------
```

```
-----------------------------------------------------------------------------------------------
   -----
|ENTRY   TOTAL   JMLE   MODEL|   INFIT   |  OUTFIT  |    CMLE      |  CMLE INFIT  |   CMLE
   OUTFIT |
|NUMBER  SCORE MEASURE   S.E. |MNSQ  ZSTD|MNSQ  ZSTD| MEASURE  S.E. |  MNSQ    ZSTD |  MNSQ
   ZSTD |
|----------------------------+----------+----------+---------------+---------------
   +---------------+
|     5     37   2.42     .22|2.30  5.61|3.62  7.27|   2.32     .22|   2.31    5.65|   3.56
   7.26|
|    23     42   2.18     .21|2.41  6.29|4.11  8.97|   2.09     .22|   2.43    6.35|   4.06
   8.98|
|    20     50   1.83     .20|1.33  2.00|1.82  3.73|   1.76     .20|   1.34    2.06|   1.81
   3.74|
```

Column	Description
ENTRY NUMBER	the sequence number of the person, or item, in your data, and is the reference number used for deletion or anchoring.
TOTAL SCORE TOTAL COUNT	Totalscore=Yes -. This is the score when reading in the data.
NON-EXTREME SCORE NON-EXTREME COUNT	Totalscore=No - the raw score and count of response by a person on the test, or the sum of the scored responses to an item by the persons, omitting responses in extreme and inestimable scores. This is the score when estimating person abilities and item difficulties. Scored responses are transformed (re-counted) so that the lowest response is zero.

<table>
<tr><td>MEASURE</td><td>the estimate (or calibration) of the person ability (theta, B, beta, etc.), or the item difficulty (b, D, delta, etc.). Values are reported in logits with two decimal places, unless rescaled by USCALE=, UIMEAN=, UPMEAN=, UDECIM=.

The difficulty of an item is defined to be the point on the latent variable at which its high and low categories are equally probable. SAFILE= can be used to alter this definition.

If unexpected results are reported, check whether TARGET= or CUTLO= or CUTHI= or ISGROUPS= are specified.</td></tr>
<tr><td>A after MEASURE, MAXIMUM, etc.</td><td>see STATUS Table below</td></tr>
<tr><td>MODEL S.E.
REAL S.E.</td><td>MODEL S.E. is the standard error of the estimate. REAL S.E. is the misfit-inflated standard error. These are commonly referred to as conditional standard errors of measurement (CSEM).
Real S.E> while you are improving your results. This assumes misfit contradicts the Rasch model. Model S.E. when your results are as good as they can be. This assumes misfit is the randomness predicted by the Rasch model.</td></tr>
<tr><td>INFIT</td><td>an information-weighted statistic, which is more sensitive to unexpected behavior affecting responses to items near the person's measure level.</td></tr>
<tr><td>OUTFIT</td><td>an unweighted statistic, more sensitive to unexpected behavior by persons on items far from the person's measure level.</td></tr>
<tr><td>MNSQ</td><td>a mean-square statistic computed for all scores responses, excluding responses in extreme total scores. This is a chi-square statistic divided by its degrees of freedom. Its expectation is 1.0. Values substantially less than 1.0 indicate overfit = dependency in your data. Values values substantially greater than 1.0 indicate underfit = unmodeled noise. See dichotomous and polytomous fit statistics.

<table>
<tr><th>Value</th><th>Meaning</th></tr>
<tr><td>>2.0</td><td>Off-variable noise is greater than useful information. Degrades measurement. Always remedy the large misfits first.</td></tr>
<tr><td>>1.5</td><td>Noticeable off-variable noise. Neither constructs nor degrades measurement</td></tr>
<tr><td>0.5 - 1.5</td><td>Productive of measurement</td></tr>
<tr><td><0.5</td><td>Overly predictable. Misleads us into thinking we are measuring better than we really are. (Attenuation paradox.). Item misfits <1.0 are only of concern when shortening a test. Person misfits <1.0 are rarely of concern.</td></tr>
</table></td></tr>
<tr><td>ZSTD
ZEMP
LOG
PROB</td><td>the INFIT or OUTFIT mean-square fit statistic t standardized to approximate a theoretical "unit normal", mean 0 and variance 1, distribution. ZSTD (standardized as a z-score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic distribution value has been adjusted to a unit normal value. The standardization is shown on RSA, p.100-101. When LOCAL=Y, then ZEMP is shown, indicating a local {0,1} standardization. When LOCAL=LOG, then LOG is shown, and the natural logarithms of the mean-squares are reported. More exact values are shown in the Output Files. When LOCAL=PROB, the probability of the mean-square is shown.
Ben Wright advises: "ZSTD is only useful to salvage non-significant MNSQ>1.5, when sample size is small or test length is short."</td></tr>
<tr><td>PTMEASUR-AL CORR.
PTMEASUR-AL EXP.</td><td>an observed point-correlation: PTBISERL-AL, PTBISERL-EX, PTMEASURE-A, PTMEASUR-EX, see Correlations. Negative reported correlations suggest that the orientation of the scoring on the item, or by the person, may be opposite to the orientation of the latent variable. This may be caused by item miskeying, reverse scoring,</td></tr>
</table>

	person special knowledge, guessing, data entry errors, or the expected randomness in the data. Correlations of 0.00 may be because the correlation cannot be calculated due to the structure of the data. In FIT ORDER Tables 6.1 and 10.1, letters A, B, ... indicating the identity of persons or items appearing on the Infit and Outfit plots, Tables 4, 5, 8, 9, precede the correlations. If the point-correlation is inestimable because items have different numbers of categories, this column does not appear, or only the FIT letters display. EXP. is the expected value of the point-correlation when the data fit the Rasch model with the estimated measures. See Correlations.
EXACT MATCH OBS% EXACT MATCH EXP%	OBServed% is the percent of data points that are within 0.5 score points of their expected values, i.e., that match predictions. EXPected% is the percent of data points that are predicted to be within 0.5 score points of their expected values.
ESTIM DISCRIM	an estimate of the 2-PL item discrimination, see DISCRIM= Negative discriminations are usually problematic and accompanied by negative point-biserial correlations. These indicate that the scoring on the item may be contradicting the overall latent variable. However, this is not a universal rule, so please look at the infit and outfit mean-squares to see whether they also indicate problems (values much greater than 1.0). Exceptions to the rule include very hard and very easy items, and situations where the person sample variance is very small.
ASYMPTOTE LOWER ASYMPTOTE UPPER	estimates of the upper and lower asymptotes for dichotomous items, see ASYMPTOTE=
P-VALUE	the observed proportion-correct (p-value) for 0/1 dichotomies, or observed average rating on the item, see PVALUE=.
RMSR	root-mean-square-residual of observations not in extreme scores, see RMSR=.
WMLE	Warm's Weighted Maximum Likelihood Estimate (WLE), see WMLE=
QCMLE	Quasi-Conditional Maximum Likelihood Estimate, see QCMLE=
WEIGH	the weight assigned by IWEIGHT= or PWEIGHT=. When WEIGHT = 0.0, the item or person is estimated, but does not influence the estimate of any other item or person.
CMLE MEASURE	CMLE item measure or CMLE-based AMLE person measure when CMLE=Yes
CMLE S.E.	CMLE measure S.E. for items and person when CMLE=Yes
CMLE INFIT MNSQ	CMLE Infit Mean-square fit computed from CMLE probabilities when CMLE=Yes
CMLE INFIT ZSTD	CMLE Infit Z-standardized fit computed from CMLE probabilities when CMLE=Yes
CMLE OUTFIT MNSQ	CMLE Outfitfit Mean-square fit computed from CMLE probabilities when CMLE=Yes
CMLE OUTFIT ZSTD	CMLE Outfit Z-standardized fit computed from CMLE probabilities when CMLE=Yes
CMLE WMLE	CMLE Warm's Weighted Maximum Likelihood estimates when CMLE=Yes and WMLE=Yes
DISPLACE	the displacement of the reported MEASURE from its data-derived value. This should only be shown with anchored measures. The displacement values can be see in IFILE= and PFILE= output files. The displacement is an estimate of the amount to add to the MEASURE to make it conform with the data. + logit displacement for a person ability indicates that the observed person score is

	higher (higher ability) than the expected person score based on the reported measure (anchor value). + logit displacement for an item difficulty indicates that the observed item score is lower (harder item) than the expected item score based on the reported measure (anchor value). *Unanchored measures:* If small displacements are shown, tighten the convergence criteria, CONVERGE=, LCONV=, RCONV= *Anchored measures:* we expect half the displacements to be negative and half to be positive, and for them to be normally distributed according to the standard errors of the measures.
PERSON ITEM	the name of the list of persons (data rows) or items (data columns) reported here
G	the grouping code assigned with ISGROUPS=. Table 3.2, 3.3, etc. show the details of rating scales, etc., for each grouping code.
M	model code assigned with MODELS=
SUBSET:	the person or items are in incomparable subsets, see Subsets.

Reported	*STATUS* PFILE=, IFILE=	*Measured?*	*Reason*
A (after Measure)	2	Yes	Anchored (fixed) measure. The reported S.E. is that which would have been obtained if the value had been estimated. Values are reported in logits with two decimal places, unless rescaled by USCALE=, UDECIM=
(MEASURE)	1	Yes	Estimated measure
MINIMUM	0	Yes	Extreme minimum score. Measure estimated using EXTRSC= MINIMUM and MAXIMUM measures may occur because other MINIMUM and MAXIMUM measures have been dropped from the estimation. Inspect with TOTALSCORE=No.
MAXIMUM	-1	Yes	Extreme maximum score. Measure estimated using EXTRSC= MINIMUM and MAXIMUM measures may occur because other MINIMUM and MAXIMUM measures have been dropped from the estimation. Inspect with TOTALSCORE=No.
DROPPED	-2	No	No responses available for measurement. Perhaps due to CUTLO=, CUTHI=, CODES=, or deletion of other persons or items. Also check that anchored items. IAFILE=, has matching SAFILE= for all items.
DELETED	-3	No	Deleted by user. PDELETE=, PDFILE=, IDELETE=, IDFILE=, PSELECT=, ISELECT=
INESTIMABLE: HIGH	-4	No	For an item, this can be resolved using SAFILE= or grouping this item with a similar estimable item: SAFILE=* 23 0 0 ; item-number bottom-category 0 23 1 0 ; item-number top-category 0 * For a person: change the observation by this person on the hardest item into a lower category.
INESTIMABLE: LOW	-5	No	The measure probably has a low value. For an item, this can be resolved using SAFILE= or grouping this item with a similar estimable item: SAFILE=* 23 0 0 ; item-number bottom-category 0 23 1 0 ; item-number top-category 0

			* For a person: change the observation by this person on the easiest item into a higher category.
DROPPED A (after Measure)	-6	Yes	Anchored (fixed) measure with no observed raw score
DESELECTED	-7 to -16	No	Temporarily deselected by Specification box with iSELECT= , etc. (usual STATUS - 10)
OMITTED	-17 to -26	No	Temporarily deleted by Specification box with iDELETE=, etc. (usual STATUS - 20)
REMOVED	-27 to -36	No	Temporarily deselected and deleted by Specification box with iSELECT= , etc., and iDELETE=, etc. (usual STATUS - 30)

Example: To eliminate misfitting items, output Table 10.1. Copy into Notepad++ (freeware) or other software capable of rectangular copy (alt+mouse). Then paste into your Winsteps control file
IDFILE=*
pasted entry numbers - put enough blank lines here first for all the numbers
*

Another approach is to screen out very unexpected answers, rather than whole people. Do this with CUTLO= -2

14.14.2 Table 10.2 Item statistics graphically in misfit order

Controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, FITLOW=, FITHIGH=, MNSQ=

Specify CHART=YES to produce Tables like this.

With MNSQ=Yes:

```
         PUPIL FIT GRAPH:  OUTFIT ORDER
+----------------------------------------------------------------------------------+
|ENTRY| MEASURE |  INFIT MEAN-SQUARE  | OUTFIT MEAN-SQUARE  |                      |
|NUMBR| -     + |0     0.7 1 1.3     2|0     0.7 1 1.3     2| PUPIL                |
|-----+---------+---------------------+---------------------+----------------------|
|   72|*        |       :  .  :     * |A      :  .  :      *| JACKSON, SOLOMON     |
|   47|  *      |       :  . *:       |J      :  .  :   *   | VAN DAM, ANDY        |
|   53|*        |       : *.  :       |K      :  .  :     * | SABOL, ANDREW        |
|   32|  *      |      *:  .  :       |w      *  .  :       | ROSSNER, JACK        |
|   21|  *      |  *    :  .  :       |a *    :  .  :       | EISEN, NORM L.       |
+----------------------------------------------------------------------------------+
```

The fit information is shown in graphical format to aid the eye in identifying patterns and outliers. The fit bars are positioned by FITLOW= and FITHIGH=. They may also be repositioned using TFILE=.

With MNSQ=No:, the ZSTD (*t*-standardized) statistics are reported:

```
+----------------------------------------------------------------------------+
|ENTRY | MEASURE |INFIT t standardized |OUTFIT t standardized|               |
|NUMBER| -     + |-3 -2 -1  0  1  2  3 |-3 -2 -1  0  1  2  3 | TAPS          |
|------+---------+---------------------+---------------------+---------------|
|    18|        E|    :     .     :    |    :     .     :    | 4-1-3-4-2-1-4 |
|    15|       * |    :    *.     :    |    :     *     :    | 1-3-2-4-1-3   |
|    14|      *  |    :     .  *  :    |    :     *     :    | 1-4-2-3-4-1   |
|    12|      *  |    :     .*    :    |    :     *     :    | 1-3-2-4-3     |
|    13|     *   |    :  *  .     :    |    :   * .     :    | 1-4-3-2-4     |
|    11|     *   |    :     *     :    |    :    *.     :    | 1-3-1-2-4     |
|    10|   *     |    :     *     :    |    :     *     :    | 2-4-3-1       |
|     7|  *      |    :     . *   :    |    :     .*    :    | 1-4-3-2       |
|     4| *       |    :     *     :    |    :     *     :    | 1-3-4         |
|     1|E        |    :     .     :    |    :     .     :    | Cube 1, then 4|
+----------------------------------------------------------------------------+
```

"OMIT" appears in fit-ordered Tables, where items better fitting than FITI=, or persons better fitting than FITP=, are excluded.

14.14.3 Table 10.3 Item option & distractor frequencies in misfit order

(controlled by Distractors=Y, OSORT=, CFILE=, PTBIS=)

ITEM OPTION FREQUENCIES are output if Distractors=Y. These show occurrences of each of the valid data codes in CODES=, and also of MISSCORE= in the input data file. Counts of responses forming part of extreme scores are included. Only items included in the corresponding main table are listed. These statistics are also in DISFILE=, which includes entries even if the code is not observed for the item. See also Distractor Analysis.

OSORT= controls the ordering of options within items. The standard is the order of data codes in CODES=.

```
         ITEM CATEGORY/OPTION/DISTRACTOR FREQUENCIES:  ENTRY ORDER
---------------------------------------------------------------------------------------------------
|ENTRY   DATA  SCORE |     DATA    |      ABILITY     S.E.  INFT OUTF PTMA |                       |
|NUMBER  CODE  VALUE |  COUNT    % |    MEAN    P.SD  MEAN  MNSQ MNSQ CORR.| ITEM                  |
|--------------------+-------------+---------------------------------------+-----------------------|
|   13   4       *** |     11  16#|     .79     1.41  .45              .08 |M. STAIRS              | 4 75% Independent
|        1         1 |     30  52 |   -1.85      .99  .18    .8  1.0  -.89 |                       | 1 0% Independent
|        3         3 |      5   9 |    1.07      .80  .40    .6   .4   .10 |                       | 3 50% Independent
|        5         5 |     15  26 |    2.63     1.06  .28   1.7  1.5   .56 |                       | 5 Supervision
|        6         6 |      7  12 |    3.25      .81  .33   1.2  1.2   .44 |                       | 6 Device
|        7         7 |      1   2 |    4.63      .00         .7   .6   .23 |                       | 7 Independent
|        MISSING *** |      1   1#|   -1.99      .00                 -.12 |                       |
---------------------------------------------------------------------------------------------------
 * Average ability does not ascend with category score
 # Missing % includes all categories. Scored % only of scored categories
```

ENTRY NUMBER is the item sequence number.
The letter next to the sequence number is used on the fit plots.

DATA CODE is the response code in the data file.
MISSING means that the data code is not listed in the CODES= specification.
Codes with no observations are not listed.

SCORE VALUE is the value assigned to the data code by means of NEWSCORE=, KEY1=, IVALUEA=, etc.
*** means the data code is missing and so ignored, i.e., regarded as not administered. MISSCORE=1 scores missing data as "1".

DATA COUNT is the frequency of the data code in the data file (unweighted) - this includes observations for both non-extreme and extreme persons and items. For counts weighted by PWEIGHT=, see DISFILE=

DATA % is the percent of scored data codes. For dichotomies, the % are the proportion-correct-values for the options.
For data with score value "***", the percent is of all data codes, indicated by "#".

ABILITY MEAN is the observed, sample-dependent, average measure of persons (relative to each item) in this analysis who responded in this category (adjusted by PWEIGHT=). This is equivalent to a "Mean Criterion Score" (MCS) expressed as a measure. It is a sample-dependent quality-control statistic for this analysis. (It is not the sample-independent value of the category, which is obtained by adding the item measure to the "score at category", in Table 3.2 or higher, for the rating (or partial credit) scale corresponding to this item.) For each observation in category k, there is a person of measure Bn and an item of measure Di. Then: average measure = sum(Bn - Di) / count of observations in category.
An "*" indicates that the average measure for a higher score value is lower than for a lower score value. This contradicts the hypothesis that "higher score value implies higher measure, and vice-versa".
The "average ability" for missing data is the average measure of all the persons for whom there is no response to this item. This can be useful. For instance, we may expect the "missing" people to be high or low performers, or to be missing random (and so they average measure would be close to the average of the sample).
These values are plotted in Table 2.6.

ABILITY P.SD is the population standard deviation of the ABILITY values = $\sqrt{(\Sigma (\text{ABILITY} - (\text{ABILITY MEAN}))^2/\text{COUNT})}$

S.E. MEAN is the standard error of the mean (average) measure of the sample of persons from a population who responded in this category (adjusted by PWEIGHT=) = $\sqrt{(\Sigma (\text{ABILITY} - (\text{ABILITY MEAN}))^2/(\text{COUNT}*(\text{COUNT}-1))}$

INFT MNSQ is the Infit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

OUTF MNSQ is the Outfit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

PTMA CORR is the point-correlation between the data code, scored 1, or non-occurrence, scored 0, of this category or distractor and the person raw scores or measures chosen by PTBISERIAL=. The computation is described in

Correlations. Example: for categories 0,1,2, then the correlation is between [1 for the target score (0 , 1, or 2) and 0 for the other scores (1 and 2, 0 and 2, or 0 and 1)] and the person ability measures for the persons producing each score.

ITEM (here, ACT) is the name or label of the item.

Data codes and Category labels are shown to the right of the box, if CLFILE= or CFILE= is specified.

* Average ability does not ascend with category score. The average ability of the persons observed in this category is lower than the average ability of the persons in the next lower category. This contradicts the Rasch-model assumption that "higher categories <-> higher average abilities."

Missing % includes all categories. Scored % only of scored categories. The percentage for the missing category is based on all the COUNTS. The percentages for the SCOREd categores are based only on those category COUNTs.

""BETTER FITTING OMIT" appears in fit-ordered Tables, where items better fitting than FITI= are excluded.

14.14.4 Table 10.4 Item most-misfitting response strings

Table 10.4 displays the unexpected responses in the up to 26 most-misfitting item-response strings.

```
MOST MISFITTING RESPONSE STRINGS
ACT                             OUTMNSQ  |PUPIL
                                         |4314 452371 17667422 315231 4 4 31725
                                         |1475789534189175348742556649769502293
                                     high-------------------------------------
   23 WATCH A RAT                  5.68 A|1110.0.......2.2...2....1112.2211122.
   20 WATCH BUGS                   1.99 B|......0......2..2.....2.......11..21.
    9 LEARN WEED NAMES             1.29 D|....0....0...........................1
                                         |---------------------------------low
                                         |4314745237101766742243152319464531725
                                         |1475 895341 91753487 255664 7 9 02293
```

In this Table, the item (rows) are sorted:

OUTFIT=Yes	Sorted by Outfit Mean-square descending
OUTFIT=No	Sorted by bigger of Outfit Mean-square and Infit mean-square descending.

The person (columns) are sorted by measure. The most able person (highest-scoring) is on the left. The person entry-numbers are in each column (vertically). In the Figure, the first is person 41. The persons shown are those with the most-unexpected responses. UCOUNT= sets the maximum number of persons to report. LINELENGTH= controls the width of the table. "high" indicates where we expect to see high observations. "low" indicates where we expect to see low observations. Expected observations are replaced by ".'.

Each row contains:
Item entry number
Item label
Item outfit mean-square
Item letter (A-Z) in Table 10.1.
The responses to the items:

0, 1, 2 and numeric values	Scored unexpected-responses
•	Expected responses, standardized residuals < |2|
(blank)	Missing data

The 26 items at the top of Table 10.1 are shown, excluding those with no unexpected responses on the displayed persons.

14.14.5 Table 10.5 Item most-unexpected observations

Table 10.5 displays the item response strings with the most-unexpected responses as shown in Table 10.6.

```
MOST UNEXPECTED RESPONSES
ACT                           MEASURE  |KID
                                       |414 2377166764321 35324  14 13725
                                       |1757534195732457542566796495202 93
                                   high--------------------------------
```

```
18 GO ON PICNIC         -3.15 D|...........0....1....1....1......
19 GO TO ZOO            -2.48 H|.......0..........1..1...........
20 WATCH BUGS            1.83 C|.......2...2....2..........1..21.
23 WATCH A RAT           2.18 A|1.0....2.2.....2.......22.211122.
 5 FIND BOTTLES AND CANS 2.42 B|.0.....2.2....2.....2.212.112..11
                               |-----------------------------low-
                               |414723771667643214353249614513725
                               |175 5341957324575 25667  49 20293
```

In this Table, the items (rows) are sorted by measure, ascending.

The persons (columns) are sorted by measure, descending. The most-able person (highest-scoring) is on the left. The person entry-numbers are in each column (vertically). In the Figure, the first is person 41. The persons shown are those with the most-unexpected responses in Table 10.6. UCOUNT= sets the maximum number of persons to report. LINELENGTH= controls the width of the table. "high" indicates where we expect to see high observations. "low" indicates where we expect to see low observations. Expected observations are replaced by ".".

Each row contains:
- Item entry number
- Item label
- Item measure
- Item letter (A-Z) in the plot in Table 10.1.
- The responses to the items:

0, 1, 2 and numeric values	Scored unexpected-responses
•	Expected responses, standardized residuals < |2|
(blank)	Missing data

The 26 items with the most-unexpected individual responses are shown, excluding those with no unexpected responses on the displayed items.

14.14.6 Table 10.6 Item most-unexpected response list

This shows the most unexpected responses sorted by unexpectedness (standardized residual). Large standardized residuals contribute to large outfit mean-square fit statistics. UCOUNT= sets the maximum number of "most unexpected responses" to report in Table 10.6.

```
MOST UNEXPECTED RESPONSES
+-------------------------------------------------------------------------------------------------+
| DATA |OBSERVED|EXPECTED|RESIDUAL|ST. RES.|MEASDIFF| ACT   | KID    | ACT          | KID              |
|------+--------+--------+--------+--------+--------+-------+--------+--------------+------------------|
|    0 |      0 |   1.93 |  -1.93 |  -7.66 |   3.53 |    18 |     73 | GO ON PICNIC | SANDBERG, RYNE   |
|    2 |      2 |    .07 |   1.93 |   7.57 |  -3.50 |    23 |     72 | WATCH A RAT  | JACKSON, SOLOMON |
|    2 |      2 |    .07 |   1.93 |   7.57 |  -3.50 |    23 |     29 | WATCH A RAT  | LANDMAN, ALAN    |
|    0 |      0 |   1.93 |  -1.93 |  -7.41 |   3.46 |    19 |     71 | GO TO ZOO    | STOLLER, DAVE    |
```

DATA is the response code in the data file
OBSERVED is the code's value after rescoring
EXPECTED is the predicted observation based on the person and item estimated measures
RESIDUAL is (OBSERVED - EXPECTED), the difference between the observed and expected values
ST. RES. is the standardized residual, the unexpectedness of the residual expressed as a unit normal deviate
MEASDIFF is the difference between the ability and difficulty estimates. This produces the EXPECTED value.
ACT is the item entry number
KID is the person entry number
ACT is the item label
KID is the person label

14.15 Table 11.1 Item misfitting responses

(controlled by FITI=, LINELENGTH=, MNSQ=, OUTFIT=, T7OPTIONS=)

These tables show the items for which the t standardized outfit (or infit, if OUTFIT=N) statistic is greater than the misfit criterion (FITI=). FITI=-10 with MNSQ=No displays all items. Items are listed in descending order of misfit. The response codes are listed in their sequence order in your data file. The residuals are standardized response score residuals, which have a model led expectation of 0, and a variance of 1. Negative residuals indicate that the observed response was less correct (or, for rating (or partial credit) scales, lower down the rating scale) than expected. The printed standardized residual is truncated, not rounded, so that its actual value is at least as extreme as that shown. Standardized residuals between -1 and 1 are not printed. For exact details, see XFILE=. "M" indicates a missing response.

"X" indicates that the person obtained an extreme score."X" in Tables 7.1 and 11.1 indicates that the observation is part of an extreme score, and so does not have a standardized residual. All residuals for extreme scores are conceptually zero. Persons with "X" in Item Table 11.1 (because they have extreme scores) do not appear in Table 7.1, and *vice-versa,* because those extreme persons and items are not part of the misfit process. Basically "X" says "this observation is excluded from the misfit computation".

For Table 11, the diagnosis of misfitting items, items with a t standardized fit greater than FITI= are reported. Selection is based on the OUTFIT statistic, unless you set OUTFIT=N in which case the INFIT statistic is used. T7OPTIONS= selects the detail lines to display:

```
TABLE OF POORLY FITTING ITEMS     (PERSONS IN ENTRY ORDER)
NUMBER   NAME    POSITION        MEASURE   INFIT (ZSTD) OUTFIT   MISFIT OVER 2.0

 23 WATCH A RAT                   2.00     5.8   A    8.1
    RESPONSE:    1:  0 2 1 1 1  2 2 0 2 0   0 1 0 1 1  0 1 0 0 0   0 1 1 0 0
  Z-RESIDUAL:          X     2  3     3       2

    RESPONSE:   26:  1 2 0 2 1  M 0 0 1 1   1 0 1 0 0  1 0 0 0 0   0 0 0 2 1
  Z-RESIDUAL:          3   6 2                           -2      -2         4

                                             v This is on the fit plots
  5 FIND BOTTLES AND CANS         2.21     5.2   B    6.5
    RESPONSE:    1:  1 2 0 0 1  2 0 0 1 0   0 2 0 0 1  1 0 0 0 0   0 1 1 0 1
  Z-RESIDUAL:          X     2  4             6         -2
```

Example: Table 11.1 with T7OPTIONS= OERZ in an analysis of Example0.txt:

```
TABLE OF POORLY FITTING ACT   (KID IN ENTRY ORDER)
NUMBER - NAME -- POSITION ------ MEASURE - INFIT (MNSQ) OUTFIT

    23  Watch a rat                 2.18     2.4   A    4.1
  OBSERVED:      1:  0    2    1    1    1     2    2    0    2    0    <- T7OPTIONS= O
  EXPECTED:         0.4   X   0.5  0.3  0.1   0.2  1.2  0.5  0.2  0.3  <- T7OPTIONS= E
  RESIDUAL:        -0.4       0.5  0.7  0.9   1.8  0.8 -0.5  1.8 -0.3  <- T7OPTIONS= R
Z-RESIDUAL:                             2     4              4         <- T7OPTIONS= Z
```

The OBSERVED value is the scored response, before recounting due to STKEEP=No, if any.
The EXPECTED value is the OBSERVED value - RESIDUAL value.

14.16 Table 12 Item maps with full item labels

(controlled by T1SCORE=, LINELENGTH=, IPEXTREME=, MRANGE=, MTICK=, MAXPAGE=, NAMLMP=, ISORT=, T1P#= see also MTOP=)

LINELENGTH=200 or higher if the displayed labels are too short.

Table 12.2 Item map with full labels

```
MEASURE       KID - MAP - ACT
               <more>|<rare>
    5              .  +
                   .  |
                      |
    4              .  +
                   .  |
                   . T|
    3              .  +
                   .  |T
                  ##  |  FIND BOTTLES AND CANS
                         WATCH A RAT
    2            .## S+
                  ##  |  LOOK IN SIDEWALK CRACKS
                         WATCH BUGS
```

In Table 12.2, the full item names are shown located at their calibrated MEASURE in Table 13.1, along with the person distribution according to Table 17.1. You can use NAMLMP= or IMAP= to control the number of characters of each name reported. MAXPAGE= controls the length of the Table. MRANGE= controls the displayed range of measures. ISORT= controls the sort order within rows. You can adjust these values from the "Specification" pull-down menu and then select Table 12 from the Output Tables menu. Thus you can experiment without needing to rerun the analysis.

```
                                 WATCH GRASS CHANGE
                     .###   |S
    1               .#### M+    WATCH ANIMAL MOVE
                      .##   |   LEARN WEED NAMES
                                 MAKE A MAP
                                 TALK W/FRIENDS ABOUT PLANTS
                 #######   |    LOOK AT PICTURES OF PLANTS
                                 LOOK UP STRANGE ANIMAL OR PLANT
                                 READ BOOKS ON PLANTS
    0              .#####   +M  FIND OUT WHAT ANIMALS EAT
                                 WATCH WHAT ANIMALS EAT
                          # S|  FIND OUT WHAT FLOWERS LIVE ON
                                 READ ANIMAL STORIES
                                 WATCH BIRDS
                          #   |  READ BOOKS ON ANIMALS
   -1                     #   +  FIND WHERE ANIMAL LIVES
                                 WATCH BIRD MAKE NEST
                          #   |S GROW GARDEN
                                 LISTEN TO BIRD SING
                          . T|
   -2                         +  GO TO MUSEUM
                              |  GO TO ZOO
                              |T
   -3                         +  GO ON PICNIC
                    <less>|<freq>
EACH "#" IS 2: EACH "." IS 1
```

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance and is left blank.

In subtable 12.12, the items are arranged by easiness. The item hierarchy is reversed.

T1P#= sets the number of persons for each #

Items arranged by measure: Look for the hierarchy of item names to spell out a meaningful construct from easiest (highest proportion-correct-value or highest average rating) at the bottom to hardest (lowest proportion-correct-value or lowest average rating) at the top.

M,S,T are the Mean, 1 and 2 Standard Deviations from the Mean for the persons and items. With IPEXTREME=Yes (the default), persons and items with extreme scores are placed at the ends of the map and are excluded from M,S,T. With IPEXTREME=No, persons and items with extreme scores are placed at their measures on the map and are included in M,S,T.

Column labels in Tables 12.2, 12.5, 12.6, 12.7, 12.8

PERSON=	MAP	ITEM=
MORE=	T	RARE=
	|	
LESS=	⊥	FREQ= frequent

Table 12.5 Item map showing expected score zones

```
MEASURE        KID - MAP - ACT - Expected score zones (Rasch-half-point thresholds)
                <more>|<rare>  Neutral                         Like
    5                 .  +
                      .  |
                         |
    4                 .  +
                      .  |                                     FIND BOTTLES AND CANS        .15
                      . T|                                     WATCH A RAT                  .15
    3                 .  +                                     LOOK IN SIDEWALK CRACKS      .15
                                                               WATCH BUGS                   .15
                                                               WATCH GRASS CHANGE           .15

                      .  |T
                     ##  |                                     WATCH ANIMAL MOVE            .15
    2               .## S+                                     LEARN WEED NAMES             .15
                     ##  |                                     LOOK AT PICTURES OF PLANTS   .15
                                                               MAKE A MAP                   .15
                                                               READ BOOKS ON PLANTS         .15
                                                               TALK W/FRIENDS ABOUT PLANTS  .15
                   .###  |S FIND BOTTLES AND CANS        .05   FIND OUT WHAT ANIMALS EAT    .15
                                                               LOOK UP STRANGE ANIMAL OR PLAN.15
                                                               WATCH WHAT ANIMALS EAT       .15
    1             .#### M+  WATCH A RAT                  .05   FIND OUT WHAT FLOWERS LIVE ON .15
                    .##  |  WATCH BUGS                   .05   READ ANIMAL STORIES          .15
                            WATCH GRASS CHANGE           .05   WATCH BIRDS                  .15
               #######   |  LOOK IN SIDEWALK CRACKS      .05   FIND WHERE ANIMAL LIVES      .15
                                                               READ BOOKS ON ANIMALS        .15
                                                               WATCH BIRD MAKE NEST         .15
    0            .#####  +M WATCH ANIMAL MOVE            .05   GROW GARDEN                  .15
                      # S|  LEARN WEED NAMES             .05   LISTEN TO BIRD SING          .15
                      #  |  LOOK AT PICTURES OF PLANTS   .05
                            MAKE A MAP                   .05
                            READ BOOKS ON PLANTS         .05
                            TALK W/FRIENDS ABOUT PLANTS  .05
   -1                 #  +  FIND OUT WHAT ANIMALS EAT    .05   GO TO MUSEUM                 .15
                            LOOK UP STRANGE ANIMAL OR PLAN.05
                            WATCH WHAT ANIMALS EAT       .05
```

Table 12.5 is only produced when there are polytomous items. It shows the items positioned at the lower edge of each expected score zone (the half-point thresholds). The expected score zone above "item-label .2½" extends from expected category score 2.5 to 3.5. Lower than "item-label.0½" is the zone from 0 to 0.5. These correspond to the thresholds on the Expected Score ICC.

If you put the item number at the start of the item labels after &END, you can show only the item numbers on this plot by using NAMLMP= or IMAP=. Column headings are the category labels that match the (rescored) category numbers in CFILE= or CLFILE=.

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent

```
                  #  |S FIND OUT WHAT FLOWERS LIVE ON .05  GO TO ZOO                      .15
                . T|  READ ANIMAL STORIES           .05
                      WATCH BIRDS                   .05
   -2               + FIND WHERE ANIMAL LIVES       .05  GO ON PICNIC                   .15
                      READ BOOKS ON ANIMALS         .05
                      WATCH BIRD MAKE NEST          .05
                    | GROW GARDEN                   .05
                    |T LISTEN TO BIRD SING          .05
   -3               +
                    | GO TO MUSEUM                  .05
                    | GO TO ZOO                     .05
   -4               +
                    | GO ON PICNIC                  .05
                    |
   -5               +
             <less>|<freq>  Dislike                      Neutral
EACH "#" IS 2: EACH "." IS 1
```

variable "|" does not advance and is left blank. The plotted values are in the ISFILE=.

The half-point thresholds are indicated by .n½ when ASCII=No or ASCII=Web, or .n5 when ASCII=Yes

Increase the length of the displayed lines with LINELENGTH=

Table 12.6 Item map showing 50% cumulative probabilities (Rasch-Thurstonian thresholds)

```
MEASURE       KID - MAP - ACT - 50% Cumulative probabilities (Rasch-Thurstonian thresholds)
             <more>|<rare>  Neutral                      Like
    5               . +
                    . |
                      |
    4               . +
                    . |
                  . T|                                   FIND BOTTLES AND CANS           .2
                                                         WATCH A RAT                     .2
    3               . +
                  .  |T                                  LOOK IN SIDEWALK CRACKS         .2
                                                         WATCH BUGS                      .2
                                                         WATCH GRASS CHANGE              .2
                 ##  |
    2           .## S+                                   WATCH ANIMAL MOVE               .2
                 ##  |                                   LEARN WEED NAMES                .2
                                                         MAKE A MAP                      .2
                                                         TALK W/FRIENDS ABOUT PLANTS     .2
              .###  |S FIND BOTTLES AND CANS         .1  LOOK AT PICTURES OF PLANTS      .2
                       WATCH A RAT                   .1  LOOK UP STRANGE ANIMAL OR PLANT.2
                                                         READ BOOKS ON PLANTS            .2
    1        .#### M+                                    FIND OUT WHAT ANIMALS EAT       .2
                                                         WATCH WHAT ANIMALS EAT          .2
               .##  | LOOK IN SIDEWALK CRACKS         .1  FIND OUT WHAT FLOWERS LIVE ON   .2
                      WATCH BUGS                      .1  READ ANIMAL STORIES             .2
                      WATCH GRASS CHANGE              .1  WATCH BIRDS                     .2
          #######  |                                     READ BOOKS ON ANIMALS           .2
    0       .#####  +M WATCH ANIMAL MOVE              .1  FIND WHERE ANIMAL LIVES         .2
                                                         WATCH BIRD MAKE NEST            .2
                 # S| LEARN WEED NAMES                .1  GROW GARDEN                     .2
                      MAKE A MAP                      .1  LISTEN TO BIRD SING             .2
                      TALK W/FRIENDS ABOUT PLANTS     .1
                 #  | LOOK AT PICTURES OF PLANTS      .1
                      LOOK UP STRANGE ANIMAL OR PLANT.1
                      READ BOOKS ON PLANTS            .1
   -1            #  + FIND OUT WHAT ANIMALS EAT       .1  GO TO MUSEUM                    .2
                      WATCH WHAT ANIMALS EAT          .1
                 #  |S FIND OUT WHAT FLOWERS LIVE ON  .1  GO TO ZOO                       .2
                      READ ANIMAL STORIES             .1
                      WATCH BIRDS                     .1
                . T|  READ BOOKS ON ANIMALS           .1
   -2               + FIND WHERE ANIMAL LIVES         .1  GO ON PICNIC                    .2
                      WATCH BIRD MAKE NEST            .1
                    | GROW GARDEN                     .1
                      LISTEN TO BIRD SING             .1
                    |T
   -3               + GO TO MUSEUM                    .1
                    | GO TO ZOO                       .1
                    |
   -4               + GO ON PICNIC                    .1
                    |
                    |
   -5               +
             <less>|<freq>  Dislike                      Neutral
EACH "#" IS 2: EACH "." IS 1
```

Table 12.6 is only produced when there are polytomous items.

The right-hand column shows the items positioned at median 50% cumulative probability (the Rasch-Thurstonian thresholds) at the lower edge of each rating probability zone. Above label.1, categories 1 and above are more probable. Below label.2, categories 1 and below are most probable. Between label.1 and label.2 is the zone which can be thought of as corresponding to a rating of 1. These correspond to the Cumulative Probability thresholds.

If you put the item number at the start of the item labels after &END, you can show only the item numbers on this plot by using NAMLMP= or IMAP=. Columns are headed by the (rescored) categories in CFILE=.

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance and is left blank. The plotted values are in the ISFILE=.

Left-hand column shows the distribution of person ability measures along the variable.

Table 12.7 Item map with Andrich thresholds (modal categories if ordered)

Table 1.7 is only produced when there are polytomous

```
MEASURE       KID - MAP - ACT - Andrich thresholds (modal categories if ordered)
               <more>|<rare>  Neutral                      Like
    5             .  +
                  .  |
                     |
    4             .  +
                  .  |
                  . T|                                     FIND BOTTLES AND CANS          .2
    3             .  +                                     WATCH A RAT                    .2
                  .  |T                                    LOOK IN SIDEWALK CRACKS        .2
                                                           WATCH BUGS                     .2
                                                           WATCH GRASS CHANGE             .2
                 ##  |
    2           .## S+                                     WATCH ANIMAL MOVE              .2
                 ##  |  FIND BOTTLES AND CANS          .1  LEARN WEED NAMES               .2
               .###  |S WATCH A RAT                    .1  LOOK AT PICTURES OF PLANTS     .2
                                                           MAKE A MAP                     .2
                                                           READ BOOKS ON PLANTS           .2
                                                           TALK W/FRIENDS ABOUT PLANTS    .2
    1         .#### M+  WATCH BUGS                     .1  FIND OUT WHAT ANIMALS EAT      .2
                        WATCH GRASS CHANGE             .1  LOOK UP STRANGE ANIMAL OR PLANT.2
                                                           WATCH WHAT ANIMALS EAT         .2
                .##  |  LOOK IN SIDEWALK CRACKS        .1  FIND OUT WHAT FLOWERS LIVE ON  .2
            #######  |  WATCH ANIMAL MOVE              .1  READ ANIMAL STORIES            .2
                                                           WATCH BIRDS                    .2
    0        .#####  +M LEARN WEED NAMES               .1  FIND WHERE ANIMAL LIVES        .2
                                                           READ BOOKS ON ANIMALS          .2
                                                           WATCH BIRD MAKE NEST           .2
                  # S|  LOOK AT PICTURES OF PLANTS     .1  GROW GARDEN                    .2
                        MAKE A MAP                     .1
                        READ BOOKS ON PLANTS           .1
                        TALK W/FRIENDS ABOUT PLANTS    .1
                  #  |  FIND OUT WHAT ANIMALS EAT      .1  LISTEN TO BIRD SING            .2
                        LOOK UP STRANGE ANIMAL OR PLANT.1
                        WATCH WHAT ANIMALS EAT         .1
   -1             #  +
                  #  |S FIND OUT WHAT FLOWERS LIVE ON  .1  GO TO MUSEUM                   .2
                        READ ANIMAL STORIES            .1
                        WATCH BIRDS                    .1
                  . T|  FIND WHERE ANIMAL LIVES        .1  GO TO ZOO                      .2
                        READ BOOKS ON ANIMALS          .1
                        WATCH BIRD MAKE NEST           .1
   -2                +  GROW GARDEN                    .1
                     |  LISTEN TO BIRD SING            .1  GO ON PICNIC                   .2
                     |T
   -3                +  GO TO MUSEUM                   .1
                     |  GO TO ZOO                      .1
                     |
   -4                +  GO ON PICNIC                   .1
                     |
                     |
   -5                +
               <less>|<freq>  Dislike                    Neutral
EACH "#" IS 2: EACH "." IS 1
```

items.

The right-hand column shows the items positioned at their Andrich thresholds (points of equal probability of adjacent categories) at the lower edge of each rating probability zone. When the thresholds are ordered, above label.2, the most probable category is 2. Below label.1, the most probable category is 0. Between label.1 and label.2 is the zone which can be thought of as corresponding to a rating of 1.

If you put the item number at the start of the item labels after &END, you can show only the item numbers on this plot by using NAMLMP= or IMAP=. Columns are headed by the (rescored) categories in CFILE=.

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance and is left blank. The plotted values are in the ISFILE=.

Left-hand column shows the distribution of person ability measures along the variable.

Table 12.8 Item map of measures for category scores (maximum probability of observing a category))

```
MEASURE       KID - MAP - ACT - Measures for category scores (maximum probability of observing a category)
               <more>|<rare>  Dislike                    Neutral                          Like
    7             .  +
                     |
                     |
                     |
    6                +
                     |
                     |
                     |
    5                +
                  .  |                                                                    Find bottles and cans        .2
                     |
                     |                                                                    Watch a rat                  .2
    4             .  +                                                                    Watch grass change           .2
                     |                                                                    Look in sidewalk cracks      .2
                                                                                          Watch bugs                   .2

                  .  |
                  . T|
    3             .  +                                                                    Watch animal move            .2
                  .  |T                                                                   Learn weed names             .2
                  #  |                                   Find bottles and cans        .1  Look at pictures of plants   .2
                                                                                          Look up strange animal or pla.2
                                                                                          Make a map                   .2
                                                                                          Read books on plants         .2
                                                                                          Talk w/friends about plants  .2
                  #  |                                   Watch a rat                  .1  Watch what animals eat       .2
    2          .## S+                                                                     Find out what animals eat    .2
```

Table 12.8 is only produced when there are polytomous items.

The right-hand column shows the items positioned at the measures where the expected score on the item = the category number. This is also the measure at which the category has its highest probability. Extreme categories are shown at measures corresponding to the

```
                 ##  |                                 Look in sidewalk cracks      .1  Find out what flowers live on.2
                                                         Watch bugs                   .1  Watch birds                  .2
                                                         Watch grass change           .1
                  #  |S                                                                   Read animal stories          .2
                                                                                          Read books on animals        .2
                .##  |                                                                    Watch bird make nest         .2
    1           ### M+                                   Watch animal move            .1  Find where animal lives      .2
                .##  |                                   Learn weed names             .1  Grow garden                  .2
                ###  |                                   Look at pictures of plants   .1  Listen to bird sing          .2
                                                         Make a map                   .1
                                                         Read books on plants         .1
                                                         Talk w/friends about plants  .1
           .#######  |  Find bottles and cans        .0  Look up strange animal or pla.1
                                                         Watch what animals eat       .1
    0          .###  +M Watch a rat                  .0  Find out what animals eat    .1  Go to museum                 .2
                  . S|  Watch bugs                   .0  Find out what flowers live on.1
                  .  |  Look in sidewalk cracks      .0  Read animal stories          .1  Go to zoo                    .2
                        Watch grass change           .0  Watch birds                  .1
                  #  |                                   Read books on animals        .1
                                                         Watch bird make nest         .1
   -1             #  +  Watch animal move            .0  Find where animal lives      .1  Go on picnic                 .2
                  #  |  Learn weed names             .0  Grow garden                  .1
                  . T|S Look at pictures of plants   .0  Listen to bird sing          .1
                        Make a map                   .0
                        Talk w/friends about plants  .0
                     |  Read books on plants         .0
                        Watch what animals eat       .0
   -2                +  Find out what animals eat    .0  Go to museum                 .1
                        Look up strange animal or pla.0
                     |  Find out what flowers live on.0
                     |  Read animal stories          .0  Go to zoo                    .1
                     |T Watch bird make nest         .0
                        Watch birds                  .0
   -3                +  Find where animal lives      .0  Go on picnic                 .1
                        Read books on animals        .0
                     |  Grow garden                  .0
                     |  Listen to bird sing          .0
                     |
   -4                +  Go to museum                 .0
                     |
                     |  Go to zoo                    .0
                     |
   -5                +
                     |  Go on picnic                 .0
                     |
                     |
   -6             #  +
               <less>|<freq>  Dislike                   Neutral                           Like
EACH "#" IS 2: EACH "." IS 1
```

category score adjustedby .25 score points (or LOWADJ= and HIADJ=) .

If you put the item number at the start of the item labels after &END, you can show only the item numbers on this plot by using NAMLMP= or IMAP=. Columns are headed by the (rescored) categories in CFILE=.

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance and is left blank. The plotted values are in the ISFILE=.

Left-hand column shows the distribution of person ability measures along the variable.

Increase the length of the displayed lines with LINELENGTH=

Table 12.9 Item map of average person measure for each category score

```
MEASURE  PUPIL - MAP - PUPIL - Average Measures for category scores
            <more>|<more>          like                   3                   4
    5          X  +
               X  |
                  |
                  |
                  |
    4          X  +
                  |
               X  |
                 T|
               X  |
    3          X  +                                          WATCH GRASS CHAN.4
                                                             LOOK IN SIDEWALK.4
               X  |T
                  |
              XX  |                                                WATCH BUGS.4
                                                             WATCH ANIMAL MOV.4
            XXXX S|                                          READ BOOKS ON PL.4
                                                             TALK W/FRIENDS A.4
    2         XXX  +                                          LOOK AT PICTURES.4
                                                                   MAKE A MAP.4
                                                             WATCH WHAT ANIMA.4
                                                             LEARN WEED NAMES.4
                                                              LOOK UP STRANGE.4
              XX  |                                          FIND OUT WHAT AN.4
```

Table 12.9 is only produced when there are polytomous items.

The right-hand column shows the categories of the items positioned by the average of the measures of the persons who responded in each category.

If you put the item number at the start of the item labels after &END, you can show only the item numbers on this plot by using NAMLMP= or IMAP=. Columns are headed by the (rescored) categories in CFILE=.

Where there are more items than can be shown on one line, the extra items are printed on

```
                                                                  WATCH BIRDS.4
              XX  |                                          READ ANIMAL STOR.4
                                                             FIND OUT WHAT FL.4
                                                             FIND WHERE ANIMA.4
                                                             READ BOOKS ON AN.4
                                                              WATCH BIRD MAKE.4
            XXXX  |S                                         LISTEN TO BIRD S.4
                                                             FIND BOTTLES AND.4
             XXX  |                                               GROW GARDEN.4
                                                                 GO TO MUSEUM.4
                                                                    GO TO ZOO.4
    1     XXXXXX  +         GO TO ZOO.2  WATCH GRASS CHAN.3      GO ON PICNIC.4
                          WATCH A RAT.2        WATCH A RAT.3
                     FIND BOTTLES AND.2         WATCH BUGS.3
           XXXXX M|                      FIND BOTTLES AND.3       WATCH A RAT.4
                                         WATCH ANIMAL MOV.3
             XXX  |  LOOK IN SIDEWALK.2         MAKE A MAP.3
                           WATCH BUGS.2  LOOK IN SIDEWALK.3
                                          LOOK UP STRANGE.3
                                         LEARN WEED NAMES.3
                                         LOOK AT PICTURES.3
                                         TALK W/FRIENDS A.3
                                         READ BOOKS ON PL.3
        XXXXXXXX  |      GO ON PICNIC.2  WATCH WHAT ANIMA.3
                                         FIND OUT WHAT AN.3
                                         FIND OUT WHAT FL.3
      XXXXXXXXXX  |  WATCH GRASS CHAN.2       WATCH BIRDS.3
                     LEARN WEED NAMES.2  READ ANIMAL STOR.3
                     WATCH ANIMAL MOV.2
    0    XXXXXXX  +M       MAKE A MAP.2  READ BOOKS ON AN.3
                                         LISTEN TO BIRD S.3
                                             GO ON PICNIC.3
                                         FIND WHERE ANIMA.3
                                              GROW GARDEN.3
                                          WATCH BIRD MAKE.3
               X  |  TALK W/FRIENDS A.2
                     LOOK AT PICTURES.2
               X S|  FIND OUT WHAT AN.2      GO TO MUSEUM.3
                      LOOK UP STRANGE.2
                     READ BOOKS ON PL.2
                     READ ANIMAL STOR.2
                     FIND OUT WHAT FL.2
                      WATCH BIRD MAKE.2
                     READ BOOKS ON AN.2
                     WATCH WHAT ANIMA.2
              XX  |       GROW GARDEN.2         GO TO ZOO.3
                  |  FIND WHERE ANIMA.2
                          WATCH BIRDS.2
   -1         XX  +
                  |
              XX  |S LISTEN TO BIRD S.2
               X T|
                  |
   -2             +
```

subsequent lines, but the latent variable "|" does not advance and is left blank. The plotted values are in the ISFILE=.

Left-hand column shows the distribution of person ability measures along the variable.

Table 12.12 Item map with full labels (reversed measures)

```
MEASURE       KID - MAP - ACT
               <more>||<freq>
    5             .  ++
                  .  ||
                     ||
    4             .  ++
                  .  ||
                  . T||
    3             .  ++  GO ON PICNIC
                  .  ||T
                 ##  ||  GO TO ZOO
    2           .## S++  GO TO MUSEUM
                 ##  ||
               .###  ||S GROW GARDEN
                         LISTEN TO BIRD SING
    1         .#### M++  FIND WHERE ANIMAL LIVES
                         WATCH BIRD MAKE NEST
                .##  ||  READ BOOKS ON ANIMALS
            #######  ||  FIND OUT WHAT FLOWERS LIVE ON
```

In Table 12.12, the items are arranged by easiness. The item hierarchy is reversed.

You can use NAMLMP= or IMAP= to control the number of characters of each name reported. MAXPAGE= controls the length of the Table. MRANGE= controls the displayed range of measures. ISORT= controls the sort order within rows. You can adjust these values from the "Specification" pull-down menu and then select Table 12 from the Output Tables menu. Thus you can experiment without needing to rerun the analysis.

Where there are more items than can be shown on one line, the extra items are printed on subsequent lines, but the latent variable "|" does not advance and is left blank.

T1P#= sets the number of persons for each #

```
                          READ ANIMAL STORIES
                          WATCH BIRDS
    0        .#####  ++M FIND OUT WHAT ANIMALS EAT
                          WATCH WHAT ANIMALS EAT
                  # S||  LOOK AT PICTURES OF PLANTS
                          LOOK UP STRANGE ANIMAL OR PLANT
                          READ BOOKS ON PLANTS
                  #   ||  LEARN WEED NAMES
                          MAKE A MAP
                          TALK W/FRIENDS ABOUT PLANTS
   -1             #  ++  WATCH ANIMAL MOVE
                  #  ||S
                  . T||  LOOK IN SIDEWALK CRACKS
                          WATCH BUGS
                          WATCH GRASS CHANGE
   -2                ++
                     ||  FIND BOTTLES AND CANS
                          WATCH A RAT
                     ||T
   -3                ++
               <less>||<rare>
EACH "#" IS 2: EACH "." IS 1
```

Items arranged by easiness. The item difficulty measures are reversed relative to the mean person measure, "M". Look for the hierarchy of item names to spell out a meaningful construct from easiest at the top to hardest at the bottom.
The double line || indicates the two sides have opposite orientations.
Each "X" is one person.

Column Labels

PERSON=	MAP	ITEM=
MORE=	T	FREQ=
	|	
LESS=	⊥	RARE=

On Plot:	*Description:*
SCORE	raw score on all active items when T1SCORE=Yes. Includes extreme items when TOTALSCORE=Yes
MEASURE	Location of person or item on the unidimensional latent variable, in logits or USCALE= units
<more>	higher person "ability" = higher raw score with complete data
<less>	lower person "ability" = lower raw score with complete data
<rare>	higher item "difficulty" = lower item "easiness" = lower score on the item with complete data: PVALUE=
<frequ> <frequent>	lower item "difficulty" = higher item "easiness" = higher score on the item with complete data: PVALUE=
M	Mean of person or item distribution
S	One "sample is the population" standard deviation from the person or item mean
T	Two standard deviations from the person or item mean
X	one person or item
#	several persons or items, e.g., EACH "#" = 4. The value for # can be changed with T1I#= for items, T1P#= for persons.
.	between 1 and (# - 1) persons or items, e.g., if # = 4, then "." = 1 to 3
|	Variable advances. Lines without "|" have the same measure as the nearest "|" above.
||	The double line || indicates the two sides have opposite orientations: person ability and item easiness. The item difficulties are reversed.This is useful if the items and persons are being compared to the responses.

14.17 Table 13 Item report in measure order

14.17.1 Table 13.1 Item statistics in measure order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, TOTAL=, DISCRIMINATION=, ASYMPTOTE=, PVALUE=)

ITEM STATISTICS: MEASURE ORDER

For details, please see Table 10.1

14.17.2 Table 13.2 Item statistics graphically in measure order

Please see Table 10.2

14.17.3 Table 13.3 Item option & distractor frequencies in measure order

(controlled by Distractors=Y, OSORT=, CFILE=, PTBIS=)

ITEM OPTION FREQUENCIES are output if Distractors=Y. These show occurrences of each of the valid data codes in CODES=, and also of MISSCORE= in the input data file. Counts of responses forming part of extreme scores are included. Only items included in the corresponding main table are listed. These statistics are also in DISFILE=, which includes entries even if the code is not observed for the item. See also Distractor Analysis.

OSORT= controls the ordering of options within items. The standard is the order of data codes in CODES=.

```
          ITEM CATEGORY/OPTION/DISTRACTOR FREQUENCIES:  ENTRY ORDER
------------------------------------------------------------------------------------------------
|ENTRY   DATA  SCORE |     DATA    |      ABILITY     S.E.  INFT OUTF PTMA |                      |
|NUMBER  CODE  VALUE |  COUNT   %  |    MEAN    P.SD  MEAN  MNSQ MNSQ CORR.| ITEM                 |
|--------------------+-------------+-----------------------------------+----------------------|
|   13   4       *** |    11  16#|     .79     1.41  .45              .08 |M. STAIRS            | 4 75% Independent
|        1         1 |    30  52 |   -1.85      .99  .18    .8  1.0  -.89 |                      | 1 0% Independent
|        3         3 |     5   9 |    1.07      .80  .40    .6   .4   .10 |                      | 3 50% Independent
|        5         5 |    15  26 |    2.63     1.06  .28   1.7  1.5   .56 |                      | 5 Supervision
|        6         6 |     7  12 |    3.25      .81  .33   1.2  1.2   .44 |                      | 6 Device
|        7         7 |     1   2 |    4.63      .00         .7   .6   .23 |                      | 7 Independent
|        MISSING *** |     1   1#|   -1.99      .00                  -.12 |                      |
------------------------------------------------------------------------------------------------
 * Average ability does not ascend with category score
 # Missing % includes all categories. Scored % only of scored categories
```

ENTRY NUMBER is the item sequence number.
The letter next to the sequence number is used on the fit plots.

DATA CODE is the response code in the data file.
MISSING means that the data code is not listed in the CODES= specification.
Codes with no observations are not listed.

SCORE VALUE is the value assigned to the data code by means of NEWSCORE=, KEY1=, IVALUEA=, etc.
*** means the data code is missing and so ignored, i.e., regarded as not administered. MISSCORE=1 scores missing data as "1".

DATA COUNT is the frequency of the data code in the data file (unweighted) - this includes observations for both non-extreme and extreme persons and items. For counts weighted by PWEIGHT=, see DISFILE=

DATA % is the percent of scored data codes. For dichotomies, the % are the proportion-correct-values for the options.
For data with score value "***", the percent is of all data codes, indicated by "#".

ABILITY MEAN is the observed, sample-dependent, average measure of persons (relative to each item) in this analysis who responded in this category (adjusted by PWEIGHT=). This is equivalent to a "Mean Criterion Score" (MCS) expressed as a measure. It is a sample-dependent quality-control statistic for this analysis. (It is not the sample-independent value of the category, which is obtained by adding the item measure to the "score at category", in Table 3.2 or higher, for the rating (or partial credit) scale corresponding to this item.) For each observation in category k, there is a person of measure Bn and an item of measure Di. Then: average measure = sum(Bn - Di) / count of observations in category.
An "*" indicates that the average measure for a higher score value is lower than for a lower score value. This contradicts the hypothesis that "higher score value implies higher measure, and vice-versa".
The "average ability" for missing data is the average measure of all the persons for whom there is no response to this item. This can be useful. For instance, we may expect the "missing" people to be high or low performers, or to be missing random (and so they average measure would be close to the average of the sample).
These values are plotted in Table 2.6.

ABILITY P.SD is the population standard deviation of the ABILITY values = $\sqrt{(\Sigma (\text{ABILITY} - (\text{ABILITY MEAN}))^2/\text{COUNT})}$

S.E. MEAN is the standard error of the mean (average) measure of the sample of persons from a population who responded in this category (adjusted by PWEIGHT=) = $\sqrt{(\Sigma (\text{ABILITY} - (\text{ABILITY MEAN}))^2/(\text{COUNT}*(\text{COUNT}-1))}$

INFT MNSQ is the Infit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

OUTF MNSQ is the Outfit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

PTMA CORR is the point-correlation between the data code, scored 1, or non-occurrence, scored 0, of this category or distractor and the person raw scores or measures chosen by PTBISERIAL=. The computation is described in Correlations. Example: for categories 0,1,2, then the correlation is between [1 for the target score (0 , 1, or 2) and 0 for the other scores (1 and 2, 0 and 2, or 0 and 1)] and the person ability measures for the persons producing each score.

ITEM (here, ACT) is the name or label of the item.

Data codes and Category labels are shown to the right of the box, if CLFILE= or CFILE= is specified.

* Average ability does not ascend with category score. The average ability of the persons observed in this category is lower than the average ability of the persons in the next lower category. This contradicts the Rasch-model assumption that "higher categories <-> higher average abilities."

Missing % includes all categories. Scored % only of scored categories. The percentage for the missing category is based on all the COUNTS. The percentages for the SCOREd categores are based only on those category COUNTs.

""BETTER FITTING OMIT" appears in fit-ordered Tables, where items better fitting than FITI= are excluded.

14.18 Table 14 Item report in entry order

14.18.1 Table 14.1 Item statistics in entry order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, TOTAL=, DISCRIMINATION=, ASYMPTOTE=, PVALUE=)

ITEM STATISTICS: ENTRY ORDER

For details, please see Table 10.1

14.18.2 Table 14.2 Item statistics graphically in entry order

Please see Table 10.2

14.18.3 Table 14.3 Item option & distractor frequencies in entry order

(controlled by Distractors=Y, OSORT=, CFILE=, PTBIS=)

ITEM OPTION FREQUENCIES are output if Distractors=Y. These show occurrences of each of the valid data codes in CODES=, and also of MISSCORE= in the input data file. Counts of responses forming part of extreme scores are included. Only items included in the corresponding main table are listed. These statistics are also in DISFILE=, which includes entries even if the code is not observed for the item. See also Distractor Analysis.

OSORT= controls the ordering of options within items. The standard is the order of data codes in CODES=.

```
          ITEM CATEGORY/OPTION/DISTRACTOR FRQUENCIES:  ENTRY ORDER
-------------------------------------------------------------------------------------------------
|ENTRY   DATA  SCORE |     DATA    |       ABILITY     S.E.  INFT OUTF PTMA |                       |
|NUMBER  CODE  VALUE |  COUNT    % |    MEAN     P.SD  MEAN  MNSQ MNSQ CORR.| ITEM                  |
|--------------------+-------------+----------------------------------------+-----------------------|
|   13   4       *** |     11  16#|     .79     1.41  .45              .08 |M. STAIRS              | 4 75% Independent
|        1         1 |     30  52 |   -1.85      .99  .18    .8  1.0  -.89 |                       | 1 0% Independent
|        3         3 |      5   9 |    1.07      .80  .40    .6    .4   .10 |                       | 3 50% Independent
|        5         5 |     15  26 |    2.63     1.06  .28   1.7  1.5   .56 |                       | 5 Supervision
|        6         6 |      7  12 |    3.25      .81  .33   1.2  1.2   .44 |                       | 6 Device
```

```
|        7         7 |      1   2 |    4.63      .00        .7   .6   .23 |                       | 7 Independent
|        MISSING *** |      1   1#|   -1.99      .00                 -.12 |                       |
--------------------------------------------------------------------------------------------------
 * Average ability does not ascend with category score
 # Missing % includes all categories. Scored % only of scored categories
```

ENTRY NUMBER is the item sequence number.
The letter next to the sequence number is used on the fit plots.

DATA CODE is the response code in the data file.
MISSING means that the data code is not listed in the CODES= specification.
Codes with no observations are not listed.

SCORE VALUE is the value assigned to the data code by means of NEWSCORE=, KEY1=, IVALUEA=, etc.
*** means the data code is missing and so ignored, i.e., regarded as not administered. MISSCORE=1 scores missing data as "1".

DATA COUNT is the frequency of the data code in the data file (unweighted) - this includes observations for both non-extreme and extreme persons and items. For counts weighted by PWEIGHT=, see DISFILE=

DATA % is the percent of scored data codes. For dichotomies, the % are the proportion-correct-values for the options.
For data with score value "***", the percent is of all data codes, indicated by "#".

ABILITY MEAN is the observed, sample-dependent, average measure of persons (relative to each item) in this analysis who responded in this category (adjusted by PWEIGHT=). This is equivalent to a "Mean Criterion Score" (MCS) expressed as a measure. It is a sample-dependent quality-control statistic for this analysis. (It is not the sample-independent value of the category, which is obtained by adding the item measure to the "score at category", in Table 3.2 or higher, for the rating (or partial credit) scale corresponding to this item.) For each observation in category k, there is a person of measure Bn and an item of measure Di. Then: average measure = sum(Bn - Di) / count of observations in category.
An "*" indicates that the average measure for a higher score value is lower than for a lower score value. This contradicts the hypothesis that "higher score value implies higher measure, and vice-versa".
The "average ability" for missing data is the average measure of all the persons for whom there is no response to this item. This can be useful. For instance, we may expect the "missing" people to be high or low performers, or to be missing random (and so they average measure would be close to the average of the sample).
These values are plotted in Table 2.6.

ABILITY P.SD is the population standard deviation of the ABILITY values = $\sqrt{(\Sigma (\text{ABILITY} - (\text{ABILITY MEAN}))^2/\text{COUNT})}$

S.E. MEAN is the standard error of the mean (average) measure of the sample of persons from a population who responded in this category (adjusted by PWEIGHT=) = $\sqrt{(\Sigma (\text{ABILITY} - (\text{ABILITY MEAN}))^2/(\text{COUNT}*(\text{COUNT}-1))}$

INFT MNSQ is the Infit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

OUTF MNSQ is the Outfit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

PTMA CORR is the point-correlation between the data code, scored 1, or non-occurrence, scored 0, of this category or distractor and the person raw scores or measures chosen by PTBISERIAL=. The computation is described in Correlations. Example: for categories 0,1,2, then the correlation is between [1 for the target score (0 , 1, or 2) and 0 for the other scores (1 and 2, 0 and 2, or 0 and 1)] and the person ability measures for the persons producing each score.

ITEM (here, ACT) is the name or label of the item.

Data codes and Category labels are shown to the right of the box, if CLFILE= or CFILE= is specified.

* Average ability does not ascend with category score. The average ability of the persons observed in this category is lower

than the average ability of the persons in the next lower category. This contradicts the Rasch-model assumption that "higher categories <-> higher average abilities."

Missing % includes all categories. Scored % only of scored categories. The percentage for the missing category is based on all the COUNTS. The percentages for the SCOREd categores are based only on those category COUNTs.

""BETTER FITTING OMIT" appears in fit-ordered Tables, where items better fitting than FITI= are excluded.

14.19 Table 15 Item report in label order

14.19.1 Table 15.1 Item statistics in label order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, ISORT=, TOTAL=, DISCRIMINATION=, ASYMPTOTE=, PVALUE=)

ISORT= $S1W22 ; sets the item sort order for Table 15.1

ITEM STATISTICS: ALPHA ORDER ON COLUMN: $S1W22

For details, please see Table 10.1

14.19.2 Table 15.2 Item statistics graphically in label order

Please see Table 10.2

14.19.3 Table 15.3 Item option & distractor frequencies in label order

(controlled by Distractors=Y, OSORT=, CFILE=, PTBIS=)

ITEM OPTION FREQUENCIES are output if Distractors=Y. These show occurrences of each of the valid data codes in CODES=, and also of MISSCORE= in the input data file. Counts of responses forming part of extreme scores are included. Only items included in the corresponding main table are listed. These statistics are also in DISFILE=, which includes entries even if the code is not observed for the item. See also Distractor Analysis.

OSORT= controls the ordering of options within items. The standard is the order of data codes in CODES=.

```
        ITEM CATEGORY/OPTION/DISTRACTOR FREQUENCIES:  ENTRY ORDER
------------------------------------------------------------------------------------------
|ENTRY   DATA  SCORE |     DATA    |       ABILITY     S.E.  INFT OUTF PTMA |                       |
|NUMBER  CODE  VALUE |  COUNT    % |    MEAN     P.SD  MEAN  MNSQ MNSQ CORR.| ITEM                  |
|--------------------+-------------+---------------------------------------+-----------------------|
|   13   4       *** |     11  16#|     .79     1.41  .45             .08 |M. STAIRS              | 4 75% Independent
|        1         1 |     30  52 |   -1.85      .99  .18    .8  1.0  -.89 |                       | 1 0% Independent
|        3         3 |      5   9 |    1.07      .80  .40    .6    .4  .10 |                       | 3 50% Independent
|        5         5 |     15  26 |    2.63     1.06  .28   1.7  1.5  .56 |                       | 5 Supervision
|        6         6 |      7  12 |    3.25      .81  .33   1.2  1.2  .44 |                       | 6 Device
|        7         7 |      1   2 |    4.63      .00         .7    .6  .23 |                       | 7 Independent
|        MISSING *** |      1   1#|   -1.99      .00                  -.12 |                       |
------------------------------------------------------------------------------------------
 * Average ability does not ascend with category score
 # Missing % includes all categories. Scored % only of scored categories
```

ENTRY NUMBER is the item sequence number.
The letter next to the sequence number is used on the fit plots.

DATA CODE is the response code in the data file.
MISSING means that the data code is not listed in the CODES= specification.
Codes with no observations are not listed.

SCORE VALUE is the value assigned to the data code by means of NEWSCORE=, KEY1=, IVALUEA=, etc.
*** means the data code is missing and so ignored, i.e., regarded as not administered. MISSCORE=1 scores missing data as "1".

DATA COUNT is the frequency of the data code in the data file (unweighted) - this includes observations for both non-extreme and extreme persons and items. For counts weighted by PWEIGHT=, see DISFILE=

DATA % is the percent of scored data codes. For dichotomies, the % are the proportion-correct-values for the options. For data with score value "***", the percent is of all data codes, indicated by "#".

ABILITY MEAN is the observed, sample-dependent, average measure of persons (relative to each item) in this analysis who responded in this category (adjusted by PWEIGHT=). This is equivalent to a "Mean Criterion Score" (MCS) expressed as a measure. It is a sample-dependent quality-control statistic for this analysis. (It is not the sample-independent value of the category, which is obtained by adding the item measure to the "score at category", in Table 3.2 or higher, for the rating (or partial credit) scale corresponding to this item.) For each observation in category k, there is a person of measure Bn and an item of measure Di. Then: average measure = sum(Bn - Di) / count of observations in category.
An "*" indicates that the average measure for a higher score value is lower than for a lower score value. This contradicts the hypothesis that "higher score value implies higher measure, and vice-versa".
The "average ability" for missing data is the average measure of all the persons for whom there is no response to this item. This can be useful. For instance, we may expect the "missing" people to be high or low performers, or to be missing random (and so they average measure would be close to the average of the sample).
These values are plotted in Table 2.6.

ABILITY P.SD is the population standard deviation of the ABILITY values = √(Σ (ABILITY - (ABILITY MEAN))²/COUNT)

S.E. MEAN is the standard error of the mean (average) measure of the sample of persons from a population who responded in this category (adjusted by PWEIGHT=) = √(Σ (ABILITY - (ABILITY MEAN))²/(COUNT*(COUNT-1))

INFT MNSQ is the Infit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

OUTF MNSQ is the Outfit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

PTMA CORR is the point-correlation between the data code, scored 1, or non-occurrence, scored 0, of this category or distractor and the person raw scores or measures chosen by PTBISERIAL=. The computation is described in Correlations. Example: for categories 0,1,2, then the correlation is between [1 for the target score (0 , 1, or 2) and 0 for the other scores (1 and 2, 0 and 2, or 0 and 1)] and the person ability measures for the persons producing each score.

ITEM (here, ACT) is the name or label of the item.

Data codes and Category labels are shown to the right of the box, if CLFILE= or CFILE= is specified.

* Average ability does not ascend with category score. The average ability of the persons observed in this category is lower than the average ability of the persons in the next lower category. This contradicts the Rasch-model assumption that "higher categories <-> higher average abilities."

Missing % includes all categories. Scored % only of scored categories. The percentage for the missing category is based on all the COUNTS. The percentages for the SCOREd categores are based only on those category COUNTs.

""BETTER FITTING OMIT" appears in fit-ordered Tables, where items better fitting than FITI= are excluded.

14.20 Table 16 Person maps with full person labels

(controlled by T1SCORE=, IPEXTREME=, MRANGE=, MTICK=, MAXPAGE=, NAMLMP=, PSORT=, T1I#=, LINELENGTH=see also MTOP=)

Table 16.3 Person map with full labels	Right-hand column shows the full person labels located by the person ability measures along the

```
MEASURE ACT - MAP - KID
        <rare>|<more>
   5          +  FATALE, NATASHA        ROSSNER, LAWRENCE F.
              |
              |
              |
              |
              |  PASTER, RUTH
   4          +
              |
              |  SCHATTNER, GAIL
              |T
              |  DOEPPNER, TOM
              |
   3          +  MCLOUGHLIN, BILLY
             T|  WRIGHT, BENJAMIN
              |
           X  |  BUFF, MARGE BABY       CHAZELLE, BERNIE
              |  CLAPP, LB              SEILER, KAREN
           X  |S ERNST, RICHARD MAX     SQURREL, ROCKY J.
   2          +  CLAPP, CHARLIE         EASTWOOD, CLINT
                 VROOM, JEFF
          XX  |  BADENOV, BORIS         KENT, CLARK
           X  |  MOOSE, BULLWINKLE      ROSSNER, BESS
              |  CORLEONE, VITO         MAN, SPIDER
                 PATRIARCA, RAY
             S|  HSIEH, PAUL FRED       SQUILLY, MICHAEL
           X  |  CLAPP, DOCENT          HOGAN, KATHLEEN
                 ROSSNER, TOBY G.
   1          +M BECKER, SELWIN         BLOFELD, VILLAIN
                 FONTANILLA, HAMES      LAMBERT, MD., ROSS W.
              |  SABILE, JACK           TOZER, AMY ELIZABETH
          XX  |  ALLEN, PETER           BABBOO, BABOO
                 CORLEONE, MICHAEL      PINHEAD, ZIPPY
         XXX  |  BEISER, ED             HSIEH, DANIEL SEB
                 MALAPROP, MRS.         SANDBERG, RYNE
           X  |  CIANCI, BUDDY          EISEN, NORM L.
          XX  |  AIREHEAD, JOHN         ANGUIANO, ROB
   0         M+  AMIRAULT, ZIPPY        DRISKEL, MICHAEL
         XXX  |S
           X  |  BAUDET, GERARD
           X  |  BOND, JAMES            ROSSNER, REBECCA A.
           X  |
  -1       X  +  LIEBERMAN, DANIEL      NORDGREN, JAN SWEDE
              |
           X S|  JACKSON, SOLOMON       LANDMAN, ALAN
           X  |T
              |  SABOL, ANDREW
              |
  -2       X  +
        <freq>|<less>
```

variable. Abbreviated person labels are shown in Table 1.3. The persons often have a normal distribution.

Left-hand column locates the item difficulty measures along the variable. Table 12 has the full item labels.

For dichotomous items, look for an even spread of items along the variable (the y-axis) with no gaps, indicating poorly defined or tested regions of the variable. Good tests usually have the items targeted (lined up with) the persons.

For polytomous items, Table 2.2 shows the operational range of the item with its rating scale.

In Table 16.3, the full person names are shown with an item distribution. You can use NAMLMP= or PMAP=to control the number of characters of each name reported. MAXPAGE= controls the length of the Table. MRANGE= controls the displayed range of measures. PSORT= controls the sort order within rows.

Persons arranged by measure: Look for the hierarchy of person names to spell out a meaningful distribution from highest scoring at the top to lowest scoring at the bottom.

M,S,T are the Mean, 1 and 2 Standard Deviations from the Mean for the persons and items. With IPEXTREME=Yes (the default), persons and items with extreme scores are placed at the ends of the map and are excluded from M,S,T. With IPEXTREME=No, persons and items with extreme scores are placed at their measures on the map and are included in M,S,T.

Column Labels

ITEM=	MAP	PERSON=
RARE=	T	MORE=
	|	
FREQ=	⊥	LESS=

Table 16.13 Person map with full labels and reversed item distribution

```
MEASURE TAP - MAP - KID
        <freq>||<more>
   5     XXX  ++
           X  ||
   4      XX  ++T
          XX S||  Rick    M  Susan   F
   3          ++  Frank   M
           X  ||
   2          ++S Bert    M  Betty   F  Elsie   F  Thomas  M
           X  ||
   1          ++  Britton F  Carol   F  David   M  Joe     M  Zula    F
              ||
   0         M++M
             ||  Anne    F  Audrey  F  Barbara F  Dorothy F  James   M
                 Kim     F  Linda   F  Mike    M  Ron     M  Tracie  F
```

Right-hand column is the person details, see Table 16.3. Abbreviated person labels are shown in Table 1.13.

Left-hand column locates the item distribution by their easiness measures along the latent variable. These are the difficulty measures reversed around the mean person difficulty "M".

Column Labels

ITEM=	MAP	PERSON=
FREQ=	T	MORE=
	|	
RARE=	⊥	LESS=

```
                   Walter  M  William M
 -1        X  ++
              ||  Janet   F  Lisa    F  Rod     M
 -2       XX  ++S Brenda  F  Pete    M
              ||
 -3           ++  Adam    M  Richard M
           X S||  Blaise  M  Martha  F
 -4           ++T
              ||  Don     M
 -5     XXXX  ++  Helen   F
        <rare>||<less>
```

On Plot:	*Description:*
SCORE	raw score on all active items when T1SCORE=Yes. Includes extreme items when TOTALSCORE=Yes
MEASURE	Location of person or item on the unidimensional latent variable, in logits or USCALE= units
<more>	higher person "ability" = higher raw score with complete data
<less>	lower person "ability" = lower raw score with complete data
<rare>	higher item "difficulty" = lower item "easiness" = lower score on the item with complete data: PVALUE=
<frequ> <frequent>	lower item "difficulty" = higher item "easiness" = higher score on the item with complete data: PVALUE=
M	Mean of person or item distribution
S	One "sample is the population" standard deviation from the person or item mean
T	Two standard deviations from the person or item mean
X	one person or item
#	several persons or items, e.g., EACH "#" = 4. The value for # can be changed with T1I#= for items, T1P#= for persons.
.	between 1 and (# - 1) persons or items, e.g., if # = 4, then "." = 1 to 3
|	Variable advances. Lines without "|" have the same measure as the nearest "|" above.
||	The double line || indicates the two sides have opposite orientations: person ability and item easiness. The item difficulties are reversed.This is useful if the items and persons are being compared to the responses.

14.21 Table 17.1 Person statistics in measure order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, TOTAL=)

PERSON STATISTICS: MEASURE ORDER

For details, please see Table 10.1

14.22 Table 17.2 Person statistics graphically in measure order

Please see Table 10.2

14.23 Table 18.1 Person statistics in entry order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, TOTAL=)

PERSON STATISTICS: ENTRY ORDER

For details, please see Table 10.1

14.24 Table 18.2 Person statistics graphically in entry order

Please see Table 10.2

14.25 Table 19.1 Person statistics in label order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, PSORT=, TOTAL=)

PSORT= @TIMEPOINT ; sets the person sort order for Table 19.1

PERSON STATISTICS: ALPHA ORDER ON COLUMN: @TIMEPOINT

For details, please see Table 10.1

14.26 Table 19.2 Person statistics graphically in label order

Please see Table 10.2

14.27 Table 20.1 Complete score-to-measure table on test of all items

For a score-to-measure table for fewer items, use ISELECT= or IDELETE= from the Specification Menu dialog box.
Table 20.2 Person score and measure distribution
Table 20.3 Complete score-to-calibration table for tests based on whole sample

```
                  TABLE OF MEASURES ON TEST OF 13 ITEM
----------------------------------------------------------------------------
| SCORE  MEASURE    S.E. | SCORE  MEASURE    S.E. | SCORE  MEASURE    S.E. |
|------------------------+------------------------+------------------------|
|    13    -6.34E   1.82 |    40    -1.35     .28 |    67     1.33     .35 |
|    14    -5.15     .99 |    41    -1.27     .28 |    68     1.46     .36 |
....
|    36    -1.65     .28 |    63      .84     .35 |    90     6.04    1.03 |
|    37    -1.58     .28 |    64      .96     .35 |    91     7.29E   1.84 |
|    38    -1.50     .28 |    65     1.08     .35 |                        |
|    39    -1.43     .28 |    66     1.21     .35 |                        |
----------------------------------------------------------------------------
CURRENT VALUES, UMEAN=.0000 USCALE=1.0000
TO SET MEASURE RANGE AS 0-100, UMEAN=46.5329 USCALE=7.3389
TO SET MEASURE RANGE TO MATCH RAW SCORE RANGE, UMEAN=49.2956 USCALE=5.7243
Predicting Score from Measure: Score = Measure * 8.2680 + 38.9511
Predicting Measure from Score: Measure = Score * .1158 + -4.5099
Maximum statistically different levels of performance (strata) = 3.8
Wright's Sample-independent Person (Test) Reliability based on maximum strata = .94
```

TOTALSCORE= YES includes extreme (maximum possible score and minimum possible score) for example file: Exam1.txt

```
                  TABLE OF MEASURES ON TEST OF 18 TAP (includes 4 extreme items)
----------------------------------------------------------------------------
| SCORE  MEASURE    S.E. | SCORE  MEASURE    S.E. | SCORE  MEASURE    S.E. |
|------------------------+------------------------+------------------------|
|     0    -8.86E   1.90 |     7    -2.97     .81 |    14     3.75     .94 |
|     1    -8.11E   1.90 |     8    -2.27     .87 |    15     4.64     .97 |
|     2    -7.37E   1.89 |     9    -1.41     .99 |    16     5.72    1.16 |
|     3    -6.62E   1.88 |    10     -.28    1.11 |    17     7.14E   1.90 |
|     4    -5.26    1.11 |    11      .93    1.06 |    18     7.87E   1.92 |
```

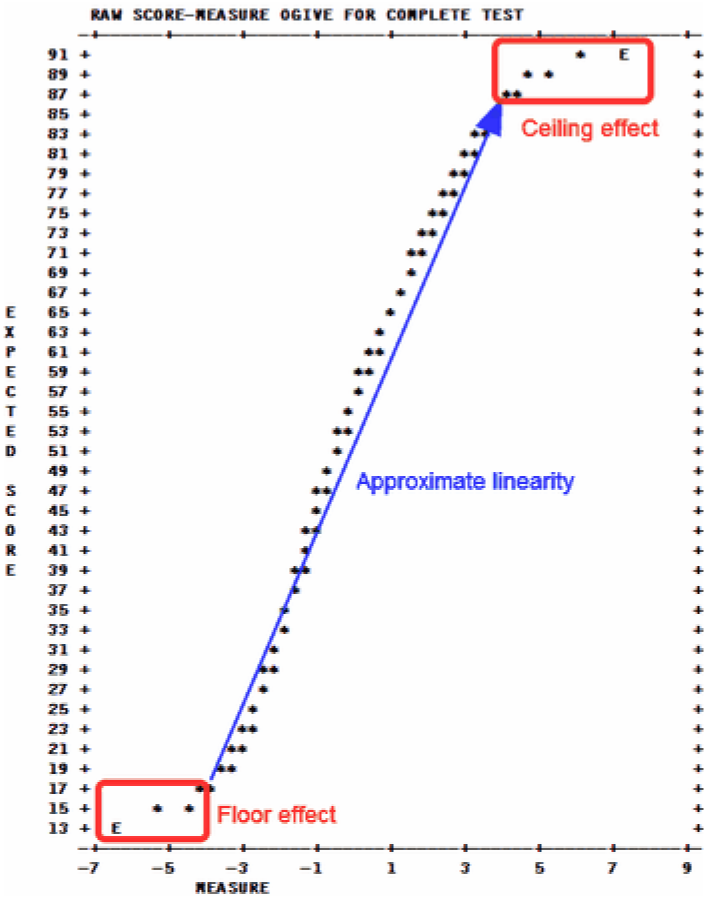
```
|     5    -4.32      .88 |     12      1.95      .98 |                         |
|     6    -3.62      .81 |     13      2.87      .95 |                         |
-----------------------------------------------------------------------------
```

TOTALSCORE= NO excludes extreme (maximum possible score and minimum possible score) for example file: Exam1.txt

```
                        TABLE OF MEASURES ON TEST OF 14 NON-EXTREME TAP
-----------------------------------------------------------------------------
| SCORE  MEASURE     S.E. | SCORE  MEASURE     S.E. | SCORE  MEASURE     S.E. |
|------------------------+------------------------+------------------------|
|     0    -6.62E    1.88 |     5    -2.27      .87 |    10      2.87      .95 |
|     1    -5.26     1.11 |     6    -1.41      .99 |    11      3.75      .94 |
|     2    -4.32      .88 |     7     -.28     1.11 |    12      4.64      .97 |
|     3    -3.62      .81 |     8      .93     1.06 |    13      5.72     1.16 |
|     4    -2.97      .81 |     9     1.95      .98 |    14      7.14E    1.90 |
-----------------------------------------------------------------------------
```

In Table 20.1	Explanation
TABLE OF MEASURES ON TEST OF 13 ITEM TOTALSCORE=Yes includes extreme items TOTALSCORE=No excludes extreme items (if any)	Raw score-to-Measure Table for all raw scores on the complete set of all active non-extreme calibrated items. This can also be output with SCOREFILE=. Table 20.1 shows the score-to-measure table for persons with complete data. For persons with missing data, this table does not apply. Score-to-measure tables for subtests or persons with missing data can be produced by using ISELECT= or IDELETE= from the Specification menu before requesting Table 20. If there are subsets, then the reported Table 20 is one of an infinite number of possible Table 20s.
SCORE	Raw score on the complete set of non-extreme or all items. If IWEIGHT= produces decimal scores, then scores with one decimal place are shown. Some SCOREs may not be observable. Some observable scores may not be shown, but may be better approximated from TCCFILE=
MEASURE	Estimated measure for the SCORE raw score on all the items, adjusted by USCALE= and UIMEAN=, if active. The MEASURE may differ slightly from Table 17. Tighten convergence to make them agree exactly. The SCOREFILE= and Table 20 person ability estimates are estimated on the basis that the current item difficulty estimates are the "true" estimates. These are the person estimates if you anchored (fixed) the items at their reported estimates. The convergence criterion used are LCONV= 0.01 and RCONV= 0.01 - these are considerably tighter than for the main analysis. So Table 20 is a more precise estimate of the person measures based on the final set of item difficulties. PFILE=, Table 17 and the other Person Measure Tables show the person abilities that are the maximum likelihood

	estimates at the current stage of estimation. To make these two sets of estimates coincide, please tighten the convergence criteria in your Winsteps control file: CONVERGE= L LCONV=.0.001 ; or tighter If STBIAS=YES is used, then score table measures are dependent on the data array, even if items are anchored.
-6.34E	"E" (Extreme, Extrapolated) is a warning that the accompanying value is not estimated in the usual way, but is an approximation based on arbitrary decisions. For extreme scores, the Rasch estimated would be infinite. So the arbitrary decision has been made to make the extreme score more central by the EXTREMESCORE= amount (or its default value), and to report the measure corresponding to that score. The Rasch standard error of an extreme score is also infinite, so the reported standard error of an "E" value is the standard error of the finite reported measure.
S.E.	The model-based standard error of the MEASURE, not adjusted for misfit.
CURRENT VALUES, UMEAN=.0000 USCALE=1.0000	This shows the current user-scaling. Changing the user-scaling in the Specification menu dialog box or the Help menu USCALE= calculator changes Table 20 immediately. Use this to experiment with different values of USCALE= and UIMEAN=.
TO SET MEASURE RANGE AS 0-100, UMEAN=46.5329 USCALE=7.3389	Suggested UIMEAN= and USCALE= values for transformation of the MEASUREs into user-friendly values in the range 0-100 resembling percentages.
TO SET MEASURE RANGE TO MATCH RAW SCORE RANGE, UMEAN=49.2956 USCALE=5.7243	Suggested UIMEAN= and USCALE= values for transformation of the MEASUREs into user-friendly values into the range or raw scores so that the MEASUREs resemble raw scores.
Predicting Score from Measure: Score = Measure * 8.2680 + 38.9511	A linear approximation of the score-to-measure ogive useful for predicting raw scores on this set of items from measures. To approximate measures by raw scores: USCALE= 8.2680 and UIMEAN= 38.9511 <- use numbers from your Table 20.1
Predicting Measure from Score: Measure = Score * .1158 + -4.5099	A linear approximation of the score-to-measure ogive useful for predicting measures from raw scores on this set of items.
Maximum statistically different levels of performance (strata) = 3.8 Wright's Sample-independent Person (Test) Reliability based on maximum strata = 0.94	Across the raw-score range in Table 20.1, statistically significant different raw scores are 1.96 * $(M_1 - M_2) / \sqrt{(SE_1^2 + SE_2^2)}$ apart where M_1 and M_2 are the two measures. SE_1 and SE_2 are their two standard errors. See www.rasch.org/rmt/rmt144k.htm. The number of different levels (strata) resembles a separation index. Wright's matching "Test" Reliability is shown. These are equivalent to the Separation and Reliability of a person sample with a uniform distribution having the range of the MEASUREs in Table 20.

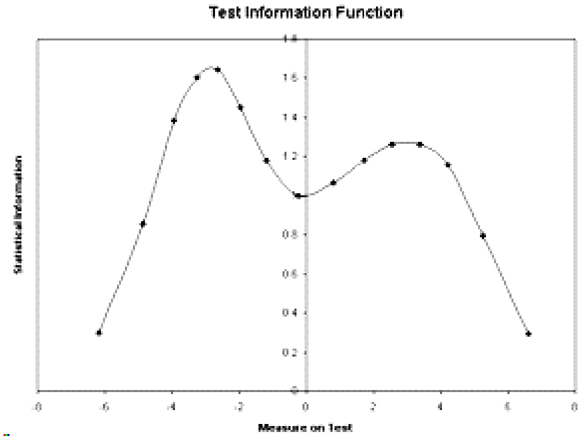



```
                                  1
PERSON             1  1123 55247311 6 35411272 12
                    T      S       M      S      T
%TILE              0    10  20  40  50  60  70  80  90  99

ITEM                       1   141221   1
                           T   S  M S   T
%TILE                      0  10  60  90  99
```

A graph of the score to measure conversion is also reported. '*' indicates the conversion. This is the Test Chracteristic Curve, TCC. Table 20.1 gives the score-to-measure conversion for a complete test, when going from the y-axis (score) to the x-axis (measure). When going from the x-axis (measure) to the y-axis(score), it predicts what score on the complete test is expected to be observed for any particular measure on the x-axis. For CAT tests and the like, no one takes the complete test, so going from the y-axis to the x-axis does not apply. But going from the x-axis to the y-axis predicts what the raw score on the complete bank would have been, i.e., the expected total score, if the whole bank had been administered.

Measure distributions for the persons and items are shown below the score-to-measure table. M is the mean, S is one P.SD (population standard deviation) from the mean. T is two P.SDs from the mean. %ILE is the percentile, the percentage below the measure. Percentiles have the range 0-99.

Test Information



The statistical information is (USCALE/S.E.)². These are plotted in the test information function in the Graph window. You can also plot the values reported in TCCFILE=

Score-to-measure Table 20 is to be produced from known item and rating scale structure difficulties

In your Winsteps control file:
IAFILE=if.txt ; usually values from IFILE=if.txt of another analysis ; the item anchor file containing the known item difficulties
SAFILE=sf.txt ; usually values from SFILE=sf.txt of another analysis ; the structure/step anchor file (only for polytomies)
CONVERGE=L ; only logit change is used for convergence
LCONV=0.0001 ; logit change too small to appear on any report.
STBIAS=NO ; no estimation bias correction with anchor values
TFILE=*
20 ; the score table
*

The data file comprises two dummy data records, so that every item has a non extreme score, e.g.,
For dichotomies:
CODES = 01
Record 1: 10101010101
Record 2: 01010101010

For a rating scale from 1 to 5:
CODES = 12345
Record 1: 15151515151
Record 2: 51515151515

14.28 Table 20.2 Person score and measure distribution

Table 20.1 Complete score-to-measure table on test of all items
Table 20.2 Person score and measure distribution
Table 20.3 Complete score-to-calibration table for tests based on whole sample

TABLE OF SAMPLE NORMS (500/100) AND FREQUENCIES CORRESPONDING TO COMPLETE TEST

SCORE	MEASURE	S.E.	NORMED	S.E.	FREQUENCY	%	CUM.FREQ.	%	PERCENTILE
0	-6.17E	1.83	147	107	0	.0	0	.0	0
1	-4.86	1.08	225	63	0	.0	0	.0	0
2	-3.94	.85	278	50	1	2.9	1	2.9	1
3	-3.27	.79	318	46	2	5.9	3	8.8	6
4	-2.64	.78	355	46	2	5.9	5	14.7	12
5	-1.97	.83	394	49	2	5.9	7	20.6	18

```
|      6    -1.19       .92|  440   54        3   8.8       10  29.4        25   |
|      7     -.23      1.00|  496   59       12  35.3       22  64.7        47   |
|      8      .80       .97|  557   57        5  14.7       27  79.4        72   |
|      9     1.72       .92|  610   54        4  11.8       31  91.2        85   |
|     10     2.55       .89|  660   52        1   2.9       32  94.1        93   |
|     11     3.37       .89|  707   52        2   5.9       34 100.0        97   |
|     12     4.21       .93|  756   54        0    .0       34 100.0       100   |
|     13     5.23      1.12|  817   66        0    .0       34 100.0       100   |
|     14     6.60E     1.84|  897  108        0    .0       34 100.0       100   |
+-----------------------------------------------------------------------------+
THE NORMED SCALE IS EQUIVALENT TO UIMEAN= 516.7919 USCALE= 45.0404
```

The columns in the Table of Sample Norms and Frequencies are:

Measures on the Complete Test:	
SCORE	raw score on a complete test containing all calibrated items: TOTALSCORE=Yes includes extreme items. TOTALSCORE=No excludes extreme items (if any)
MEASURE	measure corresponding to score
	If a person did not take all items or items are weighted, then that person is stratified with the measure on the complete test nearest the person's estimated measure (as reported in Table 18), regardless of that person's observed score.
S.E.	standard error of the measure (model). The statistical Test Information is (USCALE/S.E.)²
Statistics for this sample:	
NORMED	measures linearly locally-rescaled so that the mean person measure for this sample is 500 and the population standard deviation is 100. Equivalent to UPMEAN=500, USCALE=100/(Person P.SD)
S.E.	standard error of the normed measure (for a score based on all the items)
FREQUENCY	count of sample with measures at or near (for missing data) the complete test measure
%	percentage of sample included in FREQUENCY
CUM.FREQ.	count of sample with measures near or below the test measure, the cumulative frequency.
%	percentage of sample include in CUM. FREQ.
PERCENTILE	The percent of the sample below the current measure.There are several definitions of percentile. Winsteps uses this one: Percentile Rank: The percentile is the cumulative frequency percent for the score below + half the frequency percent for the current score, half-rounded, and constrained to the range 1-99 for non-zero frequencies: . Percentiles for other definitions can be computed from the CUM. FREQ column. See, for instance, how-to-calculate-percentile If the data are complete, then the raw data and the Rasch measures produce the same percentiles. If the data are incomplete, then the Rasch measures are used because they are robust against missing data.
NORMED SCALE	This shows the UIMEAN= and USCALE= values in order to report the person MEASURES at their NORMED (500/100) values.

Logit measures support direct probabilistic inferences about relative performances between persons and absolute performances relative to items. Normed measures support descriptions about the location of subjects within a sample (and maybe a population). Report the measures which are most relevant to your audience.

To paste this Table into Excel, set BOXSHOW=No to remove the vertical | and then copy-and-paste this table into Excel. Use Excel's "data", "text to columns" feature to put the scores and measures into columns.

Example: I want to stratify my sample into low, medium, high ability groups.
The separation index is based on the statistical fiction that your data accord exactly with a normal distribution and that the average measurement error (RMSE) precisely summarizes the precision of your data. In practice, these assumptions are only met approximately.

If your data are "complete" (everyone responds to every item), then a convenient places to start is Table 20.2. Starting at the lowest score, look down the scores until you find the score that best characterizes (as a first guess) your "low group". Then mentally multiply its S.E. by 3, and add it to the measure for the low group. This will take you to the measure for the middle group, which will be approximately statistically significantly different (p≤.05) from the low group. Do the same again for the middle group, and it will take you to the high group. Same again may take you to an even higher group, or up into the outliers at the top of the test. The cut-points will be half-way between the group centers that you have identified.

Do the same process from the top score downwards for another version of the stratification.

Then synthesize the two stratifications by adjusting the group by moving their center scores further apart (not closer together).

14.29 Table 20.3 Complete score-to-calibration table for tests based on whole sample

Table 20.1 Complete score-to-measure table on test of all items
Table 20.2 Person score and measure distribution
Table 20.3 Complete score-to-calibration table for tests based on whole sample

This Table, which must be selected explicitly with TFILE=, or as a subtable with "Request Subtable" on the "Output Tables" menu, shows an estimated item calibration for all possible rates of success by persons, i.e., the item measure corresponding to every observable proportion-correct-value or item marginal raw score for the entire sample.

Output Tables
Request Subtables
20.3
OK

or enter into your control file:
TFILE=*
20.3
*

```
TABLE OF ITEM MEASURES ON COMPLETE NON-EXTREME SAMPLE FOR TAP LIKE 4  1-3-4
----------------------------------------------------------------------------
| SCORE  MEASURE    S.E. | SCORE  MEASURE    S.E. | SCORE  MEASURE    S.E. |
|------------------------+------------------------+------------------------|
|     0    6.17E   1.87 |     12      .81     .45 |    24    -1.58     .48 |
|     1    4.84    1.08 |     13      .61     .44 |    25    -1.82     .50 |
|     2    3.98     .82 |     14      .41     .44 |    26    -2.08     .52 |
|     3    3.40     .70 |     15      .22     .44 |    27    -2.36     .54 |
|     4    2.96     .64 |     16      .03     .43 |    28    -2.67     .57 |
|     5    2.58     .59 |     17     -.16     .43 |    29    -3.01     .60 |
|     6    2.26     .55 |     18     -.34     .43 |    30    -3.40     .64 |
|     7    1.97     .53 |     19     -.53     .44 |    31    -3.85     .71 |
|     8    1.71     .50 |     20     -.73     .44 |    32    -4.43     .82 |
|     9    1.46     .49 |     21     -.93     .45 |    33    -5.29    1.08 |
|    10    1.23     .47 |     22    -1.14     .46 |    34    -6.61E   1.87 |
|    11    1.01     .46 |     23    -1.35     .47 |                        |
----------------------------------------------------------------------------
```

SCORE raw score on this item of a complete sample containing all calibrated persons. Table 20.3 shows the score-to-measure table for items with complete data. For items with missing data, this table does not apply. TOTALSCORE=Yes includes extreme persons
TOTALSCORE=No excludes extreme persons (if any).
MEASURE measure corresponding to score (user-scaled with UIMEAN=, USCALE=).
S.E. standard error of the measure.
The statistical information in an item estimate for the entire sample is $(USCALE/S.E.)^2$

The real difficulty of an item is its difficulty relative to ...	
the average difficulty of all the items	This is the Winsteps default UIMEAN= 0

the average ability of all the persons	Specify: UPMEAN= 0
a person who scores 50% on all the items in the test	a) Run a standard analysis b) Output Table 20 c) In Table 20.1, look for the measure corresponding to 50% success on the test d) Specify UIMEAN = - (corresponding to 50% success on the test) e) rerun the analysis f) look at Table 20.1, 50% success on the test should be "0".
an item on which 50% of all the persons succeed	a) run a standard analysis b) Menu: Output Tables c) Click on first entry "Request Subtables" 20.3 Click on OK c) In Table 20.3, look for the measure corresponding to 50% success by the sample d) Specify UIMEAN = - (corresponding to 50% success by the sample) e) rerun the analysis f) look again at Table 20.3, 50% success by the sample should be "0".

14.30 Table 21 Category Probability curves and Expected score ogive

(controlled by MRANGE=, CURVES=) - also called Item Response Curves, IRCs

21.1 Dichotomies: Category probabilities

```
           DICHOTOMOUS
         CURVES
     P     -------------------------------------------------------------
     R  1.0  0000000000000000
         1111111111111111
     O                           000000
         111111
     B   .8                            000
         111
     A                                    00
         11
     B   .6                                  00
         11
     I
         ***
     L   .4                                  11
         00
     I                                    11
         00
     T   .2                            111
         000
     Y                           111111
         000000
         .0  1111111111111111
         0000000000000000
           -------------------------------------------------------------
           -6        -4        -2         0         2         4
         6
                                     PERSON [MINUS]  ITEM  MEASURE
```

The probability of each response is shown across the measurement continuum. The measure to be used for determining the probability of any particular response is the difference between the measure of the person and the calibration of the item. For dichotomies, only one curve is shown plotting the probability of scoring a "1" (correct), and also of scoring a "0" (incorrect) for any measure relative to item measure. For 'S' and 'F' models these curves are approximations.

21.1 Polytomies: Individual category probabilities

```
           CATEGORY PROBABILITIES: MODES - Andrich Thresholds at
         intersections
     P     -------------------------------------------------------------
     R  1.0  00000000
         22222222
```

See Rating scale conceptualization.
When there are more than two categories, the probability of each category is shown. The points of intersection of adjacent categories are the

```
     O              0000000
       2222222
     B   .8                000
       222
     A                        000
       222
     B   .6                      00
       22
     I   .5
       00*111111111*22
     L   .4                          111 00     22
       111
     I                            111      00 22
       111
     T   .2                  1111          22*00
       1111
     Y              1111111        22222     00000
       1111111
         .0  ********222222222222222
         000000000000000********
          -------------------------------------------------------------
         -5    -4    -3    -2    -1     0     1     2     3     4
       5
                                 PERSON [MINUS]  ITEM  MEASURE
```

Rasch-Andrich thresholds (structure calibrations).

21.2 Polytomies: Expected average ratings

```
          EXPECTED SCORE ICC/IRF: MEANS
     E    -------------------------------------------------------------
     X    2
       222222222222
     P
       2222222
     E  1.5
       2222
     C
       111
     T                                   111
        |
     E    1                           111
        |
     D                             111 *
        |
         .5                     111    *
        |
     S                       0000|     *
        |
     C                0000000    |     *
        |
     O    0  000000000000        |     *
        |
     R    -------------------------------------------------------------
     E    -5    -4    -3    -2    -1     0     1     2     3     4
       5
                                 PERSON [MINUS]  ITEM  MEASURE
```

The Expected score ogive is also called the Model Item Characteristic Curve (ICC) and Item Response Function (IRF). For response structures with three or more categories, two further graphs can be drawn. The second graph depicts the expected score ogive. The vertical "*" characters correspond to integer expected scores, and the "|" characters correspond to half-point expected scores, the Rasch-half-point thresholds. The intervals between the Rasch-half-point thresholds can be thought of as the intervals corresponding to the observed categories. For the purposes of inference, measures in the zone on the x-axis between '|' and '|' correspond, on average, to the rating given on the 'y' axis, '1'. Similarly ratings on the y-axis can be thought of as corresponding to measures in the matching zone on the x-axis. The degree to which the data support this is given by the COHERENCE statistics in Table 3.2. Empirical item characteristic curves are shown in Table 29 and from the Graphs menu.

21.3 Polytomies: Cumulative category probabilities

```
          MEDIANS - Cumulative probabilities
     P    -------------------------------------------------------------
     R  1.0
       ********222222222222222
     O      0       1111111
       22222
     B   .8   0              111
       222
     A      0                   111
       22
     B   .6   0                     11
       22
     I   .5   0----------------------111---------
       222-----------------------
     L   .4   0                       | 11        |
       22
     I      0                       |   11      |
       222
```

The third graph is of the zone curves which indicate the probability of an item score at or below the stated category for any particular difference between person measure and item calibration. The area to the left of the "0" ogive corresponds to "0". The right-most area corresponds to the highest category. The P=0.5 intercepts are the median cumulative probabilities. "|" indicate the Rasch-Thurstonian thresholds.

```
      T   .2  0                        |      111   |
          222
      Y       0                        |         11111
          2222222
          .0  0                        |            |
          111111111111111********
             -------------------------------------------------------------
             -5     -4     -3     -2     -1      0      1      2      3      4
          5
                                PERSON [MINUS]  ITEM  MEASURE
```

If ISGROUPS= defines more than one item group, then one set of these curves is shown for each item group: 21.1, 21.2, 21.3, then 21.11, 21.12, 21.13, then 21.21, 21.22, 21.23, etc. Each item group is identified by an example item from the group.

To produce these using other software, see GRFILE= or Graphs Window, Copy Data.

14.31 Table 22.1, 22.2, 22.3 Sorted response matrix (Guttman scalogram)

(controlled by LINELENGTH=).

Table 22.1 Sorted observed data matrix - Guttman scalogram

```
GUTTMAN SCALOGRAM OF RESPONSES:
KID |ACT
    |1111112 1 221  121    22
    |8920311251427634569784035
    |-------------------------
  2 +2222222222222222222222222  M ROSSNER, LAWRENCE F.
 41 +2222222222222222222222212  F FATALE, NATASHA
 34 +2222222222222222222222211  F PASTER, RUTH
 17 +2222222222222222222222210  F SCHATTNER, GAIL
 50 +2222222222222222222122111  M DOEPPNER, TOM
 45 +2222222222222222222221200  F MCLOUGHLIN, BILLY
  7 +2222222222222222220220220  M WRIGHT, BENJAMIN
 16 +2222222222222222222111101  F BUFF, MARGE BABY
 48 +2222222222222222212221100  M CHAZELLE, BERNIE
 25 +2222222222222222212021101  F SEILER, KAREN
 59 +2222222222222222212111020  F CLAPP, LB
 18 +2222222222222222212102100  M ERNST, RICHARD MAX
```

The observations are printed in order of person and item measures as a Guttman Scalogram, with most able persons listed first, the easiest items printed on the left. This scalogram shows the extent to which a Guttman pattern is approximated. See also Guttman Coefficient of Reproducibility.

Table 22.2 Guttman scalogram of zoned responses

```
  GUTTMAN SCALOGRAM OF ZONED RES
 KID |ACT
     |1111112 1 221  121    22
     |8920311251427634569784035
     |-------------------------
   2 +2222222222222222222222222  M ROSSNER, LAWRENCE F.
  41 +22222222222222222222222A2  F FATALE, NATASHA
  34 +22222222222222222222222AA  F PASTER, RUTH
  17 +22222222222222222222222A@  F SCHATTNER, GAIL
  50 +2222222222222222222A22A11  M DOEPPNER, TOM
  45 +222222222222222222222AB@@  F MCLOUGHLIN, BILLY
   7 +222222222222222222@2B@BB@  M WRIGHT, BENJAMIN
  16 +2222222222222222222A111@1  F BUFF, MARGE BABY
  48 +222222222222222222A22B11@@  M CHAZELLE, BERNIE
  25 +22222222222222222A2@B11@1  F SEILER, KAREN
  59 +22222222222222222A2A11@B@  F CLAPP, LB
  18 +22222222222222222A21@B1@@  M ERNST, RICHARD MAX
```

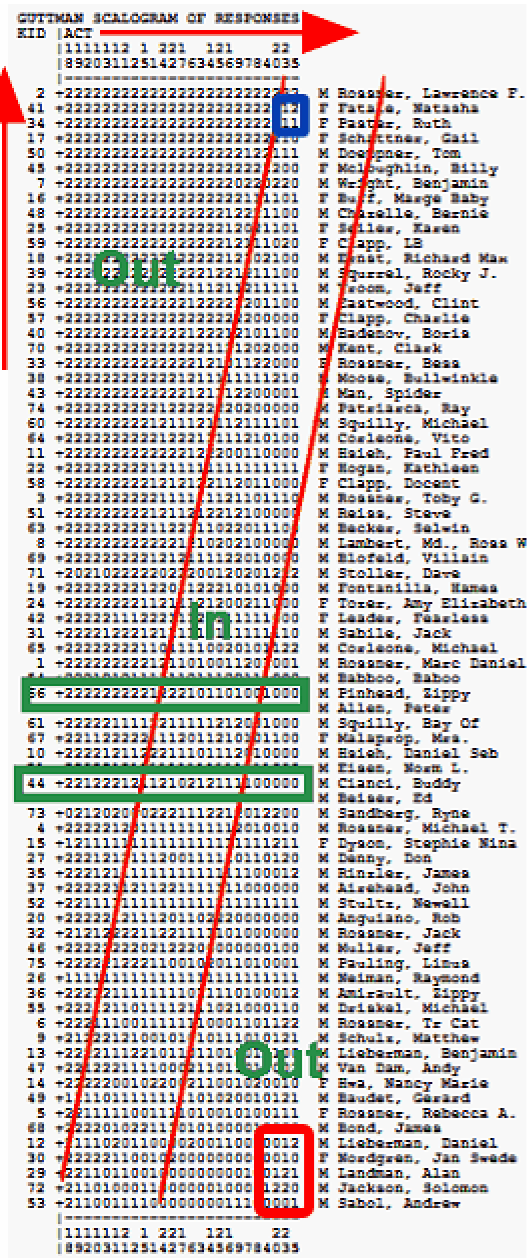
The scalogram is that of Table 22.1, but with each observation marked as to whether it conforms with its expectation or not. Observations within 0.5 rating points of their expectation are deemed to be in their expected categories, and are reported with their category values, e.g., '1', '2', etc. These ratings support the overall inferential relationship between observations and measures. Observations more than 0.5 rating points away from their expectations, i.e., in a "wrong" category, are marked with a letter equivalent: 'A' = '0','B' = '1','C' = '2', etc. These contradict observation-to-measure inferences. The proportion of in- and out-of-category observations are reported by the COHERENCE statistics in Table 3.2.

Table 22.3 Guttman scalogram of original response codes

```
   GUTTMAN SCALOGRAM OF ORIGINAL RESPONSES:
  KID |ACT
      |1111112 1 221  121    22
      |8920311251427634569784035
      |-------------------------
    2 +2222222222222222222222222  M ROSSNER, LAWRENCE F.
```

The observations are printed in order of person and item measures, with most able persons listed first, the easiest items printed on the left. This scalogram shows the original codes in the data file.

```
41 +22222222222222222222222212  F FATALE, NATASHA
34 +22222222222222222222222211  F PASTER, RUTH
17 +22222222222222222222222210  F SCHATTNER, GAIL
50 +22222222222222222222122111  M DOEPPNER, TOM
45 +22222222222222222222221200  F MCLOUGHLIN, BILLY
 7 +22222222222222222220220220  M WRIGHT, BENJAMIN
16 +22222222222222222222111101  F BUFF, MARGE BABY
48 +22222222222222222212221100  M CHAZELLE, BERNIE
25 +22222222222222222212021101  F SEILER, KAREN
59 +22222222222222222212111020  F CLAPP, LB
18 +22222222222222222212102100  M ERNST, RICHARD MAX
```



Interpreting a Scalogram. Example of Table 22.1 for Example0.txt. A scalogram orders the persons from high measure to low measure as rows, and the items from low measure (easy) to high measure (hard) as columns. The green boxes show the probabilistic advance from responses in high categories on the easy items to responses in low categories on the hard items.

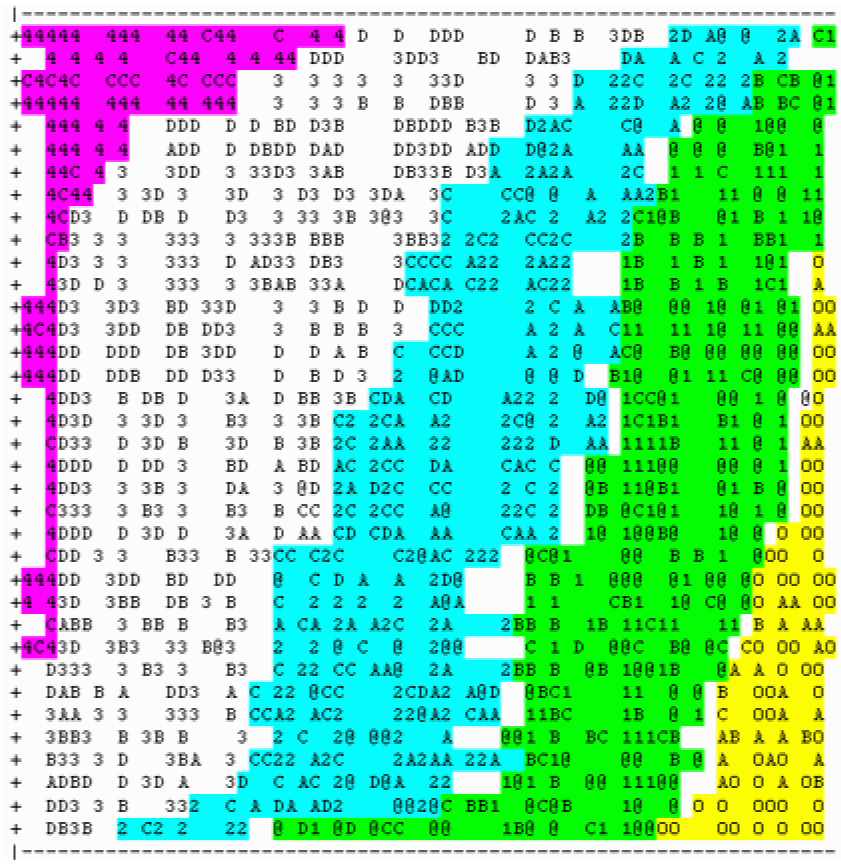
Top left corner: where the “more able” (more liking) children respond to the “easier” (to like) items. So we expect to see responses of “Like” (2). We do! Unexpected responses in this area influence the Outfit statistics more strongly.

Top right corner: (blue box) where the “most liking” children and the “hardest to like items” meet - you can see some ratings of 1.

Bottom right corner: where “less able” (less liking) children respond to the “harder” (to like) items. So we expect to see responses of “Dislike” (0). But do we?? Something has gone wrong! There are 1’s and 2’s where we expected all 0’s. Unexpected responses in this area influence the Outfit statistics more strongly.

Diagonal transition zone: Between the red diagonals lies the transition zone where we expect 1’s. In this zone Infit is more sensitive to unexpected patterns of responses. More categories in the rating scale means a wider transition zone. Then the transition zone can be wider than the observed responses.

Example of Table 22.2. Five categories: 0,1,2,3,4. Categories in the wrong scores bands are shown as @ (=0), A (=1), B (=2), C (=3), D (=4). The 5 score bands have different colors here. Band 0 is yellow. Band 1 is green. Band 2 is blue. Band 3 is white. Band 4 is mauve.



```
|------------------------------------------------------------------------
+44444  444  44 C44    C  4 4 D  D  DDD     D B B  3DB  2D A@ @   2A C1
+  4 4 4 4   C44  4 4 44 DDD    3DD3   BD  DAB3     DA  A C 2  A 2
+C4C4C  CCC  4C CCC    3  3 3 3  3  33D     3 3 D  22C  2C 22 2B CB @1
+44444  444  44 444    3  3 3 B  B  DBB     D 3 A  22D  A2 2@ AB BC @1
+  444 4 4    DDD  D D BD D3B    DBDDD B3B D2AC     C@  A @ @  1@@  @
+  444 4 4    ADD  D DBDD DAD    DD3DD ADD D@2A     AA  @ @ @  B@1  1
+  44C 4 3    3DD  3 33D3 3AB    DB33B D3A 2A2A     2C  1 1 C  111  1
+  4C44  3 3D 3    3D  3 D3 D3 3DA  3C    CC@ @  A  AA2B1   11 @ @ 11
+  4CD3  D DB D    D3  3 33 3B 3@3  3C    2AC 2  A2 2C1@B   @1 B 1 1@
+  CB3 3 3   333   3 333B BBB    3BB32 2C2  CC2C    2B  B B 1  BB1  1
+  4D3 3 3   333   D AD33 DB3    3CCCC A22  2A22    1B  1 B 1  1@1  O
+  43D D 3   333   3 3BAB 33A    DCACA C22  AC22    1B  B 1 B  1C1  A
+444D3  3D3  BD 33D    3  3 B D  D  DD2     2 C A  AB@  @@ 1@ @1 @1 OO
+4C4D3  3DD  DB DD3    3  B B B  3  CCC     A 2 A  C11  11 1@ 11 @@ AA
+444DD  DDD  DB 3DD    D  D A B  C  CCD     A 2 @  AC@  B@ @@ @@ @@ OO
+444DD  DDB  DD D33    D  B D 3  2  @AD     @ @ D  B1@  @1 11 C@ @@ OO
+  4DD3  B DB D    3A  D BB 3B CDA  CD    A22 2  D@ 1CC@1   @@ 1 @ @O
+  4D3D  3 3D 3    B3  3 3B C2 2CA  A2    2C@ 2  A2 1C1B1   B1 @ 1 OO
+  CD33  D 3D B    3D  B 3B 2C 2AA  22    222 D  AA 1111B   11 @ 1 AA
+  4DDD  D DD 3    BD  A BD AC 2CC  DA    CAC C  @@ 111@@   @@ @ 1 OO
+  4DD3  3 3B 3    DA  3 @D 2A D2C  CC    2 C 2  @B 11@B1   @1 B @ OO
+  C333  3 B3 3    B3  B CC 2C 2CC  A@    22C 2  DB @C1@1   1@ 1 @ OO
+  4DDD  D 3D D    3A  D AA CD CDA  AA    CAA 2  1@ 1@@B@   1@ @ O OO
+  CDD 3 3   B33   B 33CC C2C    C2@AC 222  @C@1    @@  B B 1  @OO  O
+444DD  3DD  BD  DD    @  C D A  A  2D@     B B 1  @@@  @1 @@ @O OO OO
+4 43D  3BB  DB 3 B    C  2 2 2  2  A@A     1 1    CB1  1@ C@ @O AA OO
+  CABB  3 BB B    B3  A CA 2A A2C  2A    2BB B  1B 11C11   11 B A AA
+4C43D  3B3  33 B@3    2  2 @ C  @  2@@     C 1 D  @@C  B@ @C CO OO AO
+  D333  3 B3 3    B3  C 22 CC AA@  2A    2BB B  @B 1@@1B   @A A O OO
+  DAB B A   DD3   A C 22 @CC    2CDA2 A@D  @BC1    11  @ @ B  OOA  O
+  3AA 3 3   333   B CCA2 AC2    22@A2 CAA  11BC    1B  @ 1 C  OOA  A
+  3BB3  B 3B B     3  2 C  2@ @@2    A   @@1 B  BC 111CB   AB A A BO
+  B33 3 D   3BA   3 CC22 A2C    2A2AA 22A  BC1@    @@  B @ A  OAO  A
+  ADBD  D 3D A    3D  C AC 2@ D@A  22    1@1 B  @@ 111@@   AO O A OB
+  DD3 3 B   332   C A DA AD2    @@2@C BB1  @C@B    1@  @ O O  OOO  O
+  DB3B  2 C2 2    22  @ D1 @D @CC  @@    1B@ @  C1 1@@OO   OO O O OO
|------------------------------------------------------------------------
```

Example of Table 22.3. Here is the Scalogram for Example 5, a computer-adaptive, multiple-choice test. The original responses are shown.

```
GUTTMAN SCALOGRAM OF ORIGINAL RESPONSES:
STUDENT |TOPIC
        |  11  3  11 1 321223221213242565442143414562 5 365553663564654646336 54
        |6402150381896777483909923156416405172645792682210768894303721395 53458
        |--------------------------------------------------------------------
      3 +                                     d   b     c    db    d    c b  cd   S   STA
      6 +                              c          b     c    d      d  c     cd   S   CHU
     27 +                          c   c   c            c   cbb  a dd c b   dd   S   ERI
      4 +                              c     b     a d  cb c dd     d  b d  dc   S   CHE
      9 +              d     c      a a cbc      c  ba b dca c db    dc bbdbb   c  S   MEL
     25 +              c   b       d c    bc    a     a d  a   c dba  d   cbccbd c  S   DAN
     24 +         a          d        ac       b     c d      c  b a    a          AP  SAR
     12 +              c   b          c      c    b b     b    b a    cb   cc c        A   ALL
     28 +                  c          c a bcc   b c acc d    b bc    b c bdcb       d  IH  GRE
     21 + b       c b a     c   b        a   bc   bb   ab a db bbd       cc    b      b  AP  MIL
```

```
11 +   a  d  c b  cc  cbad  d  ca c   d   ca ba b ac    bac   bc  d c cc   S   CHR
17 +      d     d c    c      acac cac  b c a     a  b    c  c bc b ac ac  IH  FRA
 7 +      d  c  d ccaaac d bcd ca    b cb c b  a  a a  a  ab   b    bb ac  IH  JAN
 1 +              c    c      ab    ca   dc b       a  a     c    a     c  IM  CAT
20 +     bd    b   c b cad  cd  a        bac      b    a  b     c    b     IL  JAM
22 +  d       a d c  b   d  cdabcc bbc cbdb a     a dbac     c dc   d  a   IM  BAR
30 +      d   a  a cab cdd   d  d      da      c       d  c     c   db     IL  HOL
14 + b    d  c  db caa caa   da c   dcd  b c   a cd    d     c  c   d  b   IL  TAK
23 +      d  cab  dcaa cadbbbba a   c a db     c  b    a     c  c   ab  c  IL  MEI
26 +      d   a   cc b  ac  cdd b   a  d db a  d       b  d     d   cb  c  IL  MIT
15 +  d   d   a  a caba  dcbddc c      d b     b  a       c         bb     NH  MAR
13 +  d   d     d  c bac dc  bd      d dcd     d  a    d  d  c  b    b     NH  KEL
29 +b dbd  bdcabd  baaacbd  c d c     ab   a     dd          d    c  b  c  NH  RIC
 8 +bbdadbd abaa acbcbccacbcadab   c   d cdab  a  d    a  a  c  c   cb     IL  ROB
16 +b da b bdccbbbcccbadaabba ccd   c ac bd a  a           b               NM  HEL
18 +b  a  a d  bca bc a   cccc  a     db   c   a  a       d         d      NH  JOE
10 +b badbdbcccadacbababcda cba a   a acd  a   d       a             b     NM  JON
19 +bbdad   dacbdb cabdbc  c ad     d ab b     c  a    b                   NM  THE
 2 +bbda  a d aaaa  c c a   cbd       ab   a   d                    c      NM  KAT
 5 +    aad a            ab           a  b       a                         NL  SMI
   |---------------------------------------------------------------------
   |  11  3  11 1 32122322212132425654421434145625 36555366356465464633654
   |640215038189677748390992315641640517264579268221076889430372139553458
```

Example: To display Scalogram response strings on the person Tables 6, 17, 18,19.

1. Perform your standard Winsteps analysis.
2. Output Table 22, with a LINELENGTH= big enough for all observations to be on one line.
3. Save Table 22 to your Desktop (or wherever).
4. Open the Table 22 file in software that can do a rectangular copy (NotePad++, TextPad, Word, etc.)
5. Open your Winsteps data file using the same rectangular-copy software.
6. Rectangular copy the Scalogram immediately adjacent to the person labels.
7. Adjust Winsteps control NAMELENGTH= etc for the new data file format.
8. Save the control and data file(s)
9. Perform your revised Winsteps analysis.
10. Table 6 should now display the Scalogram as part of the person label.

14.32 Table 23 Item multidimensionality

14.32.1 Table 23.0 Variance components scree plot for items

The dimensionality analysis of Table 23 stratifies the items into three clusters for each Contrast (Principal Component). The items are listed in Table 23.2. For each Contrast, each person is measured on each cluster of items. These measures are then correlated for each pair of clusters. If the correlations approach 1.0, then empirically the clusters of items are measuring approximately the same thing. Since measurement error (low test reliability) lessens the correlations, the disattenuated correlations are also reported.

From a substantive viewpoint, the PCA of residuals investigates whether there are secondary dimensions in the data. The sum of the eigenvalues of the PCA of the item intercorrelations is the count of the items. So an eigenvalue of 1 has the strength of 1 item. To be considered a "dimension" we need the strength of at least 2 items or we are merely looking at idiosyncratic single items, not dimensions. Of course, each of those idiosyncrasies represents a different dimension. Part of the art of constructing items is to make each item as similar as possible (= on the same dimension) but also as different as possible (= on different dimensions). A paradox with which item writers continually wrestle.

Statistically, for data simulated to fit the Rasch model, and so not have any secondary dimensions, the random size of the largest eigenvalue is almost always less than 2.0 - www.rasch.org/rmt/rmt191h.htm

"Strands" of items are a challenge. Consider an arithmetic test. Addition items will have a large eigenvalue. Are they a separate dimension or not? The answer depends on the application. When diagnosing learning difficulties, "Addition" is a separate dimension. When considering Grade advancement, "Addition" is one of several item strands in an Arithmetic test.

"Distorting measurement" - here the disattenuated correlation of person measures, reported in Winsteps Table 23.0. If the different putative dimensions (clusters of items) produce highly correlated person measures, then the items are measuring the same thing, though perhaps in different ways. If not, the test contains items definitely measuring different things, and so distorting each other's measurements.

For dialog box, see Cluster Measure Plot - Table 23.6.

According to Mundfrom et al. (2005), the sample size needs to be at least 6 x (number of items) for stable results: Mundfrom, D. J., Shaw, D. G., & Ke, T. L. (2005). Minimum Sample Size Recommendations for Conducting Factor Analyses. International Journal of Testing, 5(2), 159-168.

Table 23.0 Variance components scree plot for items
Table 23.1, 23.11 Principal components plots of item loadings
Table 23.2, 23.12 Item Principal components analysis/contrast of residuals
Table 23.3, 23.13 Item contrast by persons
Table 23.4, 23.14 Item contrast loadings sorted by measure
Table 23.5, 23.15 Item contrast loadings sorted by entry number
Table 23.6, 23.16 Person measures for item clusters in contrast. Cluster Measure Plot for Table 23.6.
Table 23.99 Largest residual correlations for items
Youtube video explaining Table 23

Extreme scores produce estimated measures with high standard errors. Correlations are reported excluding and also including (+Extreme) person estimates for extreme scores.

```
     Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = ACT information units
                                              Eigenvalue   Observed   Expected
Total raw variance in observations     =      50.9521 100.0%         100.0%
  Raw variance explained by measures   =      25.9521  50.9%          50.7%
    Raw variance explained by persons  =      10.3167  20.2%          20.2%
    Raw Variance explained by items    =      15.6354  30.7%          30.6%
  Raw unexplained variance (total)     =      25.0000  49.1% 100.0%   49.3%
    Unexplned variance in 1st contrast =       4.6287   9.1%  18.5%
    Unexplned variance in 2nd contrast =       2.9434   5.8%  11.8%
    Unexplned variance in 3rd contrast =       2.2957   4.5%   9.2%
    Unexplned variance in 4th contrast =       1.7322   3.4%   6.9%
    Unexplned variance in 5th contrast =       1.6327   3.2%   6.5%

Essential Unidimensionality (Rasch/Common variance) =  66.2%

       STANDARDIZED RESIDUAL VARIANCE SCREE PLOT

        VARIANCE COMPONENT SCREE PLOT
       +--+--+--+--+--+--+--+--+--+--+--+
   100%+  T                              +
       |                                 |
 V  63%+                                 +
 A     |     M                           |
 R  40%+              U                  +
 I     |                                 |
 A  25%+           I                     +
 N     |        P                        |
 C  16%+                                 +
 E     |                                 |
    10%+                                 +
 L     |                 1               |
 O   6%+                                 +
 G     |                    2            |
 |   4%+                       3         +
 S     |                          4  5   |
 C   3%+                                 +
 A     |                                 |
 L   2%+                                 +
 E     |                                 |
 D   1%+                                 +
       |                                 |
  0.5%+                                  +
       +--+--+--+--+--+--+--+--+--+--+--+
          TV MV PV IV UV U1 U2 U3 U4 U5
         VARIANCE COMPONENTS
```

Table 23.0 shows a variance decomposition of the observations for the items. This is not produced for PRCOMP=O.

If your Table says "**Total variance in observations**", instead of "Total **raw** variance in observations", then please update to the current version of Winsteps, or produce this Table with PRCOMP=R.

Extreme items and persons (minimum possible and maximum possible raw scores) are omitted from this computation because their correlations are 0.

Simulation studies, and the empirical results of Winsteps users, indicated that the previous computation of "variance explained" was over-optimistic in explaining variance. So a more conservative algorithm was implemented. Technically, the previous computation of "variance explained" used standardized residuals (by default). These are generally considered to have better statistical properties than the raw residuals. But the raw residuals (PRCOMP=R) were found to provide more realistic explanations of variance, so the current Winsteps computation uses raw residuals for "variance explained" in the top half of the variance table.

The "Unexplained variance" is controlled by PRCOMP=, which defaults to standardized residuals (PRCOMP=S). Set PRCOMP=R to express the entire table in terms of raw residuals. Standardized residuals are preferred, see Detecting Multidimensionality: Which residual data-type works best?

Processing of missing data is controlled by CIMPUTE=

Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = ITEM information units				
	Eigenvalue	**Observed** percentage of total variance	**Observed** percentage of unexplained variance	**Expected** percentage of total variance
Total raw variance in observations =	50.9	100.0%	← Expected values if these data fit the Rasch model perfectly → ← If these match reasonably, then the measures explain the expected amount of variance in the data →	100.0%
Raw variance explained by measures =	25.9	50.9%		46.5%
Raw variance explained by persons =	10.3	20.2%		18.5%
Raw Variance explained by items =	15.6	30.7%		28.0%
Raw unexplained variance (total) =	25.0 = count of items (or persons)	49.1%	100.0%	53.5%
Unexplned variance in 1st contrast =	4.6	9.1%	18.5%	← Use simulations to estimate the Rasch-model-expected values SIFILE=
Unexplned variance in 2nd contrast =	2.9	5.8%	11.8%	
Unexplned variance in 3rd contrast =	2.3	4.5%	9.2%	
Unexplned variance in 4th contrast =	1.7	3.4%	6.9%	
Unexplned variance in 5th contrast =	1.6	3.2%	6.5%	
Essential Unidimensionality (Rasch/Common variance) =		66.2%		(100%)

Table of STANDARDIZED RESIDUAL variance: the standardized residuals form the basis of the "unexplained variance" computation, set by PRCOMP=

in Eigenvalue units: variance components are rescaled so that the total unexplained variance has its expected summed eigenvalue.

ITEM information units: the eigenvalue units are rescaled to match the number of items, so these values are equivalent to "strength in item units".

Observed: variance components for the observed data

Expected: variance components expected for these data if they exactly fit the Rasch model, i.e., the variance that would be explained if the data accorded with the Rasch definition of unidimensionality - www.rasch.org/rmt/rmt173g.htm
If **Observed** and **Expected** differ noticeably, then there is a problem in the estimation. This is not a symptom of multidimensionality. Check that iteration was not stopped manually (ctrl+f) or by MUCON=/MJMLE=, also that RCONV= and LCONV= are reasonably small. However for very large or very sparse data or very long rating scales, convergence can be difficult to obtain. Then big differences between observed and expected in Table 23 have the same meaning as unexpected displacements in the Measure tables. There is a problem with the estimation.

Total raw variance in observations: total raw-score variance in the observations

Raw variance explained by measures: raw-score variance in the observations explained by the Rasch item difficulties, person abilities and polytomous scale structures.
Raw variance explained by persons: raw-score variance in the observations explained by the Rasch person abilities (and apportioned polytomous scale structures) - this is equivalent to Jelle Goeman & Nivja de Jong's Summability Index (2013)
Raw variance explained by items: raw-score variance in the observations explained by the Rasch item difficulties (and apportioned polytomous scale structures)
Raw unexplained variance (total): raw-score variance in the observations not explained by the Rasch measures
Unexplned variance in 1st, 2nd, ... contrast: variance that is not explained by the Rasch measures is decomposed into Principal Component Analysis, PCA, components = Contrasts. The size of the first, second, ... contrast (component) in the PCA decomposition of standardized residuals (or as set by PRCOMP=), i.e., variance that is not explained by the Rasch measures, but that is explained by the contrast. At most, 5 contrasts are reported. If less than 5 are reported, then the other contrasts have negative eigenvalues, usually due to the data overfitting the Rasch model. You may have cleaned the data too much, see When to stop removing items and persons in Rasch analysis?
To obtain the expected values of the Unexplned variance please simulate data, then analyze it. This is a Parallel Analysis.

Essential Unidimensionality (Rasch/Common variance): in Factor Analysis, (G Factor / Common Variance %) = Variance explained by Rasch measures / (Rasch + variance explained by contrasts). Contrasts with eigenvalues < 1.3, or beyond the 5th contrasts, are treated as part of the random noise predicted by the Rasch model www.rasch.org/rmt/rmt191h.htm. Sets of items with Essential Dimensionality > 50% are assumed to be unidimensional for practical purposes. Liu, X., Cao, P., Lai, X., Wen, J., & Yang, Y. (2023). Assessing essential unidimensionality of scales and structural coefficient bias. Educational and Psychological Measurement, 83(1), 28–47. https://doi.org/10.1177/00131644221075580

The important lines in this Table are "contrasts". If the first contrast is much larger than the size of an Eigenvalue expected by chance, usually less than 2 - www.rasch.org/rmt/rmt191h.htm - please inspect your Table 23.3 to see the contrasting content of the items which is producing this large off-dimensional component in your data, or Table 24.3 to see the contrasting persons. The threat to Rasch measurement is not the ratio of unexplained (by the model) to explained (by the model), or the amount of explained or unexplained. The threat is that there is another non-Rasch explanation for the "unexplained". This is what the "contrasts" are reporting.

How Variance Decomposition is done ...

1. A central person ability and a central item difficulty are estimated. When the central ability is substituted for the estimated person abilities for each observation, the expected total score on the instrument across all persons equals the observed total score. Similarly, when the central ability is substitute for the estimated item difficulties for each observation, the expected total score on the instrument across all items equals the observed total score.
2. For each observation, a central value is predicted from the central person ability and the central item difficulty and the estimated rating scale (if any).

   In the "Observed" columns:

3. "Total raw variance in observations =" the sum-of-squares of the observations around their central values.
4. "Raw unexplained variance (total)=" is the sum-of-squares of the difference between the observations and their Rasch predictions, the raw residuals.
5. "Raw variance explained by measures=" is the difference between the "Total raw variance" and the "Raw unexplained variance".
6. "Raw variance explained by persons=" is the fraction of the "Raw variance explained by measures=" attributable to the person measure variance (and apportioned rating scale structures).
7. "Raw variance explained by items=" is the fraction of the "Raw variance explained by measures=" attributable to the item measure variance (and apportioned rating scale structures).
8. The reported variance explained by the items and the persons is normalized to equal the variance explained by all the measures. This apportions the variance explained by the rating scale structures.
9. The observation residuals, as transformed by PRCOMP=, are summarized as an inter-person correlation matrix, with as many columns as there are non-extreme persons. This correlation matrix is subjected to Principle Components Analysis, PCA.
10. In PCA, each diagonal element (correlation of the person with itself) is set at 1.0. Thus the eigenvalue of each person is 1.0, and the total of the eigenvalues of the matrix is the number of persons. This is the sum of the variance modeled to exist in the correlation matrix, i.e., the total of the unexplained variance in the observations.

11. For convenience the size of the "Raw unexplained variance (total)" is rescaled to equal the total of the eigenvalues. This permits direct comparison of all the variance terms.
12. The correlation matrix reflects the Rasch-predicted randomness in the data and also any departures in the data from Rasch criteria, such as those due to multidimensionality in the persons.
13. PCA reports components. If the data accord with the Rasch model, then each person is locally independent and the inter-person correlations are statistically zero. The PCA analysis would report each person as its own component. Simulation studies indicate that even Rasch-conforming data produce eigenvalues with values up to 2.0, i.e., with the strength of two persons.
14. Multidimensionality affects the pattern of the residuals. The residual pattern should be random, so the "contrast" eigenvalue pattern should approximately match the eigenvalue pattern from simulated data. When there is multidimensionality the residuals align along the dimensions, causing the early contrast eigenvalues to be higher than those from random (simulated) data. So multidimensionality inflates the early PCA contrasts above the values expected from random data, and correspondingly must lower the later ones, because the eigenvalue total is fixed.
15. "Unexplned variance in 1st contrast =" reports the size of the first PCA component. This is termed a "contrast" because the substantive differences between persons that load positively and negatively on the first component are crucial. It may reflect a systematic second dimension in the persons.
16. "Unexplned variance in 2nd contrast =". Consecutively smaller contrasts are reported (up to 5 contrasts). These may also contain systematic multi-dimensionality in the persons.

    In the "Expected" columns:

17. "Raw variance explained by measures=" is the sum-of-squares of the Rasch-predicted observations (based on the item difficulties, person abilities, and rating scale structures) around their central values.
18. "Raw variance explained by persons=" is the fraction of the "Raw variance explained by measures=" attributable to the person measure variance (and apportioned rating scale structures).
19. "Raw variance explained by items=" is the fraction of the "Raw variance explained by measures=" attributable to the item measure variance (and apportioned rating scale structures).
20. The reported variance explained by the items and the persons is normalized to equal the variance explained by all the measures. This apportions the variance explained by the rating scale structures.
21. "Raw unexplained variance (total)=" is the summed Rasch-model variances of the observations around their expectations, the unexplained residual variance predicted by the Rasch model.
22. "Total raw variance in observations =" is the sum of the Rasch-model "Raw variance explained by measures=" and the "Raw unexplained variance (total)="
23. The "Model" and the "Empirical" values for the "Total raw variance in observations =" are both rescaled to be 100%.
24. Use the SIFILE= option in order to simulate data. From these data predicted model values for the contrast sizes can be obtained.

```
  STANDARDIZED RESIDUAL VARIANCE SCREE PLOT

        VARIANCE COMPONENT SCREE PLOT
     +--+--+--+--+--+--+--+--+--+--+--+
 100%+  T                             +
     |                                |
V 63%+                                +
A    |     M                          |
R 40%+              U                 +
I    |                                |
A 25%+           I                    +
N    |        P                       |
C 16%+                                +
E    |                                |
  10%+                                +
L    |                 1              |
O  6%+                                +
G    |                    2           |
|  4%+                       3        +
S    |                          4  5  |
C  3%+                                +
A    |                                |
L  2%+                                +
E    |                                |
D  1%+                                +
     |                                |
 0.5%+                                +
     +--+--+--+--+--+--+--+--+--+--+--+
         TV MV PV IV UV U1 U2 U3 U4 U5
             VARIANCE COMPONENTS
```

Scree plot of the variance component percentage sizes, logarithmically scaled:

On plot	On x-axis	Meaning
T	TV	total variance in the observations, always 100%
M	MV	variance explained by the Rasch measures
P	PV	variance explained by the person abilities
I	IV	variance explained by the item difficulties
U	UV	unexplained variance
1	U1	first contrast (component) in the residuals
2	U2	second contrast (component) in the residuals, etc.

For the observations (PRCOMP=Obs), a standard Principal Components Analysis (without rotation, and with orthogonal axes) is performed based on the scored observations.

```
     Table of OBSERVATION variance (in Eigenvalue units)
                                                -- Observed --
  Raw unexplained variance (total)      =          13.0          100.0%
    Unexplned variance in 1st contrast =           9.9           76.1%
    Unexplned variance in 2nd contrast =            .9            7.2%
    Unexplned variance in 3rd contrast =            .6            4.3%
    Unexplned variance in 4th contrast =            .3            2.6%
    Unexplned variance in 5th contrast =            .3            2.0%
```

Here "contrast" means "component" or "factor".

```
Approximate relationships between the KID measures
 PCA       ACT       Pearson       Disattenuated Pearson+Extr  Disattenuated+Extr
Contrast  Clusters  Correlation   Correlation   Correlation   Correlation  Cluster Sizes
 1         1 - 2     0.2951        0.4683        0.3592        0.5497       6       6
 1         1 - 3     0.1411        0.2191        0.1958        0.2941       6       13
 1         2 - 3     0.8065        1.0000        0.8123        1.0000       6       13
 1         1 - B     0.4541                      0.5506                     6       25
 1         2 - B     0.9030                      0.8928                     6       25
 1         3 - B     0.8934                      0.8652                     13      25
....
 5         1 - 2     0.6662        1.0000        0.6983        1.0000       5       9
 5         1 - 3     0.5850        0.9618        0.6241        1.0000       5       11
 5         2 - 3     0.7663        1.0000        0.7913        1.0000       9       11
 5         1 - B     0.7526                      0.7753                     5       25
 5         2 - B     0.9232                      0.9280                     9       25
 5         3 - B     0.9379                      0.9389                     11      25
```

For explanation, see Table 23.1

```
List of Contrast Loadings
-------------------------------------------------------------------------------------------------
| Entry          Outfit Infit   PTMA  Contrast (PCA Component) Loadings  ACT                     |
| Number  Measure  Mean-square  Corr.   1      2      3      4      5    Label                   |
|-----------------------------------------------------------------------------------------------|
|     1     -.40   .49   .55    .64  -.10    .15    .45   -.12    .58  Watch birds             |
|     2     -.71   .72   .93    .58  -.56   -.47    .14    .29   -.10  Read books on animals   |
|     3      .42   .54   .57    .72  -.29    .33   -.03   -.50   -.28  Read books on plants    |
|     4     1.75   .91   .89    .60   .41    .19    .22   -.16    .06  Watch grass change      |
|     5     2.42  3.62  2.30    .05   .62   -.30   -.32    .10   -.17  Find bottles and cans   |
```

Summary of information in Tables 14.1, 23.1, 23.11, etc.

Example 1:
We are trying to explain the data by the estimated Rasch measures: the person abilities and the item difficulties. The Rasch model also predicts random statistically-unexplained variance in the data. This unexplained variance should not be explained by any systematic effects.

```
Table of RAW RESIDUAL variance (in Eigenvalue units)
                                                   Empirical        Modeled
Total raw variance in observations      =       19.8 100.0%         100.0%
```

```
is composed of
  Raw variance explained by measures    =        7.8  39.3%          39.1%
  Raw unexplained variance (total)      =       12.0  60.7% 100.0%   60.9%
```

Nothing is wrong so far. The measures are central, so that most of the variance in the data is unexplained. The Rasch model predicts this unexplained variance will be random.

```
  Raw variance explained by measures    =        7.8  39.3%          39.1%
```

is composed of

```
    Raw variance explained by persons   =        5.7  28.9%          28.8%
    Raw Variance explained by items     =        2.1  10.4%          10.3%
```

Nothing is wrong so far. The person measures explain much more variance in the data than the item difficulties. This is probably because the person measure S.D. is bigger than the item difficulty S.D. in Table 3.1.

```
  Raw unexplained variance (total)      =       12.0  60.7% 100.0%   60.9%
```

is composed of

```
    Unexplned variance in 1st contrast =         2.6  13.1%  21.5%
    Unexplned variance in 2nd contrast =         1.4   6.9%  11.4%
    Unexplned variance in 3rd contrast =         1.3   6.4%  10.6%
    Unexplned variance in 4th contrast =         1.1   5.6%   9.3%
    Unexplned variance in 5th contrast =         1.1   5.4%   8.9%
```

(and about 7 more)

Now we have multidimensionality problems. According to Rasch model simulations, it is unlikely that the 1st contrast in the "unexplained variance" (residual variance) will have a size larger than 2.0. Here it is 2.6. Also the variance explained by the 1st contrast is 13.1%. this is larger than the variance explained by the item difficulties 10.4%. A secondary dimension in the data appears to explain more variance than is explained by the Rasch item difficulties. Below is the scree plot showing the relative sizes of the variance components (logarithmically scaled).

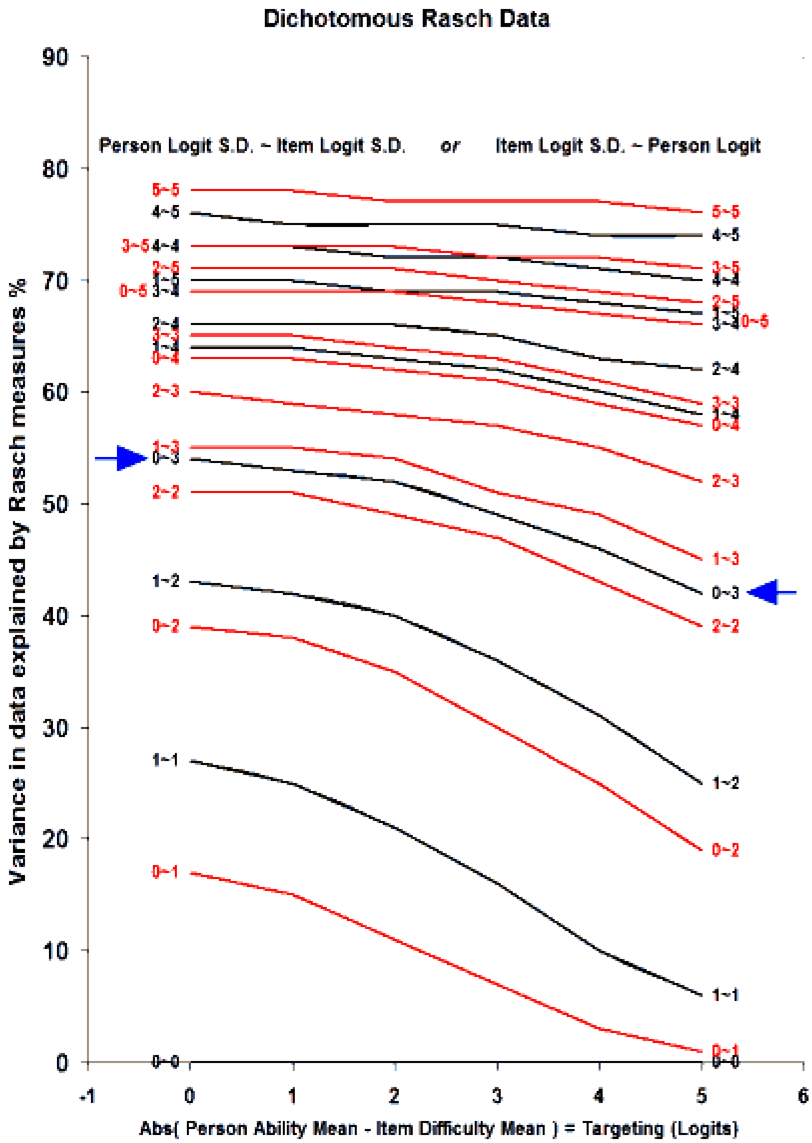
```
        VARIANCE COMPONENT SCREE PLOT
       +--+--+--+--+--+--+--+--+--+--+--+
   100%+  T                             +
       |                                |
 V 63%+                                 +
 A     |           U                    |
 R 40%+                                 +
 I     |     M                          |
 A 25%+         P                       +
 N     |                                |
 C 16%+                                 +
 E     |                 1              |
   10%+            I                    +
 L     |                                |
 O  6%+                     2  3        +
 G     |                          4  5  |
 |  4%+                                 +
 S     |                                |
 C  3%+                                 +
 A     |                                |
 L  2%+                                 +
 E     |                                |
 D  1%+                                 +
       |                                |
  0.5%+                                 +
       +--+--+--+--+--+--+--+--+--+--+--+
          TV MV PV IV UV U1 U2 U3 U4 U5
         VARIANCE COMPONENTS
```

Example 2:
Question: My Rasch dimension only explains 45.5% of the variance in the data and there is no clear secondary dimension. How can I increase the "variance explained"?

Reply: If there is "no clear secondary dimension" and no excessive amount of misfitting items or persons, then your data are under statistical control and your "variance explained" is as good as you can get without changing the sample or the instrument.

Predicted Explained-Variance

A Rasch model predicts that there will be a random aspect to the data. This is well understood. But what does sometimes surprise us is how large the random fraction is. The Figure shows the proportion of "variance explained" predicted to exist in dichotomous data under various conditions.



The x-axis is the absolute difference between the mean of the person and item distributions, from 0 logits to 5 logits. The y-axis is the percent of variance in the data explained by the Rasch measures. Each plotted line corresponds to one combination of standard deviations. The lesser of the person S.D. and the item S.D. is first, 0 to 5 logits, followed by "~". Then the greater of the person S.D. and the item S.D. Thus, the arrows indicate the line labeled "0-3". This corresponds to a person S.D. of 0 logits and an item S.D. of 3 logits, or a person S.D. of 0 logits and an item S.D. of 3 logits. The Figure indicates that, with these measure distributions about 50% of the variance in the data is explained by the Rasch measures. When the person and item S.D.s, are around 1 logit, then only 25% of the variance in the data is explained by the Rasch measures, but when the S.D.s are around 4 logits, then 75% of the variance is explained. Even with very wide person and item distributions with S.D.s of 5 logits only 80% of the variance in the data is explained.

In general, to increase the variance explained, there must be a wide range of person measures and/or of item difficulties. We can obtain this in three ways:

1. Increase the person S.D.: Include in the sample more persons with measures less central than those we currently have (or omit from the sample persons with measures in the center of the person distribution)

2. Increase the item S.D.: Include in the test more items with measures less central than those we currently have (or omit from the test items with measures in the center of the item distribution)

3. Make the data more deterministic (Guttman-like) so that the estimated Rasch measures have a wider logit range:
a.) Remove "special causes" (to use quality-control terminology) by trimming observations with extreme standardized residuals.
b.) Reduce "common causes" by making the items more discriminating, e.g., by giving more precise definitions to rating scale categories, increasing the number of well-defined categories, making the items more similar, etc.

However, for a well-constructed instrument administered in a careful way to an appropriate sample, you may already be doing as well as is practical.

For comparison, here are some percents for other instruments:		
exam12.txt	78.7%	(FIM sample chosen to exhibit a wide range of measures)
exam1.txt	71.1%	(Knox Cube Test)
example0.txt	50.8%	(Liking for Science)
interest.txt	37.5%	(NSF survey data - 3 category rating scale)
agree.txt	30.0%	(NSF survey data - 4 category rating scale)
exam5.txt	29.5%	(CAT test) - as CAT tests improve, this % will decrease!
coin-toss	0.0%	

In Winsteps Table 23.0, the "Model" column gives the "Variance Explained" value that you could expect to see if your data had perfect fit to the Rasch model with the current degree of randomness. The "Model" value is usually very close to the empirical value. This is because some parts of your data underfit the model (too little variance explained) and some parts overfit (too much variance explained).

Relationship to Bigsteps and earlier versions of Winsteps:

My apologies for the difficulties caused by the change in computation to "Variance Explained".

The earlier computation was based on the best statistical theory available to us at the time. Further developments in statistical theory, combined with practical experience, indicated that the previous computation was too generous in assigning "variance explained" to the Rasch measures. The current computation is more accurate.

Set PRCOMP=R (raw residuals) in Bigsteps and earlier versions of Winsteps, and you will obtain approximately the same explained/unexplained variance proportions as the current version of Winsteps.

Research in the last couple of years has demonstrated that PRCOMP=R gives a more realistic estimate of the variance explained than PRCOMP=S (standardized residuals). PRCOMP=S overestimates the explained variance as a proportion of the total variance.

But for decomposing the unexplained variance into "contrasts", PRCOMP=S is better. So this mixed setting is now the default for Winsteps.

The Eigenvalue reported for the 1st contrast has not changed. If this is much larger than the size of an Eigenvalue expected by chance, usually less than 2 - www.rasch.org/rmt/rmt191h.htm - Please inspect your Table 23.3 to see the contrasting content of the items which is producing this large off-dimensional component in your data.

14.32.2 Table 23.1, 23.11 Principal components plots of item loadings

Please do not interpret this as a usual factor analysis. These plots show contrasts between opposing factors, identified as "A,B,.." and "a,b,...", not loadings on one factor. For more discussion, see dimensionality and contrasts.

Quick summary:
(a) the X-axis is the measurement axis. So we are not concerned about quadrants, we are concerned about vertical differences. The Table 23 plots show contrasts between types of items: those at the top vs. those at the bottom. The Table 24 plots show contrasts between types of persons: those at the top vs. those at the bottom.

(b) "How much" is important. See the Variance Table explained in Table 23.0. Important differences have eigenvalues greater than 2.0.

(c) If the difference is important, it suggests that we divide the test into pieces, clustering the items in the top half of the plot and the items in the bottom half. Winsteps estimates a measure for each person on each cluster of items. The correlations of the measures are reported. Small disattenuated correlations indicate that the clusters of items measure different sub-dimensions.

(d) Perform separate analyses for the target clusters of items. Cross-plot and correlate the person measures. We will then see for whom the differences are important. Usually, for a carefully designed instrument, it is such a small segment that we decide it is not worth thinking of the test as measuring two dimensions. Tables 23.4 also helps us think about this.
1. Put a code into the item label to indicate the item subset to which the item belongs.
2a. Use ISELECT= for each subset code, and produce a person measure (PFILE=). Cross-plot the person measures.
or
2b. Do a Differential Person Functioning (DPF=) analysis based on the subset code. Table 31.1 will give you an inter-item-subset t-test for each person.

Table 23.0 Variance components scree plot for items
Table 23.1, 23.11 Principal components plots of item loadings
Table 23.2, 23.12 Item Principal components analysis/contrast of residuals
Table 23.3, 23.13 Item contrast by persons
Table 23.4, 23.14 Item contrast loadings sorted by measure
Table 23.5, 23.15 Item contrast loadings sorted by entry number
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Table 23.99 Largest residual correlations for items
Youtube video explaining Table 23

These plots show the contrasts by plotting the unstandardized "raw" loading on each component against the item calibration (or person measure). The contrast shows items (or persons) with different residual patterns. A random pattern with few high loadings is expected.

The horizontal axis is the Rasch dimension. This has been extracted from the data prior to the analysis of residuals.

Letters "A,B,C,..." and "a,b,c,..." identify items (persons) with the most opposed loadings on the first contrast in the residuals. On subsequent contrasts, the items retain their first contrast identifying letters. When there are 9 items (persons) or less, the item number is displayed.

The items are clustered into 3 clusters on the right-side of the plot. This is because interpreting the PCA Components ("Contrasts") usually requires us to compare the items at the top of the plot against the items at the bottom, often ignoring the middle items. The purpose of the plot associated with Table 23.6 is to help us see whether the 3 clusters of items are truly measuring different things. If they are measuring the same thing statistically, then usually no action is needed. If the clusters of items are measuring different things, then the analyst must decide what to do.

In the residuals, each item (person) is modeled to contribute one unit of randomness. Thus, there are as many residual variance units as there are items (or persons). For comparison, the amount of person (item) variance explained by the item (person) measures is approximated as units of that same size.

In the Figure below from Example0.txt, the first contrast in the standardized residuals separates the items into 3 clusters. To identify the items, see Tables 23.3, 24.3. In this example, the dimension is noticeable, with strength of around 5 out of 25 items. This is in the residual variance, i.e., in the part of the observations unexplained by the measurement model. But, hopefully, most of the variance in the observations has been explained by the model. The part of that explained variance attributable to the Persons is shown in variance units locally-rescaled to accord with the residual variances. In this example, the variance explained by the person measures is equivalent to 10 items. Consequently, the secondary dimension in the items is noticeable. The disattenuated correlation between person measures on item in Cluster 1 and person measures on items in Cluster 3 is less than 0.3. The secondary dimension underlying the 1st Contrast is biasing the person measures.

Letters display when there are more than 9 items on the plot. Numbers display when there are 9 or less items on the plot.

For items:

```
          Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = ACT information units
                                         Eigenvalue  Observed   Expected
Total raw variance in observations    =     50.9521 100.0%        100.0%
  Raw variance explained by measures  =     25.9521  50.9%         50.7%
    Raw variance explained by persons =     10.3167  20.2%         20.2%
    Raw Variance explained by items   =     15.6354  30.7%         30.6%
  Raw unexplained variance (total)    =     25.0000  49.1% 100.0%   49.3%
   Unexplned variance in 1st contrast =      4.6287   9.1%  18.5%

       STANDARDIZED RESIDUAL CONTRAST 1 PLOT

      -4     -3     -2     -1      0      1      2      3      4      5
      -+------+------+------+------+------+------+------+------+------+- COUNT  CLUSTER
   .8 +                            |                                   +
      |                            |            A B                    | 2      1
   .7 +                            |                                   +
      |                            |                                   |
   .6 +                            |                C                  + 1      1
      |                            |                                   |
C  .5 +                            |                                   +
O     |                            |                                   |
N  .4 +                            |           DE                      + 2      1
T     |                            |   F                               | 1      1
R  .3 +                            |                                   +
A     |                            |                                   |
S  .2 +                            |       G                           + 1      2
T     |                            |                                   |
   .1 +                            |                                   +
1     |                            | H                                 | 1      2
   .0 +----------------------------|-----------------------------------+
L     |                            |    I                              | 1      2
O -.1 +                         K  |   J                               + 2      2
A     |                            |L                                  | 1      2
D -.2 +                            |                                   +
I     |                            |M l                                | 2      3
N -.3 +                     j      |  k                                + 2      3
G     |                         i  |                                   | 1      3
  -.4 +      f    h              g |                                   + 3      3
      |                            |                                   |
  -.5 +                      e     |                                   + 1      3
      |              d        c    |                                   | 2      3
  -.6 +                  b         |                                   + 1      3
      |                   a        |                                   | 1      3
      -+------+------+------+------+------+------+------+------+------+-
      -4     -3     -2     -1      0      1      2      3      4      5
                                 ACT MEASURE
 COUNT:      1    1  1   11 111 21  21221  1   21 1 1

KID                     1 2 112 1 5346832333342 23222 1 1 1 1  1     11
                       T        S         M        S         T
%TILE                   0      10 20 40 50 60 70 80 90               99
```

If your plot looks like this, please change the font in your text editor (NotePad) to "fixed width": Courier New, Consolas, Lucida Console

-4 -3 -2 -1 0 1 2 3 4 5

```
     -+------+------+------+------+------+------+------+------+------+- COUNT  CLUSTER
   .8 +                 |                         +
      |                |        A B               | 2     1
   .7 +                 |                         +
      |                |                         |
   .6 +                 |            C              + 1     1
      |                |                         |
C  .5 +                  |                          +
O     |                 |                         |
N  .4 +                  |        DE                  + 2     1
T     |                |   F                       | 1     1
R  .3 +                  |                          +
A     |                |                          |
S  .2 +                 |      G                     + 1     2
T     |                |                          |
   .1 +                 |                         +
1     |                | H                        | 1     2
   .0 +-------------------------|--------------------------------+
L     |                |    I                    | 1     2
O -.1 +                K |   J                     + 2     2
A     |                |L                         | 1     2
D -.2 +                  |                         +
I     |               |M I                        | 2     3
N -.3 +             j     |  k                      + 2     3
G     |              i |                          | 1     3
  -.4 +    f   h        g |                          + 3     3
      |                |                         |
  -.5 +             e    |                          + 1     3
      |         d      c   |                         | 2     3
  -.6 +           b        |                         + 1     3
      |            a     |                         | 1     3
     -+------+------+------+------+------+------+------+------+------+-
     -4    -3    -2    -1     0     1     2     3     4     5
```

Example: A teacher survey had hundreds of items contributed by numerous stakeholders (with special agendas), but almost no hypothesized constructs. In other words, it was a mess! PCA of residuals was used to discover subsets of items that cooperated. A useful strategy is to use IWEIGHT=. Weight a core subset of items on a construct of interest "1", and weight all the other items "0". Then do a Winsteps analysis. All the items will be calibrated, but only the weighted items will contribute to the person measures. Then do a PCA of residuals. All the items will participate. The core items will cluster. Unweighted items that cluster with the core can be inspected, and added to the core if suitable. Then the process is repeated. When all the items for one construct have been identified, those items can be deleted from the dataset. The process begins again with the next core subset of items.

Correlation Table of person Measures on each of the Clusters:

Approximate relationships between the KID measures

PCA Contrast	ACT Clusters	Pearson Correlation	Disattenuated Correlation	Pearson+Extr Correlation	Disattenuated+Extr Correlation	Cluster Sizes	
1	1 - 2	0.2951	0.4683	0.3592	0.5497	6	6
1	1 - 3	0.1411	0.2191	0.1958	0.2941	6	13
1	2 - 3	0.8065	1.0000	0.8123	1.0000	6	13
1	1 - B	0.4541		0.5506		6	25
1	2 - B	0.9030		0.8928		6	25
1	3 - B	0.8934		0.8652		13	25

The items are anchored (fixed) at their difficulties from the main analysis (as reported in Table 14.1). Then the items are segmented into subtests according to their cluster numbers, and each person is measured on each subtest. The person measures for each cluster of items are correlated with their measures from the other clusters of items, and reported here as the "Pearson Correlation". Each person measure for each cluster of items has a standard error. These error variances are removed to produce the "Disattenuated Correlation". If the disattenuated correlation approaches 1.0, then the person measures from the two clusters of items are statistically the same. We cannot reject the hypothesis that the two clusters of items are measuring the same thing. If the disattenuated correlation is out of range or undefined, it is reported as (1.00) or (-1.00) matching the sign of the observed correlation.

The correlation and disattenuated correlation in, say, Table 23.1, are computed from the person measures and model standard errors shown in Table 23.6 . This would be equivalent to using the Model Reliability from Table 3.1. In the computations, the "Real" standard errors would be larger, so the "Real" disattenuated correlations would also be larger.

The "Model" disattenuated correlation is a more conservative (lower) estimate, a lower bound. The computation is based on Rasch measures, so Cronbach Alpha, which is based on raw scores, does not apply.

For the Pearson Correlation and the Disattenuated (Pearson) Correlation, persons with extreme scores on a cluster are omitted. For the Pearson+Extr(eme) Correlation and the Disattenuated (Pearson)+Extr(eme) Correlation, persons with extreme scores on a cluster are included. Cluster sizes are the counts of items in each cluster.

These correlations are approximate. For more accurate correlations, please perform separate analyses of each cluster of items, and then use the Scatterplot function to investigate the relationships between the person measures estimated from the different clusters.

The middle cluster (2) usually corresponds roughly with the Rasch dimension. So the important correlations are 1-2 and 2-3. Clusters 1 and 3 are both somewhat off-dimension so the correlation 1-3 is somewhat accidental. It is nice when it is high, but low 1-3 correlation merely tells us that 1 and 3 are off-dimension in different ways.

Roughly speaking, we look at the disattenuated correlations (otherwise measurement error clouds everything):

Correlations below 0.57 indicate that person measures on the two item clusters have half as much variance in common as they have independently. *(Cut-off for probably different latent variables?)*

Correlations above 0.71 indicate that person measures on the two item clusters have more than half their variance in common, so they are more dependent (= more the same thing) than independent (= different things).

Correlations above 0.82, twice as dependent as independent. *(Cut-off for probably the same latent variable?)*

Correlations above 0.87, three times as dependent as independent *(definitely the same thing).*

Cluster B is the baseline measures, the estimates from the main analysis. No disattenuated correlation is shown for B because B is dependent on the other clusters including the cluster with which it is compared.

Example 1: From Table 23.3 of the analysis of a large empirical dataset:

```
Approximate relationships between the person measures
Contrast 1        Pearson        Disattenuated
Item Clusters     Correlation    Correlation
1 - 2             .5151          .5762
```

Actual relationships of person measures estimated from separate analyses of the two clusters of items:

```
Contrast 1        Pearson        Disattenuated
Item Clusters     Correlation    Correlation
1 - 2             .5083          .6352
```

14.32.3 Table 23.2, 23.12 Item Principal components analysis/contrast of residuals

Please do not interpret this as a usual factor analysis. These plots show contrasts between opposing factors, not loadings on one factor. For more discussion, see dimensionality and contrasts.

This Table decomposes the matrix of item correlations based on residuals to identify possible other contrasts (dimensions) that may be affecting response patterns. Specify PRCOMP=S or =R or =L to obtain this Table.

Table 23.0 Variance components scree plot for items
Table 23.1, 23.11 Principal components plots of item loadings
Table 23.2, 23.12 Item Principal components analysis/contrast of residuals
Table 23.3, 23.13 Item contrast by persons
Table 23.4, 23.14 Item contrast loadings sorted by measure
Table 23.5, 23.15 Item contrast loadings sorted by entry number
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Table 23.99 Largest residual correlations for items
Youtube video explaining Table 23

Prior to this first contrast, the Rasch dimension has been extracted from the data. Residuals are those parts of the observations not explained by the Rasch dimension. According to Rasch specifications, these should be random and show no structure. The contrasts show conflicting local patterns in inter-item correlations based on residuals or their transformations. Letters "E", "b", etc. relate items to their unstandardized "raw" loadings on the first contrast. In this Table, "bugs", "rat" and "cans" contrast with "Grow garden". Since"bugs", "rat" and "can" misfit conspicuously, they load on a second dimension in the data.

CON- TRAST	LOADING	MEASURE	INFIT MNSQ	OUTFIT MNSQ	ENTRY NUMBER		ACT	G R
1 1	.76	1.81	1.32	1.84	A	20	Watch bugs	2
1 1	.75	2.16	2.40	4.19	B	23	Watch a rat	2
1 1	.62	2.44	2.31	3.57	C	5	Find bottles and cans	1
1 1	.40	1.68	1.11	1.21	D	8	Look in sidewalk cracks	1
1 1	.40	1.77	.90	.92	E	4	Watch grass change	1
1 1	.38	.60	.95	.94	F	16	Make a map	2
1 1	.19	1.11	.99	1.02	G	7	Watch animal move	1
1 2	.06	.30	.83	.77	H	6	Look up strange animal or plan	1
1 2	-.64	-1.33	1.24	.95	a	13	Grow garden	1
1 2	-.61	-1.52	.80	.58	b	10	Listen to bird sing	1
1 2	-.56	-.73	.95	.74	c	2	Read books on animals	1
1 2	-.53	-2.09	.71	.51	d	12	Go to museum	1
1 2	-.49	-.83	.83	.63	e	21	Watch bird make nest	2
1 2	-.41	-3.10	1.50	1.23	f	18	Go on picnic	2
1 2	-.39	-.29	.88	.77	g	24	Find out what flowers live on	2
1 2	-.38	-2.44	1.08	1.10	h	19	Go to zoo	2
1 2	-.36	-.46	.76	.62	i	15	Read animal stories	2
1 2	-.33	-.99	.64	.50	j	11	Find where animal lives	1
1 2	-.30	.41	.59	.55	k	3	Read books on plants	1
1 2	-.25	.42	.81	.74	l	14	Look at pictures of plants	2
1 2	-.24	.17	.64	.57	M	17	Watch what animals eat	2
1 2	-.15	.09	.81	.72	L	22	Find out what animals eat	2
1 2	-.11	-.42	.56	.50	K	1	Watch birds	1
1 2	-.08	.70	1.20	1.19	J	9	Learn weed names	1
1 2	-.07	.53	.78	.72	I	25	Talk w/friends about plants	2

Contrast these

with these

cluster number

The loading is that on the first PCA contrast. It is unstandardized. In the factor analysis literature, values of ±.4 or more extreme are considered substantive. To standardize the loading, divide the loadings by their root-mean-square.
The measures and mean-square statistics are the same as those reported in Table 10.1 etc.
The letters under "ENTRY NUMBER" refer to the plots in Table 23.2

The "cluster number" indicates a statistical clustering of the loadings (useful for splitting these items into unidimensional subtests). The clusters are obtained by doing a cluster-analysis of the loadings. The Fisher-linearized loadings are assigned to three (or less) clusters based on the centroids of the clusters.

To copy numbers out of this Table, use WORD to copy a rectangle of text or copy-and-paste into Excel, then "text to columns".

14.32.4 Table 23.3, 23.13 Item contrast by persons

Please do not interpret this as a usual factor analysis. These plots show contrasts between opposing factors, not loadings on one factor. For more discussion, see dimensionality and contrasts.

The effect on the persons of the contrast between the oppositely loading items (Table 23.1) at the top and bottom of the contrast plot is shown here.

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Responses by up to 9 persons (or on up to 9 items) to the items (or by the persons) with extreme positive loadings and the items (or persons) with extreme negative loadings are identified. These responses are seen to be higher, as expected, or lower than the model predicts. Counts of these are obtained for each person (or item). The persons (or items) showing the biggest impact of this contrast are listed first. Items and persons showing the most contrast are chosen for this Table based on the "Liking for Science" data.

Table 23.3 shows the impact of the first contrast in Table 23.1 on persons:

```
  ACT contrast 1 CONTRASTING RESPONSES BY PUPILS
+---------------------------------+
|          FAVORS TOP             |
| TOP 7 ACTS      | BOTTOM 7 ACTS  |
| HIGH  EXP. LOW | HIGH  EXP. LOW |     Persons scoring higher than expected on the top 7 items
+---------------------------------+
|    5    2    0 |    0    3    4 | 15  DYSON, STEPHIE NINA
|    5    2    0 |    0    3    4 | 26  NEIMAN, RAYMOND
+---------------------------------+
+---------------------------------+
|          FAVORS BOTTOM          |
| TOP 7 ACTS      | BOTTOM 7 ACTS  |
| HIGH  EXP. LOW | HIGH  EXP. LOW |      Persons scoring higher than expected on the bottom 7
   items
+---------------------------------+
|    0    3    4 |    0    7    0 | 8   LAMBERT, MD., ROSS W.
|    0    3    4 |    0    7    0 | 11  HSIEH, PAUL FRED
|    0    5    2 |    3    3    1 | 32  ROSSNER, JACK
|    0    3    4 |    0    7    0 | 51  REISS, STEVE
+---------------------------------+
```

FAVORS TOP	These persons score higher on the items at the top of the Contrast 1 plot in Table 23.1 than the items at the bottom of the contrast plot
FAVORS BOTTOM	These persons score higher on the items at the bottom of the Contrast 1 plot in Table 23.1 than the items at the top of the contrast plot
TOP 7 ACTS	Responses for the top 7 items (or top half of the items if less than 7) on the Contrast plot
BOTTOM 7 ACTS	Responses for the bottom 7 items (or top half of the items if less than 7) on the Contrast plot
HIGH	Person response is higher than expected on this many items
EXP.	Person response is expected (within 0.5 score points) on this many items
LOW	Person response is lower than expected on this many items
15 DYSON, STEPHIE NINA	Person entry number and person label. Persons with greatest differential performance between TOP and BOTTOM are shown with strongest difference listed first.
15 DYSON, STEPHIE NINA 8 LAMBERT, MD., ROSS W.	The effect of the 1st Contrast is more strongly seen in the performance of these two persons. Is there something about them that interacts with the set of items?

14.32.5 Table 23.4, 23.14 Item contrast loadings sorted by measure

```
 CONTRAST 1 FROM PRINCIPAL COMPONENT ANALYSIS
  STANDARDIZED RESIDUAL LOADINGS FOR TAP (SORTED BY MEASURE)

-------------------------------------------------------
|CON CL|       |        INFIT OUTFIT| ENTRY           |
|TRA US|LOADING|MEASURE  MNSQ MNSQ |NUMBER TAP       |
|------+-------+------------------+-----------------|
|  1 3 |  -.31 |    4.80  .74  .11 |d   15 1-3-2-4-1-3 |
|  1 1 |   .58 |    4.80  .74  .11 |B   16 1-4-2-3-1-4 |
|  1 1 |   .58 |    4.80  .74  .11 |C   17 1-4-3-1-2-4 |
|  1 3 |  -.52 |    3.37 1.56 1.49 |b   14 1-4-2-3-4-1 |
|  1 3 |  -.62 |    2.24 1.16 1.06 |a   12 1-3-2-4-3   |
|  1 2 |   .28 |    1.95  .70  .38 |F   13 1-4-3-2-4   |
|  1 3 |  -.41 |     .79 1.07  .79 |c   11 1-3-1-2-4   |
|  1 2 |  -.12 |   -1.57 1.06  .83 |f   10 2-4-3-1     |
|  1 1 |   .45 |   -2.35  .59  .43 |E    8 1-4-2-3     |
|  1 1 |   .52 |   -3.38 1.17  .96 |D    6 3-4-1       |
|  1 2 |  -.06 |   -3.38  .62  .21 |g    9 1-3-2-4     |
|  1 2 |  -.02 |   -3.83 1.04  .52 |G    5 2-1-4       |
|  1 1 |   .73 |   -3.83 1.33 2.21 |A    7 1-4-3-2     |
|  1 2 |  -.16 |   -4.40  .90  .35 |e    4 1-3-4       |
-------------------------------------------------------
```

See Table 23.2

Table 23.0 Variance components scree plot for items
Table 23.1, 23.11 Principal components plots of item loadings
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Table 23.6, 23.16 Person measures for item clusters in contrast. Cluster Measure Plot for Table 23.6.
Table 23.99 Largest residual correlations for items
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14.32.6 Table 23.5, 23.15 Item contrast loadings sorted by entry number

```
CONTRAST 1 FROM PRINCIPAL COMPONENT ANALYSIS
  STANDARDIZED RESIDUAL LOADINGS FOR TAP (SORTED BY ENTRY)

-------------------------------------------------------
|CON CL|       |        INFIT OUTFIT| ENTRY           |
|TRA US|LOADING|MEASURE  MNSQ MNSQ |NUMBER TAP       |
|------+-------+------------------+-----------------|
|  1 2 |  -.16 |   -4.40  .90  .35 |e    4 1-3-4       |
|  1 2 |  -.02 |   -3.83 1.04  .52 |G    5 2-1-4       |
|  1 1 |   .52 |   -3.38 1.17  .96 |D    6 3-4-1       |
|  1 1 |   .73 |   -3.83 1.33 2.21 |A    7 1-4-3-2     |
|  1 1 |   .45 |   -2.35  .59  .43 |E    8 1-4-2-3     |
|  1 2 |  -.06 |   -3.38  .62  .21 |g    9 1-3-2-4     |
|  1 2 |  -.12 |   -1.57 1.06  .83 |f   10 2-4-3-1     |
|  1 3 |  -.41 |     .79 1.07  .79 |c   11 1-3-1-2-4   |
|  1 3 |  -.62 |    2.24 1.16 1.06 |a   12 1-3-2-4-3   |
|  1 2 |   .28 |    1.95  .70  .38 |F   13 1-4-3-2-4   |
|  1 3 |  -.52 |    3.37 1.56 1.49 |b   14 1-4-2-3-4-1 |
|  1 3 |  -.31 |    4.80  .74  .11 |d   15 1-3-2-4-1-3 |
|  1 1 |   .58 |    4.80  .74  .11 |B   16 1-4-2-3-1-4 |
|  1 1 |   .58 |    4.80  .74  .11 |C   17 1-4-3-1-2-4 |
-------------------------------------------------------
```

See Table 23.2

Table 23.0 Variance components scree plot for items
Table 23.1, 23.11 Principal components plots of item loadings
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Table 23.3, 23.13 Item contrast by persons
Table 23.4, 23.14 Item contrast loadings sorted by measure
Table 23.5, 23.15 Item contrast loadings sorted by entry number
Table 23.6, 23.16 Person measures for item clusters in contrast. Cluster Measure Plot for Table 23.6.
Table 23.99 Largest residual correlations for items

[Youtube video](#) explaining Table 23

14.32.7 Table 23.6, 23.16 Person measures for item clusters in contrast

```
-------------------------------------------------------------------------------------------------
|                    CONTRAST 1  CLUSTER MEASURES                                                |
|                 |  CLUSTER 1   |  CLUSTER 2   |  CLUSTER 3   |   BASELINE    |                   |
|     KID  STATUS | MEASURE  S.E. | MEASURE  S.E. | MEASURE  S.E. | MEASURE  S.E. | KID LABEL         |
|-----------------+--------------+--------------+--------------+--------------+------------------|
|       1      1   |     .49   .71 |     .01   .62 |    1.15   .58 |     .61   .34 | M Rossner, Marc Daniel  |
|       2      0   |    5.68  1.85 |    4.30  1.85 |    4.06  1.84 |    6.07  1.84 | M Rossner, Lawrence F.  |
|       3      1   |    1.36   .63 |     .77   .62 |    1.15   .58 |    1.10   .36 | M Rossner, Toby G.      |
....
|      73      1   |    1.75   .62 |    1.62   .70 |    -.95   .45 |     .38   .34 | M Sandberg, Ryne        |
|      74      1   |    -.08   .81 |    2.18   .80 |    2.80  1.04 |    1.50   .37 | M Patriarca, Ray        |
|      75      1   |     .49   .71 |    -.85   .70 |     .56   .51 |     .15   .34 | M Pauling, Linus        |
-------------------------------------------------------------------------------------------------
     RELIABILITY:      .63             .68             .71             .89

Approximate relationships between the KID measures
 PCA      ACT      Pearson      Disattenuated Pearson+Extr  Disattenuated+Extr
Contrast  Clusters  Correlation  Correlation   Correlation   Correlation  Cluster Sizes
 1        1 - 2     0.2951       0.4683        0.3592        0.5497       6      6
 1        1 - 3     0.1411       0.2191        0.1958        0.2941       6      13
 1        2 - 3     0.8065       1.0000        0.8123        1.0000       6      13
 1        1 - B     0.4541                     0.5506                     6      25
 1        2 - B     0.9030                     0.8928                     6      25
 1        3 - B     0.8934                     0.8652                     13     25
```

This subtable shows the estimated person measures and standard errors for each cluster of items in the PCA contrast and the baseline measures, the estimates from the main analysis. The cluster correlations, explained in Table 23.1, are computed from these measures and reported in Table 23.0. Scatterplots of the person measures in Table 23.6 for each item cluster in Table 23.1 are shown in the Cluster Measure Plot.

The Reliability is the Spearman Reliability of the person measures estimated from each cluster of items.

For Smith's (2002) "dimensionality" method:
1. Analyze all the data. Table 23.1 identifies Item cluster 1 and Item cluster 3
2. Table 23.6 has the person measures and S.E.s.
3. Conduct *t*-tests.

Smith EV Jr. Detecting and evaluating the impact of multidimensionality using item fit statistics and principal component analysis of residuals. J Appl Meas. 2002; 3(2):205-31.

Table 23.0 Variance components scree plot for items
Table 23.1, 23.11 Principal components plots of item loadings
Table 23.2, 23.12 Item Principal components analysis/contrast of residuals
Table 23.3, 23.13 Item contrast by persons
Table 23.4, 23.14 Item contrast loadings sorted by measure
Table 23.5, 23.15 Item contrast loadings sorted by entry number
Table 23.6, 23.16 Person measures for item clusters in contrast. Cluster Measure Plot for Table 23.6.
Table 23.99 Largest residual correlations for items
Youtube video explaining Table 23

14.32.8 Table 23.99 Largest residual correlations for items

These Tables show items (Table 23.99) that may be locally dependent. Specify PRCOMP=R (for score residuals, Yen Q3) or PRCOMP=S or Y (for standardized residuals) or PRCOMP=L (for logit residuals) to obtain this Table. Residuals are those parts of the data not explained by the Rasch model. High correlation of residuals for two items (or persons) indicates that they may not be locally independent, either because they duplicate some feature of each other or because they both incorporate some other shared dimension.

Table 23.0 Variance components scree plot for items
Table 23.1, 23.11 Principal components plots of item loadings
Table 23.2, 23.12 Item Principal components analysis/contrast of residuals
Table 23.3, 23.13 Item contrast by persons
Table 23.4, 23.14 Item contrast loadings sorted by measure

Table 23.5, 23.15 Item contrast loadings sorted by entry number
Table 23.6, 23.16 Person measures for item clusters in contrast. Cluster Measure Plot for Table 23.6.
Table 23.99 Largest residual correlations for items
Youtube video explaining Table 23

Missing data are deleted pairwise if both of a pair are missing or PRCOMP=O (for observations), otherwise missing data are replaced by their Rasch expected residuals of 0.

```
     LARGEST STANDARDIZED RESIDUAL CORRELATIONS
     USED TO IDENTIFY DEPENDENT TAP
-------------------------------------------------
|CORREL-| ENTRY             | ENTRY             |
| ATION|NUMBER TAP          |NUMBER TAP         |
|-------+-------------------+-------------------|
|  1.00 |    16 1-4-2-3-1-4 |    17 1-4-3-1-2-4 |
|   .52 |     6 3-4-1       |     7 1-4-3-2     |
|   .45 |     7 1-4-3-2     |     8 1-4-2-3     |
|   .28 |     8 1-4-2-3     |     9 1-3-2-4     |
|-------+-------------------+-------------------|
|  -.67 |     8 1-4-2-3     |    14 1-4-2-3-4-1 |
|  -.58 |     7 1-4-3-2     |    14 1-4-2-3-4-1 |
|  -.49 |     6 3-4-1       |    12 1-3-2-4-3   |
|  -.48 |     7 1-4-3-2     |    11 1-3-1-2-4   |
|  -.43 |    15 1-3-2-4-1-3 |    16 1-4-2-3-1-4 |
|  -.43 |    15 1-3-2-4-1-3 |    17 1-4-3-1-2-4 |
|  -.38 |     7 1-4-3-2     |    12 1-3-2-4-3   |
|  -.37 |    12 1-3-2-4-3   |    16 1-4-2-3-1-4 |
|  -.37 |    12 1-3-2-4-3   |    17 1-4-3-1-2-4 |
|  -.32 |     5 2-1-4       |    10 2-4-3-1     |
|  -.31 |     6 3-4-1       |    10 2-4-3-1     |
|  -.29 |    12 1-3-2-4-3   |    13 1-4-3-2-4   |
|  -.29 |    11 1-3-1-2-4   |    13 1-4-3-2-4   |
|  -.28 |     6 3-4-1       |    11 1-3-1-2-4   |
|  -.28 |     4 1-3-4       |     8 1-4-2-3     |
|  -.26 |     4 1-3-4       |     5 2-1-4       |
-------------------------------------------------
```

Note: Redundant correlations of 1.0 are not printed. If A has a correlation of 1.0 with B, and also with C, assume that B and C also have a correlation of 1.0. After eliminating redundant correlations, the largest correlations are shown in the Table. To see all correlations, output ICORFILE= or PCORFILE=

In this Table, high positive residual correlations may indicate local item dependency (LID) between pairs of items or persons. When raw score residual correlations are computed, PRCOMP=R, it corresponds to **Wendy Yen's Q3 statistic**. It is used to detect dependency between pairs of items or persons. Wendy Yen suggests a small positive adjustment to the correlation of size 1/(L-1) where L is the test length. Yen (1993) mentions a value of +0.2 or higher to flag potentially problematic item pairs. A suggested action is to combine items into testlets. Comparison of person measure S.D. indicates the impact of LID.

Yen, W. M. (1984). Effects of local item dependence on the fit and equating performance of the three-parameter logistic model. Applied Psychological Measurement, 8, 125-145.
Yen, W. M. (1993). Scaling performance assessments: Strategies for managing local item dependence. Journal of Educational Measurement, 30, 187-213.
See also Cristensen K.B., et al. Critical values of Q3 - https://eprints.whiterose.ac.uk/106017/

Local dependence would be a large positive correlation. Highly locally dependent items (Corr. > +.7), such as items "Q." and "R." share more than half their "random" variance, suggesting that only one of the two items is needed for measurement. But, in classical test theory terms, these items may have the highest point-biserial correlations and so be the "best" items.

A large negative correlation indicates the opposite of local dependence, as usually conceptualized. If you look at the item fit tables, item "J." or "R." is likely to have large misfit.

Remember that "common variance = correlation^2", so items 10 and 11 only share .40*.40 = 16% of the variance in their residuals in common. 84% of each of their residual variances differ. In this Table we are usually only interested in correlations that approach 1.0 or -1.0, because that may indicate that the pairs of items are duplicative or are dominated by a shared factor.

Suggestion: simulate Rasch-fitting data like yours using the Winsteps SIFILE= option. Analyze these data with Winsteps. Compare your correlation range with that of the simulated data.

An influential paper says "[Readers] expect to see that this issue has been dealt with, if only to report that no response dependency was found." However, even simulated Rasch-fitting data will report some accidental response dependency, so this statement is too extreme. Let's amend it. to say "if only to report that no **consequential** response dependency was found.".
Tennant A, Conaghan PG. The Rasch measurement model in rheumatology: what is it and why use it? When should it be applied, and what should one look for in a Rasch paper? Arthritis Rheum. 2007 Dec 15;57(8):1358-62.

Locally-Dependent Items

In practical terms, a correlation of r=0.40 is low dependency. The two items only have 0.4*0.4=0.16 of their variance in common. Correlations need to be around 0.7 before we are really concerned about dependency.

If you want to create one super-item out of two dependent items, then use Excel (or similar) to add the scored responses on the two item together. Include the super-item in the data file instead of the dependent items. Change CODES= and use ISGROUPS= to model the additional super-item. You will notice a very small reduction in the variances of the measures.

Procedure:
1. Winsteps analyze the original data
2. Output the scored responses: "Output file", "RFILE=", responses.xls
3. In Excel, open responses.xls
4. Sum the scored responses of dependent items into a new item
5. Delete the original dependent items
6. Save responses.xls
7. In Winsteps, "Excel/RSSST" menu, "Excel", Import responses.xls
8. Create Winsteps file of the new set of items (you may need edit ISGROUPS=)
9. Analyze the new Winsteps control file

Item Calibration without Local Item Dependency (LID)

If you need item difficulties from your dataset, but without the effect of LID, here is a procedure:

1. Analyze all the dataset with Winsteps with PRCOMP=R to produce the raw residuals.
Output IFILE=iforig.txt as a reference for the original data.
2. Output ICORFILE= for the raw residuals to Excel in list format
3. Sort the list by correlation
4. Look at the top and bottom of the list. How many inter-item residual correlations are >.02 (or your correlation cut-off value)? (In my empirical dataset about .1%)
Save these item pairings to avoid administering these pairs of item together in CAT or test forms.
5. Make an IDFILE=LID.txt list of one item from each item pair with inter-item residual correlation >.02 (or your correlation cut-off value)

6. Reanalyze all the data with Winsteps and IDFILE=LID.txt
7. Output PFILE=pf.txt - these are the person measures matching only the LID-free items

8. Reanalyze all the data with Winsteps without IDFILE=. Include PAFILE=pf.txt
This forces all the item difficulties and rating-scale structures to conform with the LID-free person measures.
Anchoring the person measures prevents LID from impacting the item difficulties.
9. Output IFILE=if.txt, SFILE=sf.txt - these are the item difficulty and rating-scale threshold values for the item bank or whatever.

10. Scatterplot if.txt against iforig.txt. How much is the impact of LID on iforig.txt? Was all this work worth it?

Q1, Q3: Yen, Wendy (1984) Effects of Local Item Dependence on the Fit and Equating Performance of the Three-Parameter Logistic Model. Applied Psychological Measurement. 8:2, 125-145. https://conservancy.umn.edu/bitstream/handle/11299/107543/v08n2p125.pdf

14.33 Table 24 Person multidimensionality

14.33.1 Table 24.0 Variance components scree plot for persons

Table 24.0 shows a variance decomposition of the observations for the persons. This is not produced for PRCOMP=O.

When called from the Output Tables menu, PRCOMP= options are shown:

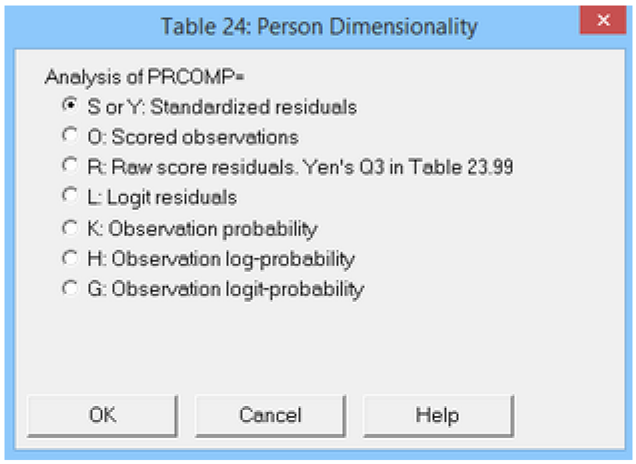


Table 24.0 Variance components scree plot for persons
Table 24.1, 24.11 Principal components plots of person loadings
Table 24.2, 24.12 Person Principal components analysis/contrast of residuals
Table 24.3, 24.13 Person contrast by items
Table 24.4, 24.14 Person contrast loadings sorted by measure
Table 24.5, 24.15 Person contrast loadings sorted by entry number
Table 24.99 Largest residual correlations for persons

```
        Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = KID information units
                                              Eigenvalue  Observed   Expected
Total raw variance in observations     =     150.8183 100.0%         100.0%
  Raw variance explained by measures   =      76.8183  50.9%          50.7%
    Raw variance explained by persons  =      30.5375  20.2%          20.2%
    Raw Variance explained by items    =      46.2809  30.7%          30.6%
  Raw unexplained variance (total)     =      74.0000  49.1% 100.0%   49.3%
    Unexplned variance in 1st contrast =      18.2333  12.1%  24.6%
    Unexplned variance in 2nd contrast =       6.9841   4.6%   9.4%
    Unexplned variance in 3rd contrast =       6.1491   4.1%   8.3%
    Unexplned variance in 4th contrast =       4.9831   3.3%   6.7%
    Unexplned variance in 5th contrast =       4.8045   3.2%   6.5%

      STANDARDIZED RESIDUAL VARIANCE SCREE PLOT

       VARIANCE COMPONENT SCREE PLOT
      +--+--+--+--+--+--+--+--+--+--+--+
  100%+  T                              +
      |                                 |
V  63%+                                 +
A     |     M                           |
R  40%+              U                  +
I     |                                 |
A  25%+           I                     +
N     |        P                        |
C  16%+                                 +
E     |                                 |
   10%+                 1               +
L     |                                 |
```

```
O  6%+                              +
G    |                              |
|  4%+                  2  3        +
S    |                        4  5  |
C  3%+                              +
A    |                              |
L  2%+                              +
E    |                              |
D  1%+                              +
     |                              |
 0.5%+                              +
     +--+--+--+--+--+--+--+--+--+--+--+
        TV MV PV IV UV U1 U2 U3 U4 U5
       VARIANCE COMPONENTS
```

For details, please see Table 23.0

```
List of Contrast Loadings
--------------------------------------------------------------------------------------------------
|  Entry          Outfit Infit   PTMA  Contrast  (PCA Component) Loadings  KID                    |
| Number  Measure  Mean-square   Corr.    1       2       3       4       5   Label                  |
|------------------------------------------------------------------------------------------------|
|      1      .61    .83   .95    .70    .01     .45   -.57     .00     .39  M Rossner, Marc Daniel |
|      3     1.10    .39   .44    .79    .07     .37    .09     .16     .19  M Rossner, Toby G.     |
|      4      .26    .70   .72    .70    .13    -.61    .03     .31    -.29  M Rossner, Michael T.  |
|      5     -.67   1.33   .88    .48    .80     .26   -.04    -.11    -.17  F Rossner, Rebecca A.  |
|      6     -.08   2.39  1.62    .20    .83    -.01   -.16     .05    -.06  M Rossner, Tr Cat      |
```

Summary of information in Tables 18.1, 24.1, 24.11, etc.

Example:
In this example, 50.9% of the variance in the data is explained by the measures. If the data fit the model perfectly, 50.7% would be explained. These percentages are close, indicating that the estimation of Rasch measures has been successful.

The variance in the data explained by the item difficulties, 30.7%, is larger than the variance explained by the person abilities, 20.2%. For dichotomies, this usually reflects the person and item measure standard deviations in Table 3.1.

The unexplained variance in the data is 49.1%. This includes the Rasch-predicted randomness and any departures in the data from Rasch criteria, such as those due to multidimensionality in the items.

The first contrast has an eigenvalue of 18.2, corresponding to a strength of over 18 persons, and considerably larger than the largest eigenvalue expected by chance. It corresponds to 12.1% of the variance in the data.

14.33.2 Table 24.1, 24.11 Principal components plots of person loadings

Please do not interpret this as a usual factor analysis. These plots show contrasts between opposing factors, identified as "A,B,.." and "a,b,...", not loadings on one factor. For more discussion, see dimensionality and contrasts.

Quick summary:
(a) the X-axis is the measurement axis. So we are not concerned about quadrants, we are concerned about vertical differences. The Table 24 plots show contrasts between types of persons: those at the top vs. those at the bottom.

(b) "How much" is important. See the Variance Table explained in Table 24.0. Important differences have eigenvalues greater than 2.0.

(c) If the difference is important, it suggests that we divide the dataset into two pieces: the persons in the top half of the plot and the persons in the bottom half. Perform two separate analyses and cross-plot and correlate the item calibrations. We will then see for which items the differences are important. Usually, for a carefully designed instrument, it is such a small segment that we decide it is not worth thinking of the test as measuring two dimensions. Table 24.4 also helps us think about this.

1. Put a code into the person label to indicate the subset to which the item belongs.
2a. Use PSELECT= for each subset code, and produce a person measure (IFILE=). Cross-plot the item calibrations.
or

2b. Do a Differential Item Functioning (DIF=) analysis based on the subset code. Table 30.1 will give you an inter-person-subset t-test for each item.

Alternatively, transpose the dataset, and investigate persons as though they are items.

Table 24.0 Variance components scree plot for persons
Table 24.1, 24.11 Principal components plots of person loadings
Table 24.2, 24.12 Person Principal components analysis/contrast of residuals
Table 24.3, 24.13 Person contrast by items
Table 24.4, 24.14 Person contrast loadings sorted by measure
Table 24.5, 24.15 Person contrast loadings sorted by entry number
Table 24.99 Largest residual correlations for persons

These plots show the contrasts by plotting the unstandardized "raw" loading on each component against the person measure. The contrast shows persons with different residual patterns. A random pattern with few high loadings is expected.

The horizontal axis is the Rasch dimension. This has been extracted from the data prior to the analysis of residuals.

Letters "A,B,C,..." and "a,b,c,..." identify persons with the most opposed loadings on the first contrast in the residuals. On subsequent contrasts, the items retain their first contrast identifying letters. When there are 9 persons or less, the person number is displayed.

In the residuals, each person is modeled to contribute one unit of randomness. Thus, there are as many residual variance units as there are persons. For comparison, the amount of variance explained by the measures is approximated as units of that same size.

In the Figure below , the first contrast in the standardized residuals separates the persons into 3 clusters. To identify the persons, see Table 24.3. In this example, the dimension is noticeable, with strength of around 18 out of 74 persons. This is in the residual variance, i.e., in the part of the observations unexplained by the measurement model. But, hopefully, most of the variance in the observations has been explained by the model. The part of that explained variance attributable to the persons is shown in variance units locally-rescaled to accord with the residual variances. In this example, the variance explained by the person measures is equivalent to 30 persons. Consequently, the secondary dimension (or whatever) in the persons is noticeable.

For persons:

```
     Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = KID information units
                                              Eigenvalue   Observed   Expected
Total raw variance in observations     =      150.8183 100.0%         100.0%
  Raw variance explained by measures   =       76.8183  50.9%          50.7%
    Raw variance explained by persons  =       30.5375  20.2%          20.2%
    Raw Variance explained by items    =       46.2809  30.7%          30.6%
  Raw unexplained variance (total)     =       74.0000  49.1% 100.0%   49.3%
    Unexplned variance in 1st contrast =       18.2333  12.1%  24.6%

       STANDARDIZED RESIDUAL CONTRAST 1 PLOT

      -4     -3     -2     -1      0      1      2      3      4      5
      -+------+------+------+------+------+------+------+------+------+- COUNT  CLUSTER
   .9 +                   A        |                                   + 1      1
      |                           B|                                   | 1      1
   .8 +                       C D  |                                   + 2      1
      |                            | E                                 | 1      1
   .7 +                   I  G    H|    F                              + 4      1
      |                            KMJL                                | 4      1
   .6 +                            |                                   +
      |                            | N                                 | 1      1
C  .5 +                 P          |      O                            + 2      1
O     |                            |                                   |
N  .4 +                           Q|                                   + 1      1
T     |                            S        R                          | 2      2
R  .3 +                     T      |                                   + 1      2
A     |                            |    U                              | 1      2
S  .2 +                           V|                                   + 1      2
T     |                            | W                                 | 1      2
```

```
   .1 +                            |Y X                                + 2      2
1     |                           1|  1    Z                           | 3      2
   .0 +----------------------------|---1--------------1----------------+ 2      2
L     |                            |   1      1  1                     | 3      2
O -.1 +                       1    |  1      1                         + 3      2
A     |                            |1                                  | 1      2
D -.2 +                            |  1    1                           + 2      2
I     |                            |1 1                                | 2      2
N -.3 +                            |  1  2                             + 3      3
G     |                            |  2      1                         | 3      3
  -.4 +                            |x    1   y     z                   + 4      3
      |                            |      v  w                         | 2      3
  -.5 +                            | u q  o   s r  p                 t + 7      3
      |                            |       ln             m            | 3      3
  -.6 +                            |        k    ji                    + 3      3
      |                            |                        h          | 1      3
  -.7 +                            |             g      f      e       + 3      3
      |                            |            c b d                  | 3      3
  -.8 +                            |                a                  + 1      3
      -+------+------+------+------+------+------+------+------+------+-
      -4     -3     -2     -1      0      1      2      3      4      5
                                 KID MEASURE
 COUNT:                 1 2 112 1 5346832333342 23222 1 1 1 1  1     1

ACT          1    1  1   11 111 21  21221  1   21 1 1
               T         S         M         S         T
%TILE        0      10   20  30 40 50 70  80   90  99
```

The plot shows a contrast in the residuals for PERSONS. Each letter is a person up to a maximum of 52 persons, A-Z and a-z. For persons 53-74, "1" means that there is one person at that location on the plot. "2" means that there are two persons, etc.

14.33.3 Table 24.2, 24.12 Person Principal components analysis/contrast of residuals

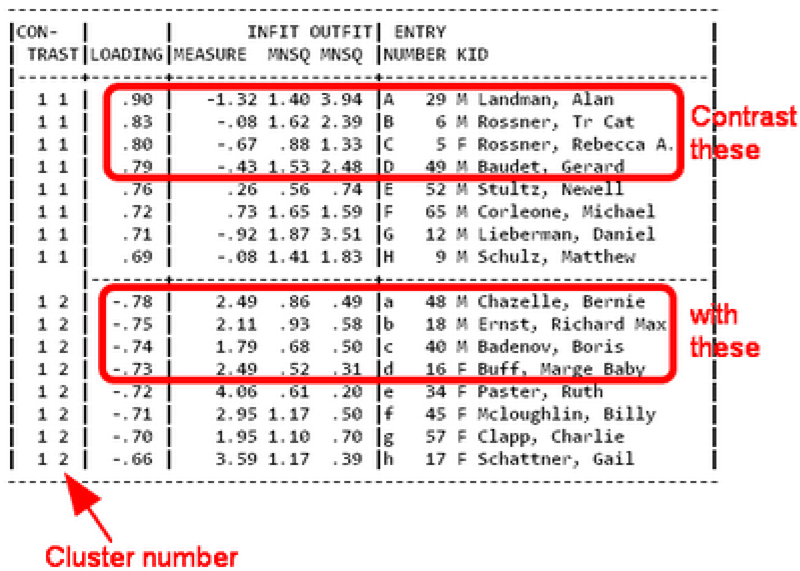
Please do not interpret this as a usual factor analysis. These plots show contrasts between opposing factors, not loadings on one factor. For more discussion, see dimensionality and contrasts.

This Table decomposes the matrix of person correlations based on residuals to identify possible other contrasts (dimensions) that may be affecting response patterns. Specify PRCOMP=S or =R or =L to obtain this Table.

Table 24.0 Variance components scree plot for persons
Table 24.1, 24.11 Principal components plots of person loadings
Table 24.2, 24.12 Person Principal components analysis/contrast of residuals
Table 24.3, 24.13 Person contrast by items
Table 24.4, 24.14 Person contrast loadings sorted by measure
Table 24.5, 24.15 Person contrast loadings sorted by entry number
Table 24.99 Largest residual correlations for persons

Prior to this first contrast, the Rasch dimension has been extracted from the data. Residuals are those parts of the observations not explained by the Rasch dimension. According to Rasch specifications, these should be random and show no structure. The contrasts show conflicting local patterns in inter-item (or inter-person) correlations based on residuals or their transformations. Letters "E", "b", etc. relate persons to their unstandardized "raw" loadings on the first contrast.

In this Table 24.3, Landman and Rossner contrast with Chazelle and Ernst. Since Landman and Rossner misfit, they load on a second dimension in the data.



```
-------------------------------------------------------------
|CON-  |       |        INFIT OUTFIT| ENTRY                       |
| TRAST|LOADING|MEASURE  MNSQ MNSQ  |NUMBER KID                   |
|------+-------+--------------------+-----------------------------|
|  1 1 |  .90  |  -1.32 1.40 3.94   |A    29 M Landman, Alan      |
|  1 1 |  .83  |   -.08 1.62 2.39   |B     6 M Rossner, Tr Cat    |
|  1 1 |  .80  |   -.67  .88 1.33   |C     5 F Rossner, Rebecca A.|
|  1 1 |  .79  |   -.43 1.53 2.48   |D    49 M Baudet, Gerard     |
|  1 1 |  .76  |    .26  .56  .74   |E    52 M Stultz, Newell     |
|  1 1 |  .72  |    .73 1.65 1.59   |F    65 M Corleone, Michael  |
|  1 1 |  .71  |   -.92 1.87 3.51   |G    12 M Lieberman, Daniel  |
|  1 1 |  .69  |   -.08 1.41 1.83   |H     9 M Schulz, Matthew    |
|      |-------+--------------------+-----------------------------|
|  1 2 | -.78  |   2.49  .86  .49   |a    48 M Chazelle, Bernie   |
|  1 2 | -.75  |   2.11  .93  .58   |b    18 M Ernst, Richard Max |
|  1 2 | -.74  |   1.79  .68  .50   |c    40 M Badenov, Boris     |
|  1 2 | -.73  |   2.49  .52  .31   |d    16 F Buff, Marge Baby   |
|  1 2 | -.72  |   4.06  .61  .20   |e    34 F Paster, Ruth       |
|  1 2 | -.71  |   2.95 1.17  .50   |f    45 F Mcloughlin, Billy  |
|  1 2 | -.70  |   1.95 1.10  .70   |g    57 F Clapp, Charlie     |
|  1 2 | -.66  |   3.59 1.17  .39   |h    17 F Schattner, Gail    |
-------------------------------------------------------------
```


The loading is that on the first PCA contrast. It is unstandardized. In the factor analysis literature, values of ±.4 or more extreme are considered substantive. To standardize the loading, divide the loadings by their root-mean-square.
The measures and mean-square statistics are the same as those reported in Table 6 etc.
The letters under "ENTRY NUMBER" refer to the plots in Table 24.2.

The "cluster number" indicates a statistical clustering of the loadings (useful for splitting these persons into two or more unidimensional sub-samples). The clusters are obtained by doing a cluster-analysis of the loadings.

To copy numbers out of this Table, use WORD to copy a rectangle of text or copy-and-paste into Excel, then "text to columns".

14.33.4 Table 24.3, 24.13 Person contrast by items

Please do not interpret this as a usual factor analysis. These plots show contrasts between opposing factors, not loadings on one factor. For more discussion, see dimensionality and contrasts.

The effect on the items of the contrast between the oppositely loading persons (Table 24.1) at the top and bottom of the contrast plot is shown here.

Table 24.0 Variance components scree plot for persons
Table 24.1, 24.11 Principal components plots of person loadings
Table 24.2, 24.12 Person Principal components analysis/contrast of residuals
Table 24.3, 24.13 Person contrast by items
Table 24.4, 24.14 Person contrast loadings sorted by measure
Table 24.5, 24.15 Person contrast loadings sorted by entry number
Table 24.99 Largest residual correlations for persons

Responses by up to 9 persons (or on up to 9 items) to the items (or by the persons) with extreme positive loadings and the items (or persons) with extreme negative loadings are identified. These responses are seen to be higher, as expected, or lower than the model predicts. Counts of these are obtained for each person (or item). The persons (or items) showing the biggest impact of this contrast are listed first. Items and persons showing the most contrast are chosen for this Table based on the "Liking for Science" data.

Table 24.3 showis the impact of the first contrast in the person residuals on items:

```
  PUPIL contrast 1 CONTRASTING RESPONSES BY ACTS
+---------------------------------+
|           FAVORS TOP            |
| TOP 9 PUPILS    | BOTTOM 9 PUPILS|
| HIGH  EXP. LOW  | HIGH  EXP. LOW |       Items biased towards top 9 persons
```

```
+---------------------------------+
|    9    0    0 |    0    0    9 | 23  WATCH A RAT
|    8    1    0 |    0    1    8 | 5   FIND BOTTLES AND CANS
|    7    2    0 |    1    7    1 | 20  WATCH BUGS
+---------------------------------+
+---------------------------------+
|          FAVORS BOTTOM          |
| TOP 9 PUPILS    | BOTTOM 9 PUPILS|
| HIGH  EXP. LOW | HIGH  EXP. LOW |       Items biased towards bottom 9 persons
+---------------------------------+
|    0    4    5 |    0    9    0 | 13  GROW GARDEN
|    0    5    4 |    0    9    0 | 2   READ BOOKS ON ANIMALS
|    0    5    4 |    0    9    0 | 15  READ ANIMAL STORIES
|    0    5    4 |    0    9    0 | 24  FIND OUT WHAT FLOWERS LIVE ON
+---------------------------------+
```

`FAVORS TOP`	These items score higher on the persons at the top of the Contrast 1 plot in Table 24.1 than the persons at the bottom of the contrast plot
`FAVORS BOTTOM`	These items score higher on the persons at the bottom of the Contrast 1 plot in Table 24.1 than the persons at the top of the contrast plot
`TOP 7 PUPILS`	Responses for the top 7 persons (or top half of the persons if less than 7) on the Contrast plot
`BOTTOM 7 PUPILS`	Responses for the bottom 7 persons (or top half of the persons if less than 7) on the Contrast plot
`HIGH`	item response is higher than expected on this many persons
`EXP.`	item response is expected (within 0.5 score points) on this many persons
`LOW`	item response is lower than expected on this many persons
`23  WATCH A RAT`	item entry number and item label. items with greatest differential performance between TOP and BOTTOM are shown with strongest difference listed first.
`23  WATCH A RAT` `13  GROW GARDEN`	The effect of the 1st Contrast is more strongly seen in the performance of these two items. Is there something about them that interacts with the set of persons?

14.33.5 Table 24.4, 24.14 Person contrast loadings sorted by measure

```
 CONTRAST 1 FROM PRINCIPAL COMPONENT ANALYSIS
  STANDARDIZED RESIDUAL LOADINGS FOR KID (SORTED BY MEASURE)

-----------------------------------------------------
|CON CL|       |       INFIT OUTFIT| ENTRY           |
|TRA US|LOADING|MEASURE  MNSQ MNSQ |NUMBER KID       |
|------+-------+-------------------+-----------------|
|  1 2 |  -.12 |     3.73  .95  .39 |h     7 Susan   F |
|  1 2 |   .13 |     3.73 1.94  .88 |O    24 Rick    M |
|  1 3 |  -.22 |     2.85  .36  .15 |f    15 Frank   M |
|  1 2 |   .00 |     1.94  .52  .18 |p    21 Thomas  M |
|  1 3 |  -.22 |     1.94  .65  .22 |g    22 Betty   F |
|  1 2 |   .46 |     1.94 1.60  .67 |J    23 Bert    M |
|  1 2 |   .32 |     1.94 1.74  .71 |L    34 Elsie   F |
|  1 2 |  -.07 |      .92  .39  .13 |l    10 Carol   F |
|  1 2 |  -.07 |      .92  .39  .13 |m    14 Zula    F |
|  1 2 |   .46 |      .92  .99  .32 |H    18 Britton F |
```

```
|  1 2 |   .46 |      .92  .99  .32 |I    20 David    M |
```

See Table 24.2

Table 24.0 Variance components scree plot for persons
Table 24.1, 24.11 Principal components plots of person loadings
Table 24.2, 24.12 Person Principal components analysis/contrast of residuals
Table 24.3, 24.13 Person contrast by items
Table 24.4, 24.14 Person contrast loadings sorted by measure
Table 24.5, 24.15 Person contrast loadings sorted by entry number
Table 24.99 Largest residual correlations for persons

14.33.6 Table 24.5, 24.15 Person contrast loadings sorted by entry number

```
 CONTRAST 1 FROM PRINCIPAL COMPONENT ANALYSIS
  STANDARDIZED RESIDUAL LOADINGS FOR KID (SORTED BY ENTRY)

-----------------------------------------------------
|CON CL|       |       INFIT OUTFIT| ENTRY          |
|TRA US|LOADING|MEASURE  MNSQ MNSQ |NUMBER KID      |
|------+-------+-------------------+----------------|
|  1 2 |  -.11 |  -2.94  .61  .29 |i     1 Richard M |
|  1 1 |   .95 |   -.26  .18  .08 |A     2 Tracie  F |
|  1 3 |  -.37 |   -.26 1.94 1.19 |c     3 Walter  M |
|  1 2 |   .00 |  -3.61  .78  .36 |P     4 Blaise  M |
|  1 1 |   .95 |   -.26  .18  .08 |B     5 Ron     M |
|  1 1 |   .95 |   -.26  .18  .08 |C     6 William M |
|  1 2 |  -.12 |   3.73  .95  .39 |h     7 Susan   F |
|  1 1 |   .95 |   -.26  .18  .08 |D     8 Linda   F |
|  1 1 |   .95 |   -.26  .18  .08 |E     9 Kim     F |
|  1 2 |  -.07 |    .92  .39  .13 |l    10 Carol   F |
|  1 2 |   .00 |  -2.23 1.02  .81 |Q    11 Pete    M |
|  1 2 |   .29 |  -2.23 1.10  .51 |M    12 Brenda  F |
|  1 3 |  -.37 |   -.26 4.12 5.28 |d    13 Mike    M |
|  1 2 |  -.07 |    .92  .39  .13 |m    14 Zula    F |
```

See Table 24.2

Table 24.0 Variance components scree plot for persons
Table 24.1, 24.11 Principal components plots of person loadings
Table 24.2, 24.12 Person Principal components analysis/contrast of residuals
Table 24.3, 24.13 Person contrast by items
Table 24.4, 24.14 Person contrast loadings sorted by measure
Table 24.5, 24.15 Person contrast loadings sorted by entry number
Table 24.99 Largest residual correlations for persons

14.33.7 Table 24.99 Largest residual correlations for persons

Table 24.99 shows persons that may be locally dependent. Specify PRCOMP=R (for score residuals) or PRCOMP=S or Y (for standardized residuals) or PRCOMP=L (for logit residuals) to obtain this Table. Residuals are those parts of the data not explained by the Rasch model. High correlation of residuals for two items (or persons) indicates that they may not be locally independent, either because they duplicate some feature of each other or because they both incorporate some other shared dimension.

Missing data are deleted pairwise if both of a pair are missing or PRCOMP=O (for observations), otherwise missing data are replaced by their Rasch expected residuals of 0.

```
     LARGEST STANDARDIZED RESIDUAL CORRELATIONS
     USED TO IDENTIFY DEPENDENT KID
---------------------------------------------
|CORREL-| ENTRY           | ENTRY           |
|  ATION|NUMBER KID       |NUMBER KID       |
|-------+-----------------+-----------------|
|  1.00 |      1 Richard M |    27 Adam    M |
|  1.00 |      2 Tracie  F |     5 Ron     M |
|  1.00 |      2 Tracie  F |     6 William M |
|  1.00 |      2 Tracie  F |     8 Linda   F |
|  1.00 |      2 Tracie  F |     9 Kim     F |
|  1.00 |      2 Tracie  F |    26 Barbara F |
|  1.00 |      2 Tracie  F |    31 James   M |
```

```
|  1.00 |     10 Carol   F |     14 Zula    F |
|  1.00 |     10 Carol   F |     32 Joe     M |
|  1.00 |     16 Dorothy F |     28 Audrey  F |
|  1.00 |     18 Britton F |     20 David   M |
|  1.00 |     19 Janet   F |     30 Lisa    F |
|-------+-----------------+-----------------|
|  -.82 |      4 Blaise  M |     25 Don     M |
|  -.75 |     21 Thomas  M |     34 Elsie   F |
|  -.75 |     19 Janet   F |     33 Martha  F |
|  -.75 |     30 Lisa    F |     33 Martha  F |
|  -.70 |     22 Betty   F |     23 Bert    M |
|  -.67 |     18 Britton F |     22 Betty   F |
|  -.67 |     20 David   M |     22 Betty   F |
|  -.65 |     16 Dorothy F |     33 Martha  F |
---------------------------------------------
```

For more about this Table, see Table 23.99

14.34 Table 25 Item report in displacement order

14.34.1 Table 25.1 Item statistics in displacement order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, TOTAL=, DISCRIMINATION=, ASYMPTOTE=, PVALUE=)

ITEM STATISTICS: DISPLACEMENT ORDER

For details, please see Table 10.1

14.34.2 Table 25.2 Item statistics graphically

Please see Table 10.2

14.34.3 Table 25.3 Item option & distractor frequencies

(controlled by Distractors=Y, OSORT=, CFILE=, PTBIS=)

ITEM OPTION FREQUENCIES are output if Distractors=Y. These show occurrences of each of the valid data codes in CODES=, and also of MISSCORE= in the input data file. Counts of responses forming part of extreme scores are included. Only items included in the corresponding main table are listed. These statistics are also in DISFILE=, which includes entries even if the code is not observed for the item. See also Distractor Analysis.

OSORT= controls the ordering of options within items. The standard is the order of data codes in CODES=.

```
         ITEM CATEGORY/OPTION/DISTRACTOR FREQUENCIES:  ENTRY ORDER
----------------------------------------------------------------------------------------------------
|ENTRY    DATA  SCORE |     DATA    |      ABILITY     S.E.  INFT OUTF PTMA |                        |
|NUMBER   CODE  VALUE |  COUNT    % |    MEAN    P.SD  MEAN  MNSQ MNSQ CORR.| ITEM                   |
|--------------------+-------------+------------------------------------+------------------------|
|   13    4       *** |     11  16#|     .79     1.41  .45             .08 |M. STAIRS               | 4 75% Independent
|         1         1 |     30  52 |   -1.85      .99  .18   .8  1.0  -.89 |                        | 1 0% Independent
|         3         3 |      5   9 |    1.07      .80  .40   .6   .4   .10 |                        | 3 50% Independent
|         5         5 |     15  26 |    2.63     1.06  .28  1.7  1.5   .56 |                        | 5 Supervision
|         6         6 |      7  12 |    3.25      .81  .33  1.2  1.2   .44 |                        | 6 Device
|         7         7 |      1   2 |    4.63      .00        .7   .6   .23 |                        | 7 Independent
|         MISSING *** |      1   1#|   -1.99      .00                 -.12 |                        |
----------------------------------------------------------------------------------------------------
 * Average ability does not ascend with category score
 # Missing % includes all categories. Scored % only of scored categories
```

ENTRY NUMBER is the item sequence number.
The letter next to the sequence number is used on the fit plots.

DATA CODE is the response code in the data file.
MISSING means that the data code is not listed in the CODES= specification.
Codes with no observations are not listed.

SCORE VALUE is the value assigned to the data code by means of NEWSCORE=, KEY1=, IVALUEA=, etc.
*** means the data code is missing and so ignored, i.e., regarded as not administered. MISSCORE=1 scores missing

data as "1".

DATA COUNT is the frequency of the data code in the data file (unweighted) - this includes observations for both non-extreme and extreme persons and items. For counts weighted by PWEIGHT=, see DISFILE=

DATA % is the percent of scored data codes. For dichotomies, the % are the proportion-correct-values for the options. For data with score value "***", the percent is of all data codes, indicated by "#".

ABILITY MEAN is the observed, sample-dependent, average measure of persons (relative to each item) in this analysis who responded in this category (adjusted by PWEIGHT=). This is equivalent to a "Mean Criterion Score" (MCS) expressed as a measure. It is a sample-dependent quality-control statistic for this analysis. (It is not the sample-independent value of the category, which is obtained by adding the item measure to the "score at category", in Table 3.2 or higher, for the rating (or partial credit) scale corresponding to this item.) For each observation in category k, there is a person of measure Bn and an item of measure Di. Then: average measure = sum(Bn - Di) / count of observations in category.
An "*" indicates that the average measure for a higher score value is lower than for a lower score value. This contradicts the hypothesis that "higher score value implies higher measure, and vice-versa".
The "average ability" for missing data is the average measure of all the persons for whom there is no response to this item. This can be useful. For instance, we may expect the "missing" people to be high or low performers, or to be missing random (and so they average measure would be close to the average of the sample).
These values are plotted in Table 2.6.

ABILITY P.SD is the population standard deviation of the ABILITY values = √(Σ (ABILITY - (ABILITY MEAN))²/COUNT)

S.E. MEAN is the standard error of the mean (average) measure of the sample of persons from a population who responded in this category (adjusted by PWEIGHT=) = √(Σ (ABILITY - (ABILITY MEAN))²/(COUNT*(COUNT-1))

INFT MNSQ is the Infit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

OUTF MNSQ is the Outfit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

PTMA CORR is the point-correlation between the data code, scored 1, or non-occurrence, scored 0, of this category or distractor and the person raw scores or measures chosen by PTBISERIAL=. The computation is described in Correlations. Example: for categories 0,1,2, then the correlation is between [1 for the target score (0 , 1, or 2) and 0 for the other scores (1 and 2, 0 and 2, or 0 and 1)] and the person ability measures for the persons producing each score.

ITEM (here, ACT) is the name or label of the item.

Data codes and Category labels are shown to the right of the box, if CLFILE= or CFILE= is specified.

* Average ability does not ascend with category score. The average ability of the persons observed in this category is lower than the average ability of the persons in the next lower category. This contradicts the Rasch-model assumption that "higher categories <-> higher average abilities."

Missing % includes all categories. Scored % only of scored categories. The percentage for the missing category is based on all the COUNTS. The percentages for the SCOREd categores are based only on those category COUNTs.

""BETTER FITTING OMIT" appears in fit-ordered Tables, where items better fitting than FITI= are excluded.

14.35 Table 26 Item report in correlation order

14.35.1 Table 26.1 Item statistics in correlation order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, ISORT=, TOTAL=, DISCRIMINATION=, ASYMPTOTE=, PVALUE=, PTBIS=)

Negative point-biserial correlations or point-measure correlations, PTBIS=, indicate that the responses to the item contradict the latent variable defined by the consensus of the items. The items may need to be omitted or rescored in the opposite direction. This may also be an indication that a multiple-choice item has the wrong option keyed as correct. Always investigate negative point correlations before the Rasch fit statistics.

ITEM STATISTICS: CORRELATION ORDER

For details, please see Table 10.1

14.35.2 Table 26.2 Item statistics graphically

Please see Table 10.2

14.35.3 Table 26.3 Item option & distractor frequencies

(controlled by Distractors=Y, OSORT=, CFILE=, PTBIS=)

ITEM OPTION FREQUENCIES are output if Distractors=Y. These show occurrences of each of the valid data codes in CODES=, and also of MISSCORE= in the input data file. Counts of responses forming part of extreme scores are included. Only items included in the corresponding main table are listed. These statistics are also in DISFILE=, which includes entries even if the code is not observed for the item. See also Distractor Analysis.

OSORT= controls the ordering of options within items. The standard is the order of data codes in CODES=.

```
          ITEM CATEGORY/OPTION/DISTRACTOR FREQUENCIES:  ENTRY ORDER
-------------------------------------------------------------------------------------------
|ENTRY   DATA  SCORE |     DATA    |      ABILITY     S.E.  INFT OUTF PTMA |                      |
|NUMBER  CODE  VALUE |  COUNT    % |    MEAN    P.SD  MEAN  MNSQ MNSQ CORR.| ITEM                 |
|--------------------+-------------+-----------------------------------+----------------------|
|   13   4       *** |     11  16#|      .79    1.41  .45              .08 |M. STAIRS             | 4 75% Independent
|        1         1 |     30  52 |   -1.85     .99  .18    .8  1.0  -.89 |                      | 1 0% Independent
|        3         3 |      5   9 |    1.07     .80  .40    .6    .4   .10 |                      | 3 50% Independent
|        5         5 |     15  26 |    2.63    1.06  .28   1.7  1.5   .56 |                      | 5 Supervision
|        6         6 |      7  12 |    3.25     .81  .33   1.2  1.2   .44 |                      | 6 Device
|        7         7 |      1   2 |    4.63     .00          .7    .6   .23 |                      | 7 Independent
|        MISSING *** |      1   1#|   -1.99     .00                  -.12 |                      |
-------------------------------------------------------------------------------------------
 * Average ability does not ascend with category score
 # Missing % includes all categories. Scored % only of scored categories
```

ENTRY NUMBER is the item sequence number.
The letter next to the sequence number is used on the fit plots.

DATA CODE is the response code in the data file.
MISSING means that the data code is not listed in the CODES= specification.
Codes with no observations are not listed.

SCORE VALUE is the value assigned to the data code by means of NEWSCORE=, KEY1=, IVALUEA=, etc.
*** means the data code is missing and so ignored, i.e., regarded as not administered. MISSCORE=1 scores missing data as "1".

DATA COUNT is the frequency of the data code in the data file (unweighted) - this includes observations for both non-extreme and extreme persons and items. For counts weighted by PWEIGHT=, see DISFILE=

DATA % is the percent of scored data codes. For dichotomies, the % are the proportion-correct-values for the options.
For data with score value "***", the percent is of all data codes, indicated by "#".

ABILITY MEAN is the observed, sample-dependent, average measure of persons (relative to each item) in this analysis who responded in this category (adjusted by PWEIGHT=). This is equivalent to a "Mean Criterion Score" (MCS) expressed as a measure. It is a sample-dependent quality-control statistic for this analysis. (It is not the sample-independent value of the category, which is obtained by adding the item measure to the "score at category", in Table

3.2 or higher, for the rating (or partial credit) scale corresponding to this item.) For each observation in category k, there is a person of measure Bn and an item of measure Di. Then: average measure = sum(Bn - Di) / count of observations in category.
An "*" indicates that the average measure for a higher score value is lower than for a lower score value. This contradicts the hypothesis that "higher score value implies higher measure, and vice-versa".
The "average ability" for missing data is the average measure of all the persons for whom there is no response to this item. This can be useful. For instance, we may expect the "missing" people to be high or low performers, or to be missing random (and so they average measure would be close to the average of the sample).
These values are plotted in Table 2.6.

ABILITY P.SD is the population standard deviation of the ABILITY values = √(Σ (ABILITY - (ABILITY MEAN))²/COUNT)

S.E. MEAN is the standard error of the mean (average) measure of the sample of persons from a population who responded in this category (adjusted by PWEIGHT=) = √(Σ (ABILITY - (ABILITY MEAN))²/(COUNT*(COUNT-1))

INFT MNSQ is the Infit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

OUTF MNSQ is the Outfit Mean-Square for observed responses in this category (weighted by PWEIGHT=, and omitting responses in extreme person scores). Values greater than 1.0 indicate unmodeled noise. Values less than 1.0 indicate loss of information.

PTMA CORR is the point-correlation between the data code, scored 1, or non-occurrence, scored 0, of this category or distractor and the person raw scores or measures chosen by PTBISERIAL=. The computation is described in Correlations. Example: for categories 0,1,2, then the correlation is between [1 for the target score (0 , 1, or 2) and 0 for the other scores (1 and 2, 0 and 2, or 0 and 1)] and the person ability measures for the persons producing each score.

ITEM (here, ACT) is the name or label of the item.

Data codes and Category labels are shown to the right of the box, if CLFILE= or CFILE= is specified.

* Average ability does not ascend with category score. The average ability of the persons observed in this category is lower than the average ability of the persons in the next lower category. This contradicts the Rasch-model assumption that "higher categories <-> higher average abilities."

Missing % includes all categories. Scored % only of scored categories. The percentage for the missing category is based on all the COUNTS. The percentages for the SCOREd categores are based only on those category COUNTs.

""BETTER FITTING OMIT" appears in fit-ordered Tables, where items better fitting than FITI= are excluded.

14.36 Table 27 Item subtotals

14.36.1 Table 27.1 Item subtotal summaries on one line

(controlled by ISUBTOT=, UDECIMALS=, REALSE=)
These summarize the measures from the main analysis for all items selected by ISUBTOT= (Table 27), including extreme scores.

Table
27.2 Measure sub-totals bar charts, controlled by ISUBTOT=
27.3 Measure sub-totals summary statistics, controlled by ISUBTOT=

```
        Subtotal specification is: ISUBTOTAL=$S1W1

ALL ACT SCORES ARE NON-EXTREME
-------------------------------------------------------------------------------------------------
     ---------------------
```

```
|    ACT    MEAN    MEAN     MEAN     S.E.                                         MODEL       MODEL
      TRUE    MEAN        |
|   COUNT   SCORE   COUNT   MEASURE    MEAN     P.SD     S.SD   MEDIAN   SEPARATION  RELIABILITY    RMSE
       SD    OUTFIT  CODE |
|-----------------------------------------------------------------------------------------------
    --------------------|
|      25    95.0    75.0      .00      .29     1.41     1.43      .16      5.86          .97        .24
      1.39    1.08    *       |
|       4    90.5    75.0      .31      .73     1.27     1.47     -.11      5.89          .97        .21
      1.25    1.41    F       |
|       4   137.5    75.0    -2.24      .39      .67      .78    -2.26      1.62          .72        .36
       .57     .94    G       |
|       5    88.6    75.0      .32      .51     1.02     1.14      .42      4.81          .96        .21
      1.00     .89    L       |
|       1    83.0    75.0      .60       -       .00       -       .60       .00          .00        .19
       .00     .95    M       |
|       3   105.0    75.0     -.26      .34      .49      .60     -.48      2.14          .82        .21
       .44     .63    R       |
|       1    85.0    75.0      .53       -       .00       -       .53       .00          .00        .19
       .00     .74    T       |
|       7    76.6    75.0      .82      .45     1.10     1.19     1.10      5.29          .97        .21
      1.08    1.37    W       |
------------------------------------------------------------------------------------------------
    ---------------------
SUBTOTAL RELIABILITY: inestimable
UMEAN=0 USCALE=1
```

Subtotal specification is: ISUBTOTAL=$S1W1	identifies the columns in the item label to be used for classifying the item by $S1W1 or whatever, using the column selection rules.
EXTREME AND NON-EXTREME KID SCORES ALL SCORES ARE NON-EXTREME NON-EXTREME SCORES ONLY	The items included in this summary table. Items with non-extreme scores (omits items with 0% and 100% success rates)
ITEM COUNT	count of items. "ITEM" is the name assigned with ITEM=
MEAN SCORE	weighted average item score by the persons
MEAN COUNT	weighted average of the count of responses by the persons
MEAN MEASURE	average measure of items
S.E. MEAN	standard error of the average measure of items. If only one item, then the S.E. of the item estimate
P.SD	population standard deviation of the item measures.
S.SD	sample standard deviation of the item measures.
MEDIAN	the measure of the middle item
REAL/MODEL SEPARATION	the separation coefficient: the "true" adjusted standard deviation / root-mean-square measurement error of the items (REALSE= inflated for misfit).
REAL/MODEL RELIABILITY	the item measure reproducibility = ("True" item measure variance / Observed variance) = Separation ² / (1 + Separation ²)
RMSE	Statistical average of the standard errors of the measures
TRUE SD	Observed population S.D. adjusted for measurement error
MEAN OUTFIT	Average outfit mean-square for the group. Expectation near 1.0
ITEM CODE	the classification code in the item label. The first line, "*", is the total for all items. The remaining codes are those in the item columns specified by $S1W1 or whatever, using the column selection rules.
SUBTOTAL RELIABILITY	the reliability (reproducibility) of the means of the subtotals = true variance / observed variance = (observed variance - error variance) / observed variance. Observed variance = variance of MEAN MEASURES

	Error variance = mean-square of the S.E. MEAN *inestimable* = some subtotal counts are too small to estimate Reliability
UMEAN=0 USCALE=1	Current user-scaling

```
-------------------------------------------------------------
|    ACT    MEAN DIFFERENCE        Welch-2sided  | Cohen's d |
| CODE CODE MEASURE   S.E.     t     d.f.  Prob. |Effect Size|
|------------------------------------------------------------|
| F    G       2.55    .83   3.07       4  .037  |   2.17     |
| F    L       -.01    .90   -.02       5  .988  |    .01     |
| F    R        .57    .81    .70       4  .524  |    .47     |
| F    W       -.52    .86   -.60       5  .575  |    .40     |
| G    L      -2.56    .64  -3.99       6  .007  |   2.55     |
| G    R      -1.98    .52  -3.82       4  .019  |   2.79     |
| G    W      -3.07    .60  -5.15       8  .001  |   2.86     |
| L    R        .58    .62    .94       5  .390  |    .58     |
| L    W       -.50    .68   -.74       8  .483  |    .43     |
| R    W      -1.08    .57  -1.91       7  .098  |   1.01     |
-------------------------------------------------------------
```

ITEM CODE	the classification code in the item label for subtotal "1"
CODE	the classification code in the item label for subtotal "2"
MEAN DIFFERENCE	difference between the mean measures of the two CODE subtotals, "1" and "2"
MEASURE	size of the difference between "1" and "2"
S.E.	standard error of the difference = sqrt ((S.E. Mean "1")² + (S.E. Mean "2")²)
t	Student's t = MEASURE / S.E.
Welch2-sided	2-sided *t*-test using Welch's adaptation of Student's *t*-test.
d.f.	Welch's degrees of freedom
Prob.	two-sided probability of Student's *t*. See t-statistics.
Cohen's *d* Effect Size	V = COUNT * P.SD^2 d = (MEAN DIFFERENCE) / SQRT ((v1 + V2)/ (COUNT1 + COUNT2 -2)) Wikipedia: Effect Size

One-way ANOVA of subtotal means and variances

This reports a one-way analysis of variance for the subtotal means. Are they the same (statistically) as the overall mean?

```
---------------------------------------------------------------
| ANOVA -    KID                                               |
| Source  Sum-of-Squares   d.f.  Mean-Squares  F-test  Prob>F |
|--------------------------------------------------------------|
| @TOPIC            1.70    1.00          1.70    1.89   .1761 |
| Error            26.91   30.00           .90                 |
| Total            28.61   31.00           .92                 |
|--------------------------------------------------------------|
| Fixed-Effects Chi-square: 1.7026 with 1 d.f., prob. .1919    |
---------------------------------------------------------------
```

Source	the variance component.
@TYPE (the specified ISUBTOTAL= classification)	the variation of the subtotal mean measures around the grand mean.
Error	Error is the part of the total variation of the measures around their grand mean not explained by the @TYPE
Total	total variation of the measures around their grand mean
Sum-of-Squares	the variation around the relevant mean

d.f.	the degrees of freedom corresponding to the variation (= number of measures - 1)
Mean-Squares	Sum-of-Squares divided by d.f.
F-test	@TYPE Mean-Square / Error Mean-Square
Prob>F	the right-tail probability of the F-test value with (@TYPE, Error) d.f. A probability less than .05 indicates statistically significant differences between the means.
Fixed-Effects Chi-Square (of Homogeneity)	a test of the hypothesis that all the subtotal means are the same, except for sampling error
d.f.	degrees of freedom of chi-square = number of sub-totals - 1
prob.	probability of observing this value of the chi-square or larger if the hypothesis is true. A probability less than .05 indicates statistically significant differences between the means.
inestimable	some item counts are too small and/or some variances are zero.

Example: test the hypothesis "All the items have the same difficulty" with a "Fixed Effects" Chi-Square of Homogeneity:

ISUBTOTAL = $N ; each item is in its own group

then Table 27.1.

14.36.2 Table 27.2 Item subtotal measure bar charts

These show the distributions of the measures from the main analysis for each sub-sample. Summaries are shown in Tables 27.1 (Items, ISUBTOT=).

Here is the measure distribution of the total sample:

```
3   1  2  2     1    1             1      11      1        31
S                        M                         S        T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  * TOTAL   (ACT)
-5   -4    -3    -2    -1     0     1     2     3     4     5  GLOBAL SAMPLE COUNT
```

M = Mean, S = one standard deviation from mean, T = two standard deviations from mean.

Here is the measure distribution of the total sample standardized to a sample size of 1000:

```
1      1  1                                                1
6   5  1  1     5    5             5      55      5        65
7   6  2  2     6    6             6      66      6        76
S                        M                         S        T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  * TOTAL   (ACT)
-5   -4    -3    -2    -1     0     1     2     3     4     5  PER THOUSAND IN GLOBAL SAMPLE
```

Read the counts vertically so that the first left-hand count is 167.

Here is the measure distribution of one sub-sample, specified as $S9W1="F", using the column selection rules.

```
2   1  1  1     1                  1      11      1        3
T  S                        M                        S      T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  1    (ACT)
-5   -4    -3    -2    -1     0     1     2     3     4     5  LOCAL SAMPLE COUNT
```

Here is the measure distribution of the sub-sample standardized to a sample size of 1000:

```
1                                                          2
5   7  7  7     7                  7      77      7        3
4   7  7  7     7                  7      77      7        1
T  S                        M                        S      T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  1
-5   -4    -3    -2    -1     0     1     2     3     4     5  PER THOUSAND IN LOCAL SAMPLE
```

Here is the measure distribution of the sub-sample standardized so that the total at any measure is 1,000, but in proportion to the observed counts in each sub-sample:

```
     1           1                   1      11      1        1
6    0  5  5     0                   0      00      0        0
6    0  0  0     0                   0      00      0        0
7    0  0  0     0                   0      00      0        0
T          S                   M                    S         T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  1
-5    -4    -3    -2    -1     0     1     2     3     4     5  PER THOUSAND AT MEASURE FOR COUNTED LOCAL SAMPLES
```

Here is the measure distribution of the sub-sample standardized so that the total any measure is 1,000, but based on the proportion observed when the sizes of all sub-samples are adjusted to be equal:

```
     1           1                   1      11      1        1
3    0  1        0                   0      00      0        0
1    0  8  7     0                   0      00      0        0
6    0  8  2     0                   0      00      0        0
T              S                  M                  S        T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  1
-5    -4    -3    -2    -1     0     1     2     3     4     5  PER THOUSAND AT MEASURE FOR EQUAL LOCAL SAMPLES
```

14.36.3 Table 27.3+ Item subtotal detailed summary statistics

(controlled by ISUBTOT=, UDECIMALS=)
These summarize the measures from the main analysis for all items selected by ISUBTOT=. Table 27.1 shows one-line summary statistics. Bar charts are shown in Table 27.2. Detailed summary statistics in Table 27.3, 27.4, ...

```
TOTAL FOR ALL 14 NON-EXTREME TAP
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      16.9      35.0         .00     .71       .96     .0    .68    -.1 |
| P.SD      12.9        .0        3.48     .21       .28     .7    .58     .5 |
| S.SD      13.3        .0        3.61     .22       .29     .7    .60     .6 |
| MAX.      32.0      35.0        4.80    1.07      1.56    1.2   2.21    1.1 |
| MIN.       1.0      35.0       -4.40     .45       .59   -1.3    .11    -.6 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .77 TRUE SD    3.39  SEPARATION  4.41  TAP    RELIABILITY  .95 |
|MODEL RMSE    .74 TRUE SD    3.40  SEPARATION  4.59  TAP    RELIABILITY  .95 |
| S.E. OF TAP MEAN = .97                                                      |
| MEDIAN = -.39                                                               |
-------------------------------------------------------------------------------
  MAXIMUM EXTREME SCORE: 3 TAP 16.7%
  MINIMUM EXTREME SCORE: 1 TAP 5.6%

TOTAL FOR ALL 18 EXTREME AND NON-EXTREME TAP
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      18.9      35.0        -.76     .96                                  |
| P.SD      14.0        .0        4.26     .51                                  |
| S.SD      14.4        .0        4.39     .52                                  |
| MAX.      35.0      35.0        6.13    1.85                                  |
| MIN.        .0      35.0       -6.59     .45                                  |
|-----------------------------------------------------------------------------|
| REAL RMSE   1.10 TRUE SD    4.12  SEPARATION  3.73  TAP    RELIABILITY  .93 |
|MODEL RMSE   1.09 TRUE SD    4.12  SEPARATION  3.79  TAP    RELIABILITY  .93 |
| S.E. OF TAP MEAN = 1.03                                                     |
| MEDIAN = -1.96                                                              |
-------------------------------------------------------------------------------
```

For details, please see Table 3.1

14.37 Table 28 Person subtotals

14.37.1 Table 28.1 Person subtotal summaries on one line

(controlled by PSUBTOT=, UDECIMALS=, REALSE=)
These summarize the measures from the main analysis for persons selected by PSUBTOT= (Table 28), including extreme scores. PSUBTOTAL= is useful for quantifying the impact of a test on different types of test-takers.

Table
    28.2 Measure sub-totals bar charts, controlled by PSUBTOT=

[28.3](#) Measure sub-totals summary statistics, controlled by [PSUBTOT=](#)

Subtotal specification is: PSUBTOTAL=@GENDER

Subtotals

```
NON-EXTREME KID SCORES ONLY
-----------------------------------------------------------------------------------------------
    ---------------------
|     KID    MEAN    MEAN     MEAN     S.E.                            MODEL      MODEL
       TRUE    MEAN        |
|   COUNT   SCORE   COUNT  MEASURE    MEAN     P.SD     S.SD   MEDIAN  SEPARATION RELIABILITY    RMSE
        SD    OUTFIT CODE |
|----------------------------------------------------------------------------------------------
    --------------------|
|      74   31.4    25.0      .90      .14     1.22     1.22      .67      2.88         .89        .40
       1.15    1.08   *      |
|      18   35.7    25.0     1.62      .38     1.56     1.61     1.43      3.05         .90        .49
       1.49     .74   F      |
|      56   30.0    25.0      .67      .13      .97      .98      .49      2.47         .86        .37
        .90    1.19   M      |
-----------------------------------------------------------------------------------------------
    ---------------------
SUBTOTAL RELIABILITY: .00
UMEAN=0 USCALE=1
```

Subtotal specification is: PSUBTOTAL=@GENDER	identifies the columns in the Person label to be used for classifying the Person by [@GENDER](#) or whatever, using the column [selection rules](#).
EXTREME AND NON-EXTREME SCORES	All persons with estimated measures
NON-EXTREME SCORES ONLY	Persons with non-extreme scores (omits Persons with 0% and 100% success rates)
PERSON COUNT	count of Persons. "PERSON" is the name assigned with [PERSON=](#)
MEAN SCORE	weighted average person score on the items
MEAN COUNT	weighted average of the count of responses to the items
MEAN MEASURE	average measure of Persons
S.E. MEAN	standard error of the average measure of Persons. If only one person, then the S.E. of the person estimate
P.SD	[population](#) [standard deviation](#) of the Persons.
S.SD	sample [standard deviation](#) of the Persons.
MEDIAN	the measure of the middle Person
REAL/MODEL SEPARATION	the [separation](#) coefficient: the "true" adjusted [standard deviation](#) / root-mean-square measurement error of the Persons (REAL = inflated for misfit).
REAL/MODEL RELIABILITY	the Person measure reproducibility = ("True" Person measure variance / Observed variance) = Separation ² / (1 + Separation ²)
RMSE	Statistical average of the standard errors of the measures
TRUE SD	Observed population S.D. adjusted for measurement error
MEAN OUTFIT	Average outfit mean-square for the group. Expectation near 1.0 This column is blank when Extreme scores are included in the Table because extreme scores do not have Outfit statistics of the usual type.
CODE	the classification code in the Person label. The first line, "*", is the total for all Persons. The remaining codes are those in the Person columns specified by [@GENDER](#) or whatever, using the column

	selection rules. In this example, "F" is the code for "Female" in the data file. "M" for "Male". It is seen that the two distributions are almost identical.
SUBTOTAL RELIABILITY	the reliability (reproducibility) of the means of the subtotals = true variance / observed variance = (observed variance - error variance) / observed variance. Observed variance = variance of MEAN MEASURES Error variance = mean-square of the S.E. MEAN

Independent-samples t-test of pairs of subtotal means

```
-------------------------------------------------------------
|    KID     MEAN DIFFERENCE        Welch-2sided | Cohen's d |
| CODE CODE MEASURE   S.E.     t     d.f.  Prob. |Effect Size|
|-----------------------------------------------------------|
| F    M         .95    .40   2.37      21  .028  |      .82   |
-------------------------------------------------------------
```

PERSON CODE	the classification code in the Person label for subtotal "1"
CODE	the classification code in the Person label for subtotal "2"
MEAN DIFFERENCE	difference between the mean measures of the two CODE subtotals, "1" and "2"
MEASURE	size of the difference between "1" and "2"
S.E.	standard error of the difference = sqrt ((S.E. Mean "1")² + (S.E. Mean "2")²)
t	Student's t = MEASURE / S.E.
Welch d.f.	Welch's degrees of freedom
2-sided Prob.	two-sided probability of Student's *t*. See t-statistics.
Cohen's *d* Effect Size	V = COUNT * P.SD^2 d = (MEAN DIFFERENCE) / SQRT ((v1 + V2)/ (COUNT1 + COUNT2 -2)) Wikipedia: Effect Size

One-way ANOVA of subtotal means and variances

This reports a one-way analysis of variance for the subtotal means. Are they the same (statistically) as the overall mean?

```
---------------------------------------------------------------
| ANOVA -    KID                                              |
| Source  Sum-of-Squares   d.f.  Mean-Squares  F-test  Prob>F |
|-------------------------------------------------------------|
| @GENDER            3.41    1.00          3.41     .67   .5743 |
| Error            169.12   33.00          5.12                |
| Total            172.53   34.00          5.07                |
|-------------------------------------------------------------|
| Fixed-Effects Chi-square: .6565 with 1 d.f., prob. .4178     |
---------------------------------------------------------------
```

Source	the variance component.
@GENDER (the specified PSUBTOTAL= classification)	the variation of the subtotal mean measures around the grand mean.
Error	Error is the part of the total variation of the measures around their grand mean not explained by the @GENDER
Total	total variation of the measures around their grand mean
Sum-of-Squares	the variation around the relevant mean
d.f.	the degrees of freedom corresponding to the variation (= number of measures - 1)

Mean-Squares	Sum-of-Squares divided by d.f.
F-test	@GENDER Mean-Square / Error Mean-Square
Prob>F	the right-tail probability of the F-test value with (@GENDER, Error) d.f. A probability less than .05 indicates statistically significant differences between the means.
Fixed-Effects Chi-Square (of Homogeneity)	a test of the hypothesis that all the subtotal means are the same, except for sampling error
d.f.	degrees of freedom of chi-square = number of sub-totals - 1
prob.	probability of observing this value of the chi-square or larger if the hypothesis is true. A probability less than .05 indicates statistically significant differences between the means.
inestimable	some person counts are too small and/or some variances are zero.

14.37.2 Table 28.2 Person subtotal measure bar charts

These show the distributions of the measures from the main analysis for each sub-sample. Summaries are shown in Tables 28.1 (Items, PSUBTOT=).

Here is the measure distribution of the total sample:

```
                            1
1    1   2   2   2    3     2      5     4     1    2
  T            S            M            S            T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  * TOTAL  (KID)
-5   -4    -3    -2    -1     0     1     2     3     4     5  GLOBAL SAMPLE COUNT
```

Read the counts vertically so that the center count is 12 observed near -0.4.

M = Mean, S = one standard deviation from mean, T = two standard deviations from mean.

Here is the measure distribution of the total sample standardized to a sample size of 1000:

```
                            3      1     1
2    2   5   5   5    8     4      4     1     2    5
9    9   8   8   8    6     3      3     5     9    8
  T            S            M            S            T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  * TOTAL  (KID)
-5   -4    -3    -2    -1     0     1     2     3     4     5  PER THOUSAND IN GLOBAL SAMPLE
```

Here is the measure distribution of one sub-sample, specified as $S9W1="F", using the column selection rules.

```
1        1       1    2     7      3     2          1
  T            S            M            S            T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  F  (KID)
-5   -4    -3    -2    -1     0     1     2     3     4     5  LOCAL SAMPLE COUNT
```

Here is the measure distribution of the sub-sample standardized to a sample size of 1000:

```
                      1     3      1     1
5        5       5    1     8      6     1          5
6        6       6    2     9      7     2          6
  T            S            M            S            T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  F  (KID)
-5   -4    -3    -2    -1     0     1     2     3     4     5  PER THOUSAND IN LOCAL SAMPLE
```

Here is the measure distribution of the sub-sample standardized so that the total at any measure is 1,000, but in proportion to the observed counts in each sub-sample:

```
1
0        5       5    6     5      6     5          5
0        0       0    6     8      0     0          0
0        0       0    7     4      0     0          0
T     S                M                S               T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  F  (KID)
```

```
   -5    -4    -3    -2    -1     0     1     2     3     4     5  PER THOUSAND AT MEASURE FOR COUNTED LOCAL SAMPLES
```

Here is the measure distribution of the sub-sample standardized so that the total any measure is 1,000, but based on the proportion observed when the sizes of all sub-samples are adjusted to be equal:

```
1
0        4       4    6     5      5     4          4
0        8       8    5     7      8     8          8
0        6       6    4     0      7     6          6
T     S                M              S                T
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  F  (KID)
-5    -4    -3    -2    -1     0     1     2     3     4     5  PER THOUSAND AT MEASURE FOR EQUAL LOCAL SAMPLES
```

14.37.3 Table 28.3+ Person subtotal detailed summary statistics

(controlled by PSUBTOT=, UDECIMALS=)
These summarize the measures from the main analysis for all persons selected by PSUBTOT=. Table 28.1 shows one-line summary statistics. Bar charts are shown in Table 28.2. Detailed summary statistics in Table 28.3.

```
TOTAL FOR ALL 34 NON-EXTREME KID
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT     |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN       9.9      18.0        -.19    1.01       .99    -.2    .68    -.1 |
| P.SD       2.1        .0        1.97     .10       .94    1.2   1.29     .7 |
| S.SD       2.1        .0        2.00     .10       .95    1.2   1.30     .7 |
| MAX.      14.0      18.0        3.73    1.11      4.12    2.5   6.07    2.2 |
| MIN.       5.0      18.0       -4.32     .82       .18   -1.5    .08    -.7 |
|------------------------------------------------------------------------------|
| REAL RMSE   1.18 TRUE SD    1.58  SEPARATION  1.34  KID    RELIABILITY  .64 |
|MODEL RMSE   1.01 TRUE SD    1.69  SEPARATION  1.67  KID    RELIABILITY  .74 |
| S.E. OF KID MEAN = .34                                                       |
| MEDIAN = -.26                                                                |
-------------------------------------------------------------------------------
  MINIMUM EXTREME SCORE: 1 KID 2.9%

TOTAL FOR ALL 35 EXTREME AND NON-EXTREME KID
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT     |
|          SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN       9.7      18.0        -.37    1.03                                 |
| P.SD       2.4        .0        2.22     .17                                 |
| S.SD       2.4        .0        2.25     .18                                 |
| MAX.      14.0      18.0        3.73    1.85                                 |
| MIN.       3.0      18.0       -6.62     .82                                 |
|------------------------------------------------------------------------------|
| REAL RMSE   1.21 TRUE SD    1.86  SEPARATION  1.55  KID    RELIABILITY  .70 |
|MODEL RMSE   1.05 TRUE SD    1.96  SEPARATION  1.87  KID    RELIABILITY  .78 |
| S.E. OF KID MEAN = .38                                                       |
| MEDIAN = -.26                                                                |
-------------------------------------------------------------------------------
```

For details, please see Table 3.1

14.38 Table 29 Empirical ICCs and option frequencies

A subtable of plots is shown for each item. The subtables are numbered by Item Entry number. These plots only appear if there is something to show.

```
        EMPIRICAL & MODEL ICCs : 1. WATCH BIRDS
        -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-
      2 +          x          xxxxxx xx x x..*...*.......*......+
         |                         .......                      |
 O       |                      ...                             |
 B       |                  x...                                |
 S       |               x  .                                   |
 E       |            x    ..                                   |
 R  1.5 +              x.                                       +
 V       |              ..                                      |
 E       |             .   xx                                   |
 D       |            .                                         |
         |           .                                          |
```

EMPIRICAL & MODEL ICCs
This Table displays, as dots, the model expected score ogive, also called the predicted Item Characteristic Curve (ICC) and the predicted Item Response Function (IRF). The model ICC is shown by '.'. this is the expected average score on the item for persons at each measure relative to the item.

```
A       |           .x                                       |
V     1 +     xx x x.   x x                                  +
E       |         ..                                         |
R       |        .                                           |
A       |       .    x                                       |
G       |      .                                             |
E       |     .                                              |
     .5 +   ..                                               +
S       | .                                                  |
C       |.                                                   |
O       |                                                    |
R       |                                                    |
E       |                                                    |
      0 +   x   x                                            +
        -+-----+-----+-----+-----+-----+-----+-----+-----+-
        -2    -1     0     1     2     3     4     5     6     7
                 KID MEASURE
```

The empirical observed average score per measure, the empirical ICC, is shown by x's.
Observed average scores on the items are shown by 'x'. When '.' and 'x' coincide, '*' is shown.

You can use this plot to compute the empirical item discrimination.

See also Graphs menu: Expected and Empirical ICCs

```
        EMPIRICAL CODE FREQUENCIES: "C"  : 2. 2
        ++------+------+------+------+------+------+------+------++
    100 +                                                         +
     96 +.......                                                  +
F    92 +       ....                                              +
R    88 +           ..                                            +
E    84 +             ..                                          +
Q    80 +               ..                                        +
U    76 +                 ..                                      +
E    72 +                   .                                     +
N    68 +                    .                                    +
C    64 +                     ..                                  +
Y    60 +                       .                                 +
     56 +                        .                                +
O    52 +                         .                               +
F    48 +                          .                              +
     44 +                           .                             +
R    40 +                            .                            +
E    36 +                             ..                          +
S    32 +                    C          .                         +
P    28 +              C C               .                        +
O    24 +                   C    C        ..                      +
N    20 +           C          C            ..                    +
S    16 +     C                   C CC  C     ..                  +
E    12 +                             C         ..                +
%     8 +                                 CC      ....            +
      4 +                                             ........    +
      0 +                                                     ....+
        ++------+------+------+------+------+------+------+------++
        -4     -3     -2     -1      0      1      2      3      4
                              PERSON MEASURE
```

EMPIRICAL CODE FREQUENCIES: multiple-choice items
This shows the relative frequency of each item response code for each measure level.

For a multiple-choice item, with C as an incorrect distractor, this could like the plot below. The dots are the Rasch ogive for an incorrect answer.

- See also Graphs menu: Empirical category category curves

```
        EMPIRICAL CODE FREQUENCIES: "1" Neutral : 1. WATCH BIRDS
        -+-----+-----+-----+-----+-----+-----+-----+-----+-
    100 +    NN N N   N N                                    +
     96 +                                                    +
F    92 +                                                    +
R    88 +                                                    +
E    84 +            N                                       +
Q    80 +                                                    +
U    76 +           N                                        +
E    72 +                                                    +
N    68 +                  NN                                +
C    64 +                                                    +
Y    60 +                                                    +
     56 +           .                                        +
O    52 +       ... ...  N                                   +
F    48 +      ..       .                                    +
     44 +     .          ..                                  +
R    40 +   ..             .                                 +
E    36 + .            N    .                                +
S    32 +.                N .                                +
P    28 +                     .                              +
O    24 +                     N..                            +
N    20 +                        .                           +
S    16 +                         ..                         +
E    12 +                           ..                       +
%     8 +                             ....                   +
      4 +                                 .......            +
      0 +                                        ...............+
        -+-----+-----+-----+-----+-----+-----+-----+-----+-
        -2    -1     0     1     2     3     4     5     6     7
```

EMPIRICAL CODE FREQUENCIES: polytomies
For a polytomous item, the percentage frequencies of responses, and the model ordinal probability, of each category are shown at each measure level. The dots are the model curve. "N" is the empirical frequency for category N = Neutral.

KID MEASURE	

14.39 Table 30 DIF Differential Item Functioning

14.39.1 Table 30.1 Differential item functioning DIF pairwise

Table 30 supports the investigation of item bias, Differential Item Functioning (DIF), i.e., interactions between individual items and types of persons.

Table
30.1 is best for pairwise comparisons, e.g., Females vs. Males.
30.2 DIF report (measure list: person class within item)
30.3 DIF report (measure list: item within person class)
30.4 DIF report (item-by-person class chi-squares)
30.5 Within-class fit report (person class within item)
30.6 Within-class fit report (item within person class)
30.7 Item measure profiles for classes of persons
Excel DIF Plots
Excel DIF Scatterplots

You need to choose a baseline item difficulty for your DIF comparisons.

In Table 30.1, we usually choose one group (the majority group) to be the baseline, and DIF is computed pairwise relative to that group. Both groups have statistical uncertainty.

In Table 30.2, we have many roughly equally-sized groups, such as age groups, and we take the average of all the groups (the item difficulty from the main analysis - this is the best estimate when the data fit the model) as the baseline. Then DIF is relative to this baseline which is regarded as a known value. Only the focus group has statistical uncertainty.

The rules for DIF reporting are the same for Tables 30.1 and 30.2, but the underlying computations are somewhat different.

In Table 30.1 - the hypothesis is "this item has the same difficulty for two groups"
In Table 30.2, 30.3 - the hypothesis is "this item has the same difficulty as its average difficulty for all groups"
In Table 30.4 - the hypothesis is "this item has no overall DIF across all groups"

Table 30.1 reports a probability and a size for DIF statistics. Usually we want:
1. probability so small that it is unlikely that the DIF effect is merely a random accident
2. size so large that the DIF effect has a substantive impact on scores/measures on the test

A general thought: Significance tests, such as DIF tests, are always of doubtful value in a Rasch context, because differences can be statistically significant, but far too small to have any impact on the meaning, or practical use, of the measures. So we need both statistical significance and substantive difference before we take action regarding bias, etc.

Table 30.1 is a pairwise DIF (bias) analysis: this is testing "item difficulty for Group A vs. item difficulty for Group B". Table 30.1 makes sense if there are only two groups, or there is one majority reference group.

Tables 30.2 and 30.3 are a global DIF (bias) analysis: this is testing "item difficulty for Group A vs. item difficulty for all groups combined." Tables 30.2 and 30.3 make sense when there are many small groups, e.g., age-groups in 5 year increments from 0 to 100.

DIF results are considerably influenced by sample size, so if you have only two person-groups, go to Table 30.1. If you have lots of person-groups go to Table 30.2

Specify DIF= for person classifying indicators in person labels. Item bias and DIF are the same thing. The widespread use of "item bias" dates to the 1960's, "DIF" to the 1980's. The reported DIF is corrected to test impact, i.e., differential average performance on the whole test. Use ability stratification to look for non-uniform DIF using the selection rules. Tables 30.1 and 30.2 present the same information from different perspectives.

From the Output Tables menu, the DIF/DPF dialog is displayed.

Table 31 supports person bias, Differential Person Functioning (DPF), i.e., interactions between individual persons and classifications of items.

Table 33 reports bias or interactions between classifications of items and classifications of persons.

In these analyses, persons with extreme scores are excluded, because they do not exhibit differential ability across items. For background discussion, see DIF and DPF considerations.

Example output:
You want to examine item bias (DIF) between Females and Males. You need a column in your Winsteps person label that has two (or more) demographic codes, say "F" for female and "M" for male (or "0" and "1" if you like dummy variables) in column 9.

Table 30.1 is best for pairwise comparisons, e.g., Females vs. Males.
DIF class specification is: DIF=@GENDER

```
-----------------------------------------------------------------------------------------------------------------------
| KID   Obs-Exp   DIF   DIF   KID   Obs-Exp   DIF   DIF      DIF    JOINT  Rasch-Welch    Mantel-Haenszel Size Active TAP          |
| CLASS Average MEASURE S.E.  CLASS Average MEASURE S.E.  CONTRAST  S.E.    t  d.f. Prob. Chi-squ Prob. CUMLOR Slices Number  Name |
|-----------------------------------------------------------------------------------------------------------------------|
| F         .00   -6.59E  .00  M         .00   -6.59E  .00       .00   .00   .00   0 1.000                               1 1-4   |
| F         .04   -5.24> 1.90  M       -.04   -3.87   .90     -1.37  2.10  -.65  28 .5194   .0000 1.000           7      4 1-3-4 |
| F         .01   -1.67   .68  M       -.01   -1.48   .70      -.19   .97  -.19  31 .8468   .1316 .7167   -.06    7     10 2-4-3-|
|-----------------------------------------------------------------------------------------------------------------------|
| M         .00   -6.59E  .00  F         .00   -6.59E  .00       .00   .00   .00  30 1.000                               1 1-4   |
-----------------------------------------------------------------------------------------------------------------------
Width of Mantel-Haenszel slice: MHSLICE = .010 logits
```

The most important numbers in Table 30.1: The DIF CONTRAST is the difference in difficulty of the item between the two groups. This should be at least 0.5 logits for DIF to be noticeable. "Prob." shows the probability of observing this amount of contrast by chance, when there is no systematic item bias effect. For statistically significance DIF on an item, Prob. ≤ .05.

DIF class specification defines the columns used to identify DIF classifications, using DIF= and the selection rules.
For summary statistics on each class, use Table 28.
To eliminate unwanted classes: PSELECT=@GENDER={FM}

Reading across the Table 30.1 columns:
PERSON CLASS identifies the CLASS of persons. PERSON is specified with PERSON=, e.g., the first here is CLASS is "A".

Obs-Exp Average is the average difference between the observed and expected responses for the Class on the Item. When this is positive, the Class has higher ability than expected or the item is easier than expected.

DIF estimates with the the iterative-logit (Rasch-Welch) method:

DIF MEASURE is the difficulty of this item for this class, with all else held constant, e.g., -.40 is the local difficulty for Class A of Item 1. The more difficult, the higher the DIF measure. The measures are conveniently listed in the Excel file for the DIF plots, or copy them from the Table into Excel.
For the raw scores corresponding to these measures, see Table 30.2
-.52> reports that this measure corresponds to an extreme maximum person-class score. EXTRSCORE= controls extreme score estimate.
1.97< reports that this measure corresponds to an extreme minimum person-class score. EXTRSCORE= controls extreme score estimate.
-6.91E reports that this measure corresponds to an item with an extreme score, which cannot exhibit DIF
DIF MEASURE is the same as doing a full analysis of the data, outputting PFILE=pf.txt and SFILE=sf.txt, then doing another analysis with PAFILE=pf.txt and SAFILE=sf.txt and PSELECT=@DIF=code

DIF S.E. is the standard error of the DIF MEASURE. A value of ".00" indicates that DIF cannot be observed in these data.

PERSON CLASS identifies the CLASS of persons, e.g., the second CLASS is "D".

DIF MEASURE is the difficulty of this item for this class, with all else held constant, e.g., -.52 is the local difficulty for Class D of Item 1. > means "extreme maximum score".

DIF S.E. is the standard error of the second DIF MEASURE

DIF CONTRAST is the "effect size" in logits (or USCALE= units), the difference between the two DIF MEASURE, i.e., size of the DIF across the two classifications of persons, e.g., -.40 - -.52 = .11 (usually in logits). A positive DIF contrast indicates that the item is more difficult for the first, left-hand-listed CLASS.
If you want a sample-based effect size, then
effect size = DIF CONTRAST / (person sample measure S.D.)

JOINT S.E. is the standard error of the DIF CONTRAST = sqrt(first DIF S.E.² + second DIF S.E.²), e.g., 2.50 = sqrt(.11² + 2.49²)
Welch t gives the DIF significance as a Welch's (Student's) t-statistic » DIF CONTRAST / JOINT S.E. The t-test is a two-sided test for the difference between two means (i.e., the estimates) based on the standard error of the means (i.e., the standard error of the estimates). The null hypothesis is that the two estimates are the same, except for measurement error.

d.f. is the joint degrees of freedom, computed according to Welch-Satterthwaite. When the d.f. are large, the t statistic can be interpreted as a unit-normal deviate, i.e., z-score.

INF means "the degrees of freedom are so large they can be treated as infinite", i.e., the reported t-value is a unit normal deviate.

Prob. is the two-sided probability of Student's *t*. See t-statistics.

MantelHanzel reports Mantel-Haenszel (1959) DIF test for dichotomies or Mantel (1963) for polytomies using MHSLICE=. Statistics are reported when computable.

Chi-squ. is the Mantel-Haenszel for dichotomies or Mantel for polytomies chi-square with 1 degree of freedom.

Prob. is the probability of observing these data (or worse) when there is no DIF based on a chi-square value with 1 d.f.

Size CUMLOR (cumulative log-odds ratio in logits) is an estimate of the DIF (scaled by USCALE=). When the size is not estimable, +. and -. indicate direction. For dichotomous items, this is the size of the DIF, where it is a simple log-odds-ratio. For polytomous items, no definitive polytomous DIF size statistic has been defined, but the cumulative log-odds ratio usually gives an approximate indication of the polytomous DIF size. CUMLOR is the Liu-Agresti Cumulative Log-Odds Estimator (1996).

Active Slices is a count of the estimable stratified cross-tabulations used to compute MH. MH is sensitive to score frequencies. If you have missing data, or only small or zero counts for some raw scores, the MH statistic can go wild or not be estimable. Please try different values of MHSLICE= (thin and thick slicing) to see how robust the MH estimates are.

ITEM Number is the item entry number. ITEM is specified by ITEM=
Name is the item label.

Below "----", each line in the Table is repeated with the CLASSes reversed.

ETS DIF Category	**with DIF Contrast and DIF Statistical Significance**	
C = moderate to large	**|DIF| ≥ 0.64 logits**	**prob(|DIF| ≤ 0.43 logits) ≤ .05 (2-sided)** *approximately: |DIF| > 0.43 logits + 2 * DIF S.E.*
B = slight to moderate	**|DIF| ≥ 0.43 logits**	**prob(|DIF| = 0 logits) ≤ .05 (2-sided)** *approximately: |DIF| > 2 * DIF S.E*
A = negligible	-	-
C-, B- = DIF against focal group; C+, B+ = DIF against reference group		
ETS (Educational Testing Service) use Delta δ units. 1 logit = 2.35 Delta δ units. 1 Delta δ unit = 0.426 logits.		
Zwick, R., Thayer, D.T., Lewis, C. (1999) An Empirical Bayes Approach to Mantel-Haenszel DIF Analysis. . Journal of Educational Measurement, 36, 1, 1-28 More explanation at www.ets.org/Media/Research/pdf/RR-12-08.pdf pp. 3,4		

For meta-analysis, the DIF Effect Size = DIF Contrast / S.D. of the "control" CLASS (or the pooled CLASSes). The S.D. for each CLASS is shown in Table 28.

Example: The estimated item difficulty for Females, the DIF MEASURE, is 2.85 logits, and for males the DIF MEASURE is 1.24 logits. So the DIF CONTRAST, the apparent bias of the item against Females, is 1.61 logits. An alternative interpretation is that the Females are 1.61 logits less able on the item than the males.

```
                           Males           Females
Item 13: +---------+---------+-+-------+-------+-+>> difficulty increases
         -1        0         1.24     +2      2.85   DIF measure
                              +---------------> = 1.61 DIF contrast
```

DIF with CMLE Estimates

If you want to use the CMLE item and threshold estimates for DIF analysis, then
1. Do a standard Winsteps analysis with CMLE=YES

2. Winsteps output file menu:
near bottom: IFILE= field selection:
Clear all
Select Entry number and CMLE measure (4th column)
OK

3. Output file menu: output IFILE= to cmleif.txt (text file: permanent)

4. Output file menu: output SFILE= to cmlesf.txt (text file: permanent)

5. Edit cmlesf.txt - remove first measure and ;
 3 -.86 ; -.80
becomes
 3 -.80
save the file.

6. In the Winsteps control file:
IAFILE= cmleif.txt
SAFILE= cmlesf.txt

7. run the Winsteps analysis: item measures and thresholds are anchored at their CMLE values

8. do the DIF analysis: Table 30

14.39.2 Table 30.2, 30.3 Differential item functioning DIF list

Table 30 supports the investigation of item bias, Differential Item Functioning (DIF), i.e., interactions between individual items and types of persons. Specify DIF= for person classifying indicators in person labels. Item bias and DIF are the same thing. The item measures by person class are plotted in the DIF Plot.

In Table 30.1 - the hypothesis is "this item has the same difficulty for two groups"
In Table 30.2, 30.3 - the hypothesis is "this item has the same difficulty as its average difficulty for all groups" - this is the best estimate when the data fit the model
In Table 30.4 - the hypothesis is "this item has no overall DIF across all groups"

Example output:
You want to examine item bias (DIF) between Females and Males in Exam1.txt. You need a column in your Winsteps person label that has two (or more) demographic codes, say "F" for female and "M" for male (or "0" and "1" if you like dummy variables) in column 9.

Table 30.1 is best for pairwise comparisons, e.g., Females vs. Males. Use Table 30.1 if you have two classes.

Table 30.2 or Table 30.3 are best for multiple comparisons, e.g., regions against the national average. Table 30.2 sorts by item then person class then item. Table 30.3 sorts by person class then item.

```
------------------------------------------------------------------------------
    -------------
| KID         OBSERVATIONS        BASELINE       DIF      DIF      DIF   DIF   DIF
    TAP          |
```

```
| CLASS     COUNT  SCORE AVERAGE EXPECT MEASURE   SCORE MEASURE   SIZE  S.E.   t    d.f. Prob.
    Number   Name |
|-----------------------------------------------------------------------------------------------
    ------------|
| F           18      18   1.00   1.00   -6.59     .00   -6.59    .00   .00   .00      1 1.000
        1 1-4   |
| M           17      17   1.00   1.00   -6.59     .00   -6.59    .00   .00   .00      1 1.000
        1 1-4   |
| F           18      16    .89    .92   -4.40    -.03   -3.93    .48   .89   .54     16 .5998
        4 1-3-4 |
| M           17      16    .94    .91   -4.40     .03   -5.15>  -.75  1.91  -.39    14 .7020
        4 1-3-4 |
| F           18      15    .83    .88   -3.83    -.05   -3.22    .61   .79   .77     16 .4504
        5 2-1-4 |
| M           17      16    .94    .89   -3.83     .05   -5.14> -1.30  1.90  -.69    14 .5036
        5 2-1-4 |
------------------------------------------------------------------------------------------------
    -------------
```

This displays a list of the local difficulty/ability estimates underlying the paired DIF analysis. These can be plotted directly from the Plots menu.

DIF class specification identifies the columns containing DIF classifications, with DIF= set to @GENDER using the selection rules.

The DIF effects are shown ordered by CLASS within item (column of the data matrix).

KID CLASS identifies the CLASS of persons. KID is specified with PERSON=, e.g., the first CLASS is "F"
OBSERVATIONS are what are seen in the data
COUNT is the number of observations of the classification used for DIF estimation, e.g., 18 non-extreme F persons responded to TAP item 1.
AVERAGE is the average observation on the classification, e.g., 0.89 is the p-value, proportion-correct-value, of item 4 for F persons.
COUNT * AVERAGE = total score of person class on the item
BASELINE is the prediction without DIF
EXPECT is the expected value of the average observation when there is no DIF, e.g., 0.92 is the expected proportion-correct-value for F without DIF.
MEASURE is the what the overall measure would be without DIF, e.g., -4.40 is the overall item difficulty of item 4 as reported in Table 14.
DIF: Differential Item Functioning
DIF SCORE is the difference between the observed and the expected average observations, e.g., 0.92 - 0.89= -0.03
DIF MEASURE is the item difficulty for this class, e.g., item 4 has a local difficulty of -3.93 for CLASS F.
The average of DIF measures across CLASS for an item is not the BASELINE MEASURE because score-to-measure conversion is non-linear. ">" (maximum score), "<" (minimum score) indicate measures corresponding to extreme scores for this CLASS. "E" indicates an extreme score on all items.
DIF SIZE is the difference between the DIF MEASURE for this class and the BASELINE DIFFICULTY, i.e., -3.93 - -4.40 = .48. Item 4 is .48 logits more difficult for class F than expected.
DIF S.E. is the approximate standard error of the difference, e.g., 0.89 logits
DIF t is an approximate Student's t-statistic test, estimated as DIF SIZE divided by the DIF S.E.
d.f. t has approximately (COUNT-2) degrees of freedom excluding observations of extreme persons.
Prob. is the two-sided probability of Student's *t*. See t-statistics.

These numbers are plotted in the DIF plot. Here item 4 is shown. The y-axis is the "DIF Measure".

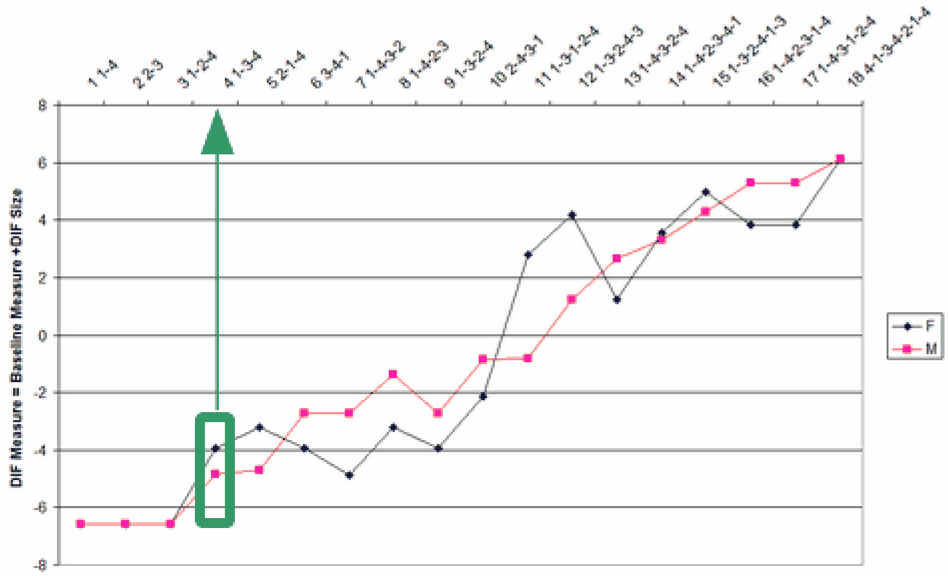


Table 31.1 Differential person functioning DPF pairwise

Example 1: Where do I extract appropriate difficulties for my classes for both items that exhibit DIF and those that don't?

The DIF-sensitive difficulties are shown as "DIF Measure" in Table 30.1. They are more conveniently listed in Table 30.2. The "DIF Size" in Table 30.2 or Table 30.3 shows the size of the DIF relative to the overall measure in the IFILE=.

To apply the DIF measures as item difficulties, you would need to produce a list of item difficulties for each group, then analyze that group (e.g., with PSELECT=) using the specified list of item difficulties as an anchor file (IAFILE=).

My approach would be to copy Table 30.3 into an Excel spreadsheet, then use "Data", "Text to Columns" to put each Table column into a separate Excel column. The anchor file would have the item number in the first column, and either the overall "baseline measure" or the group "DIF measure" in the second column. Then copy and paste these two columns into a .txt anchor file.

Example 2: What is the impact of DIF on person measures?
Please look at Winsteps Table 30.2 or 30.3. The average effect of the DIF on person measures of the person group is (DIF Size for the item for the person group)/(total number of items). DIF has raised the person measures if the observed average of the scored responses is greater than expected, and *vice-versa.*

14.39.3 Table 30.4 Differential item functioning DIF fit summary

In Table 30.1 - the hypothesis is "this item has the same difficulty for two groups"
In Table 30.2, 30.3 - the hypothesis is "this item has the same difficulty as its average difficulty for all groups" - this is the best estimate when the data fit the model
In Table 30.4 - the hypothesis is "this item has no overall DIF across all groups"

Table 30.4 summarizes the CLASS/GROUP Differential Item Functioning statistics for each item shown in Table 30.2. Table 30.2 shows a t-statistic for each CLASS/GROUP. These are summarized as chi-square statistics for each item, indicating whether the observed DIF within each item is due to chance alone. The null hypothesis is that the DIF is statistically zero across the classes. Please do not use anchoring (IAFILE=, PAFILE=, SAFILE=) when investigating this Table.

```
DIF class/group specification is: DIF=@GENDER
---------------------------------------------------------------------------------
| KID        SUMMARY DIF                BETWEEN-CLASS       TAP                 |
| CLASSES    CHI-SQUARE   D.F.  PROB.  UNWTD MNSQ  t=ZSTD  Number Name          |
|-------------------------------------------------------------------------------|
|       2          .8772      1  .3490        .9200   .4132       6 3-4-1       |
|       2         2.2427      1  .1342       2.5792  1.2592       7 1-4-3-2     |
|       2         1.9207      1  .1658       1.9963  1.0211      13 1-4-3-2-4   |
---------------------------------------------------------------------------------
```

KID CLASSES/GROUPS is the count of person CLASSES or GROUPS for the item: 2 = Male and Female.

SUMMARY DIF CHI-SQUARE is the sum of the *t*-statistic values from Table 30.2, squared and normalized. See Example 1 below.
D.F. is the degrees of freedom, the count of CLASSES or GROUPS contributing to the chi-square less 1.
PROB. is the probability of the chi-square. Values less than .05 indicate statistical significance.

BETWEEN-CLASS are Between-Group Fit Statistics, testing the hypothesis: "The dispersion of the group measures accords with Rasch model expectations."
UNWTD MNSQ is the unweighted mean-square (chi-square divided by its degrees of freedom). It is the size of the misfit (expectation = 1.0, overfit <1.0, underfit >1.0).
t=ZSTD is the significance of the MEAN-SQUARE standardized as a unit-normal deviate (*t*-statistic with infinite degrees of freedom).

TAP is the item. Number is the item entry number. Name is the item label.

Item-Trait Interaction Chi-Square - RUMM2020 Item-Trait Chi-Square and Winsteps DIF Size
The SUMMARY DIF CHI-SQUARE values in Table 30.4 are equivalent to the item-trait chi-square statistics reported by RUMM with DIF=MA3 (or however many strata are chosen in RUMM). In RUMM, the trait CLASSes are obtained by ordering the persons by measure, omitting extreme scores, and dividing the ordered list as equally as possible into equal size classes, including all persons with the same measure in the same class.

The Root Mean Square Error of Approximation (RMSEA)
RMSEA is a transformation of the Item-Trait Chi-Square and so of the SUMMARY DIF CHI-SQUARE with DIF=MA3. Its computation is
RMSEA = $\sqrt{}$ max([((χ^2/df) - 1)/(N - 1)] , 0)
where
χ^2 = SUMMARY DIF CHI-SQUARE
d.f. = D.F.
N is the person sample size

Example 1. SUMMARY DIF CHI-SQUARE.
Let's do an analysis of Exam1.txt with Udecimals=4. Output Table 30 with DIF=@Gender
In Table 30.2, the values for item 13:
CLASS F: COUNT= 18, DIF SIZE= -.7268, DIF S.E.= .6764
CLASS M: COUNT= 16, DIF SIZE= -.7075, DIF S.E.= .7497
So the t-statistics are approximately:
CLASS F: t = -.7268/.6764 with (18-1) d.f. -> -1.0745 with 17 d.f.
CLASS M: t = -.7075/.7497 with (16-1) d.f. -> .9437 with 15 d.f.
Squared and normalized. The normalizing transformation is Peizer and Pratt (1968) in the *Handbook of the Normal Distribution, Second Edition* (Patel and Read), p. 214.
CLASS F: t**2 = 1.1546 -> normalized(t**2) = 1.0843
CLASS M: t**2 = .8905 -> normalized(t**2) = .8363
Chi-square = 1.0843 + .8363 = 1.9207 with (2-1) = 1 d.f.

Andersen's Likelihood-Ratio Test (LRT, 1973) is a chi-squared test that the item difficulties are statistically the same for different subgroups of persons, so this a generalized DIF (Differential Item Functioning) test. A typical grouping is by raw score, for instance a high-low spit of the person sample. If the sample is large enough, each raw score could be a person subgroup. Winsteps does not compute LRT, but an equivalent chi-squared computation is in Winsteps 30.4. LRT lumps all items together, but Table 30.4 reports each item separately. So LRT is equivalent to summing the CHI-SQUARE and D.F. columns in 30.4 and looking up that chi-squared probability. If you wish to do a high-low score split, then DIF=MA2. .

If you wish to compute LRT, then the easiest way is to use Winsteps Output Files IPMATRIX= (omit extreme scores, omit person identifiers) to output the dichotomous scored responses to R Statistics. And then analyze the data with R package eRm and output LRtest. For instance:

```
> install.packages("eRm")
> library(eRm)
> res <- RM(data)
```

> LRtest(res, splitcr = "median", se = TRUE)

14.39.4 Table 30.5, 30.6 Within-class fit report

Table 30.5 Within-class fit report (person class within item).

DIF class specification is: DIF=@GENDER

KID CLASS	OBSERVATIONS COUNT	AVERAGE	BASELINE EXPECT	MEASURE	DIF SIZE	DIF S.E.	W-INFIT MNSQ	ZSTD	W-OUTFIT MNSQ	ZSTD	TAP Number	Name
....												
F	18	.89	.85	-3.38	-.55	.90	.46	-1.22	.19	-.42	9	1-3-2-4
M	16	.88	.92	-3.38	.67	.91	.88	-.02	.23	-.35	9	1-3-2-4
F	18	.72	.65	-1.57	-.58	.68	.80	-.55	.76	.04	10	2-4-3-1
M	16	.69	.77	-1.57	.72	.69	1.47	1.02	.91	.35	10	2-4-3-1

Table 30.6 Within-class fit report (item within person class)

DIF class specification is: DIF=@GENDER

KID CLASS	OBSERVATIONS COUNT	AVERAGE	BASELINE EXPECT	MEASURE	DIF SIZE	DIF S.E.	W-INFIT MNSQ	ZSTD	W-OUTFIT MNSQ	ZSTD	TAP Number	Name
....												
F	18	.89	.85	-3.38	-.55	.90	.46	-1.22	.19	-.42	9	1-3-2-4
F	18	.72	.65	-1.57	-.58	.68	.80	-.55	.76	.04	10	2-4-3-1
....												
M	16	.88	.92	-3.38	.67	.91	.88	-.02	.23	-.35	9	1-3-2-4
M	16	.69	.77	-1.57	.72	.69	1.47	1.02	.91	.35	10	2-4-3-1

For a general description, see Table 30.2

The DIF effects are shown ordered by CLASS within item (column of the data matrix).

KID CLASS identifies the CLASS of persons. KID is specified with PERSON=, e.g., the first CLASS is "F"
OBSERVATIONS are what are seen in the data
COUNT is the number of observations of the classification used for DIF estimation, e.g., 18 F persons responded to TAP item 1.
AVERAGE is the average observation on the classification, e.g., 0.89 is the proportion-correct-value of item 4 for F persons. COUNT * AVERAGE = total score of person class on the item
BASELINE is the prediction without DIF
EXPECT is the expected value of the average observation when there is no DIF, e.g., 0.92 is the expected proportion-correct-value for F without DIF.
MEASURE is the what the overall measure would be without DIF, e.g., -4.40 is the overall item difficulty of item 4 as reported in Table 14.

DIF SIZE is the size of the DIF
DIF S.E. is the S.E. of the DIF size

W-INFIT is the Within-Group infit statistic for the person CLASS on the item.
W-OUTFIT is the Within-Group outfit statistic for the person CLASS on the item.
MNSQ is the mean-square statistic (chi-square divided by its degrees of freedom).
ZSTD is the mean-square statistic expressed as a z-score (unit normal deviate).

14.39.5 Table 30.7 Item measure profiles for classes of persons

Table 30.7 shows the item difficulty and summary scores for each person classification selected by DIF=

```
TABLE 30.7 LIKING FOR SCIENCE (Wright & Masters  ZOU211WS.TXT  Apr 30 2017 13: 3
INPUT: 75 KID  25 ACT  REPORTED: 75 KID  25 ACT  3 CATS        WINSTEPS 3.93.0
--------------------------------------------------------------------------------

DIF class specification is: DIF=@GENDER
```

* ALL KID ON ACT COUNT	T.SCORE	MEASURE	S.E.	F KID CLASS COUNT	T.SCORE	MEASURE	S.E.	M KID CLASS COUNT	T.SCORE	MEASURE	S.E.	ACT ENTRY	LABEL

```
|     75      109     -.40    .21 |     18       29     -.48    .49 |     57       80     -.40    .23 |         1 Watch birds                    |
|     75      116     -.71    .23 |     18       29     -.48    .49 |     57       87     -.76    .24 |         2 Read books on animals          |
```

same with BOXSHOW=No, useful for pasting into Excel:

```
 * ALL KID ON ACT              F KID CLASS                  M KID CLASS                  ACT
  COUNT T.SCORE MEASURE  S.E.   COUNT T.SCORE MEASURE  S.E.   COUNT T.SCORE MEASURE  S.E.   ENTRY LABEL

     75      109     -.40    .21      18       29     -.48    .49      57       80     -.40    .23         1 Watch birds
     75      116     -.71    .23      18       29     -.48    .49      57       87     -.76    .24         2 Read books on animals
```

Column	Meaning
COUNT	Count of non-missing responses to this item by this person classification group.
T.SCORE	Total score on this item by this person classification group.
MEASURE	Item difficulty for this person group = overall item difficulty + item DIF for the person group
S.E.	S.E. of the MEASURE

14.40 Table 31 DPF Differential Person Functioning

14.40.1 Table 31.1 Differential person functioning DPF pairwise

Table 31 supports person bias, Differential Person Functioning (DPF), i.e., interactions between individual persons and classifications of items. This is useful for estimating sub-test, domain and strand measures for individuals in the context of an overall measure.

Tables:
- 31.2 DPF report (measure list: item class within person)
- 31.3 DPF report (measure list: person within item class)
- 31.4 DPF report (person by item-class chi-squares)
- 31.5 Within-class fit report (item class within person)
- 31.6 Within-class fit report person class within item)
- 31.7 Person measure profiles for classes of items
- DPF plots
- DPF Scatterplots

Table 31.1 reports a probability and a size for DPF statistics. Usually we want:
1. probability so small that it is unlikely that the DPF effect is merely a random accident
2. size so large that the DPF effect has a substantive impact on scores/measures on the test

Specify DPF= for classifying indicators in item labels. Use difficulty stratification to look for non-uniform DPF using the selection rules.

From the Output Tables menu, the DPF dialog is displayed.

Table 30 supports the investigation of item bias, Differential Item Functioning (DIF), i.e., interactions between individual items and types of persons.

Table 33 reports bias or interactions between classifications of items and classifications of persons.

In these analyses, persons and items with extreme scores are excluded, because they do not exhibit differential ability across items. For background discussion, see DIF and DPF concepts.

Example output:

Table 31.1

```
DPF class specification is: DPF=$S1W1
----------------------------------------------------------------------------------------------------------
| TAP   Obs-Exp   DPF   DPF   TAP   Obs-Exp   DPF   DPF      DPF    JOINT  Rasch-Welch      KID           |
| CLASS Average MEASURE S.E.  CLASS Average MEASURE S.E.  CONTRAST S.E.   t  d.f. Prob. Number  Name      |
|---------------------------------------------------------------------------------------------------------|
| 1        -.05  -3.52  1.05  2          .04  -2.80  1.65      -.73  1.95  -.37   2 .7459      1 Adam    M1|
| 1        -.05  -3.52  1.05  3          .39  -2.78> 2.07      -.74  2.32  -.32   0 .0000      1 Adam    M1|
| 1        -.05  -3.52  1.05  4          .00  -2.94E  .00      -.58   .00   .00   0 1.000      1 Adam    M1|
```

DPF Specification defines the columns used to identify Differential Person Function classifications, using the selection rules.

TAP CLASS is the item class
Obs-Exp Average is the average difference between the observed and expected responses for the Class by the person. When this is positive, the Class is easier than expected or the person has higher ability than expected.
DPF MEASURE is the ability of the person for this item class, with all else held constant. This is output in the Excel file for the DPF plots.
DPF MEASURE is the same as doing a full analysis of the data, outputting IFILE=if.txt and SFILE=sf.txt, then doing another analysis with IAFILE=if.txt and SAFILE=sf.txt and ISELECT=@DPF=code. ">" and "<" indicate that the scores for the group are extreme.
DPF S.E. is the standard error of the measure
DPF CONTRAST is the difference in the person ability measures, i.e., size of the DPF, for the two classifications of items.
JOINT S.E. is the standard error of the DPF CONTRAST

DPF estimates with the the iterative-logit (Rasch-Welch) method:
t gives the DPF significance as a Student's t-statistic test. The t-test is a two-sided test for the difference between two means (i.e., the estimates) based on the standard error of the means (i.e., the standard error of the estimates). The null hypothesis is that the two estimates are the same, except for measurement error.
d.f. is the joint degrees of freedom by the Welch method.
Prob. is the two-sided probability of Student's *t*. See t-statistics.

-5.24> reports that this measure corresponds to an extreme maximum score. EXTRSCORE= controls extreme score estimate.
5.30< reports that this measure corresponds to an extreme minimum score. EXTRSCORE= controls extreme score estimate.

14.40.2 Table 31.2, 31.3 Differential person functioning DPF list

Table 31.2 sorts by class then item. Table 31.3 sorts by item then class. The person measures by item class are plotted in the DPF Plot.

Table 31 supports the investigation of item bias, Differential Person Functioning (DPF), i.e., interactions between individual persons types of items. Specify DPF= for item classifying indicators in item labels. Person bias and DPF are the same thing.

Example output:
You want to examine person bias (DPF) between starting-blocks in Exam1.txt. You need a column in your Winsteps item label that has two (or more) item type codes.

Table 31.1 is best for pairwise comparisons, e.g., Positive vs. Negative items. Use Table 31.1 if you have two classes.

Table 31.2 or Table 31.3 are best for multiple comparisons, e.g., regions against the national average.

Table 31.2 sorts by person then item class.

```
-----------------------------------------------------------------------------------------------
    ----------------
| TAP          OBSERVATIONS         BASELINE        DPF      DPF      DPF    DPF    DPF
    KID               |
| CLASS     COUNT   SCORE AVERAGE EXPECT MEASURE    SCORE MEASURE    SIZE  S.E.    t     d.f. Prob.
    Number  Name      |
```

```
|-----------------------------------------------------------------------------------------------
    ---------------|
| 1          13        4     .31     .35    -2.94     -.04    -3.54    -.60  1.05   -.57      9 .5857
        1 Adam     M|
| 2           3        2     .67     .64    -2.94      .03    -2.70     .24  1.65    .15      1 .9083
        1 Adam     M|
| 3           1        1    1.00     .61    -2.94      .39    -2.53>    .41  2.18    .19      1 .8819
        1 Adam     M|
| 4           1        0     .00     .00    -2.94      .00    -2.94     .00   .00    .00      1 1.000
        1 Adam     M|
| 1          13        6     .46     .48     -.26     -.02     -.77    -.51  1.35   -.38      9 .7161
        2 Anne     F|
```

Table 31.3 sorts by item class then person.

```
------------------------------------------------------------------------------------------------
    ----------------
| TAP          OBSERVATIONS         BASELINE       DPF      DPF      DPF    DPF    DPF
    KID                 |
| CLASS     COUNT  SCORE AVERAGE EXPECT MEASURE   SCORE MEASURE   SIZE  S.E.    t     d.f. Prob.
    Number  Name      |
|-----------------------------------------------------------------------------------------------
    ---------------|
| 1          13        4     .31     .35    -2.94     -.04    -3.54    -.60  1.05   -.57      9 .5857
        1 Adam     M|
| 1          13        6     .46     .48     -.26     -.02     -.77    -.51  1.35   -.38      9 .7161
        2 Anne     F|
| 1          13        7     .54     .55      .92     -.01      .81    -.11  1.13   -.10      9 .9261
        3 Audrey   F|
| 1          13        4     .31     .30    -3.61      .01    -3.54     .07  1.05    .07      9 .9483
        4 Barbara  F|
```

This displays a list of the local difficulty/ability estimates underlying the paired DPF analysis. These can be plotted directly from the Plots menu.

DPF class specification identifies the columns containing DPF classifications, with DPF= set to $S1W2 using the selection rules.

The DPF effects are shown ordered by CLASS within person (row of the data matrix).

TAP CLASS identifies the CLASS of items. KID is specified with ITEM=, e.g., the first CLASS is "1-"
OBSERVATIONS are what are seen in the data
COUNT is the number of observations of the classification used for DPF estimation, e.g., 11 responses were made by person 1 to non-extreme items in item class "1-".
AVERAGE is the average observation on the classification, e.g., 0.18 is the average score class "1-" items by person 1.
COUNT * AVERAGE = total score of person on the item class.
BASELINE is the prediction without DPF
EXPECT is the expected value of the average observation when there is no DPF, e.g., 0.92 is the expected average for person 1 on item class "1-" without DPF.
MEASURE is the what the overall ABILITY measure would be without DPF, e.g., -2.94 is the overall person ability of person 1 as reported in Table 18.
DPF: Differential Person Functioning
DPF SCORE is the difference between the observed and the expected average observations, e.g., 0.92 - 0.89= -0.03
DPF MEASURE is the person ability for this item class, e.g., person 1 has a local ability of -3.52 for item CLASS "1-".
The average of DPF measures across CLASS for an item is not the BASELINE MEASURE because score-to-measure conversion is non-linear. ">" (maximum score), "<" (minimum score), "E" (extreme score) indicate measures corresponding to extreme scores.
DPF SIZE is the difference between the DPF MEASURE for this class and the BASELINE measure ability, i.e., -3.93 - -4.40 = .48. Item 4 is .48 logits more difficult for class F than expected.
DPF S.E. is the approximate standard error of the difference, e.g., 0.89 logits
DIF t is an approximate Student's t-statistic test, estimated as DIF SIZE divided by the DIF S.E.
d.f. t has approximately (COUNT-2) degrees of freedom excluding observations of extreme items.

Prob. is the two-sided probability of Student's t. See t-statistics.

Person performance profiles by subtest

1. Put a subtest code in each item label
   @subtest=1W1 ; position of subtest code in item label
2. Run Table 31 Differential Person Functioning for @subtest.
3. Output the DPF Excel Plots
4. The Excel Worksheet lists each person with subtest measures

14.40.3 Table 31.4 Differential person functioning DPF fit summary

Table 31.4 summarizes the CLASS Differential Person Functioning statistics for each person shown in Table 31.2. Table 31.2 shows a t-statistic for each CLASS. These are summarized as chi-square statistics for each person, indicating whether the observed DPF within each person is due to chance alone. The null hypothesis is that the DPF is statistically zero across the classes. Please do not use anchoring (IAFILE=, PAFILE=, SAFILE=) when investigating this Table.

```
DPF class/group specification is: DPF=$S1W1
-----------------------------------------------------------------------------
| TAP        SUMMARY DPF              BETWEEN-CLASS       KID               |
| CLASSES    CHI-SQUARE   D.F.  PROB.  MEAN-SQUARE t=ZSTD  Number Name       |
|---------------------------------------------------------------------------|
|       2         .2914      1  .5893       .2291  -.3520        1 Adam    M |
```

TAP CLASSES/GROUPS is the count of item CLASSES or GROUPS for the person.
SUMMARY DIF CHI-SQUARE is the sum of the squared normalized t-statistic values from Table 31.2.
D.F. is the degrees of freedom, the count of CLASSES or GROUPS contributing to the chi-square less 1.
PROB. is the probability of the chi-square. Values less than .05 indicate statistical significance.

BETWEEN-CLASS/GROUP are Between-Group Fit Statistics, testing the hypothesis: "The dispersion of the group measures accords with Rasch model expectations."
MEAN-SQUARE is chi-square divided by its degrees of freedom. It is the size of the misfit (expectation = 1.0, overfit <1.0, underfit >1.0).
t=ZSTD is the significance of the MEAN-SQUARE standardized as a unit-normal deviate (t-statistic with infinite degrees of freedom).

KID is the person. Number is the person entry number. Name is the person label.

14.40.4 Table 31.5, 31.6 Within-class fit report

Table 31.5 Within-class fit report (item class within person).
Table 31.6 Within-class fit report (person class within item)

```
DIF class specification is: DIF=@GENDER
-----------------------------------------------------------------------------------------------------
| TAP         OBSERVATIONS    BASELINE          DPF       DPF       W-INFIT     W-OUTFIT  KID           |
| CLASS      COUNT AVERAGE EXPECT MEASURE       SIZE      S.E.    MNSQ  ZSTD  MNSQ  ZSTD Number  Name    |
|---------------------------------------------------------------------------------------------------|
| 1             11     .18     .23   -2.94      -.60      1.05     .71  -.53   .25  -.31       1 Adam    M|
```

For a general description, see Table 31.2

The DPF effects are shown ordered by CLASS within person (row of the data matrix).

TAP CLASS identifies the CLASS of items. KID is specified with ITEM=, e.g., the first CLASS is "1-"
OBSERVATIONS are what are seen in the data
COUNT is the number of observations of the classification used for DPF estimation, e.g., 11 "1-" items responses were made by person 1.
AVERAGE is the average observation on the classification, e.g., 0.18 is the average score class "1-' items by person 1.
COUNT * AVERAGE = total score of person on the item class.
BASELINE is the prediction without DPF

EXPECT is the expected value of the average observation when there is no DPF, e.g., 0.92 is the expected average for person 1 on item class "1-" without DPF.
MEASURE is the what the overall ABILITY measure would be without DPF, e.g., -2.94 is the overall person ability of person 1 as reported in Table 18.

DPF SIZE is the size of the DPF
DPF S.E. is the S.E. of the DPF size

W-INFIT is the Within-Group infit statistic for the item CLASS on the person.
W-OUTFIT is the Within-Group outfit statistic for the item CLASS on the person.
MNSQ is the mean-square statistic (chi-square divided by its degrees of freedom).
ZSTD is the mean-square statistic expressed as a z-score (unit normal deviate).

14.40.5 Table 31.7 Person measure profiles for classes of items

.Table 31.7 shows the person ability and summary scores for each item classification selected by DPF=

```
TABLE 31.7 An MCQ Test: administration was Compu ZOU749WS.TXT  Apr 30 2017 13:11
INPUT: 30 STUDENT  69 TOPIC  REPORTED: 30 STUDENT  48 TOPIC  2 CATS WINSTEPS 3.93.0
------------------------------------------------------------------------------------

DPF class specification is: DPF=1
-------------------------------------------------------------------------------------------------------------
| * ALL TOPIC ON STUDENT       | i TOPIC CLASS                | n TOPIC CLASS                | STUDENT       |
| COUNT T.SCORE MEASURE  S.E.  | COUNT T.SCORE MEASURE  S.E.  | COUNT T.SCORE MEASURE  S.E.  | ENTRY LABEL   |
|------------------------------+------------------------------+------------------------------+---------------|
|    21       9   -1.92   .00  |     5       0   -3.39  1.64  |    16       9   -1.50   .59  |     2 NM  KAT |
|     9       2   -3.09   .00  |     3       1   -2.18  1.40  |     6       1   -3.63  1.19  |     5 NL  SMI |
```

same with BOXSHOW=No, useful for pasting into Excel:

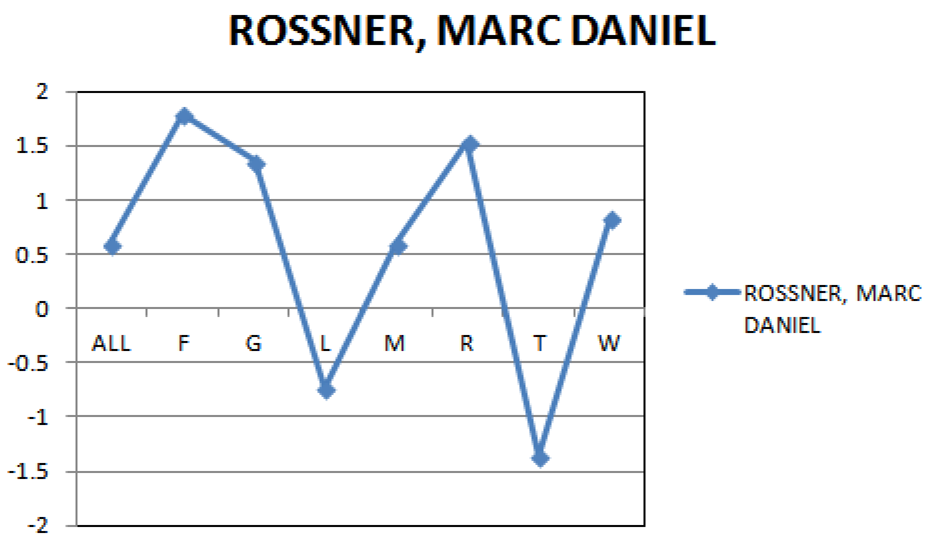
```
  * ALL TOPIC ON STUDENT         i TOPIC CLASS                  n TOPIC CLASS                  STUDENT
  COUNT T.SCORE MEASURE  S.E.    COUNT T.SCORE MEASURE  S.E.    COUNT T.SCORE MEASURE  S.E.    ENTRY LABEL

     21       9   -1.92   .00       5       0   -3.39  1.64       16       9   -1.50   .59        2 NM  KAT
      9       2   -3.09   .00       3       1   -2.18  1.40        6       1   -3.63  1.19        5 NL  SMI
```

For the MEASUREs, ">" (maximum score), "<" (minimum score), "E" (extreme score) indicate measures corresponding to extreme scores.

Excel procedure:
1. Output Table 31.7
2. Paste into a new Excel worksheet
3. In Excel, "Data", "Text to Columns", "Fixed width"
4. "Insert", "Line Chart with Markers"
5. "Select Data", the Excel spreadsheet row. "Category labels", the top row of the Excel spreadsheet.
6. X-axis, text labels.

Here is the plot for Example0.txt across items with different first letters:



This can be automated with an Excel macro:

```
Sub Profile()
   firstsubtest = "A"  ' in Excel spreadsheet, delete unwanted columns. First subtest column
   lastsubtest = "H"  ' total score + 7 subtests
   firstperson = 2 ' first person in row 2 of the worksheet
   lastperson = 5 ' last person in row 76 of the spreadsheet
   personname = "I" ' person name in co.umn 9 = I
   For thisperson = lastperson To firstperson Step -1
     thispersonrow  = Trim(thisperson)
     Set objchart = Charts.Add
     objchart.ChartType = xlLineMarkers
     objchart.SeriesCollection.New Series
     objchart.SeriesCollection(1).Values = "='Sheet1'!$" + firstsubtest + "$" + thispersonrow  + ":$" + lastsubtest + "$" + thispersonrow
     objchart.SeriesCollection(1).Name = "='Sheet1'!$" + personname + "$" + thispersonrow
     objchart.SeriesCollection(1).XValues = "='Sheet1'!$" + firstsubtest + "$1:$" + lastsubtest + "$1"
   Next thisperson

   ' and to print the charts
   For Each ch In ActiveWorkbook.Charts
       ch.PrintOut
   Next ch

End Sub
```

14.41 Table 32 Control specifications

This gives the current setting of every Winsteps control variable. This is the default setting for unchanged variables. This can be accessed as Table 32 from a control file, or from the Output Files pull-down menu "Control variable list=". It is written to a temporary text file, but can be "saved as" to a permanent file.

```
; Values of Control Specifications
; CONTROL FILE = C:\data\kct.txt - WINSTEPS 3.90.0
; OUTPUT REPORT FILE = C:\data\ZOU713ws.txt
; DATE AND TIME = Feb 11 23:29 2004
ALPHANUM =
ASCII = Y
BATCH = N
CATREF = 0
CFILE =
CHART = N
CLFILE =
CODES = 01
CONVERGE = E
....
```

14.42 Table 33 DGF Differential Group Functioning

14.42.1 Table 33.1, 33.2 Differential group functioning DGF pairwise

This Table identifies Differential Group Functioning DGF interactions between classification-groups of persons (identified by DIF=, referencing the person labels) and classification-groups of items (identified by DPF=, referencing the item labels) using the column selection rules. Differential average classification-group performance (DGF) is powerful when looking for latent classes among the persons. Differential bundle functioning (DBF) is powerful when looking for local dependence among the items. For more details, see Table 30 (DIF) and Table 31 (DPF). A graphing technique can be used to display DIF item characteristic curves for non-uniform DIF. DGf can be used for investigating Differential Skills Functioning (DSF).

Table
- 33.1 DGF report (paired person classes on each item class)
- 33.2 DGF report (paired item classes on each person class)
- 33.3 DGF report (list of person classes within item class)
- 33.4 DGF report (list of item classes within person class)
- 33.7 DGF Item group-Person group profiles
- 33.8 DGF Item group-Person group profiles

We put a code in the person label of every person indicating whether the person belongs to the Control Group, "C", or the Treatment Group, "T". The column for this code is the Differential Item Functioning DIF= column. Then, if we want a report for every item, it is a DIF analysis, Winsteps Table 30.

If we want to group items, then we put a code in the item label of every item which indicates the item group to which the item belongs. The column for this code is the Differential Person Functioning, DPF= column. Then, if we want a report for every person, it is a DPF analysis, Winsteps Table 31.

If we want to do "person group" with "item group" . Then this is DGF (Differential Group Functioning). Person DIF= column and Item DPF= column, Winsteps Table 33.

DGF analysis: the log-odds model for an individual person in the group and item in the group is:

$$\log(P_{ni1}/P_{ni0}) = B_{gn} - D_{hi} - M_{gh}$$

where

B_{gn} is the overall estimate from the main analysis of the ability of person n (who is in group DIF g)
D_{hi} is the overall estimate from the main analysis of the difficulty of item i (which is in DPF group h)
M_{gh} is the interaction (bias, DGF) for person group g on item group h. This is estimated from all persons in group g combined with all items in group h.

The DGF dialog displays when Table 33 is called from the Output Tables or Plots menus.

Table 33.1

```
DGF CLASS-LEVEL BIAS/INTERACTIONS FOR DIF=@GENDER AND DPF=$S1W1
-------------------------------------------------------------------------------------------
| PERSON   DGF    DGF   DGF  PERSON   DGF    DGF   DGF     DGF    JOINT  Rasch-Welch   ITEM |
| CLASS  SCORE   SIZE  S.E.  CLASS  SCORE   SIZE  S.E. CONTRAST  S.E.   t  d.f. Prob.  CLASS |
|-----------------------------------------------------------------------------------------|
| F        .00    .06   .28  M        .01   -.16   .27      .22    .39   .57 452 .5708   1   |
| F        .01   -.18   .50  M        .00    .00   .61     -.18    .79  -.23 101 .8208   2   |
| F        .04   -.50   .83  M       -.04    .76  1.04    -1.26   1.33  -.95  32 .3484   3   |
| F       -.01    .00< 3.00  M       -.01    .00< 2.40      .00   3.84   .00  32 1.0000  4   |
| M        .01   -.16   .27  F        .00    .06   .28     -.22    .39  -.57 452 .5708   1   |
| M        .00    .00   .61  F        .01   -.18   .50      .18    .79   .23 101 .8208   2   |
| M       -.04    .76  1.04  F        .04   -.50   .83     1.26   1.33   .95  32 .3484   3   |
| M       -.01    .00< 2.40  F       -.01    .00< 3.00      .00   3.84   .00  32 1.0000  4   |
-------------------------------------------------------------------------------------------
```

The most important numbers in Table 33.1: The DGF CONTRAST is the difference in difficulty of the item between the two groups. This should be at least 0.5 logits for DGF to be noticeable. "Prob." shows the probability of observing this amount of contrast by chance, when there is no systematic item bias effect. For statistically significance DGF on an item, Prob. ≤ .05.

Table 33.2

```
DGF CLASS-LEVEL BIAS/INTERACTIONS FOR DIF=@GENDER AND DPF=$S1W1
-------------------------------------------------------------------------------------------
| ITEM    DGF    DGF   DGF  ITEM    DGF    DGF   DGF     DGF     JOINT  Rasch-Welch    PERSON |
| CLASS SCORE   SIZE  S.E.  CLASS SCORE   SIZE  S.E. CONTRAST  S.E.    t  d.f. Prob.  CLASS  |
|-----------------------------------------------------------------------------------------|
| 1       .00    .06   .28  2       .01   -.18   .50      .24    .57   .42 119 .6774    F     |
| 1       .00    .06   .28  3       .04   -.50   .83      .56    .87   .64  30 .5261    F     |
| 1       .01   -.16   .27  2       .00    .00   .61     -.16    .67  -.24 100 .8097    M     |
| 1       .01   -.16   .27  3      -.04    .76  1.04     -.92   1.07  -.86  25 .3973    M     |
| 2       .01   -.18   .50  1       .00    .06   .28     -.24    .57  -.42 119 .6774    F     |
| 2       .01   -.18   .50  3       .04   -.50   .83      .32    .97   .33  39 .7420    F     |
```

This Table contrasts, for each item class, the size and significance of the Differential Item Functioning for pairs of person classifications.

DGF class specification defines the columns used to identify DGF classifications, using DIF= and DPF=, see the selection rules.

Reading across the Table 33.1 columns:
PERSON CLASS identifies the CLASS of persons specified with DIF=, e.g., the first here is CLASS is "F".
DGF estimates with the the iterative-logit (Rasch-Welch) method:
DGF SCORE is the average response score-point difference between the observed and the expected scores for this PERSON CLASS on this ITEM CLASS. Higher scores mean locally higher ability or locally lower difficulty relative to each groups performance overall.
DGF SIZE is the differential difficulty of this item (scaled by USCALE=) for this class, with all else held constant, e.g., .07 is the relative difficulty for Kid Class F on Item Class1. The more difficult, the higher the DGF measure.
  -.52> reports that this measure corresponds to an extreme maximum person-class score. EXTRSCORE= controls extreme score estimate.
  1.97< reports that this measure corresponds to an extreme minimum person-class score. EXTRSCORE= controls extreme score estimate.
  -6.91E reports that this measure corresponds to an item with an extreme score, which cannot exhibit DIF
DGF S.E. is the standard error of the DGF SIZE (scaled by USCALE=).
PERSON CLASS identifies the CLASS of persons, e.g., the second CLASS is "M".
DGF SCORE is the average response score-point difference between the observed and the expected scores for this PERSON CLASS on this ITEM CLASS.
DGF SIZE is the differential difficulty of this item for this class, with all else held constant, e.g., -.15 is the relative difficulty for Kid Class M on Item Class1. The more difficult, the higher the DGF measure.
DGF S.E. is the standard error of the second DGF SIZE.
DGF CONTRAST is the difference between the two DGF SIZE, i.e., size of the DGF across the two classifications of persons, e.g., .07 - -.15 = .23 (usually in logits). A positive DGF contrast indicates that the item is more difficult for the first, left-hand-listed CLASS. See details in Table 33.3.
JOINT S.E. is the standard error of the DGF CONTRAST = sqrt(first DIF S.E.^{2} + second DIF S.E.^{2}), e.g., .38 = sqrt(.27^2 + .27^2)
t gives the DGF significance as a Student's t-statistic = DGF CONTRAST / JOINT S.E. The t-test is a two-sided test for the difference between two means (i.e., the estimates) based on the standard error of the means (i.e., the standard error of the estimates). The null hypothesis is that the two estimates are the same, except for measurement error.
d.f. is the joint degrees of freedom by the Welch method.
INF means "the degrees of freedom are so large they can be treated as infinite", i.e., the reported t-value is a unit normal deviate.
Prob. is the two-sided probability of Student's t. See t-statistics.
ITEM CLASS is the item classification specified by DPF=. Here the first ITEM CLASS is "1"

Each line in the Table is repeated with the PERSON CLASSes in reversed order.

14.42.2 Table 33.3, 33.4 Differential group functioning DGF list

Table 33 supports the investigation of item bias, Differential Group Functioning (DGF), i.e., interactions between classes of items and types of persons. Specify DIF= for person classifying indicators in person labels, and DPF= for item classifying indicators in the item labels.

Example output:
You want to examine item bias (DIF) between Females and Males in Exam1.txt. You need a column in your Winsteps person label that has two (or more) demographic codes, say "F" for female and "M" for male (or "0" and "1" if you like dummy variables) in column 9.

Table 33.1 is best for pairwise comparisons, e.g., Females vs. Males. Use Table 33.1 if you have two classes of persons, and Table 33.2 if you have two classes of items.

Table 33.3 or Table 33.4 are best for multiple comparisons, e.g., regions against the national average. Table 33.3 sorts by item class then person class. Table 33.4 sorts by person class then item class.

Table 33.3

DGF CLASS-LEVEL BIAS/INTERACTIONS FOR DIF=@GENDER AND DPF=$S1W1

PERSON CLASS	OBSERVATIONS COUNT	AVERAGE	BASELINE EXPECT	DGF SCORE	DGF SIZE	DGF S.E.	DGF t	Prob.	ITEM CLASS
F	234	.46	.46	.00	.06	.28	-.22	.8294	1
F	54	.85	.84	.01	-.18	.50	.36	.7224	2
F	18	.89	.85	.04	-.50	.83	.60	.5541	3
F	18	.00	.01	-.01	.00<	3.00	.00	1.000	4
M	221	.51	.50	.01	-.16	.27	.59	.5552	1
M	51	.86	.86	.00	.00	.61	.00	1.000	2
M	17	.82	.87	-.04	.76	1.04	-.74	.4734	3
M	17	.00	.01	-.01	.00<	2.40	.00	1.000	4

Table 33.4

ITEM CLASS	OBSERVATIONS COUNT	AVERAGE	BASELINE EXPECT	DGF SCORE	DGF SIZE	DGF S.E.	DGF t	Prob.	PERSON CLASS
1	234	.46	.46	.00	.06	.28	-.22	.8294	F
1	221	.51	.50	.01	-.16	.27	.59	.5552	M
2	54	.85	.84	.01	-.18	.50	.36	.7224	F
2	51	.86	.86	.00	.00	.61	.00	1.000	M
3	18	.89	.85	.04	-.50	.83	.60	.5541	F
3	17	.82	.87	-.04	.76	1.04	-.74	.4734	M
4	18	.00	.01	-.01	.00<	3.00	.00	1.000	F
4	17	.00	.01	-.01	.00<	2.40	.00	1.000	M

This displays a list of the local difficulty/ability estimates underlying the paired DGF analysis. These can be plotted directly from the Plots menu.

DGF class specification identifies the person-label columns containing DIF classifications, with DIF= set to @GENDER using the selection rules. The item-label columns for item classes are specified by DPF=.

Table 33.3. The DGF effects are shown ordered by Person CLASS within item class.
Table 33.4. The DGF effects are shown ordered by Person CLASS within Item CLASS.

KID CLASS identifies the CLASS of persons. KID is specified with PERSON=, e.g., the first CLASS is "F"
OBSERVATIONS are what are seen in the data
COUNT is the number of observations of the classification used for DIF estimation, e.g., 18 F persons responded to TAP item 1.
AVERAGE is the average observation on the classification, e.g., 0.89 is the proportion-correct-value of item 4 for F persons. COUNT * AVERAGE = total score of person class on the item
BASELINE is the prediction without DGF
EXPECT is the expected value of the average observation when there is no DIF, e.g., 0.92 is the expected proportion-correct-value for F without DGF.
DGF: Differential Group Functioning
DGF SCORE is the difference between the observed and the expected average observations, e.g., 0.92 - 0.89= -0.03
DGF SIZE is the relative difficulty for this class, e.g., person CLASS F has a relative difficulty of .07 for item CLASS 1-. ">" (maximum score), "<" (minimum score) indicate measures corresponding to extreme scores.
DGF S.E. is the approximate standard error of the difference, e.g., 0.89 logits
DGF t is an approximate Student's t-statistic test, estimated as DGF SIZE divided by the DGF S.E. with COUNT-2 degrees of freedom excluding observations for extreme persons or items (shown by TOTALSCORE=No).
Prob. is the two-sided probability of Student's *t*. See t-statistics.
ITEM CLASS identifies the CLASS of items.

14.42.3 Table 33.7, 33.8 Item group-Person group profiles

The measurement profile for each person group across the item groups, and *vice-versa*, are shown. The profiles are similar to Table 31.7.

```
TABLE 33.7 KNOX CUBE TEST                         ZOU182WS.TXT  Jun  4 2019 16:37
KID class/group specification is: DIF=@GENDER  TAP class/group specification is: DPF=$S1W1
------------------------------------------------------------------------------------------------------------------------------------------
| 1 TAP CLASS/GROUP            | 2 TAP CLASS/GROUP            | 3 TAP CLASS/GROUP            | 4 TAP CLASS/GROUP            | KID         |
|     1       1       1     1 |     2       2       2     2 |     3       3       3     3 |     4       4       4     4 | KID         |
| COUNT T.SCORE    SIZE  S.E. | COUNT T.SCORE    SIZE  S.E. | COUNT T.SCORE    SIZE  S.E. | COUNT T.SCORE    SIZE  S.E. | CLASS/GROUP|
|----------------------------+----------------------------+----------------------------+----------------------------+------------|
|   234     108     .07   .27 |    54      46    -.18   .51 |    18      16    -.55   .90 |    18       0    -.96  1.98 | F           |
|   221     113    -.15   .27 |    51      44    -.03   .60 |    17      14     .68   .90 |    17       0    -.49  1.90 | M           |
------------------------------------------------------------------------------------------------------------------------------------------

TABLE 33.8 KNOX CUBE TEST                         ZOU182WS.TXT  Jun  4 2019 16:37
KID class/group specification is: DIF=@GENDER  TAP class/group specification is: DPF=$S1W1
---------------------------------------------------------------------------
| F KID CLASS/GROUP            | M KID CLASS/GROUP            | TAP         |
|     F       F       F     F |     M       M       M     M | TAP         |
| COUNT T.SCORE    SIZE  S.E. | COUNT T.SCORE    SIZE  S.E. | CLASS/GROUP|
|----------------------------+----------------------------+------------|
|   234     108     .07   .27 |   221     113    -.15   .27 | 1           |
|    54      46    -.18   .51 |    51      44    -.03   .60 | 2           |
|    18      16    -.55   .90 |    17      14     .68   .90 | 3           |
|    18       0    -.96  1.98 |    17       0    -.49  1.90 | 4           |
---------------------------------------------------------------------------
```

14.43 Table 34.1 Columnar statistical comparison and scatterplot

```
--------------------------------------------------------------------------------------
|        Entry numbers         |Differenc|        Measure         | Comparison        |
|1                           18|-13     -8|-7                     7| NUM TAP           |
|-----------------------------+---------+------------------------+-------------------|
|*                            |         | *          .           |  1  1-4           |
|  *                          |       * | *          .           |  2  2-3           |
|   *                         |      *  | *          .           |  3  1-2-4         |
|     *                       |        *|    *       .           |  4  1-3-4         |
|       *                     |       * |     *      .           |  5  2-1-4         |
|        *                    |      *  |      *     .           |  6  3-4-1         |
|          *                  |    *    |     *      .           |  7  1-4-3-2       |
|            *                |    *    |        *   .           |  8  1-4-2-3       |
|             *               | *       |      *     .           |  9  1-3-2-4       |
|               *             |  *      |         *  .           | 10  2-4-3-1       |
|                 *           |     *   |            .*          | 11  1-3-1-2-4     |
|                  *          |     *   |            .  *        | 12  1-3-2-4-3     |
|                    *        |   *     |            .  *        | 13  1-4-3-2-4     |
|                      *      |    *    |            .    *      | 14  1-4-2-3-4-1   |
|                       *     |     *   |            .       *   | 15  1-3-2-4-1-3   |
|                         *   |   *     |            .       *   | 16  1-4-2-3-1-4   |
|                           * | *       |            .       *   | 17  1-4-3-1-2-4   |
|                            *|  *      |            .         * | 18  4-1-3-4-2-1-4 |
--------------------------------------------------------------------------------------
```

For details, please see Scatterplot: Compare Statistics

14.44 Table 35 Paired-person (cheating) agreement

(controlled by PSELECT=, ISELECT=, PSUBTOTAL=, MAXPAGE=, LINELENGTH=)

In Table 35, the response string for each person (row) is compared with the response string for every other person (row). The underlying details for Table 35 are reported in the AGREEFILE= file.

Sub-samples (groups of persons) can be specified with PSUBTOTAL=. Five plots are displayed for each sub-sample, unless the plot is empty.

When Table 35 is launched from the Output Tables menu, the Table 35 dialog box displays.

Table 35	

Table 35.1-5 - plots for the entire sample or for the accumulated sub-samples selected by PSUBTOTAL=
Table 35.11-15, 35.21-25, ... - plots for sub-samples selected by PSUBTOTAL=

x-axis: "Average of two person measures" = average of the ability measures for each pair of two persons.
plotted values: 1-9 are counts of pairs at the x,y coordinates. * is more than 9 pairs.

Table 35.1, 35.11, 35.21, ...

```
     % SAME (PAIRED STUDENT) OBSERVED RESPONSES
     -4      -2       0       2       4       6
     +-------+-------+-------+-------+-------+
100%|                                    1    |
    |                                         |
 90%|                                         |
    |                              1          |
 80%|               11 1                      |
    |                 1                       |
 70%|                  2             2        |
    |       1      1  21 1        1           |
 60%|           1 1  13  1                    |
    |           11 2 4111 1  2 21  2          |
 50%|      1  1212 22224  1  1   11           |
    |         232111 142   1 1 1              |
 40%|           23 1121                       |
    |      1     1     11 11                  |
 30%|       1       21             1          |
    |         1 1 1  1 11                     |
 20%|        1                                |
    |                                         |
 10%|                                         |
    |                                         |
  0%|       1                                 |
     +-------+-------+-------+-------+-------+
     -4      -2       0       2       4       6
      AVERAGE OF THE TWO STUDENT MEASURES
```

Table 35.1, 35.11, 35.21, ...
y-axis: "% Same (paired student) observed responses" = the count of items for which both persons have the same response code in CODES= divided by the count of items for which both persons have a non-missing response %.

Cheating detection: shared responses. For cheating-detection, see www.rasch.org/rmt/rmt61d.htm

In the plot, "1" indicates that 1 pair are plotted at this point. "2" indicates 2 pairs. "4" indicates 4 pairs, and so on up to "9". When there are 10 or more pairs at a point, "*" is plotted.

Table 35.2, 35.12, 35.22, ...

```
  % SAME (PAIRED STUDENT) SCORED RESPONSES
     -4      -2       0       2       4       6
     +-------+-------+-------+-------+-------+
100%|                 1                  1    |
    |                                         |
 90%|                  1                      |
    |              1  1            1          |
 80%|               11   1                    |
    |          1     133                      |
 70%|          1 1 11441 1           2        |
    |       1  1 112 2111 2       1           |
 60%|         114112121      2                |
    |         1111    221  1 1 21  2          |
 50%|      1  1 34 11114         11           |
    |       1     1 1        1 1              |
 40%|        1       1                        |
    |      1        1     11                  |
 30%|                              1          |
    |         1      1 11                     |
 20%|                                         |
    |                                         |
 10%|                                         |
    |                                         |
  0%|       1                                 |
     +-------+-------+-------+-------+-------+
     -4      -2       0       2       4       6
      AVERAGE OF THE TWO STUDENT MEASURES
```

Table 35.2, 35.12, 35.22, ...
y-axis: "% Same (paired student) scored responses" = the count of items for which both persons have the same score divided by the count of items for which both persons have a non-missing response %.

Table 35.3, 35.13, 35.23, ...

```
% SAME (PAIRED STUDENT) OBSERVED HIGHEST (RIGHT) RESPONSES
           -4      -2       0       2       4       6
           +-------+-------+-------+-------+-------+
      100%|                 1                  1    |
          |                                         |
       90%|                                         |
          |                              1          |
       80%|              1   1                      |
          |                 1  1                    |
       70%|                1 1             2        |
          |               1 2           1           |
```

Table 35.3, 35.13, 35.23, ...
y-axis: "% Same (paired student) observed highest (right) responses" = the count of items for which both persons have the same highest scored response divided by the count of items for which one or both persons have a highest scored response %.

Cheating detection: shared knowledge

```
     60%|               322  2                   |
        |         1   2 231 1   1 11  2          |
     50%|         1 21211111    2 1 11           |
        |         14111121    1                  |
     40%|        1113   1231    1 1              |
        |      1 1121 121 2   1                  |
     30%|        1           1        1          |
        |        1     11121                     |
     20%|      1   111                           |
        |               1                        |
     10%|                                        |
        |                                        |
      0%|     211                                |
        +-------+-------+-------+-------+-------+
        -4     -2       0       2       4       6
         AVERAGE OF THE TWO STUDENT MEASURES
```

Table 35.4, 35.14, 35.24, ...

```
% SAME (PAIRED STUDENT) OBSERVED LOWEST (WRONG) RESPONSES
          -4     -2       0       2       4       6
          +-------+-------+-------+-------+-------+
      100%|                                        |
          |                                        |
       90%|                                        |
          |                                        |
       80%|                                        |
          |                                        |
       70%|                                        |
          |               1                        |
       60%|      1       1 11                      |
          |                                        |
       50%|     1                                  |
          |          1      2 1                    |
       40%|          1  1  1                       |
          |     1  2  1    323                     |
       30%|            1 11311                     |
          |        1412 41 21       1              |
       20%|       1 122121224                      |
          |      1   1 1 151 1 21 4 1              |
       10%|          11   11                       |
          |           1                            |
        0%|      1 1 11  1 111111   11124 2        |
          +-------+-------+-------+-------+-------+
          -4     -2       0       2       4       6
           AVERAGE OF THE TWO STUDENT MEASURES
```

Table 35.4, 35.14, 35.24, ...

y-axis: "% Same (paired student) observed lowest (wrong) responses" = the count of items for which both persons have the same lowest scored response divided by the count of items for which one or both persons have a lowest scored response %.

Cheating detection: shared ignorance - a better indication of cheating than shared knowledge.

Table 35.5, 35.15, 35.25, ...

```
        % SAME (PAIRED STUDENT) MISSING RESPONSES
        -4     -2       0       2       4       6
        +-------+-------+-------+-------+-------+
    100%|                                        |
        |                                        |
     90%|                                   1    |
        |                         1   2 2        |
     80%|         1     1                        |
        |        1   11 11 1    1                |
     70%|          1   11 1   1 2     1          |
        |     11 3331    421 11   1  21          |
     60%|         125  1222 1     11             |
        |     111  21231 55   1 1   1            |
     50%|      1      1 3421 1                   |
        |           1 11   1 1                   |
     40%|              1  2                      |
        |             11                         |
     30%|                                        |
        |               1                        |
     20%|                                        |
        |                                        |
     10%|                                        |
        |                                        |
      0%|                                        |
        +-------+-------+-------+-------+-------+
        -4     -2       0       2       4       6
         AVERAGE OF THE TWO STUDENT MEASURES
```

Table 35.5, 35.15, 35.25, ...

This Table is only output when there are missing observations in the data.

y-axis: "% Same (paired student) missing responses" = the count of items for which both persons have a missing response divided by the count of items for which one or both persons have a missing response %.

Pairs of students near the top of the plot responded to almost the same items.

CAT testing: to detect test overlap, which we want to minimize in order avoid item over-exposure and "tracking" through the item bank.

14.45 Table 36 PKMAP person diagnostic maps

PKMAP diagnostic maps are a means of displaying the responses of a person to the items. They are described in KIDMAP: Person-by-Item Interaction Mapping. The Table Heading is only shown at the start of Table 36, not for each subtable.

PKMAP is the Winsteps implementation of KidMap. KidMaps date back to 1978 - https://www.rasch.org/rmt/rmt82k.htm - There have been many variations. PKMAPs were added to Winsteps in 2011. There were two major variants: KIDMAPS for dichotomies and KIDMAPS for polytomies.

Dichotomies used the item difficulty as the location, and the left-column for success and the right-column for failure.

Polytomies are more complicated. Consider a 1 (bad) - 5 (good) category rating scale. A rating of 5 (good) is a definite success, so is in the left-hand column. A rating of 1 (bad) is a definite failure, and so is in the right-hand column. But at what positions? Winsteps matches the locations in Table 2.2, so that a rating of 1 is positioned at the measure for a score of 1.25 (depending on 1P= and other settings) on the item, and a rating of 5 is positioned at the measure for a score of 4.75 on the item.

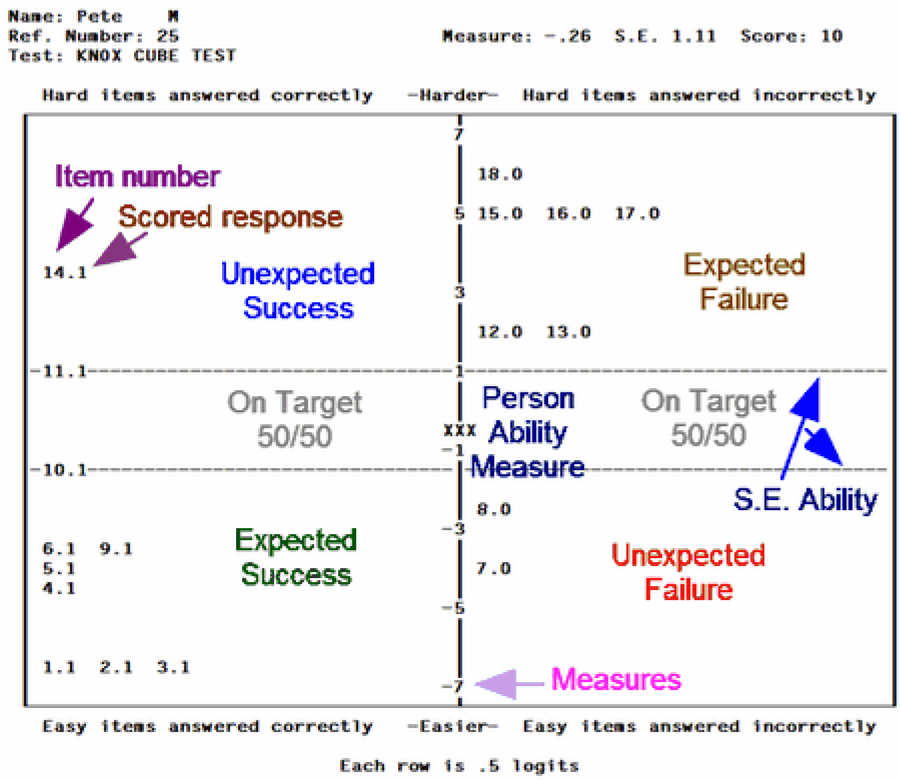
Categories 2, 3, 4 can all be located at the measures for expected scores of 2.0, 3.0, 4.0 on the items. Since all these ratings indicate some success, they are shown in the left-hand column.

When dichotomies are displayed with polytomies, the polytomous rules are used. So that a 1/2 dichotomy on a polytomous PKMAP is positioned at 1.25 (for a score of 1) or 1.75 (for a score of 2). You can see this in an analysis of Example0.txt with ISGROUPS=0. Then, in Table 2.2, we see that Item 12. "Go to Museum" is a dichotomy with scores of 1 and 2.

If you need the PKMAP to display in a different way, please email to me an example of what you want. I will add a control variable to PKMAP to produce it according to your design.

For dichotomies, text output:

PKMAP=*
MAXPAGE=40
ASCII=No
*
Table 36

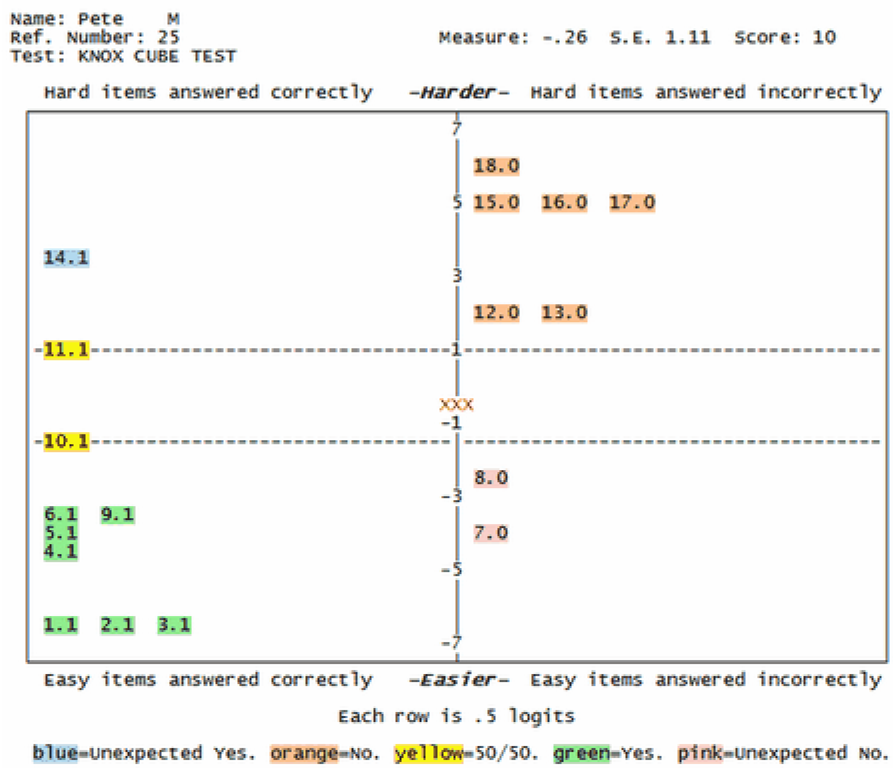


Webpage output, with automatic page-breaks when printed:

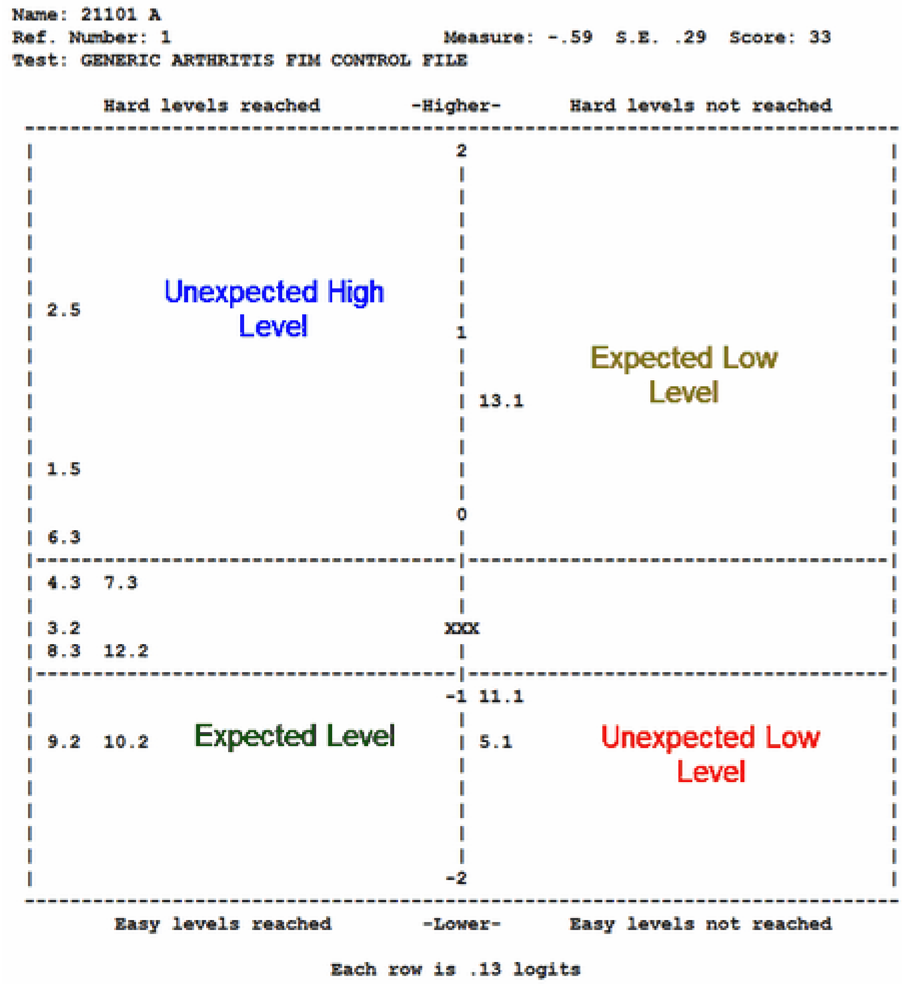
ASCII=Webpage
PKMAP=*
MAXPAGE=40
*
TFILE=*
OFILE=X.HTM
36 ; displays the PKMAPs as one webpage X.HTM
*

@SCHOOL=$S4W2 ; school code in person label
@CLASS=$S6W3 ; classroom code in person label
TFILE=*
OFILE = "c:\MyFolder\"+@SCHOOL+"\"+@CLASS+".htm"
36 ; writes Table 36 PKMAPs to one file for each CLASS files in its SCHOOL folder
; blanks in folder or file names are converted to _ (underlines)
*

For dichotomies:



For polytomies:



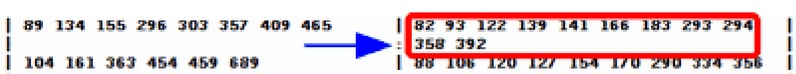
```
Name: 21101 A
Ref. Number: 1                      Measure: -.59  S.E.  .29  Score: 33
Test: GENERIC ARTHRITIS FIM CONTROL FILE

        Hard levels reached        -Higher-      Hard levels not reached
 -----------------------------------------------------------------------------
 |                                    2                                      |
 |                                    |                                      |
 |                                    |                                      |
 |                                    |                                      |
 |                                    |                                      |
 |                                    |                                      |
 |                                    |                                      |
 | 2.5                                |                                      |
 |                                    1                                      |
 |                                    |                                      |
 |                                    |                                      |
 |                                    | 13.1                                 |
 |                                    |                                      |
 |                                    |                                      |
 | 1.5                                |                                      |
 |                                    |                                      |
 |                                    0                                      |
 | 6.3                                |                                      |
 |------------------------------------|--------------------------------------|
 | 4.3  7.3                           |                                      |
 |                                    |                                      |
 | 3.2                               XXX                                     |
 | 8.3  12.2                          |                                      |
 |------------------------------------|--------------------------------------|
 |                                   -1 11.1                                 |
 |                                    |                                      |
 | 9.2  10.2                          | 5.1                                  |
 |                                    |                                      |
 |                                    |                                      |
 |                                    |                                      |
 |                                    |                                      |
 |                                    |                                      |
 |                                   -2                                      |
 -----------------------------------------------------------------------------
         Easy levels reached         -Lower-      Easy levels not reached

                            Each row is .13 logits
```

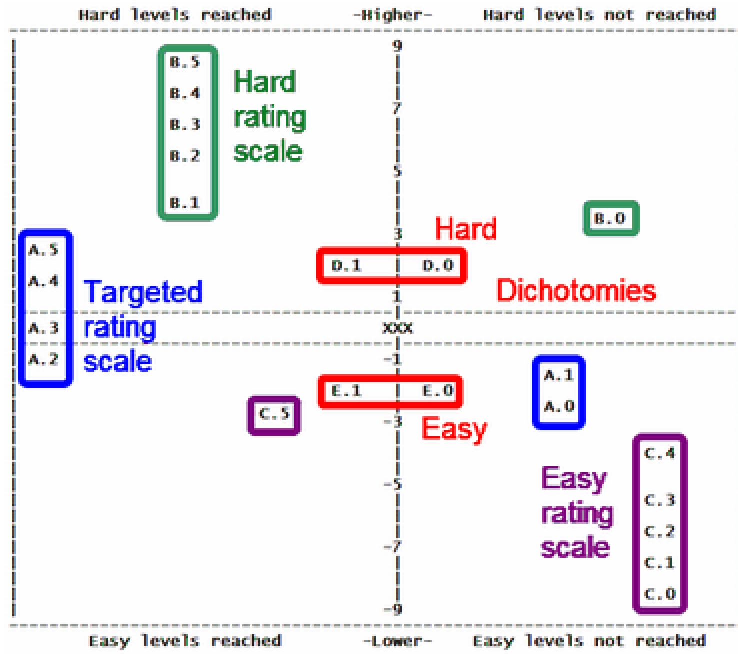

Continuation lines:

When there are too many item numbers to fit on one line, they are continued on the next line, indicated by ":"



```
| 89 134 155 296 303 357 409 465       | 82 93 122 139 141 166 183 293 294  |
|                                     : 358 392                            |
| 104 161 363 454 459 689              | 88 106 120 127 154 170 290 334 356 |
```

What observation goes where:



This Figure (using the Lucida Console font) shows the location in a PKMAP of every possible response to 6-category (0-5) rating-scale items A, B, C and two-category (0-1) dichotomous items, D, E, by a person of 0 logits ability.

For details of the PKMAP control variables, please see PKMAP=

PKMAP Size

The internal height of PKMAP grid box is 61 or MAXPAG= value - 8.
The internal width of the PKMAP grid box is LINELENGTH= value - 6.

PKMAP page breaks

Each diagnostic map automatically starts on a new page when Table 36 is output as a webpage (ASCII=W) or as a Word document (ASCII=D).

Adjusting PKMAP wording

1. With the current PKMAP settings, "Output Tables" menu. Table 36. To list the settings at the start of Table 36, include in your control file:
   PKMAP=*
   1D = Yes
   *

2. Table 36 processing may be interrupted with Ctrl+F.

```
Processing Table 36
>=====================================<
```

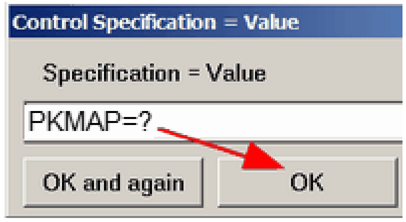
3. Copy the PKMAP instructions from Table 36 into a new text file.

```
1= Name: #NAME#
2= Ref. Number: #ENTRY#                    Measure: #MEASURE#  S.E. #ERROR#  Score: #SCORE#
3= Test: #TITLE#
4=Hard items answered incorrectly
5=Hard items answered correctly
6=XXX
7=Easy items answered incorrectly
8=Easy items answered correctly
```

4. Edit the PKMAP instructions in the new file

5. Save the new file

6. Specification box: PKMAP=?



7. A file dialog box displays. Navigate to the new file. Then click OK.

8. "Output Tables" menu. Table 36. Again ....

Questions:
1. Can I select cases, e.g., all cases with infit and outfit > 1.33? Very important to diagnose potential atypical cases.

Reply: Include in your PKMAP= file:
1F = 1.33

You wrote:
2. Can I select a particular person, e.g., #123 is interesting because of misfit on infit and outfit?

Reply: Winsteps specification menu box: PDELETE=+123
Output Table 36
Winsteps specification menu box: PDELETE=

You wrote: Select on other criteria, e.g., age, gender?
Windows specification menu box:
PSELECT=??????M

3. Can I display the item labels instead of just the item entry numbers on the map?

Reply: Include in your PKMAP= file:
1R = #LABEL#
or, if you only want part of the label:
1R =#$S3E5$# ; for columns 3,4,5 in the item label

4. It does not appear that all cases get PKMAPs, do they? How are the persons selected?

Reply: Usually everyone has a PKMAP. Your control file or PKMAP= file contains a PSELECT= or PDELETE= instruction. This removes some people.

14.46 Tables 37-41 Person Keyforms

14.46.1 Table 37 Person KeyForms - Measure order

Table 37 Person KeyForms - Measure order. Table 37 was Table 17.3-
Table 38 Person KeyForms - Entry order. Table 38 was Table 18.3-
Table 39 Person KeyForms - Alphabetical order. Table 39 was Table 19.3-.
Table 40 Person KeyForms - Misfit order. Table 40 was Table 7.2-.
Table 41 Person KeyForms Misfit order, only unexpected responses
Items are always in difficulty order, descending.
See also Plots menu, Keyform plot.

This set of subtable displays a version of Table 2.2 with the responses filled in for each person. These can be useful for diagnosis and individual reporting. The responses are the original values in the data file, as far as possible.

```
KEY: .1.=OBSERVED, 1=EXPECTED, (1)=OBSERVED, BUT VERY UNEXPECTED.

NUMBER - NAME ------------------ MEASURE - INFIT (MNSQ) OUTFIT - S.E.
     72  JACKSON, SOLOMON          -1.32     2.0   A    5.2      .37
```

```
-6       -4        -2         0         2         4         6
|---------+---------+---------+---------+---------+---------|  NUM   ACT
                    .0.                                          5  FIND BOTTLES AND CANS
                     0                         (2)              23  WATCH A RAT
                     0                        (2)               20  WATCH BUGS
                     0              (1)                          4  WATCH GRASS CHANGE
                     0             (1)                           8  LOOK IN SIDEWALK CRACKS
                    .0.                                          7  WATCH ANIMAL MOVE
                    .0.                                          9  LEARN WEED NAMES
                    .0.                                         16  MAKE A MAP
                     0        .1.                               25  TALK W/FRIENDS ABOUT PLANTS
                    .0.                                          3  READ BOOKS ON PLANTS
                    .0.                                         14  LOOK AT PICTURES OF PLANTS
                    .0.                                          6  LOOK UP STRANGE ANIMAL OR PLANT
                    .0.                                         17  WATCH WHAT ANIMALS EAT
                    .0.                                         22  FIND OUT WHAT ANIMALS EAT
               .0.   1                                          24  FIND OUT WHAT FLOWERS LIVE ON
                    .1.                                          1  WATCH BIRDS
                    .1.                                         15  READ ANIMAL STORIES
             .0.     1                                           2  READ BOOKS ON ANIMALS
            .0.      1                                          21  WATCH BIRD MAKE NEST
            .0.      1                                          11  FIND WHERE ANIMAL LIVES
                    .1.                                         13  GROW GARDEN
         .0.         1                                          10  LISTEN TO BIRD SING
                    .1.                                         12  GO TO MUSEUM
                    .1.                                         19  GO TO ZOO
                    .2.                                         18  GO ON PICNIC
|---------+---------+---------+---------+---------+---------|  NUM   ACT
-6       -4        -2         0         2         4         6
```

The vertical line of numbers corresponds to the person measure, and indicates the expected (average) responses. Responses marked .0. or .1. or .2. are observed and expected. Responses shown merely as 0 or 1 are expected, but not observed. Responses (1) and (2) are observed and statistically significantly unexpected, |*t*|≥2, p<5%. Table 41 shows only the unexpected responses.

Response code with no dots or parentheses: this only happens in the ability column and indicates the response we expected a person of that ability to make. If there are several similar responses, e.g., wrong answers to an MCQ item, then one response is chosen.

Response code with .dots. This is the response the person actually made, but is not a statistically unexpected response.

Response code with () This is the response the person actually made, but is a statistically unexpected response, p<.05 double-sided.

Table 41 Person KeyForms Misfit order, only unexpected responses

This table displays a version of Table 2.2 with only the unexpected responses filled in for each person. These can be useful for diagnosis and individual reporting. The responses are the original values in the data file, as far as possible. Persons without unexpected responses are omitted.

```
KEY: .1.=OBSERVED, 1=EXPECTED, (1)=OBSERVED, BUT VERY UNEXPECTED.

NUMBER - NAME ------------------ MEASURE - INFIT (MNSQ) OUTFIT - S.E.
     29  Anne    F                  -.26     4.1   A    6.1      1.11

-5   -4    -3    -2    -1     0     1     2     3     4     5
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
                            0                          (1)     14  1-4-2-3-4-1
                            0           .1.                    11  1-3-1-2-4
        (0)                 1                                   8  1-4-2-3
0)                          1                                   7  1-4-3-2
|-----+-----+-----+-----+-----+-----+-----+-----+-----+-----|  NUM   TAP
-5   -4    -3    -2    -1     0     1     2     3     4     5
```

The vertical line of numbers corresponds to the person measure, and indicates the expected (average) responses. Responses (1) and (2) are observed and statistically significantly unexpected, |*t*|≥2, p<5%. Responses shown merely as 0 or 1 are expected, but not observed. The full list of responses is in Table 40.

14.46.2 Table 38 Person KeyForms - Entry order

See Table 37

14.46.3 Table 39 Person KeyForms - Alphabetical order

See Table 37

14.46.4 Table 40 Person KeyForms - Misfit order

See Table 37

14.46.5 Table 41 Person KeyForms - Misfit order, only unexpected responses

See Table 37

14.47 Table 42.1 Person statistics in displacement order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, TOTAL=)

PERSON STATISTICS: DISPLACEMENT ORDER

For details, please see Table 10.1

14.48 Table 42.2 Person statistics graphically in displacement order

Please see Table 10.2

14.49 Table 43.1 Person statistics in correlation order

(controlled by USCALE=, UMEAN=, UDECIM=, LOCAL=, TOTAL=)

Table 43 is not output when person-point correlations are inestimable because items have different numbers of categories.

PERSON STATISTICS: CORRELATION ORDER

For details, please see Table 10.1

14.50 Table 43.2 Person statistics graphically in correlation order_2

Please see Table 10.2. Table 43 is not output when person-point correlations are inestimable because items have different numbers of categories.

14.51 Table 44.1 Global statistics

```
Global Statistics:
Active KID: 35, non-extreme: 34
Active TAP: 18, non-extreme: 14
Active datapoints: 630
Missing datapoints: none
Non-extreme datapoints: 476, ln(476) = 6.1654
Standardized residuals N(0,1): mean: -.009 P.SD: .827 count: 476.00
```

```
Fit Indicators:
Equal-item-discriminations test of Parallel ICCs/IRFs: 7.4177 with 13 d.f., probability =
    .9174
van den Wollenberg Q1 test of Parallel ICCs/IRFs: 64.5188 with 117 d.f., probability =
    1.0000
Estimated Free Parameters = Lesser of (Non-extreme KID or Non-extreme TAP) - 1 +
    Sum(Thresholds - 1) = 17
Analysis Degrees of freedom (d.f.) by counting = 476 - 17 = 459
Log-Likelihood chi-squared: 221.6118 with 459 d.f., probability = 1.0000
Pearson Global chi-squared: 325.2167 with 459 d.f., probability = 1.0000
Akaike Information Criterion, AIC = (2 * parameters) + chi-squared = 255.6118
Schwarz Bayesian Information Criterion, BIC = (parameters * ln(non-extreme datapoints)) +
    chi-squared = 326.4239
Global Root-Mean-Square Residual: .2318 with expected value: .2344 count: 630.00
Capped Binomial Deviance: .0802 with expected value: .0858 count: 630.00 dichotomies
```

Global statistics:	Statistics based on the currently-selected data, omitting permanently and temporarily deleted, deselected and dropped items and persons
Active person, weighted, non-extreme	Persons currently active in this analysis. Weighted count only if active persons are weighted. Non-extreme persons do not have extreme scores (0%, 100% scores)
Active item, weighted, non-extreme	Items currently active in this analysis. Weighted count only if active items are weighted.
Active datapoints, weighted, non-extreme	Observations/responses currently active in this analysis (includes extreme scores). Weighted count only if active items or persons are weighted. Non-extreme items do not have extreme scores (0%, 100% scores)
Missing datapoints, % of Active+Missing datapoints	Observations/responses not active in this analysis, usually because they do not have scored values. If any potentially active data are missing, then percent that are active
Non-extreme datapoints, weighted, non-extreme	Observations/responses currently active in this analysis (excludes extreme scores). Weighted count if any active persons or items are weighted.
Standardized residuals N(0,1): mean: P.SD: count:	Standardized Residuals are modeled to have a unit normal distribution. Large departures from mean of 0.0 and standard deviation of 1.0 indicate that the data do not conform to the basic Rasch model specification that randomness in the data be normally distributed do that standardized residuals to be close to mean 0.0, P.SD 1.0. The count is of relevant observations.
Fit Indicators:	
Equal-item-discriminations test of Parallel ICCs/IRFs: .... with .... d.f., probability = ...	Parallel ICCs are tested using a fixed-effects chi-squared test of the item discriminations, DISCRIM=Yes in Table 14, etc. - The degrees of freedom are (number of active items - 1).
van den Wollenberg Q1 test of Parallel ICCs/IRFs: .... with .... d.f., probability = ...	The Q_1 test (1982, 1995 - below) for parallel ICCs is modified to include polytomous ICCs and missing data by stratifying the person sample by ability (theta) instead of raw score.
Estimated Free Parameters = Lesser of (Non-extreme persons or Non-extreme items) - 1 + Sum(Thresholds - 1)	Count of free parameters. Anchoring is ignored. Item and Person weights are included
Analysis Degrees of freedom (d.f.) by counting	Weighted count of datapoints in non-extreme response strings less the count of free parameters.
Log-Likelihood chi-squared: .... with ... d.f., probability = ..	The chi-square value asymptotically = -2 * log-likelihood of the active datapoints. It is based on the currently-reported estimates which may depart noticeably from the "true" maximum likelihood estimates for these datapoints. The probability that these data fit the Rasch model globally. Despite good global fit, there can be considerable local misfit in Tables 6 and 10.
Pearson Global chi-squared: ... with ... d.f., probability = ...	This chi-squared is calculated using the squared standardized residuals, which approximate unit-normal deviates.

	Cressie, N., & Read, T. R. (1989). Pearson's X2 and the log-likelihood ratio statistic G2: a comparative review. International Statistical Review, 57, 19-43.
Akaike Information Criterion, AIC	AIC = 2*k - 2*ln(L) where k = parameters, and -2*ln(L) is the log-likelihood chi-square. Used for model comparison: higher values indicate worse adjusted fit
Schwarz Bayesian Information Criterion, BIC	BIC = ln(n)*k - 2*ln(L) where n is the number of Non-extreme datapoints. Used for model comparison: higher values indicate worse adjusted fit. ln() = natural logarithm of count of datapoints
Global (Weighted) Root-Mean-Square Residual (RMSR) with expected value:	This is $\sqrt{(\sum(X-E)^2)}$ where the sum is across X, each of the observations, and E, the expectation of each observation according to the Rasch model. Weighting is applied to the data if IWEIGHT= or PWEIGHT= are specified. The expected value of the RMSR according to the Rasch model. RMSR values smaller than the expected value indicate better fit (or overfit) to the Rasch model.
Capped (Weighted) Binomial Deviance (CBD) = ... with expected value ... for ... dichotomies	This is the average of -[X*LOG10(E) + (1-X)*LOG10(1-E)] for all dichotomous observations where X=0,1 is the observation and E is its Rasch-model expectation. E is limited to the range 0.01 to 0.99. Weighting is applied to the data if IWEIGHT= or PWEIGHT= are specified. Glickman, Mark E. "Parameter estimation in large dynamic paired comparison experiments." *Journal of the Royal Statistical Society: Series C (Applied Statistics) 48.3 (1999):* 377-394. The expected value of the CBD according to the Rasch model. CBD values smaller than the expected value indicate better fit (or overfit) to the Rasch model.

Example: Rating Scale Model (RSM) and Partial Credit Model (PCM) of the same dataset. When the models are nested (as they are with RSM and PCM), then we have:

RSM chi-square and RSM d.f.

PCM chi-square (which should be smaller) and PCM d.f. (which will be smaller)

Then the model choice could be based on: (RSM LL chi-square - PCM LL chi-square) with (RSM-PCM) d.f., However, global fit statistics obtained by analyzing your data with conditional Rasch estimation, CMLE, or log-linear models (e.g., in SPSS) will be more exact than those produced by Winsteps. For the more information about the choice between RSM and PCM, see www.rasch.org/rmt/rmt143k.htm.

if global fit statistics are the decisive evidence for choice of analytical model, then Rasch analysis may not be appropriate. In the statistical philosophy underlying Rasch measurement, the decisive evidence for choice of model is "which set of measures is more meaningful and useful" (a practical decision), not "which set of measures fit the model better" (a statistical decision).

However, local fit and misfit are more important than global fit for decision-making: "Evaluating Restrictive Models in Educational and Behavioral Research: Local Misfit Overrides Model Tenability" (2020) Tenko Raykov, Christine DiStefano. Educational and Psychological Measurement.

Glas C.A.W., Verhelst N.D. (1995) Testing the Rasch Model. In: Fischer G.H., Molenaar I.W. (eds) Rasch Models. Springer, New York, NY.
van den Wollenberg, A. L. (1982). Two new test statistics for the Rasch model. Psychometrika 47: 123–140.

Question: Is it possible in Winsteps to obtain the p-value corresponding to the chi-square test on the difference in model fit between the **Rating Scale Model and Partial Credit Model**?

Answer: Yes, do the two analyses. Output Table 44. Compare the two log-likelihood chi-squares. However, the big challenge is the d.f. of the difference between the chi-squares. You can estimate these as "number of PCM Andrich thresholds - number of RSM Andrich thresholds" which is probably different from the difference in the "d.f. by simulation" of the two analyses.

14.52 Table 45 Person measures after each item

Table 45 shows the measures and fit statistics for the persons after the administration of each item, starting with the first item. This is useful for tracking how the person measures change as the items are administered. The item difficulties are based on all the items and persons. If items are deleted or selected in the "Specification" menu box, then the person measures are estimated only on the active items. The final measures in Table/Plot 45 will differ from the reported measures in Table 18.

```
          CUMULATIVE KID MEASURES AFTER EACH ACT
 -----------------------------------------------------------------------------------------------
    ----------------------------
| KID     | 1 -1.49  Watch birds                     | 2 -1.49 Read books on animals
    | KID                       |
| NUMBER | SCORE COUNT OBS MEASURE M.S.E. IMSQ OMSQ | SCORE COUNT OBS MEASURE M.S.E. IMSQ OMSQ
    | LABEL                     |
|--------+------------------------------------------+-------------------------------------------
    +-------------------------|
|      1 |     1     1   1   -1.47   4.50  .00  .00 |     3     2   2    2.17   1.41 1.00 1.00
    | M Rossner, Marc Daniel  |
|      2 |     2     1   2    3.01   2.18  .00  .00 |     4     2   2    3.90   1.98  .00  .00
    | M Rossner, Lawrence F.  |
|      3 |     2     1   2    3.01   2.18  .00  .00 |     4     2   2    3.90   1.98  .00  .00
    | M Rossner, Toby G.      |
|      4 |     1     1   1   -1.47   4.50  .00  .00 |     1     2   0   -5.14   1.41 1.00 1.00
    | M Rossner, Michael T.   |
------------------------------------------------------------------------------------------------
    ---------------------------
```

The displayed fields are controlled by T45OPTIONS= and the Table 45 dialog box.

Field	Meaning	Table 45	Table 45 Plot
KID NUMBER	Person entry number in data file	First column	in first column of Excel Worksheet
1	Item entry number in data file	Top row	x-axis of plot and second row of worksheet
-1.49	Item difficulty	Top row	
Watch birds	Item label (name)	Top row	
SCORE	total score by person so far	**T45OPTIONS=**1??????	y-axis choice
COUNT	total count of valid observations so far	**T45OPTIONS=**?1?????	y-axis choice
OBS	scored observation. Missing is usually blank or "."	**T45OPTIONS=**??1????	y-axis choice
MEASURE	estimated person measure so far	**T45OPTIONS=**???1???	y-axis choice
M.S.E. R.S.E.	"Model" standard error of the measure assuming data fit the Rasch model. "Real" standard error of the measure assuming data	**T45OPTIONS=**????1??	y-axis choice

	misfit the Rasch model when REALSE=Yes		
IMSQ	Infit mean-square fit statistic	**T45OPTIONS=**??????1?	y-axis choice
OMSQ	Outfit mean-square fit statistic	**T45OPTIONS=**???????1	y-axis choice
KID LABEL	Person label (name)	"Person Label field" column selection in dialog box.	"Person Legend field" column selection in dialog box. Last column of worksheet.
In dialog box:			
Start at first observation	Are values reported in cells with missing (not administered) observations?	values for items before the first valid observation are displayed as missing "." or not plotted	
Skip missing observations		values for items after the first valid observation and before the last valid observation are displayed as missing "." or not plotted	
End at last observation		values for items after the last valid observation are displayed as missing "." or not plotted	
Omit extreme items			Extreme, unanchored items are omitted from the plot. They do not change the measures, S.E.s or Mean-Squares.
(Sort order)	Sequence of persons displayed.	Person entry order	Person Legends are ordered by last displayed value which is in "Sort" column of worksheet

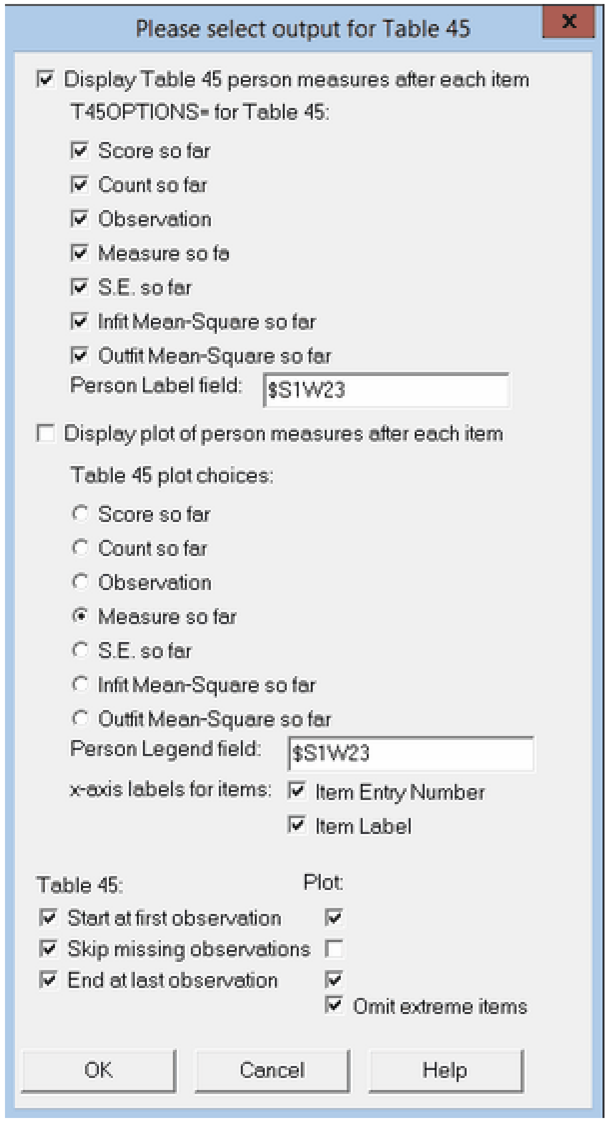
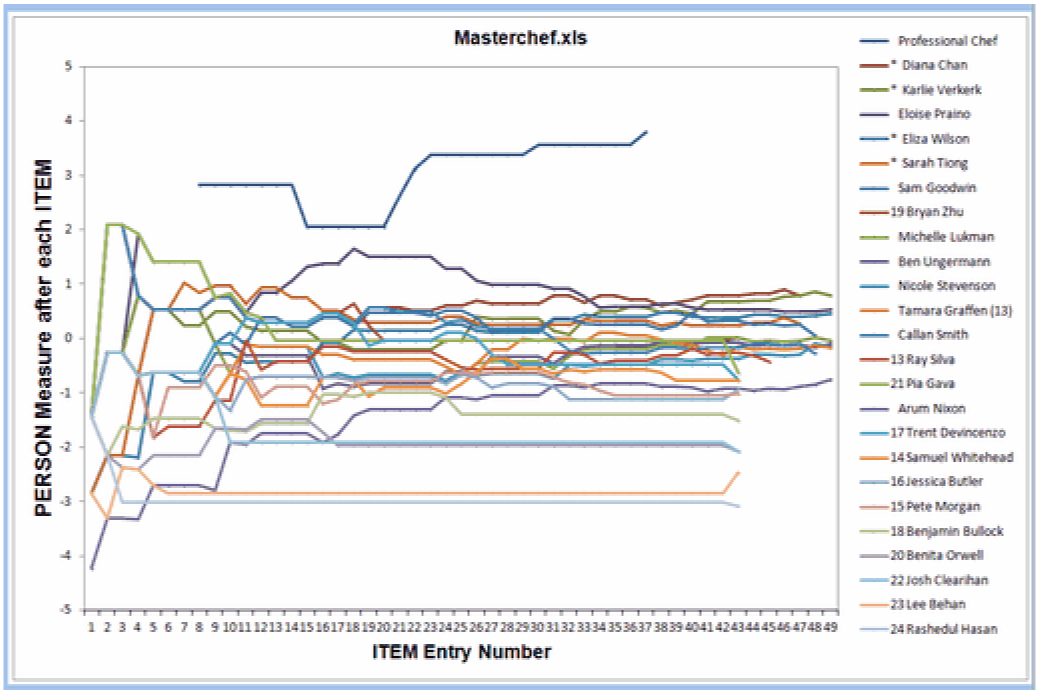


Table 45 Plot of "Masterchef" Measures, 2017. Horizontal lines for lower persons are bridging missing data.



14.53 Table heading

At the top of each output Table is basic information about the analysis:

```
TABLE 1.0 LIKING FOR SCIENCE (Wright & Masters p. ZOU214ws.txt Feb  1 14:38 2005
INPUT: 75 KIDS, 25 ACTS  REPORTED: 75 KIDS, 25 ACTS, 3 CATS      WINSTEPS 5.10.1
--------------------------------------------------------------------------------
```

TABLE 1.0 is identifies the current Table and sub-table.

LIKING FOR SCIENCE (Wright & Masters is set by TITLE=

ZOU214ws.txt is the name of the disk file containing this Table.

Feb 1 14:38 2005 is the date and time of this analysis.

INPUT: 75 KIDS, 25 ACTS
75 KIDS gives the number of cases in the data file(s) and the case (row) identification PERSON=
25 ACTS gives the number of items specified by NI= and the column (item) identification ITEM=

REPORTED: 75 KIDS
shows how many rows, cases, persons, subjects, objects are currently active for reporting (PDELETE=, PDFILE=, PSELECT=)

25 ACTS
shows how many columns, items, agents are currently active for reporting (IDELETE=, IDFILE=, ISELECT=).

3 CATS
shows how many categories are currently active for reporting.. The number of categories is determined by the ISGROUPS= item groups and the data structure as screened by CODES=. etc. For details of the categories, see Table 3.2
3 CATS indicates that the Rating Scale Model is being used.
6 CATS indicates that the items are analyzed as two groups of items. Each groups has a rating scale with 3 categories.
75 CATS indicates that each of the 25 items is analyzed with 3 categories, the Partial Credit Model.

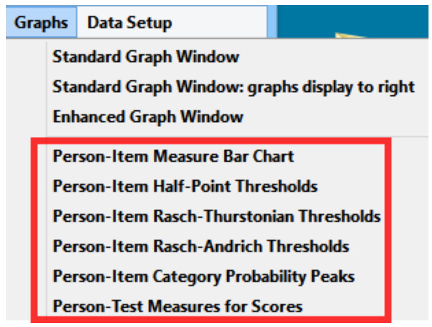
Item Grouping (Rating Scale Model, Grouped Rating Scale Model, Partial Credit Model) is flagged by the extreme right-hand column "G" in item Table 10.1, etc.

In previous versions of Winsteps, ANALYZED was used to mean "used for item analysis", omitting extreme scores.

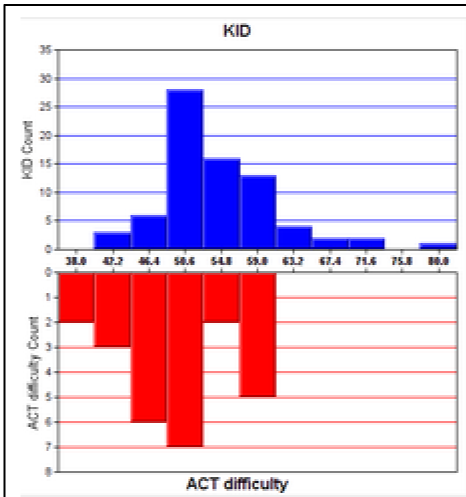
15 Charts

15.1 Person-item histograms or barcharts

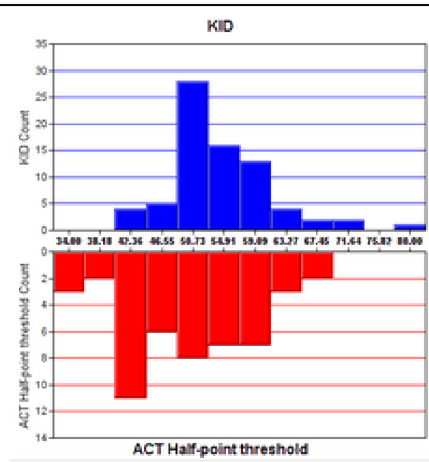
Click on Person-Item Histogram on the Graphs menu:



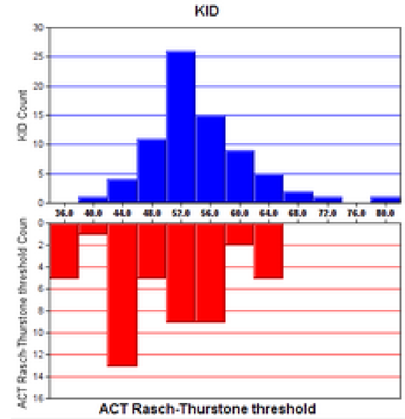
A standard histogram of the person ability distribution (upper, from PFILE=) and item difficulty distribution (lower, from IFILE=) displays:



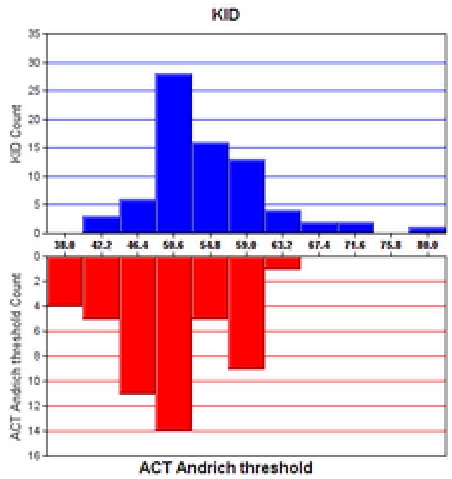
Person Measure - Item Difficulty Histogram



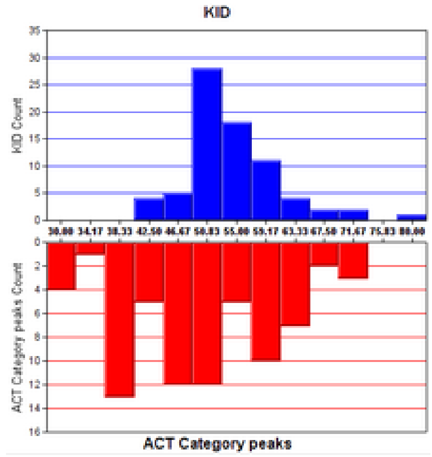
Person Measure - Item Half-Point Thresholds Histogram



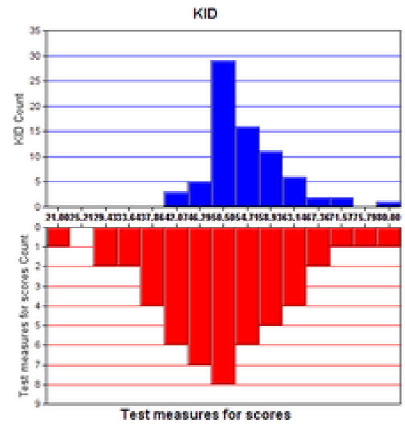
Person Measure - Item Thurstonian Thresholds Histogram



Person Measure - Item Andrich Thresholds Histogram

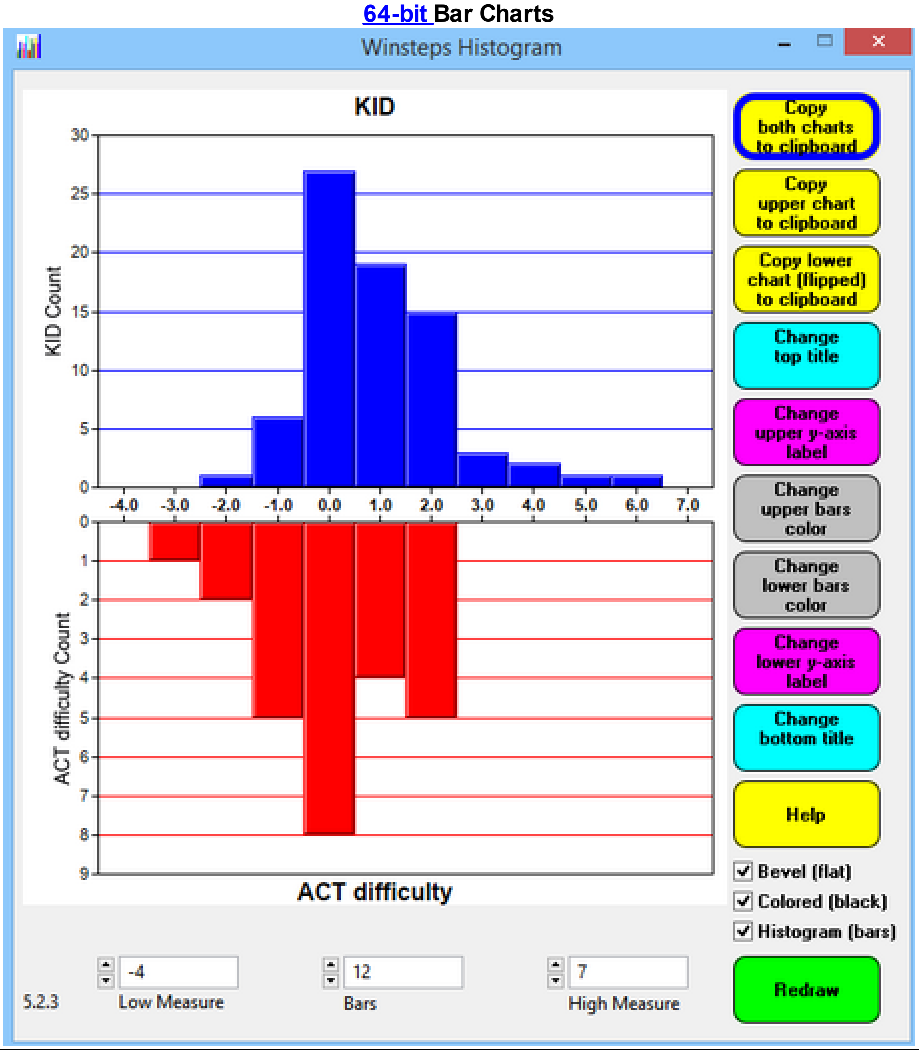


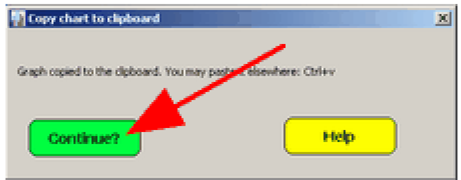
Person Measure - Item Category Peaks (maximum probabilities) Histogram



Person Measures - Test Measures for All Scores on Complete Test

[64-bit](64-bit) Bar Charts



<table>
<tr>
<td>Copy both charts to clipboard</td>
<td>copies both person and item histograms to the Windows clipboard, so that they can be pasted into a Word document or elsewhere.

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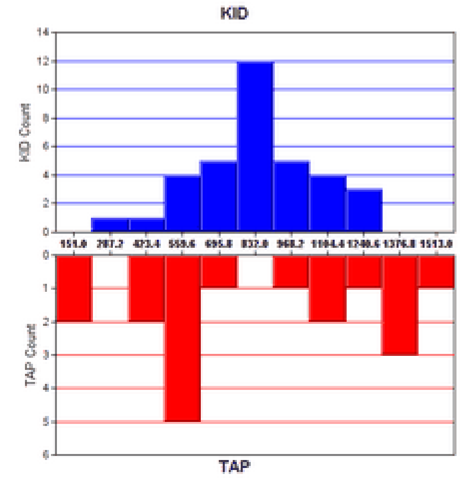
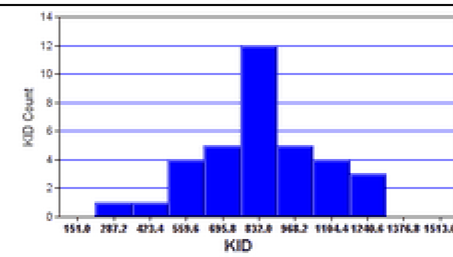
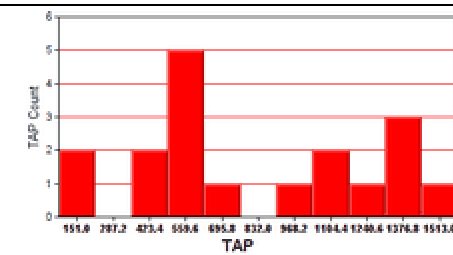
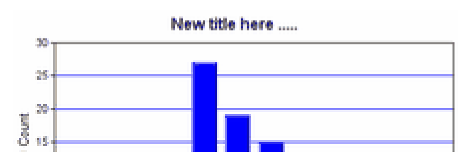
<td>
</td>
</tr>
<tr>
<td>Copy upper chart to clipboard</td>
<td>copies the upper (person) histogram to the Windows clipboard, so that they can be pasted into a Word document or elsewhere.

The title is shown below the x-axis.</td>
<td>
</td>
</tr>
<tr>
<td>Copy lower chart (flipped) to clipboard</td>
<td>copies the lower (item) histogram to the Windows clipboard, so that they can be pasted into a Word document or elsewhere.

The bars are drawn upwards.</td>
<td>
</td>
</tr>
<tr>
<td>Change top title</td>
<td>change the top (person) title

</td>
<td>
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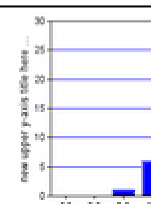
</tr>
<tr>
<td>Change upper y-axis label</td>
<td>change the upper y-axis (person count) title

</td>
<td></td>
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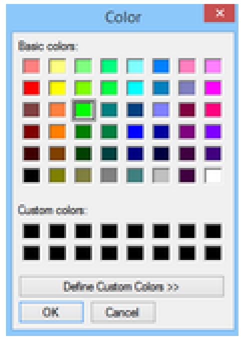
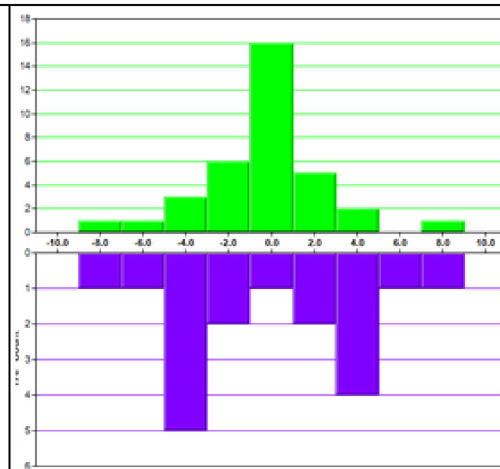
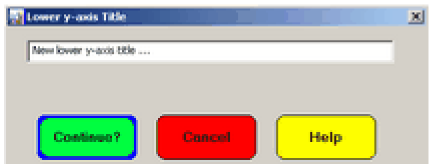
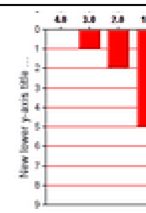
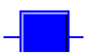
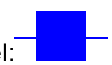
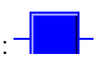
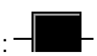
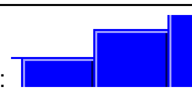
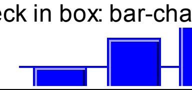
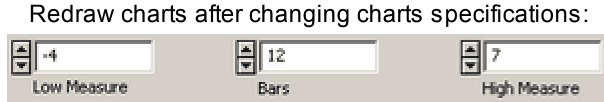
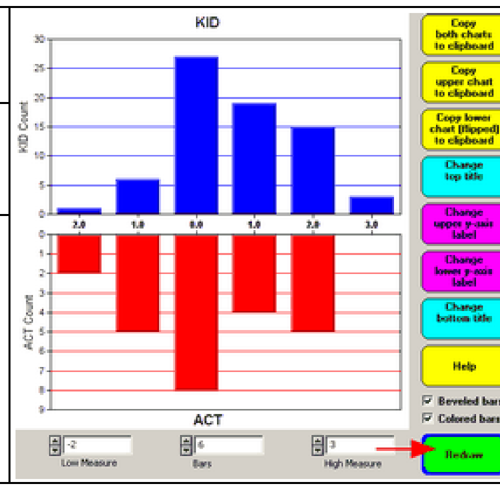
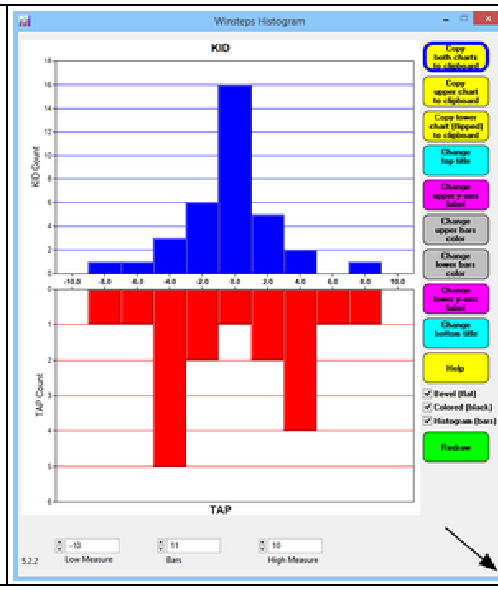
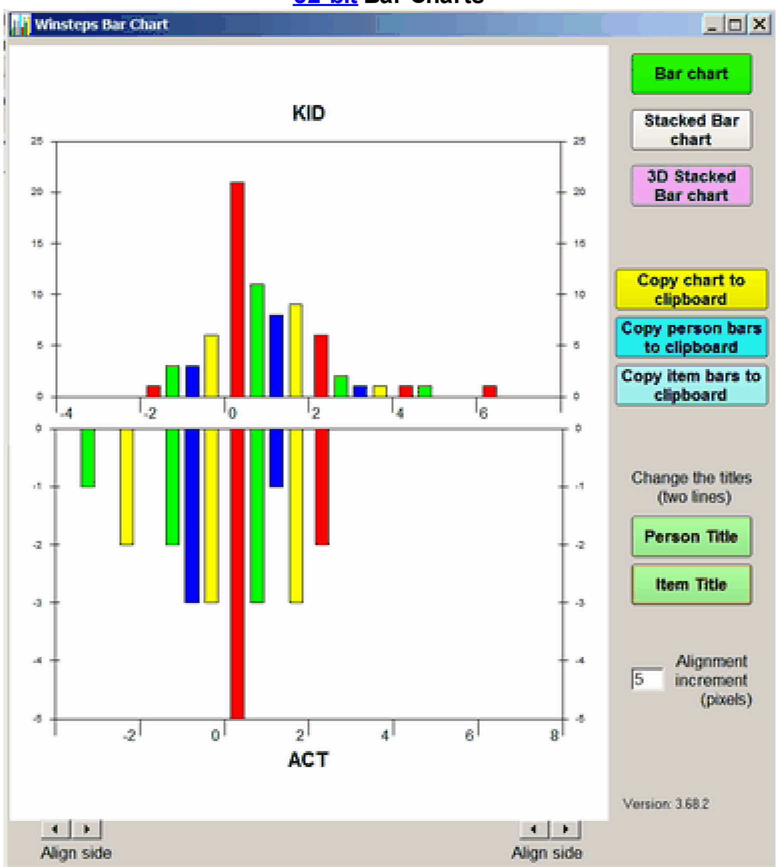
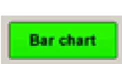
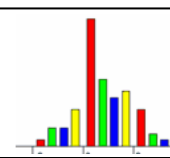
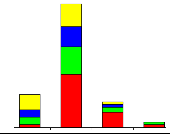
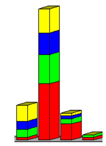
</table>

Change upper bars color		
Change lower bars color		
Change lower y-axis label	change the lower y-axis (item count) title 	
Change bottom title		
☑ Bevel (flat)	Checked in box: beveled: 	No check in box: no bevel: 
☑ Colored (black)	Check in box: colored: 	No check in box: black and white: 
☑ Histogram (bars)	Check in box: histogram-format: 	No check in box: bar-chart-format: 
Redraw	Redraw charts after changing charts specifications: 	
-4 Low Measure	Change lowest displayed value on the x-axis, then click on Redraw button	
12 Bars	Change the number of bars displayed on the bar chart, then click on Redraw button	
7 High Measure	Change highest displayed value on the x-axis, then click on Redraw button	

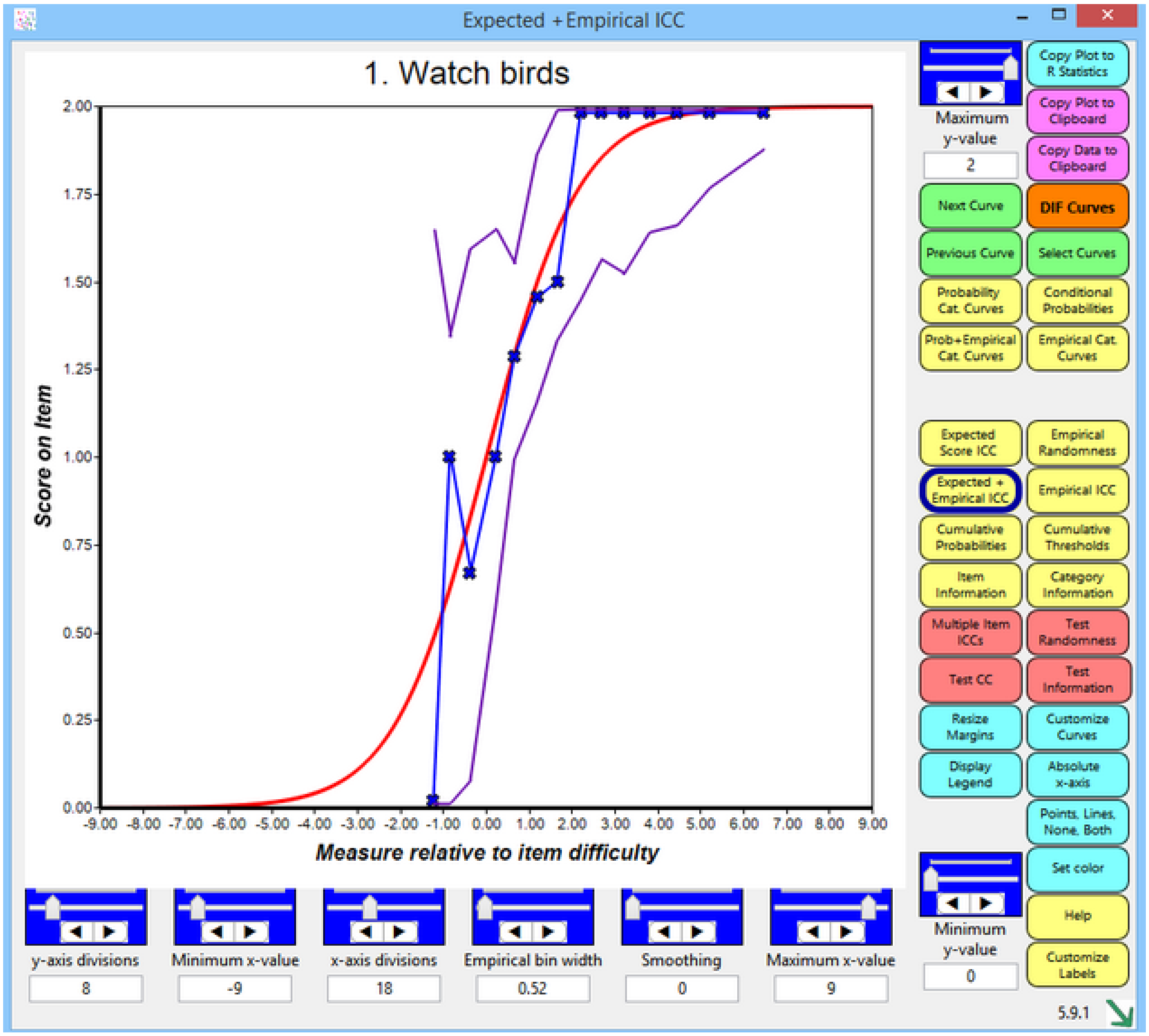
<table>
<tr><td></td><td>Drag graph larger with lower right corner</td><td>
</td></tr>
</table>

<table>
<tr><td colspan="3">[32-bit]() Bar Charts

</td></tr>
<tr><td>
</td><td>displays a standard barchart. The colors have no special meaning.</td><td></td></tr>
</table>

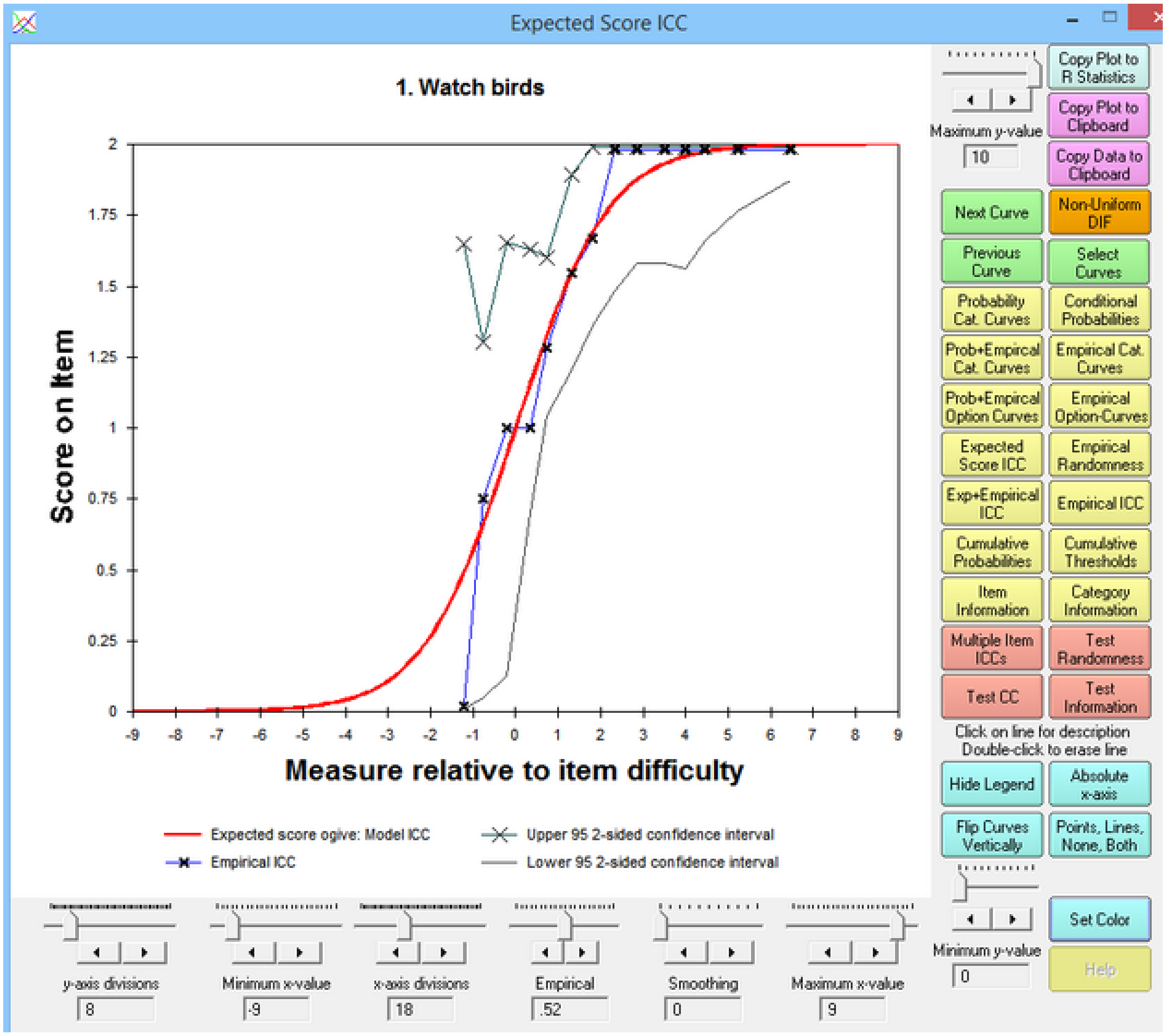
Stacked Bar chart	displays a stacked barchart	
3D Stacked Bar chart	displays a 3-dimensional stacked barchart	
Copy chart to clipboard	Copies the barchart to the Windows clipboard. This only copies the part of the plot that is visible on your screen. Maximize the chart window and increase your screen resolution if the entire plot is not visible. To increase screen resolution: Windows "Start", "Settings", "Control Panel", "Display", "Settings" and move the "Screen resolution" slider to the right. Open a graphics program, such as *Paint,* and paste in the image for editing.	
Copy person data to clipboard	Copies the person measure frequencies (upper barchart) to the Windows clipboard (for pasting into Excel, etc.) Use **paste special** to paste as a picture meta-file, bitmap or as a text listing of the data points.	
Copy item data to clipboard	Copies the item measure frequencies (lower barchart)to the Windows clipboard (for pasting into Excel, etc.) Use **paste special** to paste as a picture meta-file, bitmap or as a text listing of the data points.	
Person Title	Places cursor so you can type in a different person title	**New title goes here and a second line if you want**
Item Title	Places cursor so you can type in a different item title	**ACT**
5 Alignment increment (pixels)	This allows the alignment of the sides of the lower graph with those of the upper graph	Align side

16 Graphs

16.1 Graphs window



Enhanced 64-bit Graph Display



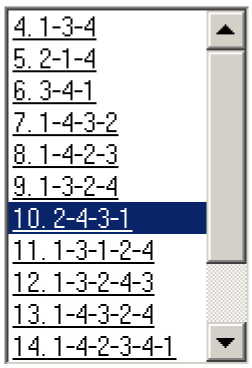
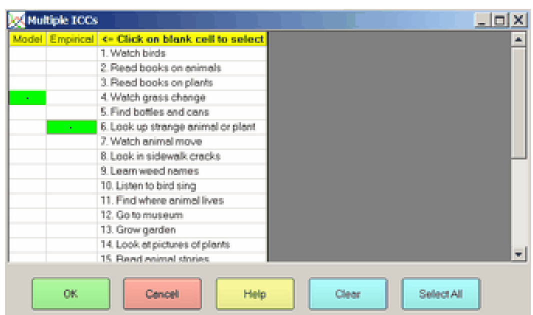
Standard 32-bit Graph Display

Button or Slider	**Function**
Graph Box	*Standard* or *Enhanced* - see [Graphs menu](#)
Title	Item entry number and label, or depends on type of graph
y-axis label and units	depends on type of graph
x-axis label	"Measure", person measures "Measure relative to item difficulty", (person measures - item difficulty) To switch from "Measure" to "Measure relative to item difficulty", click the blue button "Relative x-axis" To switch from "Measure relative to item difficulty" to "Measure", click the blue button "Absolute x-axis"
x-axis units	logits or [user-scaled](#) units
legend below x-axis label	displayed when blue *"Display Legend"* button is clicked
32-bit: curve label	click once on curve
32-bit: hide curve	double-click on curve. If all curves are hidden, then they are all re-displayed.
Right-hand side:	

Maximum y-value	Sets the maximum value on the vertical y-axis. Can be adjusted with slider, up-down arrows, or value in text box.
Copy Plot to R Statistics	One-click! launches R Statistics and displays the plot.
Copy Plot to Clipboard For better quality, see 32-bit: Graphs Window - bottom right 64-bit: drag bottom-right green arrow larger	Copies the graph to the Windows clipboard. This only copies the part of the plot that is visible on your screen. Maximize the chart window and increase your screen resolution if the entire plot is not visible. To increase screen resolution: Windows "Start", "Settings", "Control Panel", "Display", "Settings" and move the "Screen resolution" slider to the right. Open a graphics or word-processing program, such as ***Paint*** or ***Word,*** or install the freeware: Irfanview.Then **paste** in the image for editing. To save the graphics plot in black-and-white, "Save As", "Black-and-white". For more options, see www.techjunkie.com/save-clipboard-image-as-jpg-png/ Copying many similar graphs can be expedited with a keyboard macro, such as autohotkey: www.autohotkey.com
Copy Data to Clipboard	Copies the graphed numbers to the Windows clipboard (for pasting into Excel, etc.) Use **paste special** to paste as a picture meta-file, bitmap or as a text listing of the data points. Each row corresponds to a set of points to plot: Column A - ignore (internal row identifier) Column B - x-axis for point on first curve: measure relative to item difficulty or relative to latent variable Column C - y-axis for point on first curve: probability, expected score, etc. Column D - x-axis for point on second curve: measure relative to item difficulty or relative to latent variable Column E - y-axis for point on second curve: probability, expected score, etc. etc. Scatterplot: Column C (y-axis) against Column B (x-axis) Column E (y-axis) against Column D (x-axis) etc. Combined plots: the curves on two or more Winsteps graphs can be combined into one Excel plot using "Copy Data" from the different graphs into one Excel worksheet.
Next Curve	Displays the same graph for the item with the next higher entry number.
Non-Uniform DIF	Displays the Rasch-model curve for the item and the empirical DIF curves for the DIF classifications groups when "Non-uniform DIF" is clicked on the Graphs Menu,
Previous Curve	Displays the same graph for the item with the next lower entry number.
Select Curves	Displays the graph for the selected item from the curve-selection-box:
Probability Cat. Curves	Displays the Rasch-model probability-curve for each response-category
Conditional Probabilities	Displays the Rasch-model probability-curve for the relative probability of each adjacent pair of categories. These are dichotomous ogives.
Prob+Empirical Cat. Curves	Displays the Rasch-model probability-curve for each response-category, together with the empirical curve summarizing the data in each empirical interval.
Empirical Cat. Curves	Displays the empirical curve for each response-category, summarizing the data in each empirical interval
Prob+Empirical Option Curves	Displays the Rasch-model probability-curve for each response-option, together with the empirical curve summarizing the data in each empirical interval.
Empirical Option-Curves	Displays the empirical curve for each response-option, summarizing the data in each empirical interval
Expected Score ICC	Displays the expected-score item characteristic curve, the item's Rasch-model logistic ogive.
Empirical Randomness	Displays the fit of the item, summarizing the data in each empirical interval
Exp+Empirical ICC Expected + Empirical ICC	Displays the expected-score item characteristic curve, the item's Rasch-model logistic ogive, together with the empirical ICC summarizing the data in each empirical interval.

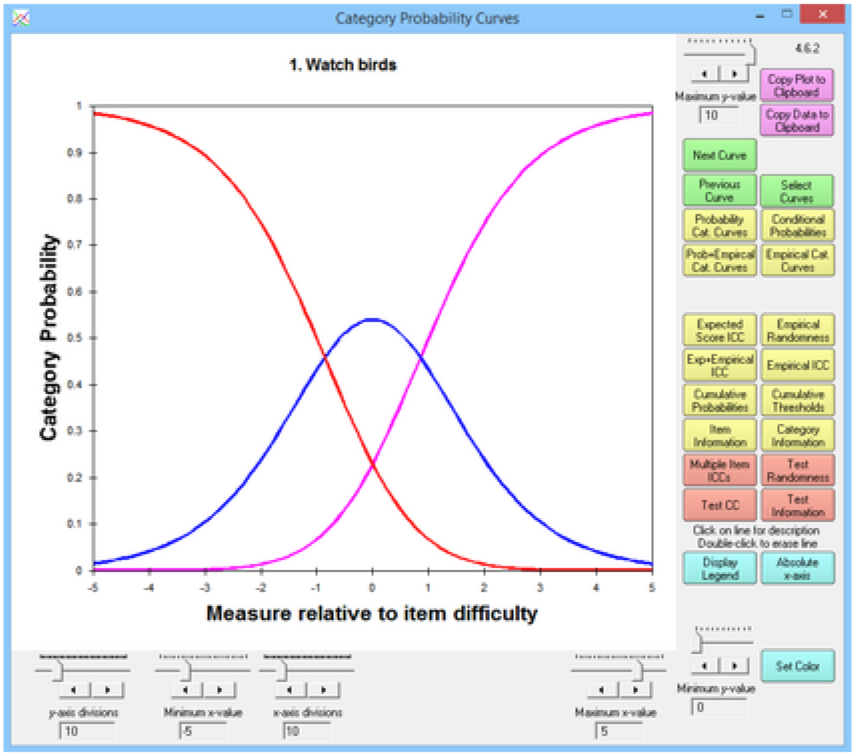
Empirical ICC	Displays the item's empirical item characteristic curve, summarizing the data in each empirical interval.
Cumulative Probabilities	Displays the Rasch-model cumulative probability-curve for each response-category and the categories below it. Click on the "Flip Curves Vertically" button for the probability of each category and the categories above it.
Cumulative Thresholds	Display the probabilities of all categories up to and including each category, and also the probabilities of all the categories above each category. The curves cross on the 0.5 probability line at the cumulative threshold (Rasch-Thurstonian threshold)
Item Information	Displays the item-information function according to the Rasch model.
Category Information	Displays the information function for each category according to the Rasch model.
Multiple Item ICCs	Displays multiple Rasch-model and empirical item characteristic curves as selected in the ICC-selection box.
Test Randomness	Displays the fit of all the items in the test, summarizing the data in each empirical interval
Test CC	Displays the Rasch-model test characteristic curve (TCC), showing the relationship between raw scores and Rasch measures on the complete test of all active items.
Test Information	Displays the Test-Information Function (TIF) according to the Rasch model. The inverse square-root of the test information is the standard error of the Rasch person measure.
Enhanced: Resize Margins	Changes the left-side margin and the legend height, so they can be better displayed
Enhanced: Customize Curves	Hide unwanted curves and change colors of the curves
Standard: Click on line for description	Click on a curve to show its description below the graph. You can identify an individual traceline by **single-left-clicking** on it. Its description will then appear below the plot. Click elsewhere on the plot to remove the selection indicators.
Standard: Double-click to erase line	You can remove a traceline by **double-left-clicking** on it. Click on the command button, e.g., "Probability Curves", to return the plot to its initial appearance.
Display Legend Hide Legend	Click on "Display legend" to show descriptions of all the curves below the graph. Click on "Hide legend" to remove the descriptions.
Absolute x-axis Relative x-axis	Click on "Absolute x-axis" to show the graphs with measures (or raw scores) on the latent variable along the x-axis. Click on "Relative x-axis" to show the graphs with the x-axis plotted relative to the item difficulty. Multiple Item ICCs shows what happens for these two choices
Flip Curves Vertically	Reverses the cumulative probability curves on the y-axis
Points, Lines, None, Both	Click on this button to show the empirical curves as both points("x") and lines, points only, lines only, and neither points nor lines.
Adjust minimum Y-value	Sets the minimum value on the vertical y-axis
Smoothing	Controls the degrees of smoothing of the empirical curve (jagged with "x")
Set Color	Click on a curve to select it, the click on "Set Color" to change its color using the color-selection-box. White makes the line disappear.
Help	Click on Help to display this page.
Customize Labels	Change Heading, x-axis label, y-axis label
Across the bottom: left to right	
y-axis divisions	Sets the number of tick-marked intervals on the y-axis
Minimum x-value	Sets the minimum value on the horizontal x-axis. To decrease the minimum possible X-value, set EXTREMESCORE= to a small value.
x-axis divisions	Sets the number of tick-marked intervals on the x-axis. *Enhanced:* zero (0) automatically assigns x-axis divisions
Empirical interval	Sets the number of empirical summary-intervals on the X-axis. Each observation, Xni, has an observed (empirical) value, such as 0 or 1 for a dichotomy, and also a measure on the rating scale = Ability of person n - Difficulty of item i.

	These observations are summarized into empirical intervals on the latent variable. Each summary is plotted as the mean of the observed values in the interval (y-axis) and the mean of the measures (x-axis). The maximum size of the interval is from the lowest measure for any observation to the highest measure for an observation. The minimum size of the interval is .01 logits. The difference between the maximum size and the minimum size is divided into roughly 100 increments. Using the empirical interval slider, or left-right arrows, changes the size of the interval. The current size of the interval is shown in "Empirical x.xx Interval" The 1-200 number of the empirical slider is a rough indicator of relative size, and can be ignored.
Smoothing	Smooths the empirical line, which is a series of points joined by line segments. Winsteps uses "cubic spines" for smoothing functions.
Maximum x-value	Sets the maximum value on the horizontal X-axis. To increase the maximum possible X-value, set [EXTREMESCORE=](#) to a small value.

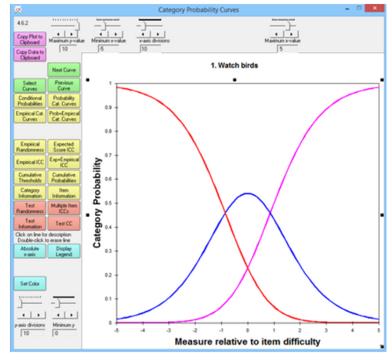
Curve selection Box		This box displays the item entry numbers and labels. Click on the item which you want displayed.
ICC Selection Box		To select the curves: click on the cells and they will turn green to indicate which curves are selected for display. Then click OK to display the curves.
Color Selection Box		Click on desired background color, and the OK

16.2 Graphs window - bottom right

If the option is checked in the [Graphs menu](#), the Graphs are displayed in the bottom right of the [Graphs window](#), so that they can be pulled larger. This is useful for increasing the quality of the graphs when their size is reduced.



Standard Graph Window



Graphs displayed to bottom right

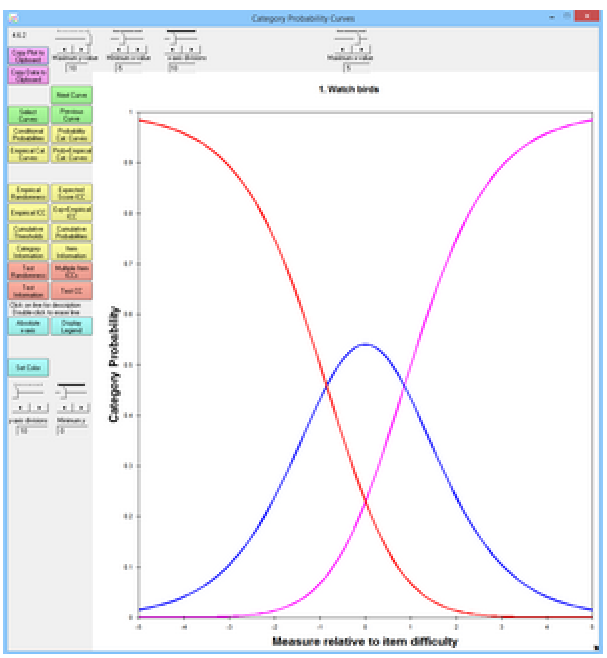
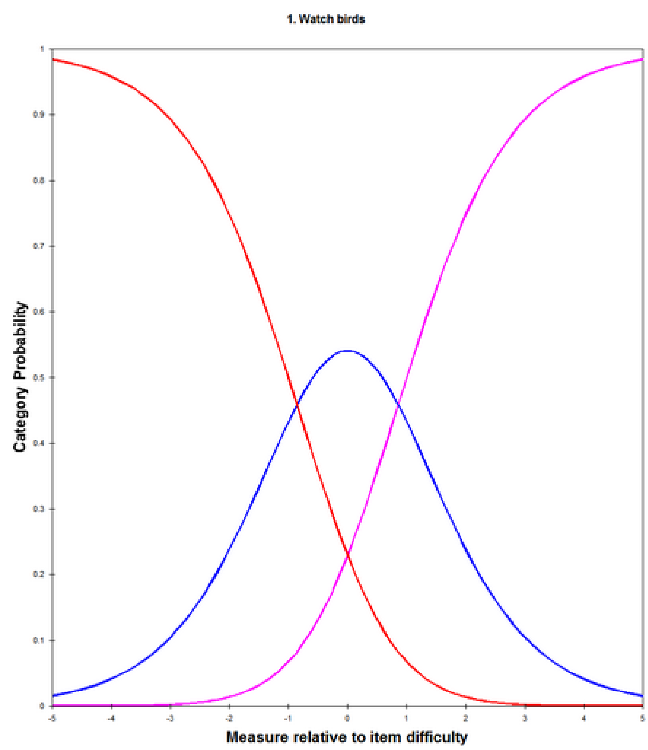


Image pulled to lower-right by dragging on bottom right corner



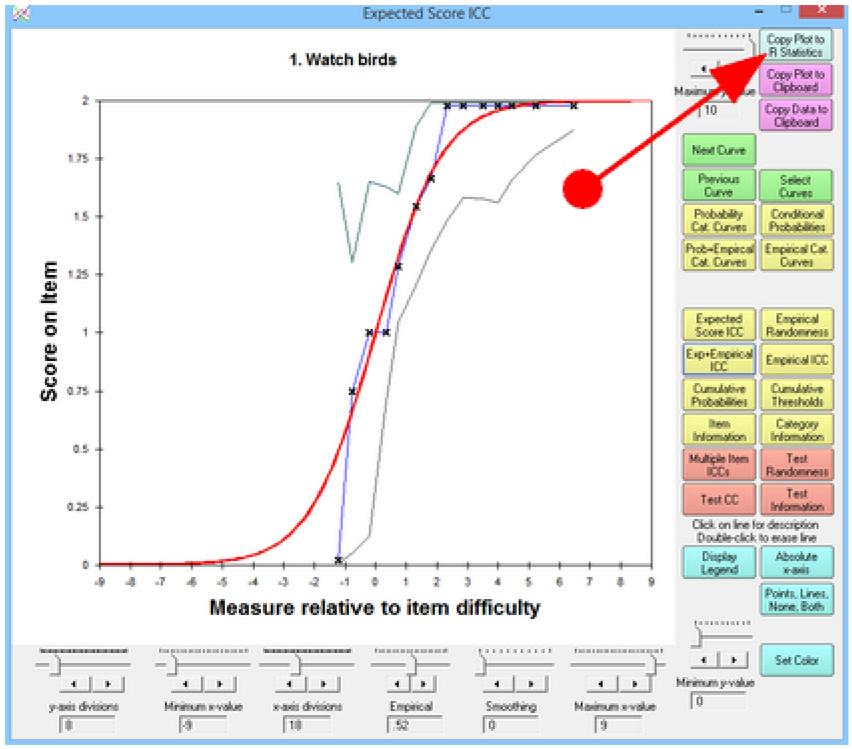
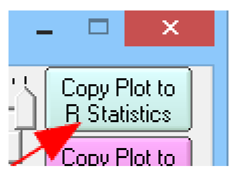
Copy-plot-to-clipboard, thenImage resized to standard size. Notice that the lines are finer. Use Graphics software to beautify the text.

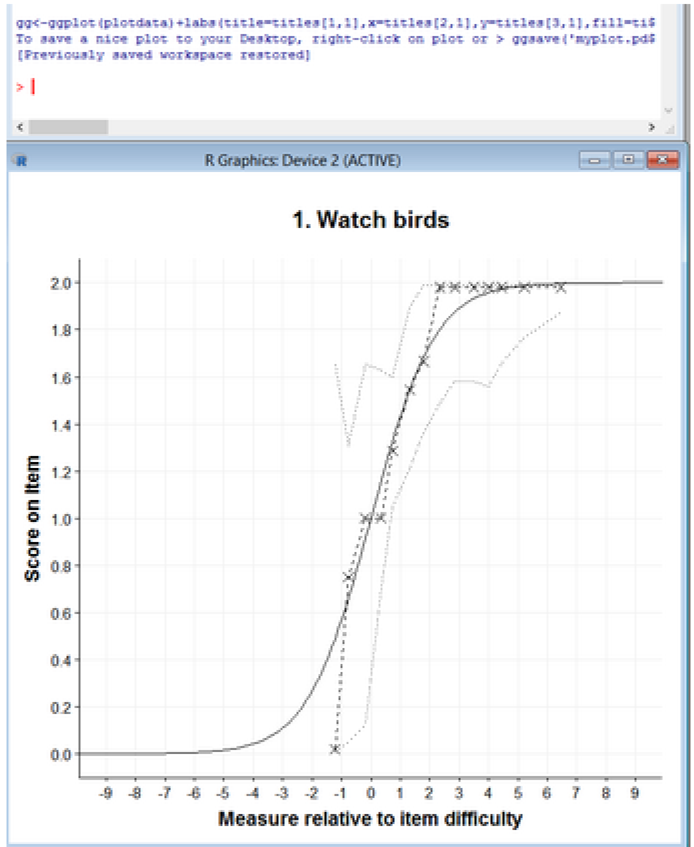
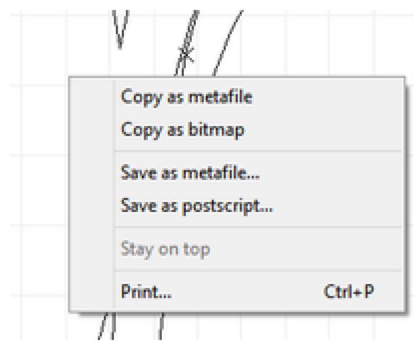
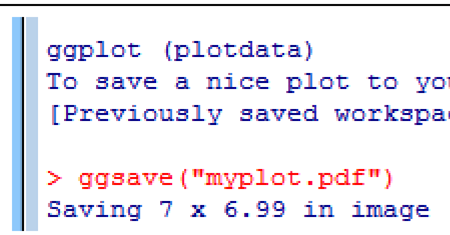
To convert one of these to .jpg .png, .gif

1. Copy plot to clipboard
2. Paste into Paint or your graphics program
or install the freeware: Irfanview

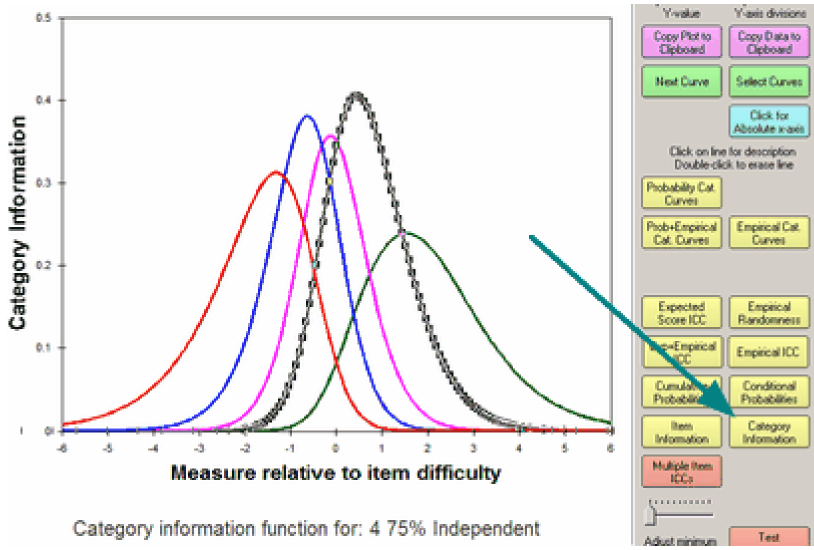
For more options, see www.techjunkie.com/save-clipboard-image-as-jpg-png/ 3. Save as .jpg, etc.	

16.3 Graphs window - Publication-Quality

What we do:	What we see:
1. [Install R Statistics](#) (once only) 2. Launch Winsteps 3. Do an analysis 4. [Graphs menu](#) 5. Choose and display graph 6. Make any adjustments you want	
7. One Click! Click on "Copy Plot to R Statistics"	

8. Do nothing 9. A short wait: required R Statistics are installed automatically (once only) 10. R statistics function "ggplot" activates automatically 11. The plot displays	
1. Right-click on plot to save with publication -quality better than on the screen!	
1. Or save the plot with ggsave ("myplot.pdf") ggsave ("myplot.svg") other options: .eps, .tex, .pdf, .jpg, .tif, .png, .bmp, .svg and .wmf	

16.4 Category information function

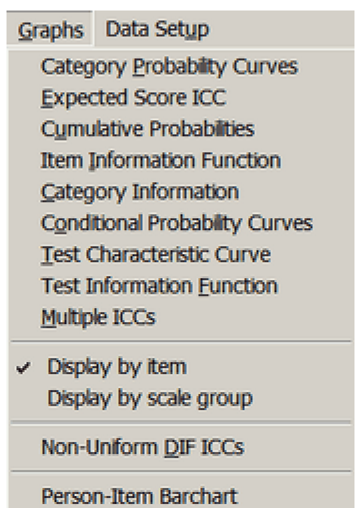


Select by clicking on "Category Information" or from the [Graphs](#) menu. This shows the item information partitioned according to the probability of observing each category, as defined in R.D. Bock (1972).

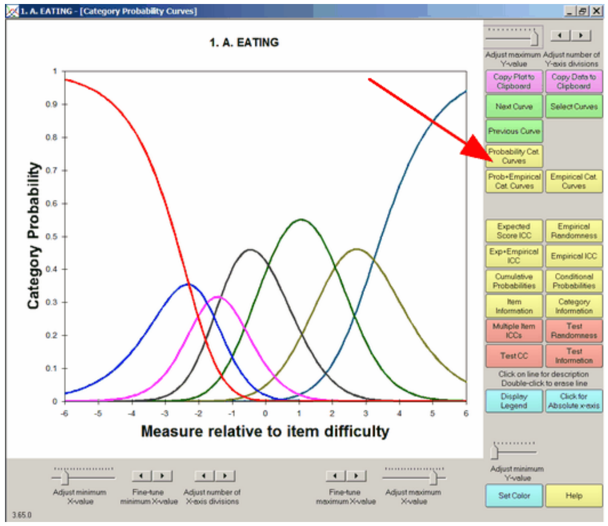
Buttons are described in [Graph window](#).

16.5 Category probability curves (Rasch-Andrich thresholds)

On the [Graphs menu](#), click on "Display by item" or "Display by scale group"

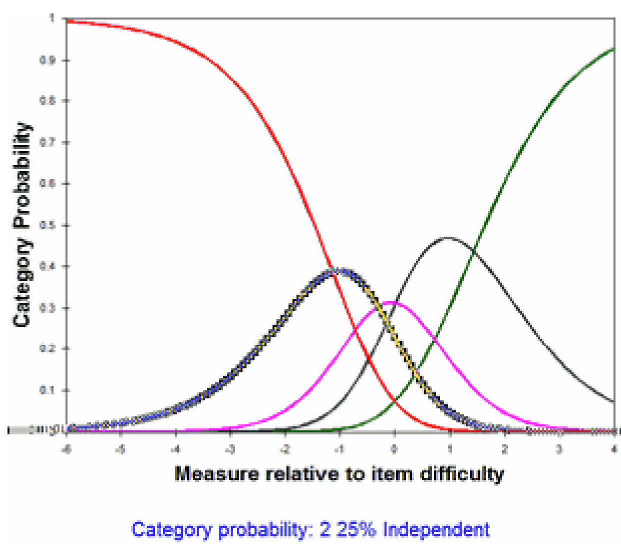


Click on "Category Probability Curves" (Item Response Curves, IRCs)



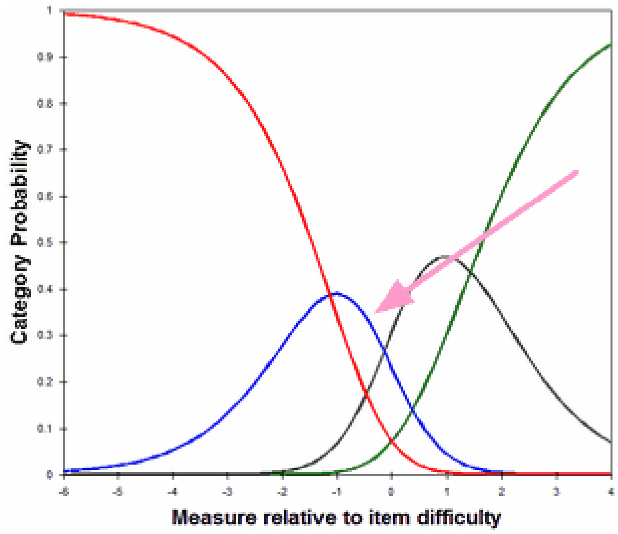
Select by clicking on "Probability Cat. Curves" in the Graph or from the [Graphs](#) menu.
Buttons are described in [Graph window](#).

This shows the probability of observing each ordered category according to the Rasch model. **[Rasch-Andrich thresholds](#)** are the intersections of the curves for adjacent categories. To identify a category, click on it:

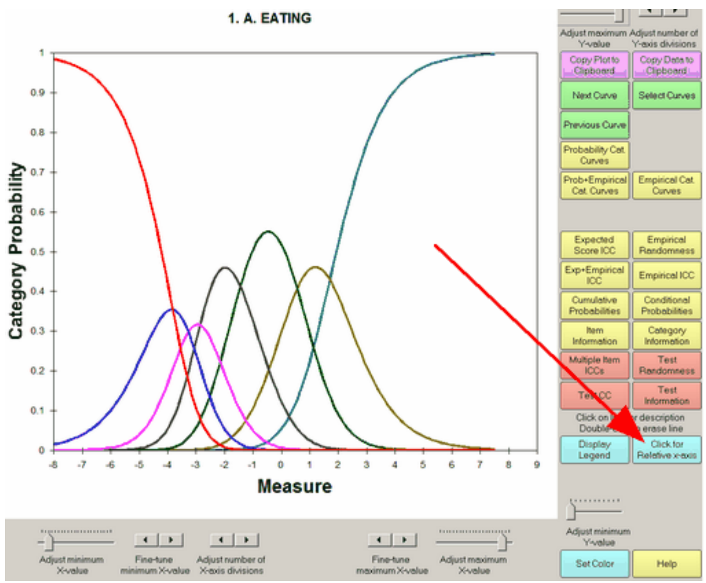


The caption can be clicked on and moved. "2" is the category score. "25% independent" is the category description from [CFILE=](#) or [CLFILE=](#). To clear the black highlighting, click somewhere else on the plot.

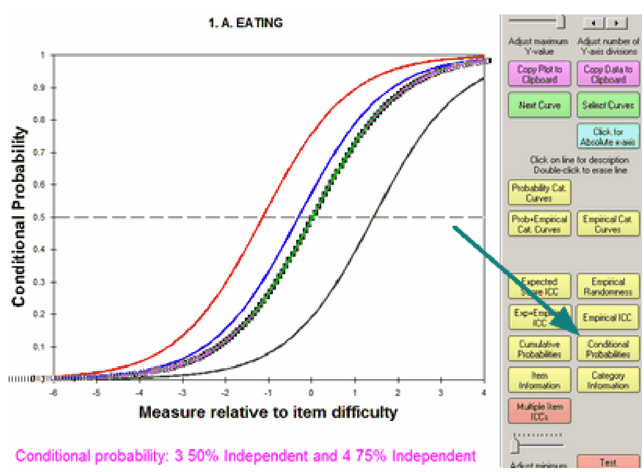
To delete the line corresponding to a category, double-click on it:



For individual items, the horizontal scaling can be changed from relative to item difficulty to relative to the latent variable by clicking on "Click for Absolute x-axis":



16.6 Conditional probability curves



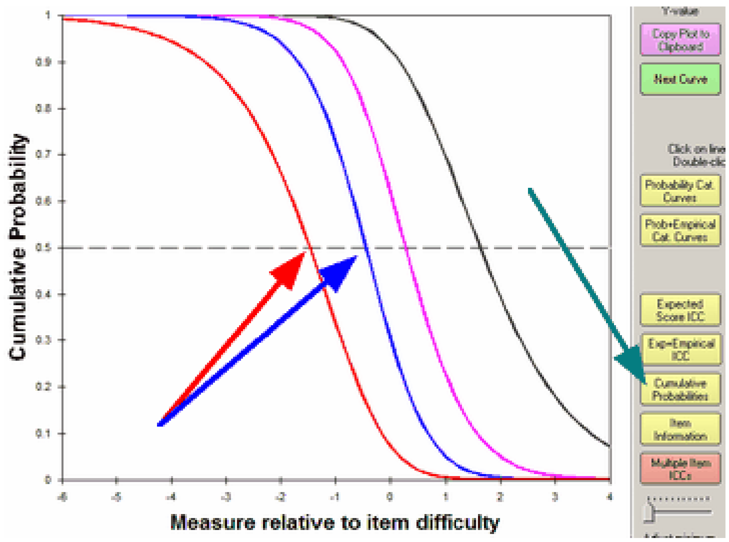
Select by clicking on "Conditional Probabilities" or from the Graphs menu. Conditional probabilities of observing adjacent categories. These are a series of Rasch dichotomous ogives. The intercepts with 0.5 probability are the Rasch-Andrich thresholds. They can be disordered relative to the latent variable.

Buttons are described in Graph window.

Polytomous RP50 values are the points where the ogives cross the 0.5 line. Click on "Absolute x-axis" for values relative to the latent variable. "Copy data to clipboard", then paste into Excel to see the numerical value.

Polytomous RP67 values are the points where the ogives cross the invisible 0.67 line. Click on "Absolute x-axis" for values relative to the latent variable. "Copy data to clipboard", then paste into Excel to see the numerical value.

16.7 Cumulative probabilities



Select by clicking on "Cumulative Probabilities" or from the Graphs menu.

Lines: This shows the modeled category probability curves accumulated so that the left-hand curve (red) is the probability of being observed in the lowest category. The next curve (blue) is the probability of being observed in the lowest or next lowest category. And so on to the right. If the categories are number 1, 2, 3, 4, 5. Then the red line is the probability of observing category 1. The blue line is the probability of observing categories 1 or 2. The pink line is the probability of observing categories 1 or 2 or 3. The black line is the probability of observing categories 1 or 2 or 3 or 4. The probability of observing categories 1 or 2 or 3 or 4 or 5 (which includes every category) is 1.0 and corresponds to the upper side of the graph box.

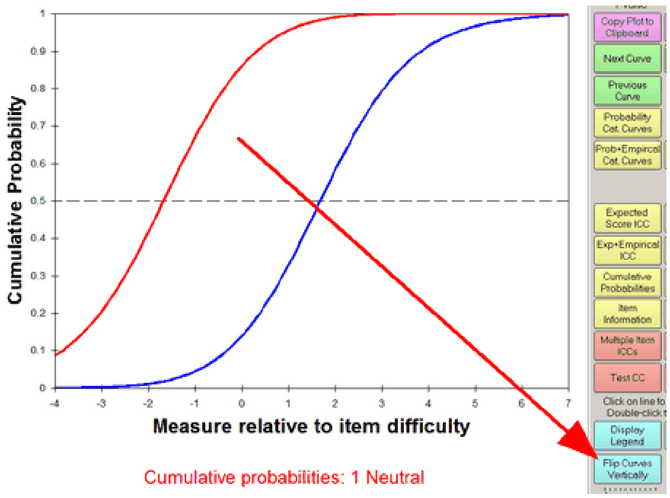
The cumulative probability is the y-axis in this graph, but is the x-axis in G.N. Masters (1988) "The Analysis of Partial Credit Scoring" (Figure 2), *Applied Measurement in Education,* 1:4, 279-297. The cumulative probability accumulates the probabilities across the categories upwards from low category to high category (or *vice versa)* for any ability level.

Arrows: The points of intersection between these curves and the 0.5 probability line are the Rasch-Thurstonian thresholds. The points at which being observed in this category (or below) and the category above (or higher) are equal. These curves are always in the order of the category scores. The red arrow points to the Thurstonian threshold where the probability of observing category 1 and of observing categories 2 or 3 or 4 or 5 are equal. The is called the Thurstonian threshold for Category 2. The blue arrow points to the Thurstonian threshold where the probability of observing categories 1 or 2 and of observing categories 3 or 4 or 5 are equal. The is called the Thurstonian threshold for Category 3. The interval between the Thurstonian Threshold for Category 2 and the Thurstonian Threshold for Category 3 is one definition of the interval for category 2 on the latent variable.

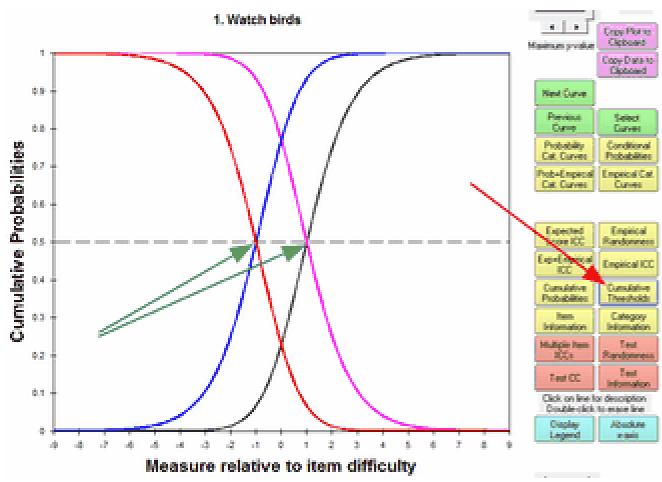
Buttons are described in Graph window.

Click on the "Flip Curves Vertically" button to change the vertical direction of the curves. This reverses the definition of the cumulative probability curves. When flipped the red line in the plot above is the probability of observing categories 2 or 3 or

4 or 5. The flipped blue line in the plot above is the probability of observing categories 3 or 4 or 5. The flipped pink line is the probability of observing categories 4 or 5. The black line is the probability of observing category 5. Flipping the curves does not change the Thurstonian Thresholds. The red arrow continues to point to the Thurstonian Threshold for category 2.



16.8 Cumulative thresholds (Rasch-Thurstone thresholds)



Select by clicking on "Cumulative Thresholds" in the Graphs window.

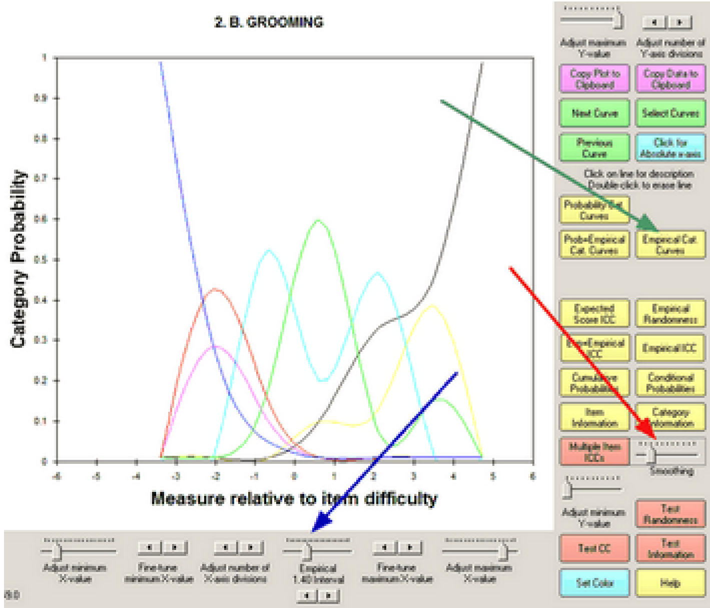
Lines: This shows the modeled category probability curves accumulated in pairs so that the left-hand curve (red) is the probability of being observed in the lowest category. The next curve (blue) is the probability of being observed in categories above the lowest category. Then the next curve (brown) is the probability of being observed in the two lowest categories. The next curve (pink) is the probability of being observed in categories above the two lowest categories. And so on to the right for rating scales with more categories.

The cumulative probability is the y-axis in this graph, but is the x-axis in G.N. Masters (1988) "The Analysis of Partial Credit Scoring" (Figure 2), *Applied Measurement in Education,* 1:4, 279-297. The cumulative probability accumulates the probabilities across the categories upwards from low category to high category (or *vice versa)* for any ability level.

Arrows: The points of intersection between these curves and the 0.5 probability line are the **Rasch-Thurstonian thresholds** (green arrows). The points at which being observed in this category (or below) and the category above (or higher) are equal. These curves are always in the order of the category scores. The interval between the Thurstonian Threshold for Category 2 and the Thurstonian Threshold for Category 3 is one definition of the interval for category 2 on the latent variable.

Buttons are described in Graph window.

16.9 Empirical category curves - frequency polygons

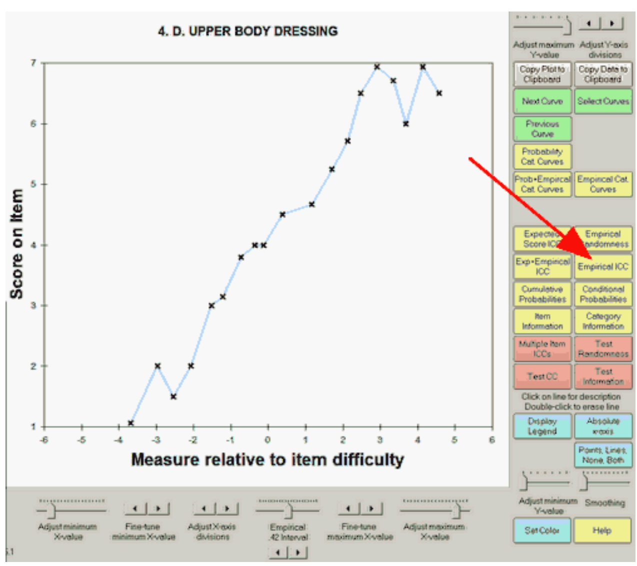


These are the empirical (data-describing) category curves (frequency polygons). They are obtained by clicking on "Empirical Cat. Curves" or from the Graphs menu. The width of each empirical interval can be adjusted by the "Empirical Interval" control. The smoothing of the empirical curves by discrete cubic splines is adjusted by the smoothing control.

Buttons are described in Graph window.

Charles S. Duris (1980). Fortran Routines for Discrete Cubic Spline Interpolation and Smoothing. ACM Algorithm 547.

16.10 Empirical ICC, IRF



Select by clicking on "Empirical ICC" or from the Graphs menu.

Line: This shows the empirical (data-descriptive) item characteristic curve. Each black "x" represents observations in an interval on the latent variable. The "x" is positioned at the average rating (y-axis) at the average measure (x-axis) for observations close by. "Close by" is set by the empirical slider beneath the plot. The blue lines are merely to aid the eye discern the trend. The curve can be smoothed with the "smoothing" slider. The Points button controls whether points+lines, points or lines are displayed.

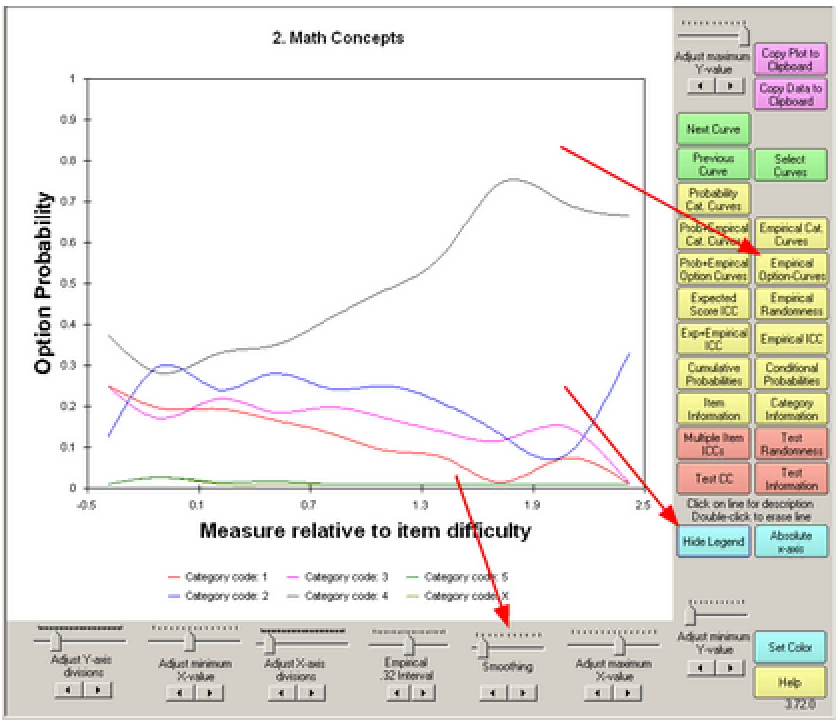
Buttons are described in Graph window.

The markers on the empirical ICCs are the data-points. The lines between the markers are interpolations.

Think of the empirical ICC for an item. This summarizes the scored responses to the item. There is one scored response by each person. Each person has an ability. The abilities are stratified into ability ranges. The size of the range is shown by the slider below the middle of the graph. In each ability range, one marker is plotted. The x-axis is the average ability of the persons in that range. If there is no person, then there is no marker. The y-axis is the average of the scored responses by the persons. The low end of the lowest slot is the lowest person ability (- item difficulty) observed for the item.

The lines between the markers are to help our eyes see the pattern of the markers more clearly. If each ability range is very wide, then there may be only one or two markers. If the each ability range is very narrow, there could be one marker for each observation. There is an art to adjusting the width of the ability ranges to produce the most useful empirical ICC.

16.11 Empirical option curves



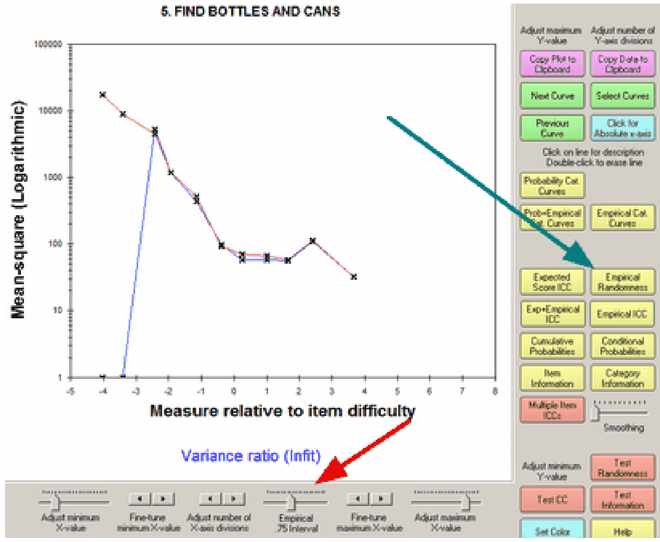
In the Graphs window, click on "Empirical Option Curves" (no Probability). Each curve has a different color. Then click on "Legend". The color for each option is shown below the graph.

This shows the probability of choosing each option for a multiple-choice item (MCQ) as a trace line. The ascending option should be the correct response. The other options should be the incorrect distractors.

The "Empirical Option Curves" button and curves are active when Winsteps has the required information beyond that displayed in the "Empirical Category Curves". This happens when
1) "Display by item" is checked on the Winsteps Graphs menu.
and
2) The data have a scoring key or other rescoring commands.

See, for instance, Robert L. Brennan, "Educational Measurement", chapter: "Test Development'.

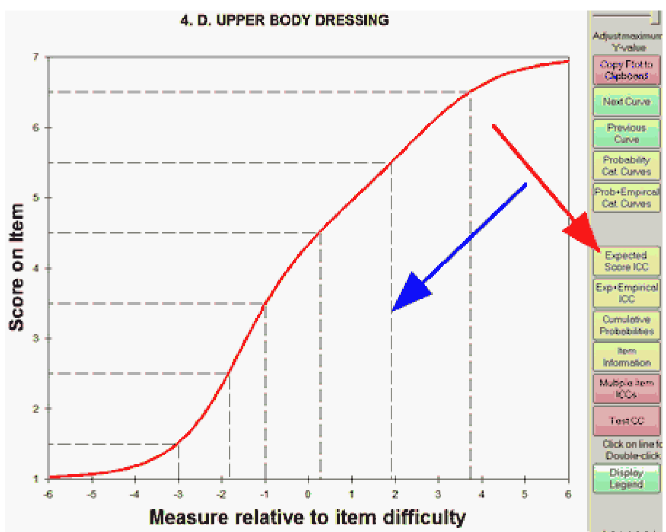
16.12 Empirical randomness



Select by clicking on "Empirical Randomness" or from the [Graphs](#) menu. Empirical intervals are set with the "Empirical Interval" slider.
This displays the local value of the mean-square statistics. The Outfit mean-square statistic (standardized residual chi-square divided by its degrees of freedom) is the red line. The Infit mean-square statistic (ratio of observed to expected residual variance) is the blue line.

Buttons are described in [Graph window](#).

16.13 Expected score ICC, IRF (Rasch-half-point thresholds)



Select by clicking on "Expected Score ICC" or from the [Graphs](#) menu. **Expected Score ICC** plots the model-expected item characteristic curve, also called the Item Response Function, IRF. This shows the Rasch-model prediction for each measure relative to item difficulty Its shape is always ascending monotonic. The dashed lines indicate the **[Rasch-half-point thresholds](#)** correspond to expected values of .5 score points. The intervals on the x-axis demarcated by dashed lines are the zones within which the expected score rounds to each observed category. To remove the dashed lines, double-click on them.

The plot is of the "model item characteristic curve (ICC)" , also called the "item response function (IRF)". This is used for inference. If we know the score on the item, we can infer the ability of the person responding. If we know the ability of the person responding, we can infer the expected score on the item.

(difficulty of item + person's score on the item on y-axis) -> person's ability on x-axis

(person's ability on x-axis - difficulty of item) -> expected score on the item on y-axis

Item discrimination: the item is more discriminating where the ICC is steeper, and less discriminating where the ICC is flatter.

Buttons are described in Graph window.

Computation of the IRF

For an item with categories k=0,1,2,...,m and Andrich Thresholds Fk, with F0 chosen to be 0, then

At location x on the latent variable (relative to the item difficulty), the probability of observing category k is

Pk(x) = exponential(k*x - sum(Fh) for h=0 to k) / sump(x)

sumpx = sum (exponential(k*x - sum(Fh) for h=0 to k)) for k=0 to m

The expected score y at location x is given by

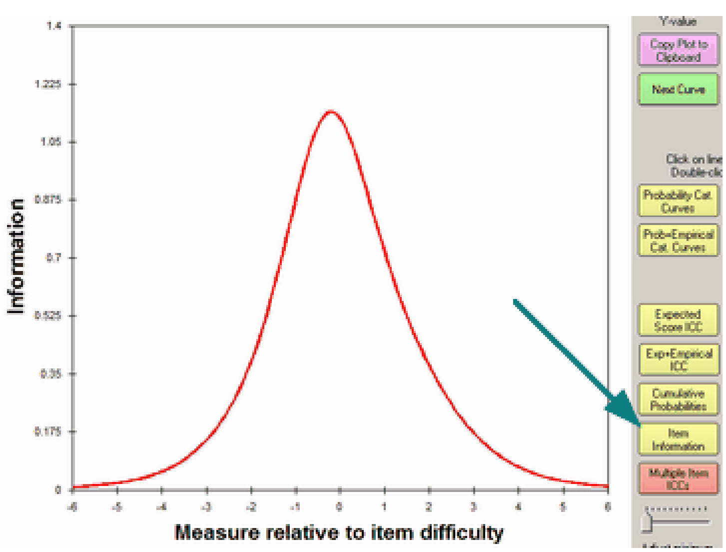
y = sum (k*Pk(x)) for k=0 to m

Computation of the Half-Point Threshold

The formula for the half-point threshold is solved iteratively, for category j, the half-point threshold is at point x (relative to the item difficulty) given by

j - 0.5 = sum (k*Pk(x)) for k=0 to m

16.14 Item information function

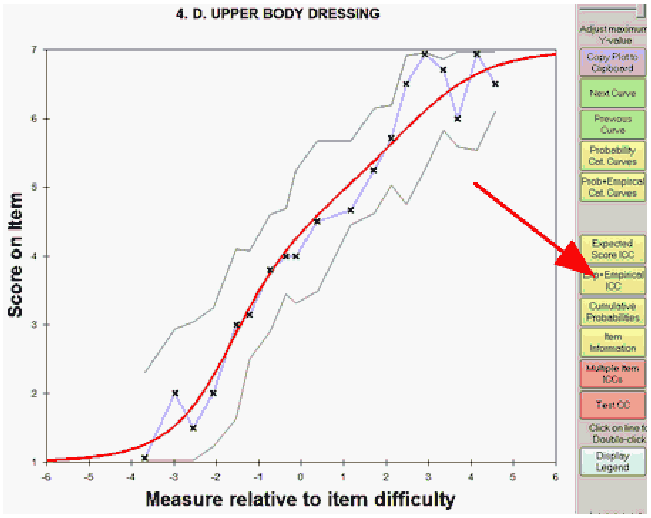


Select by clicking on "Item Information" or from the Graphs menu. This shows the (Ronald A.) Fisher measurement information in responses made to items. It is the same as the binomial variance (dichotomies) or the multinomial variance (polytomies).

This is the weighting used in TARGET=Y.

Buttons are described in Graph window.

16.15 Model and empirical ICCs



This shows the joint display of the expected and empirical ICCs. The boundary lines indicate the upper and lower 95% two-sided confidence intervals (interpreted vertically). When an empirical point lies outside of the boundaries, then some unmodeled source of variance maybe present in the observations. **Double-click** on a line on this plot to remove it from the display.

The solid red "model" line is generated by the relevant Rasch model. For a test of dichotomous items, these red curves will be the same for every item.

The empirical blue line is interpolated between the average ratings in each interval along the variable, marked by **x**. The empirical ("**x**") x- and y-coordinates are the means of the measures and ratings for observations in the interval. The display of the blue line and the x's is controlled by the Points button.

The upper **green** line (and the lower gray line) are at 1.96 model standard errors above (and below) the model "red line", i.e., form a two-sided 95% confidence band around the model red line. The vertical distance of these lines from the red line is determined by the number of observations in the interval, not by their fit.

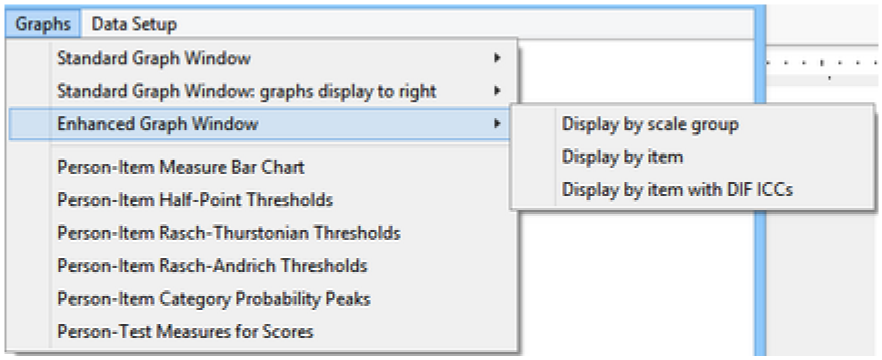
Buttons are described in Graph window.

The confidence bands are read vertically (not horizontally). There are two plotted values:
1. the mean of the observed values in the interval. Indicated by *
2. the mean of the expected values in the interval. This is the red central line.
3. the confidence interval is around the mean expected value, the point on the red line vertically aligned with *
Each expected value has a model variance. These model variances are accumulated in the interval. Then converted into the standard error of the mean, SEM, around the mean expected value. SEM = square-root(summed model variance)/(count of observations in the interval). 1.96*SEM vertically from the expected value are the confidence bands.

Observed data -> Rasch Model -> Rasch estimates -> Model-based "Expected" ICC
Observed data -> summarized in a Rasch context, so that the x- and y- axes are the same as the Model ICC -> Empirical ICC

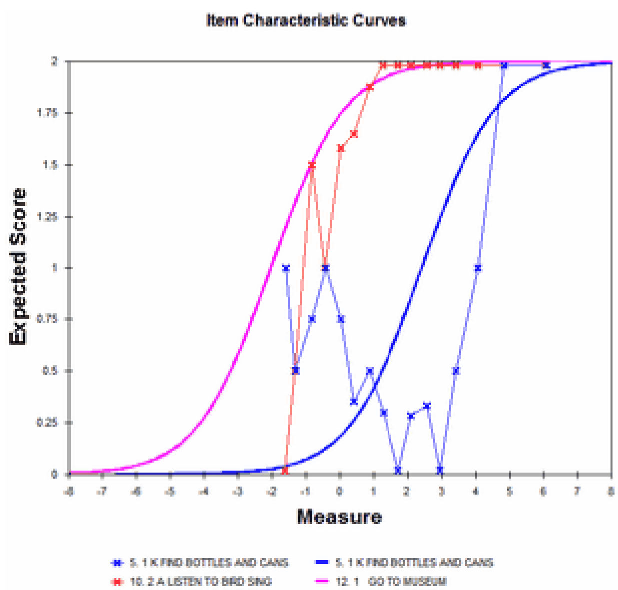
16.16 Multiple item ICCs

Select by clicking on "Multiple Item ICCs" in the [Graphs](#) menu. This enables the display of multiple model and empirical item characteristic curves/item response functions ICCs/IRFs and item information functions IIFs on the same graph.



On the Graphs pull-down menu, please check "Display by Item"

Click on the "Model", "Empirical", and "Information" curves you wish to display. Click again on your selection to clear it. Click on "OK" to display the curves.

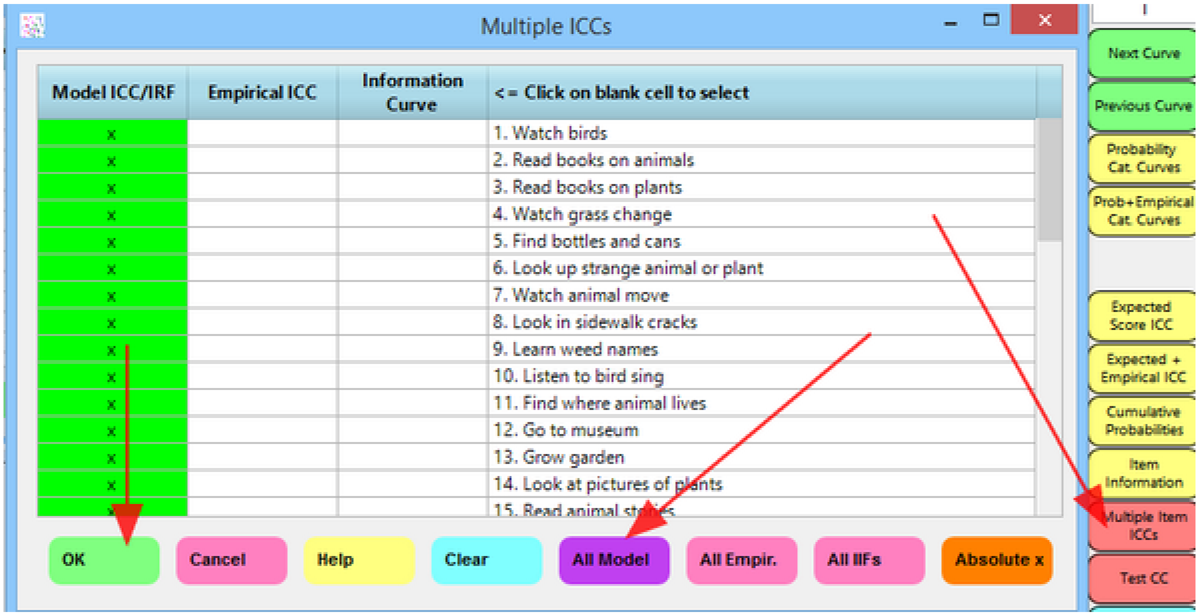


Buttons are described in [Graph window](#). The x-axis can use absolute scaling relative to the latent trait (as in this Figure) or scaling relative to each item difficulty. Absolute scaling is in logits or your user-scaled units (USCALE=, UIMEAN=) or [raw scores](#).

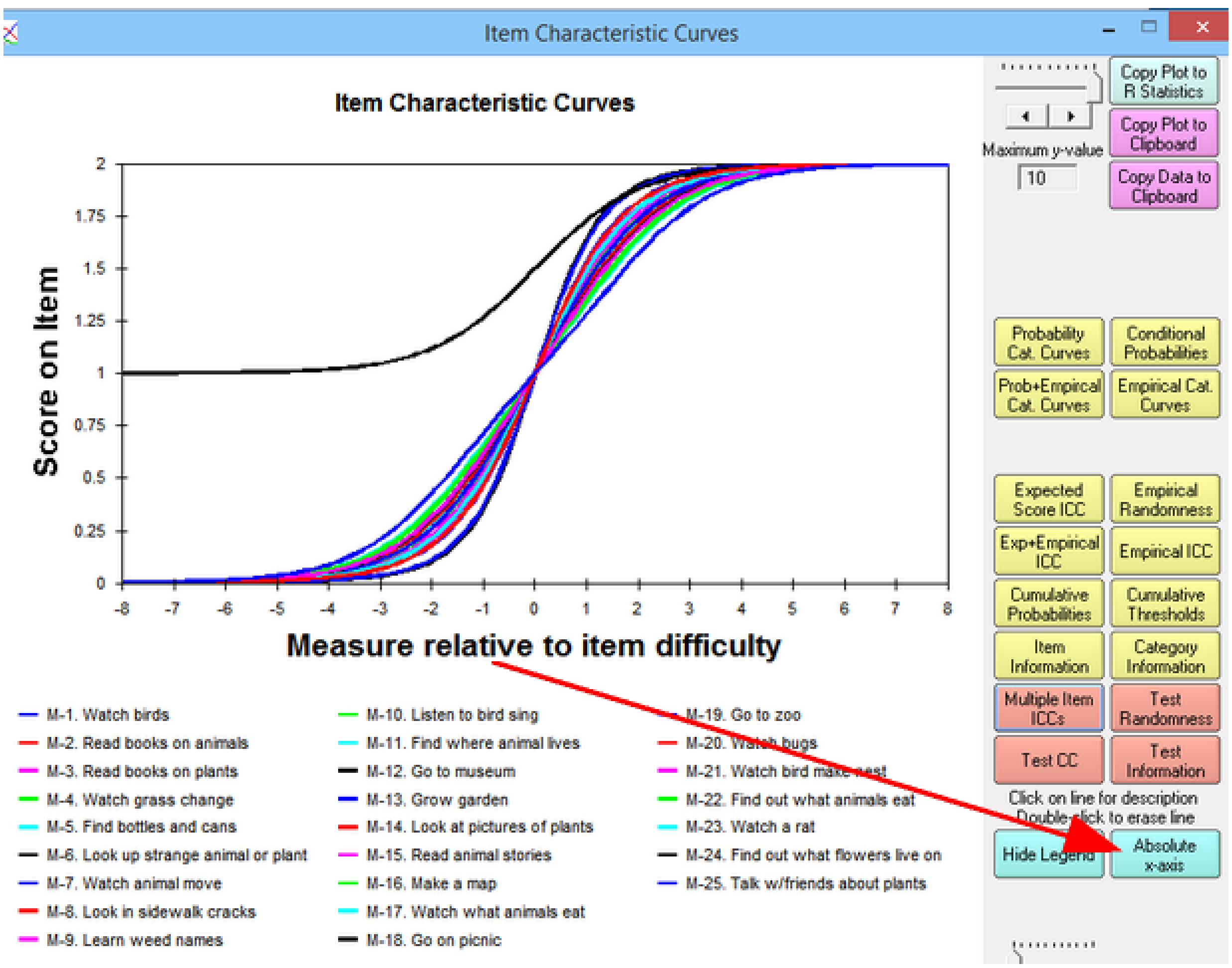
Displayed are the selected model and empirical ICCs and IIFs. A similar technique is used to display [DIF item characteristic curves](#) for [non-uniform DIF](#).

Example: [Example0.txt](#) - Partial credit ICC's - ISGROUPS=0

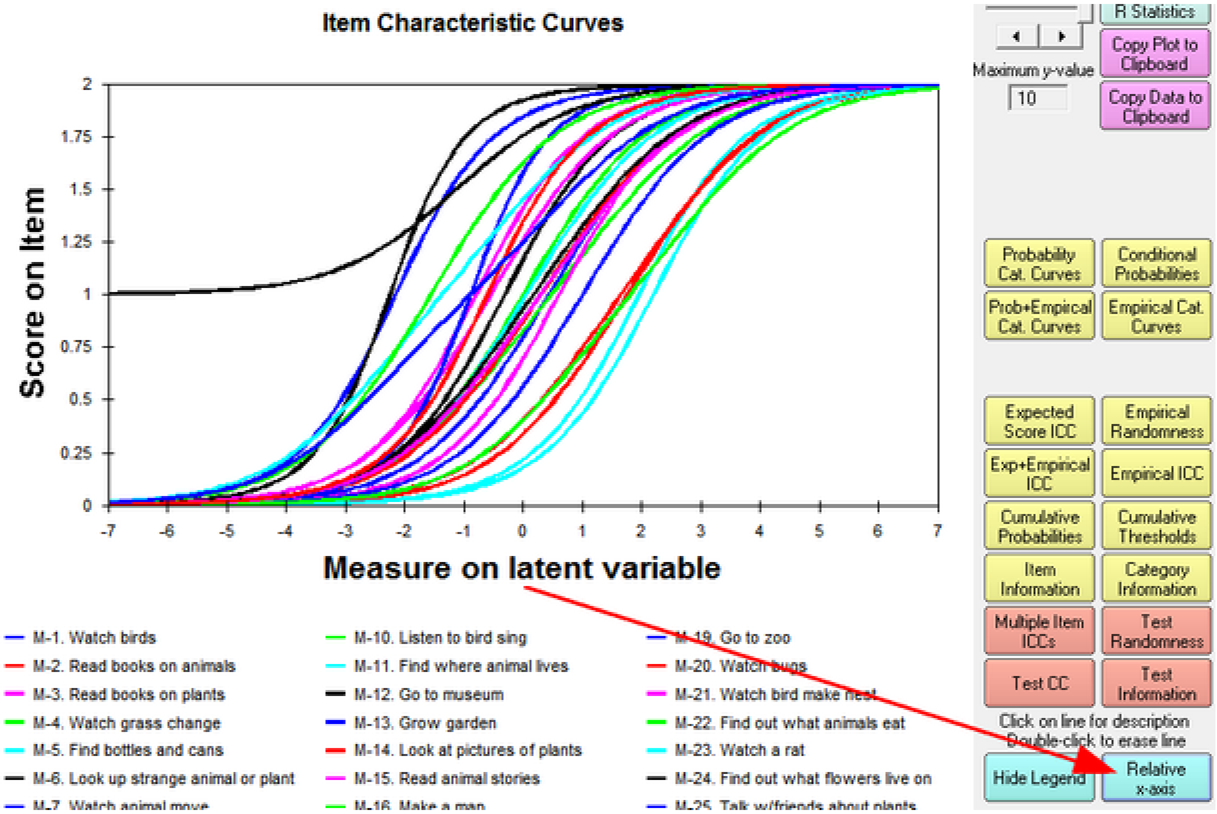
"Graphs" window, "Multiple-item ICCs", "Select All Model ICCs", OK



When the curves are plotted "Measure relative to item difficulty", they all center on zero. The curves squash together.

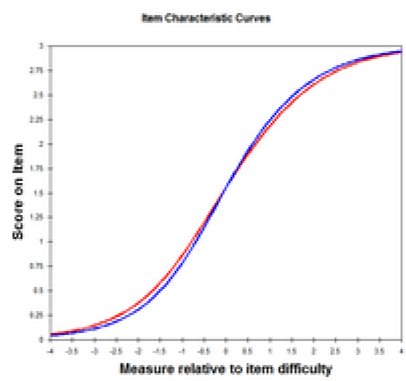


Click on "Absolute x-axis". The curves are plotted "Measure on latent variable". Each curve centers on its own item difficulty. The curves spread out.



Example: **We want to compare two ICCs**

```
title = "Compare ICCs"
ni = 2
item1 = 1
name1 = 1
codes = 0123  ; 4 category rating scales
isgroups=0
IAFILE=*
1 0
2 0
*
SAFILE=*
1 0 0      ; anchor values for first rating scale
1 1 -0.8
1 2 -0.3
1 3 1.1
2 0 0      anchor values for second rating scale
2 1 -1.1
2 2 -0.25
2 3 1.3
*
&END
Scale 1
Scale 2
END LABELS
30  ; dummy data with 4 categories
03
11
```

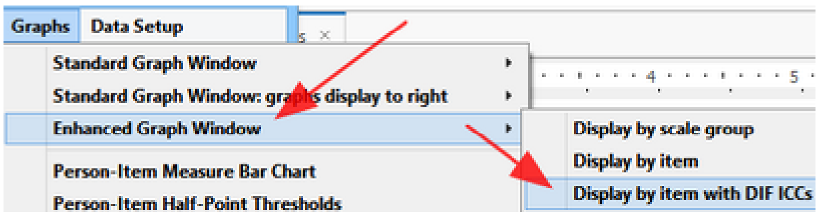


The Andrich thresholds differ, but the ICCs are almost the same.

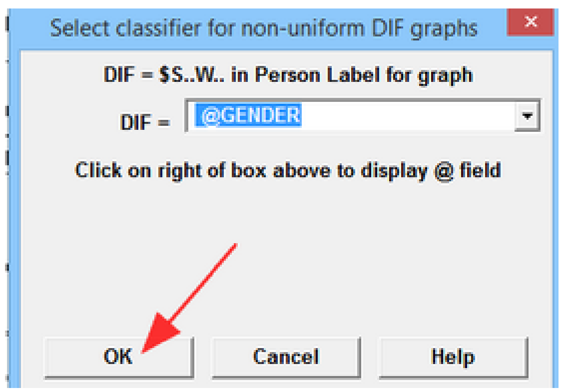
22	

16.17 Uniform & Non-uniform DIF ICCs

Non-uniform DIF ICCs (non-uniform Differential Item Functioning Item Characteristics Curves) are also called *Group Empirical IRFs* (Item Response Functions) and *Group Trace Lines.* These are displayed for items. To see non-uniform DPF (person) ICCs, first transpose the data, then display these with the persons as items. Non-uniform DIF can also be investigated numerically using Winsteps Table 30..



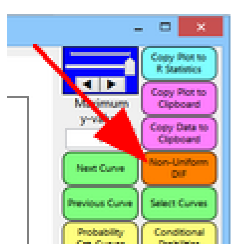
Click on "Display by item" and "Display enhanced graph".. Select the Non-Uniform DIF ICCs option on the Graphs menu.



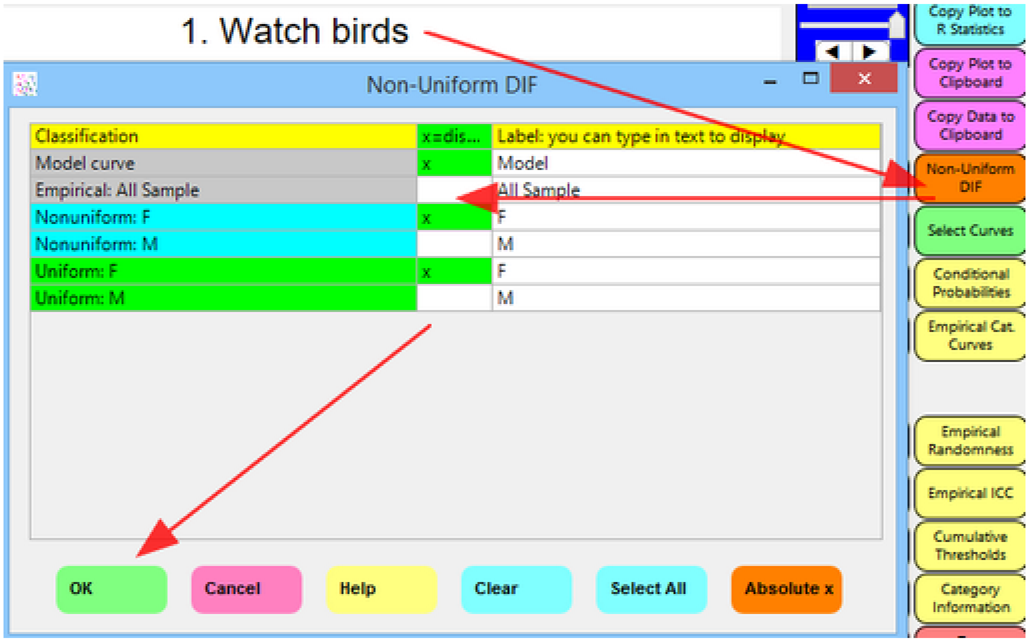
Confirm the columns in the person label of the DIF= group classification.

Your screen reports that the DIF information is being collected from the data file.

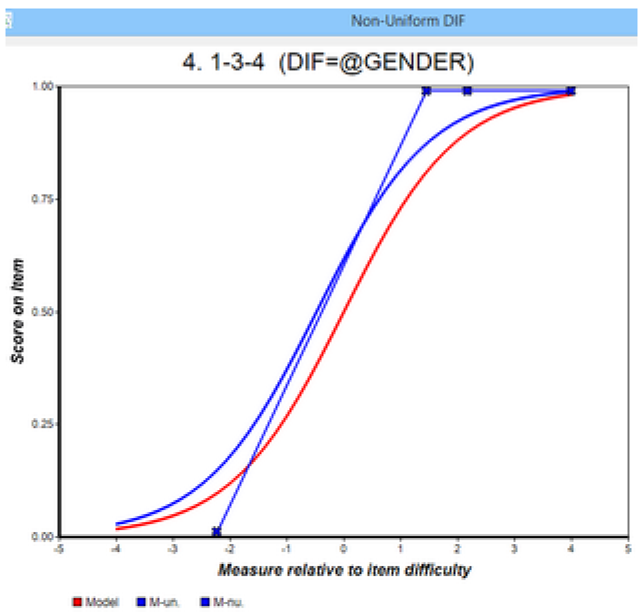
In the Graph window, click on "Non-Uniform ICCs"



The DIF selection dialog box displays:

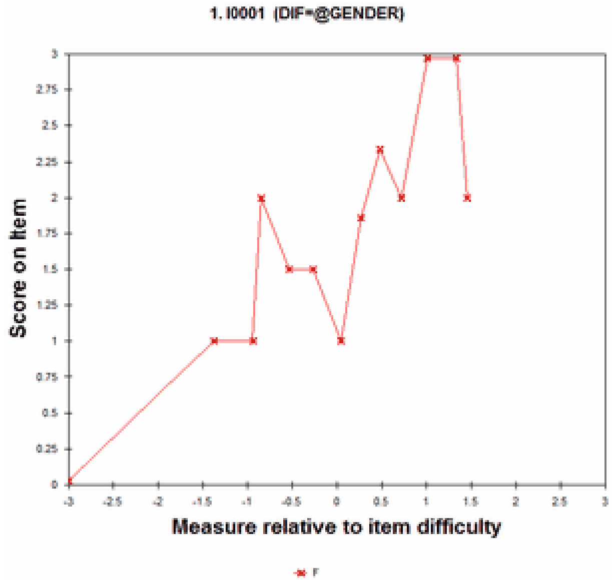


Choose which curves you want to see by clicking in a box. The box turns green with the letter "x".



Here, the model ICC (red) for the item and the uniform (smooth) and non-uniform (jagged) DIF curves (blue) for the "M" person group are shown.

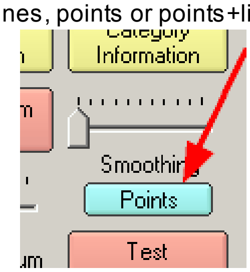
For Standard graphing:



Double-click on unwanted lines to remove them. Here only the non-uniform DIF line for the F group is shown.

16.18 Points and lines

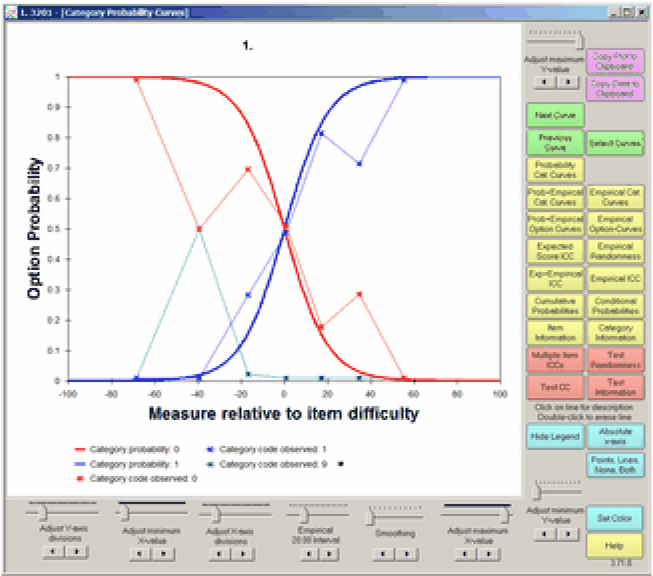
On the empirical curves you can control whether lines, points or points+lines are displayed.



By default, points+lines are displayed. Click on "Points" to display only points. Then click on it again to display only lines. Then click again for points+lines.

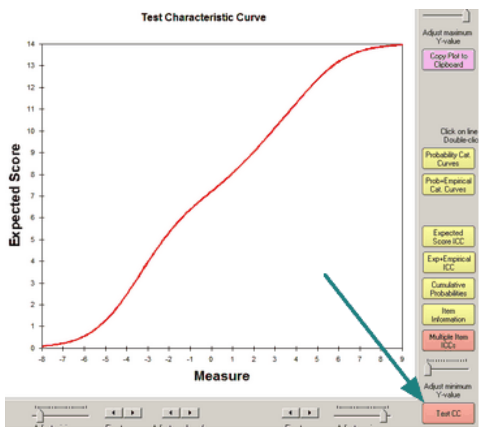
Buttons are described in Graph window.

16.19 Category probability and empirical curves



This shows the Rasch-model probability curves for each category. For dichotomous items there are two probability curves, one for "correct" and one for "incorrect". For empirical curves, there is one for each option.

16.20 Test Characteristic Curve TCC

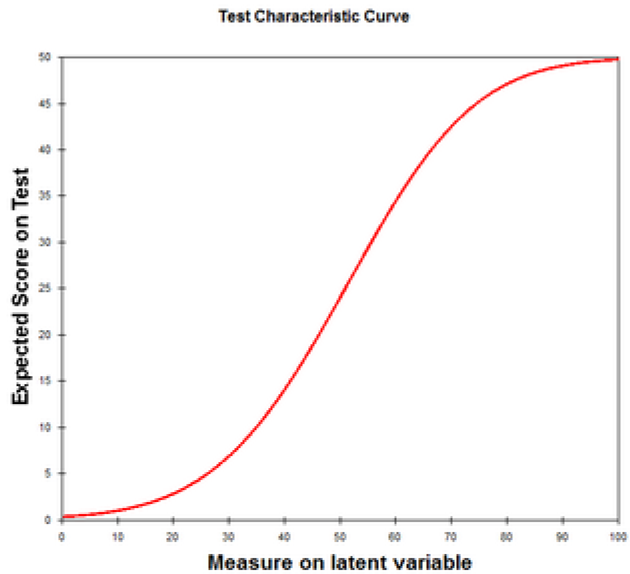


Select by clicking on "Test CC" or from the Graphs menu. This is the test characteristic curve (TCC), the score-to-measure ogive for this set of items. It is always monotonic ascending. See also TCCFILE= and Table 20.

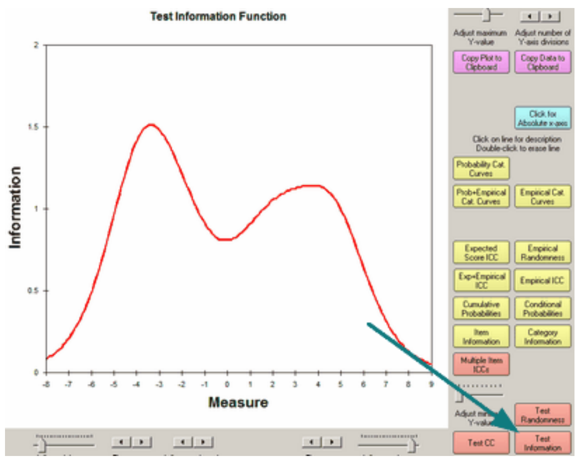
For customized range and increments, use TCCHIGH=, TCCLOW=, TCCINCR=

Buttons are described in Graph window.

With 0-100 user-friendly rescaling using UIMEAN= and USCALE= from Table 20.1, the TCC for Example0.txt becomes this:



16.21 Test Information Function TIF



Select by clicking on "Test Information" or from the [Graphs](#) menu. This shows the Fisher information for the test (set of items) on each point along the latent variable. The test information function reports the "statistical information" in the data corresponding to each score or measure on the complete test. Since the standard error of the Rasch person measure (in logits) is 1/square-root (information), the units of test information would be in inverse-square-logits. See also [TCCFILE=](#) and [Table 20](#).

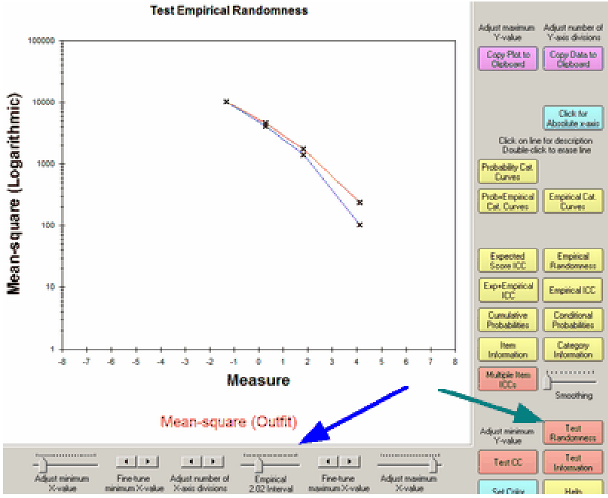
In practice, the values of the information function are largely ignored, and only its shape is considered.

We usually want the test information function to peak
1. where the most important cut-point is (criterion-referenced tests)
2. where the mode of the sample is (norm-referenced tests)
The width of the information function is the effective measurement range of the test.

Buttons are described in [Graph window](#).

To increase the maximum possible Measure range, set [EXTREMESCORE=.01](#) or other small value.

16.22 Test Empirical Randomness



Select by clicking on "Test Randomness" or from the [Graphs](#) menu. Empirical intervals are set with the "Empirical Interval" slider. This displays the local value of the mean-square statistics. The Outfit mean-square statistic (standardized residual chi-square divided by its degrees of freedom) is the red line. The Infit mean-square statistic (ratio of observed to expected residual variance) is the blue line.

The Test Empirical Randomness shows the average mean-square for the subset of responses in a (person ability - item difficulty) interval on the latent variable. For instance,
Are the noisy responses by people with high abilities relative to the item difficulties (= carelessness) = high mean-squares for high measures?
Are the noisy responses by people with low abilities relative to the item difficulties (guessing) = high mean-squares for low measures?
Are the responses too predictable for people with abilities far from the item difficulties (= Binet-style response imputation) = low mean-squares for high measures and for low measures?

In classical test theory, 3-PL IRT, and conventional statistics, low mean-squares are considered good. In Rasch theory, they indicate some redundancy in the responses, but they do no harm.

Buttons are described in [Graph window](#).

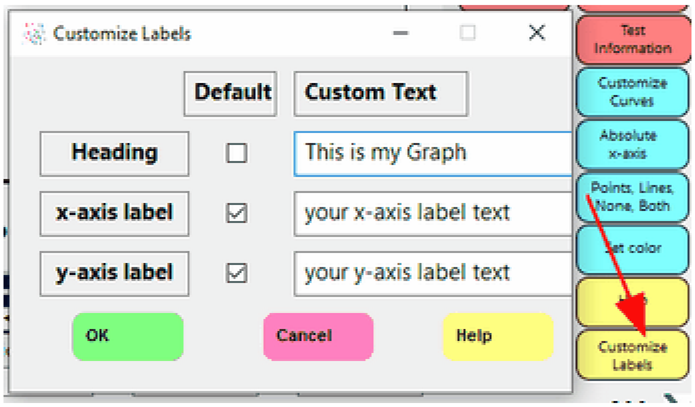
16.23 Customize Curves

In the [Graph window](#), the "Customize Curves" button displays the "Customize the Graph" dialog box. Click "OK" to action the choices. The choices reset to the default values when the next Graph is selected.

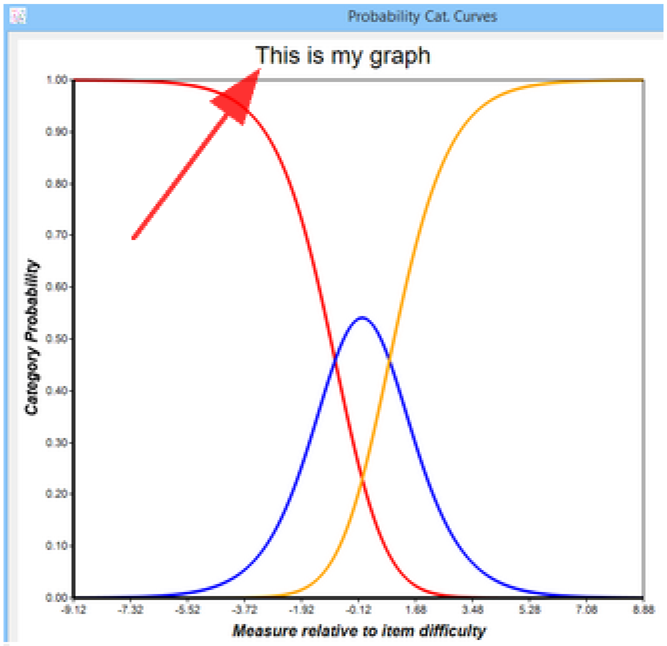
Column	Meaning
Layer	Layer (curve or line) in the graph
Display?	Show (Yes) or Hide (No) this layer
Color	Color of the layer: number of color in the right-hand box
Label	Text of curve label shown with "Display Legend" button
-	Colored block of numbered color
OK	Action the choices in the Graph window

16.24 Customize Labels

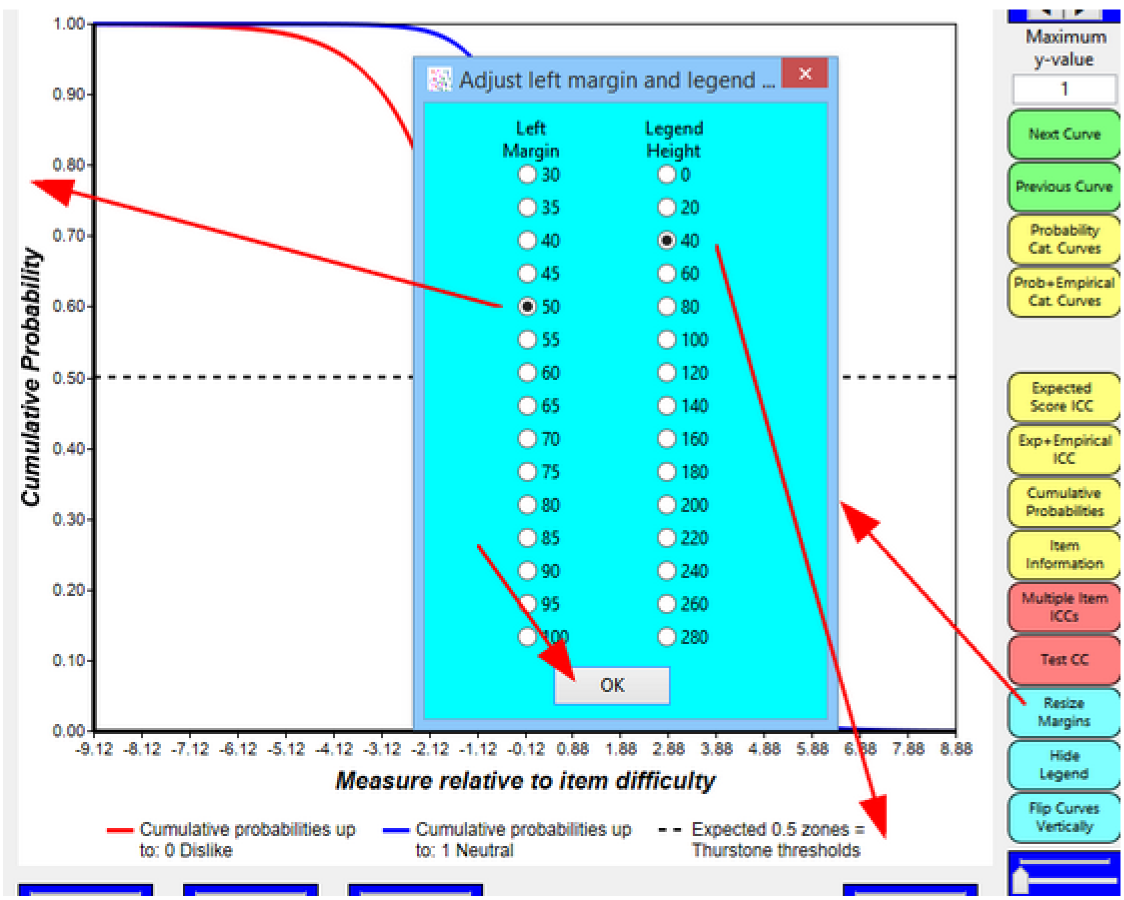
In the Graph window, the "Customize Labels" button displays the "Customize the Labels" dialog box. Click "OK" to action the choices. The choices reset to the default values when "default" is selected.



Column	Meaning
Heading	Top of the Graph
y-axis label	Left side of the Graph
x-axis label	Bottom of the Graph
Default	click on check box to select or unselect default label
Custom Text	Type in your Label text, then un-check Default check box.
OK	Action the choices in the Graph window



16.25 Resize Left Margin and Legend Height



Click on "Resize margins" to change the width of the left margin, which contains the y-axis title.

When Legends are displayed, the height of their area can be changed.

Click OK for the new values and to redraw the graph window.

17 Plots - Excel

17.1 Excel interfaces

If Excel plots launched by Winsteps display on your screen, no action is needed.

After clicking on the Plot button in a Winsteps dialog box, Winsteps interfaces with Excel through module winexcel and Windows to produce plots. There are two options In Edit menu, Edit Initial Settings, **Excel Plot:**

1. 32-bit - most Windows PCs with Excel installed. Excelplot32=Yes

On disk: **winexcel.exe**

On screen: **`Activating Excel 32-bit interface ...`**

Internally: This interface uses winexcel.exe to communicate through Windows to Excel. The Excel plot launches automatically. It is the interface in Winsteps versions before 5.2.4 June 2022.

2. 64-bit - most Windows PCs with Excel installed. Excelplot32=6

On disk: **winexcel64.exe**

On screen: **`Activating Excel 64-bit interface ...`**

Internally: This interface uses winexcel64.exe to communicate through Windows to Excel. The Excel plot launches automatically.

3. 64-bit or 32-bit - all versions of Excel. Excelplot32=No

On disk: **winexcel.dat**

On screen: Activating Excel.xlsm interface ...
Excel .xlsm workbook should activate soon. Please continue ...

Internally: This interfaces uses winexcel.dat to create a .xlsm Excel workbook in the Windows temporary folder %temp%.

Excel installed in Windows: This .xlsm workbook launches automatically on most Windows versions of Excel provided that **Excel macros are enabled.**
To enable macros: Open Excel -> Click on File -> Options - > Trust Center -> Trust Center Settings… -> Macro Settings -> Enable all macros.

All Excel installations: These may be able to launch the Excel plot by **manually launching the .xlsm file** with the available version of Excel. While Winsteps is open, the .xlsm file is in Windows folder %temp% (something like C:\Users\....\AppData\Local\Temp\ ). Look for the most recent .xlsm file in the %temp% folder and launch it.

Excel Worksheet Maximum Size

.xls supports 65536 rows and 256 columns while **.xlsx** supports 1048576 rows and 16384 columns

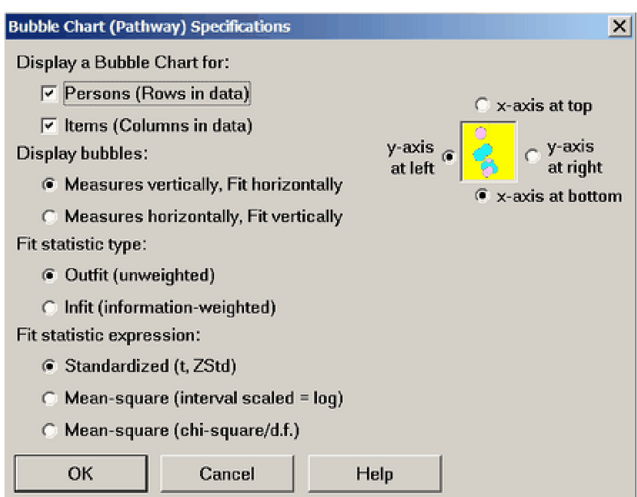
17.2 Bubble charts: Developmental pathways

From the Plots menu, Bubble charts show measures and fit values graphically. They are featured in "Applying the Rasch Model". For successful operation, Excel must be available on your computer. Its maximum is 65,536 rows.

There is an explanation in https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.15.020111 (Planininc et al.) see its Figure 3.

To produce these charts, Winsteps writes out the requisite values into a temporary file. Excel is then launched automatically. It reads in the temporary file and follows instructions to create a bubble plot. The plot is displayed, and the Excel worksheet becomes available for any alterations that are desired. The Excel worksheet may be made permanent using "Save As". The free Excel Add-in XY Chart Labeler from https://www.appspro.com/Utilities/ChartLabeler.htm is useful if your want to change the bubble labels.

Selecting "Bubble Chart" from the Plots menu:



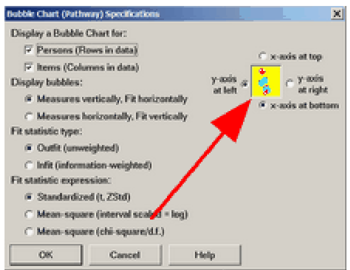
With the default axis choice: measures vertically, fit horizontally:

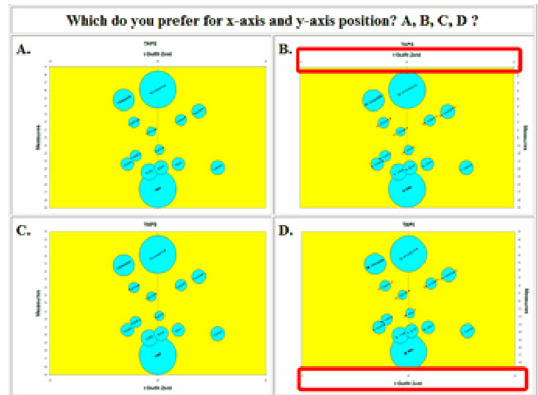
For the items: vertical axis = item measure = item difficulty
Horizontal axis = item fit statistic

For the persons: vertical axis = person measure = person ability
Horizontal axis = person fit statistic

For the items+persons: vertical axis = measures = item difficulty and person ability
Horizontal axis = item fit statistic and person fit statistic

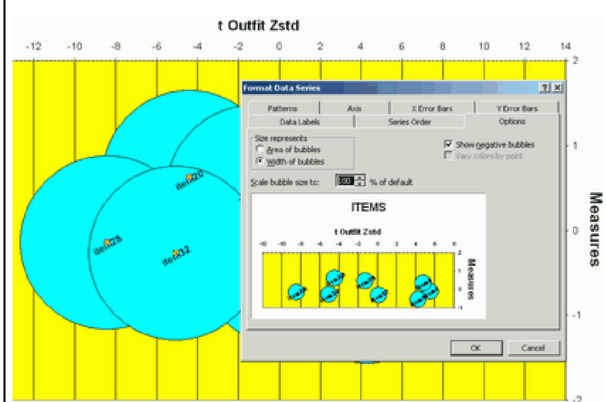
1. **Positioning the axes and labels:** use the dialog box, or right-click on the axes and axes-titles to reposition them.



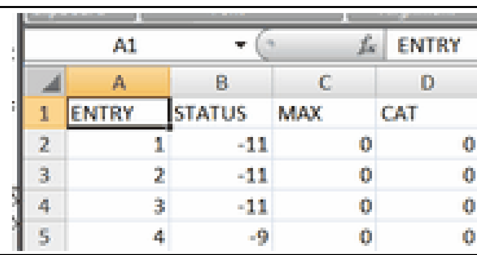


Bubble Resizing: The relative bubble sizes are set by the standard errors. of the measures. But their overall absolute size is set by Excel. Please determine the actual bubble resizing by comparing the bubble size to the measure-axis scaling. If the bubbles are roughly the same size, then their measures will be significantly different (p≤.05) if they do not overlap along the measure axis when the bubble radius is 1.96 * 1.414 * S.E. / 2 = 1.4 * S.E.

To change their overall sizes on the bubble chart:
Right click on the edge of a circle.
"Format Data Series"
"Options"
"Scale bubble size to:"



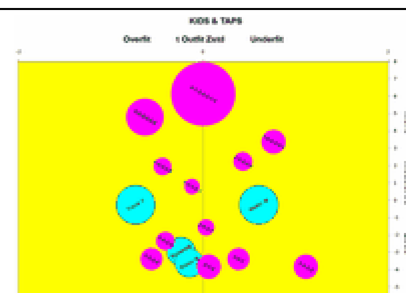
Bubbles showing Likert categories:
Likert data is shown in vertical bubbles -- such in Bond and Fox (2007) Fig 6.2 p.104 -- but this is not yet produced by Winsteps automatically. Please produce an item bubble-chart. Then, in its Excel worksheet, edit in extra lines for each item. Use values from ISFILE= for the item difficulties.



	A	B	C	D
1	ENTRY	STATUS	MAX	CAT
2	1	-11	0	0
3	2	-11	0	0
4	3	-11	0	0
5	4	-9	0	0

Autoshape the bubbles:
Excel 2007 and later:
Let us change the shapes of the bubbles for persons and items.

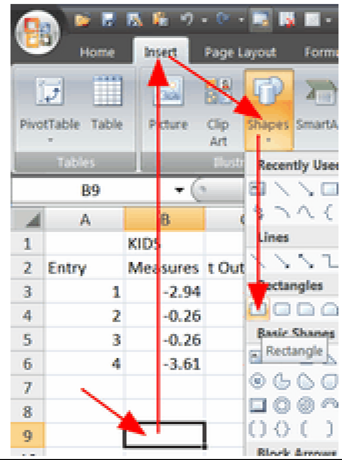
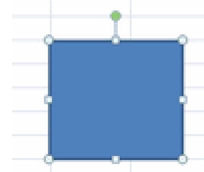
This may take several attempts to produce the bubbles you want.



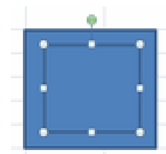
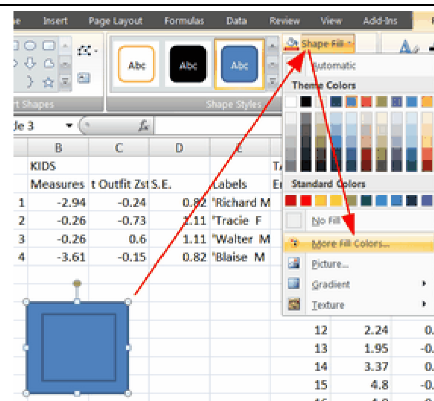
<table>
<tr>
<td>In Excel 2007,

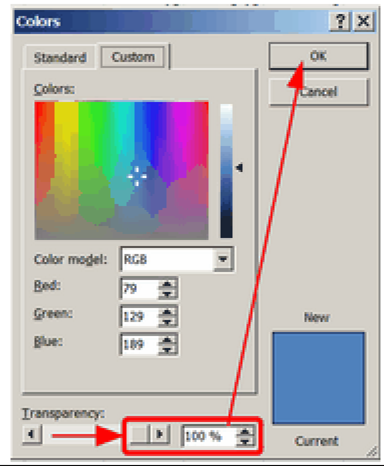
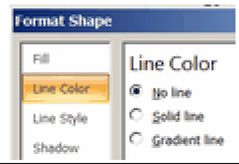
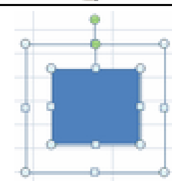
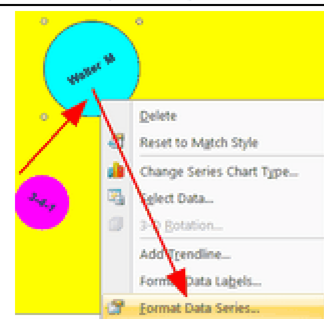
In your worksheet,

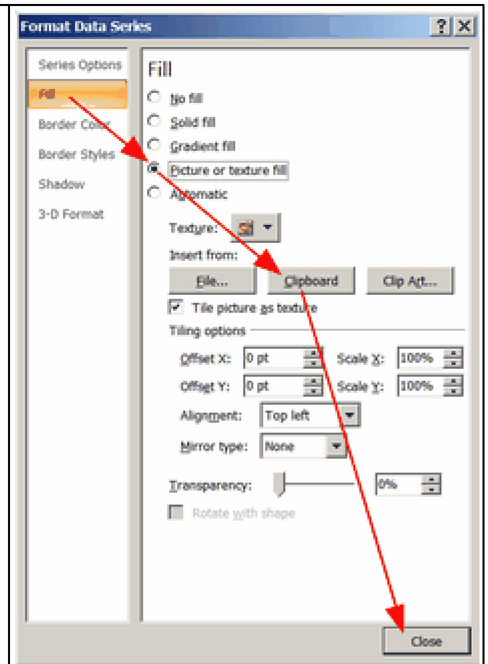
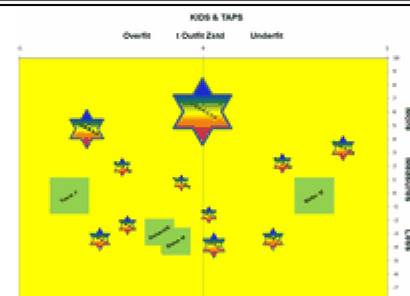
Click on an empty cell

Insert
Shapes
Rectangle</td>
<td>
</td>
</tr>
<tr>
<td>Drag your mouse to draw a square</td>
<td></td>
</tr>
<tr>
<td>Insert
Shapes
Rectangle (or any other shape)

Drag your mouse to draw a square inside the other square

Right-click the new square
Format Shape
Fill
Color (your choice of color)</td>
<td></td>
</tr>
<tr>
<td>2. Click on the outer square to select it.
 “Shape fill”
“More fill colors”</td>
<td>
</td>
</tr>
</table>

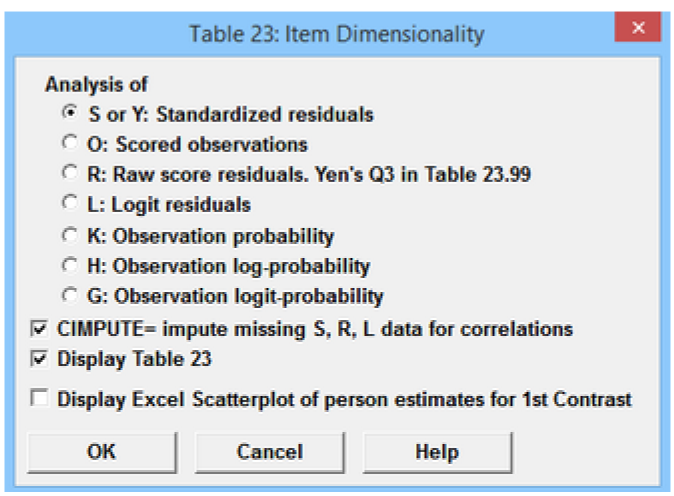
"Colors" Transparency" "100%" OK	
Right-click on box Format shape Line color No line (the box disappears)	
Click on one box ctrl+click on the other box ctrl+c to copy	
On the bubble chart Right-click a child bubble Format data series	

Format Data Series Border Color No line Fill Picture Clipboard Close The bubbles should now look like your colored rectangle.	
This is a little more creative, using Star shapes and gradient-color fill.	

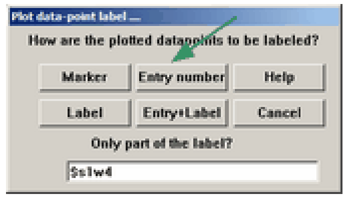
17.3 Cluster Measure Plot - Table 23.6

From the Plots menu, Cluster Measure Plot produces the plotted output corresponding to Table 23.6. It shows the person measures for each cluster of items (perhaps belonging to different dimensions) in Table 23.1.

From the Output Tables or the Plots menu, these dialogs are displayed:



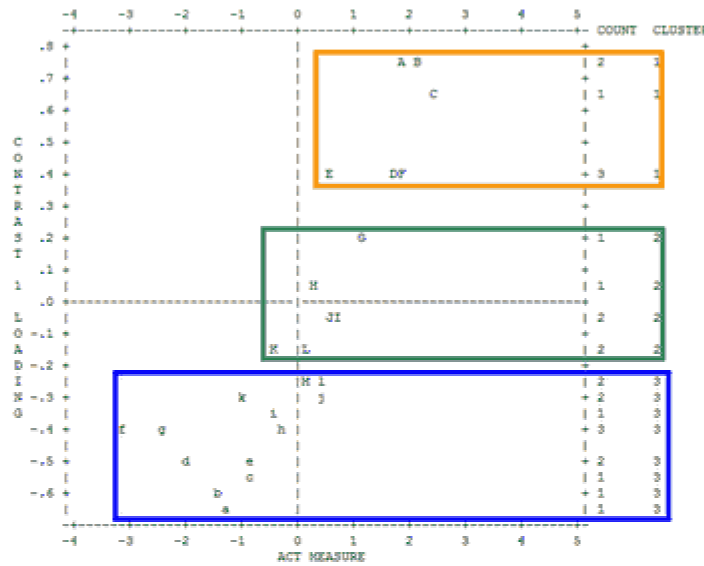
Choose PRCOMP= option, and whether to output Table 23 and/or the Excel plot of Table 23.6
CIMPUTE= controls imputing missing values



When the Excel plot is chosen, then select what data point labels are is to be displayed on the Excel plot. In this case, the person entry number.

Here is Table 23.1

3 clusters of items are identified vertically. The items at the top contrast in some way with the items at the bottom. They could be on different dimensions or strands or item formats or ....



Here is Table 23.6

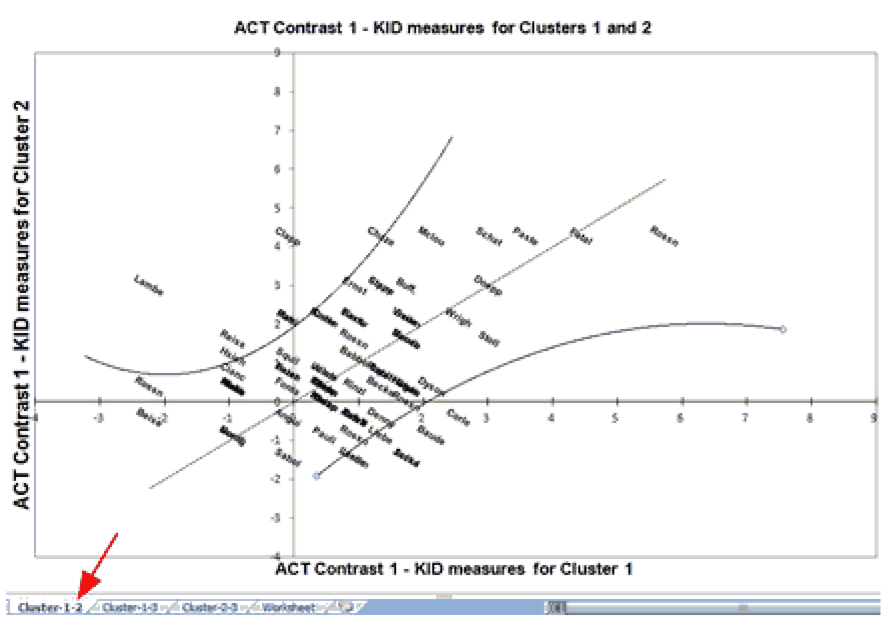
This reports the measures for each person on each cluster of items. If the clusters are different dimensions, then we expect the person measures to be considerably different for the different clusters.

```
TABLE 23.6 LIKING FOR SCIENCE (Wright & Masters  ZOU550WS.TXT  Apr  1 2015 10:55
INPUT: 79 KID  25 ACT  REPORTED: 77 KID  25 ACT  6 CATS         WINSTEPS 3.90.0
--------------------------------------------------------------------------------

-------------------------------------------------------------------------------------------
|                        CONTRAST 1  CLUSTER MEASURES                                      |
|                 |   CLUSTER 1   |   CLUSTER 2   |   CLUSTER 3   |                          |
|     KID  STATUS | MEASURE  S.E. | MEASURE  S.E. | MEASURE  S.E. | KID LABEL                |
|-----------------+---------------+---------------+---------------+--------------------------|
|       5      1  |     .48   .71 |     .00   .63 |    1.09   .59 | M Rossner, Marc Daniel   |
|       6      1  |    1.35   .63 |     .77   .62 |    1.14   .58 | M Rossner, Toby G.       |
|       7      1  |     .48   .71 |     .38   .62 |     .07   .47 | M Rossner, Michael T.    |
|       8      1  |     .94   .66 |    -.87   .71 |   -1.15   .45 | F Rossner, Rebecca A.    |
```

Here is the Excel plot for Clusters 1 and 2.

The person measures, estimated for each cluster of item, are cross-plotted. 95% Confidence Bands are drawn based on the S.E.s of the measures. The confidence bands are averaged across the persons.The diagonal line on the plot is the identity line. All the points in the plot would fall on this line if the person measures on both clusters were the same.

If almost all the points are within the confidence bands, then the two clusters of items are not measuring the persons in a statistically different way. However, individual persons outside the confidence bands do

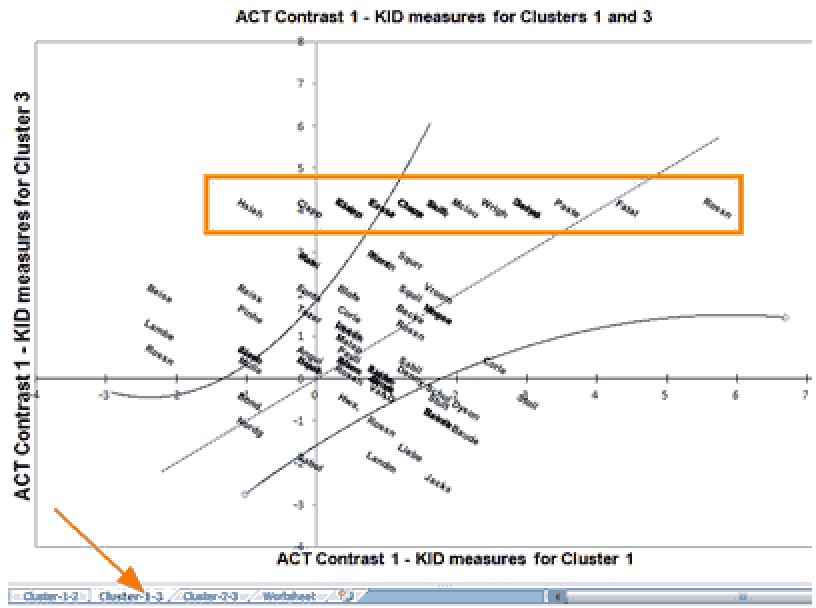


have statistically different performance levels on the clusters.

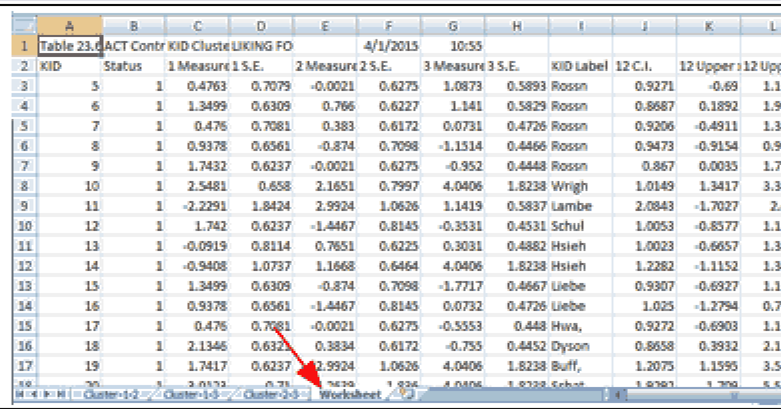
Each plotted point has its own confidence interval. These are in the Worksheet Column (U,V) and (W,X). Excel plots smooth curves (trend lines) through the end-points of all these intervals using quadratic (2) polynomials. Please right click on the curves to change the polynomials. For some plots, quartic (4) polynomials may be better.

Here is the Excel plot for Clusters 1 and 3.
The items in Clusters 1 and 3 are the most different, so we expect that their person measures will also be the most different. Here we see more persons outside the confidence bands, but also many within.

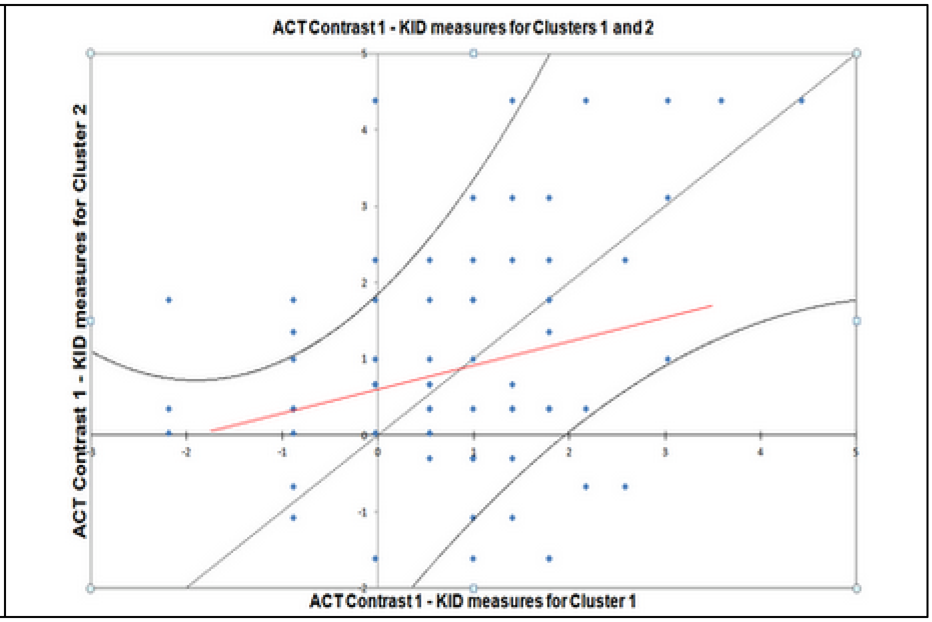
In this plot, the persons in the orange box have maximum scores on the items in Cluster 3, but different score on the items in Cluster 1.



Cluster Measure Worksheet
Columns A-I correspond to Table 23.6.
Columns J-X are for drawing the confidence bands. For the formulas for these columns, see Scatterplot.



	A	B	C	D	E	F	G	H	I	J	K	L
1	Table 23.6	ACT Contr	KID Cluste	LIKING FO		4/1/2015	10:55					
2	KID	Status	1 Measure	1 S.E.	2 Measure	2 S.E.	3 Measure	3 S.E.	KID Label	12 C.I.	12 Upper	12 Upp
3	5	1	0.4763	0.7079	-0.0021	0.6275	1.0873	0.5893	Rossn	0.9271	-0.69	1.16
4	6	1	1.3499	0.6309	0.766	0.6227	1.141	0.5829	Rossn	0.8687	0.1892	1.92
5	7	1	0.476	0.7081	0.383	0.6172	0.0731	0.4726	Rossn	0.9206	-0.4911	1.35
6	8	1	0.9378	0.6561	-0.874	0.7098	-1.1514	0.4466	Rossn	0.9473	-0.9154	0.97
7	9	1	1.7432	0.6237	-0.0021	0.6275	-0.952	0.4448	Rossn	0.867	0.0035	1.73
8	10	1	2.5481	0.658	2.1651	0.7997	4.0406	1.8238	Wrigh	1.0149	1.3417	3.37
9	11	1	-2.2291	1.8424	2.9924	1.0626	1.1419	0.5837	Lambe	2.0843	-1.7027	2.4
10	12	1	1.742	0.6237	-1.4467	0.8145	-0.3531	0.4531	Schul	1.0053	-0.8577	1.15
11	13	1	-0.0919	0.8114	0.7651	0.6225	0.3031	0.4882	Hsieh	1.0023	-0.6657	1.33
12	14	1	-0.9408	1.0737	1.1668	0.6464	4.0406	1.8238	Hsieh	1.2282	-1.1152	1.34
13	15	1	1.3499	0.6309	-0.874	0.7098	-1.7717	0.4667	Liebe	0.9307	-0.6927	1.16
14	16	1	0.9378	0.6561	-1.4467	0.8145	0.0732	0.4726	Liebe	1.025	-1.2794	0.77
15	17	1	0.476	0.7081	-0.0021	0.6275	-0.5553	0.448	Hwa,	0.9272	-0.6903	1.16
16	18	1	2.1346	0.632	0.3834	0.6172	-0.755	0.4452	Dyson	0.8658	0.3932	2.12
17	19	1	1.7417	0.6237	2.9924	1.0626	4.0406	1.8238	Buff,	1.2075	1.1595	3.57

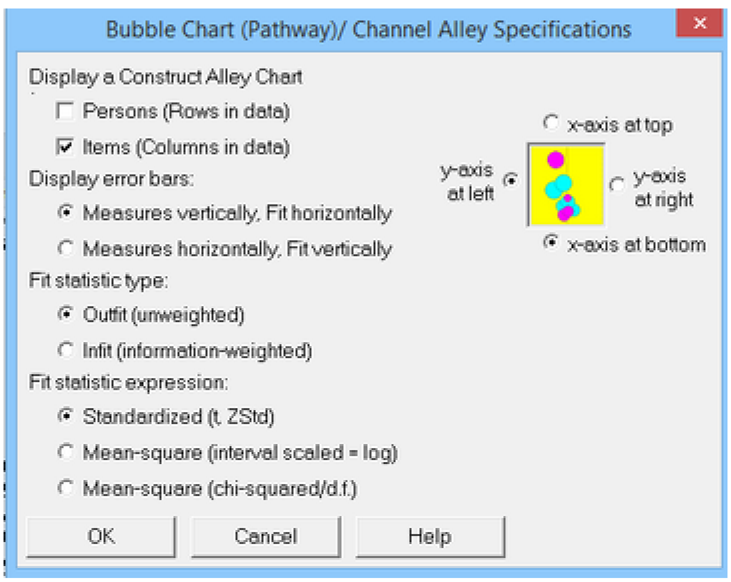
Trend Lines The dotted diagonal line is the identity line. The points would lie on this line if the person measures were the same for both sets of items. The curved lines are 95% two-sided confidence intervals. Points outside the lines have significantly different measures. The red line is a trend line showing the relationship between the two sets of person measures. This line goes through a point defined by the means of the two sets of person measures. The slope of the line is the ratio of the two standard deviations.	

17.4 Construct Alley Plot with error bars

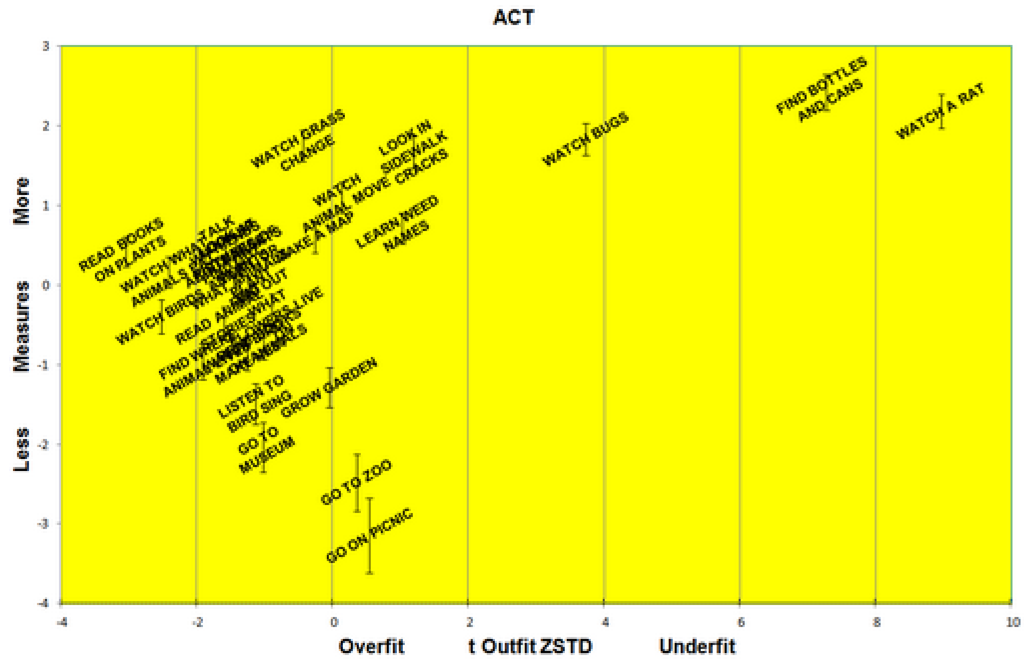
From the Plots menu, the Construct Alley show measures and fit values graphically. They originate in Massof (2005) and are featured in several papers by Leslie Pendrill. For successful operation, Excel must be available on your computer.

To produce these charts, Winsteps writes out the requisite values into a temporary file. Excel is then launched automatically. It reads in the temporary file and follows instructions to create a construct plot. The plot is displayed, and the Excel worksheet becomes available for any alterations that are desired. The Excel worksheet may be made permanent using "Save As". The free Excel Add-in XY Chart Labeler from https://www.appspro.com/Utilities/ChartLabeler.htm is useful if your want to change the point labels.

Selecting "Construct Alley" from the Plots menu:



For instructions about this dialog box, see Bubble Charts

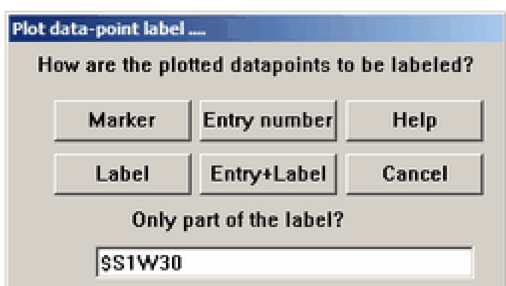


Construct Alley for [Example0.txt](). The Error Bars are one S.E. above and below the item difficulty.

Massof, R. W. (2005, April). Application of stochastic measurement models to visual function rating scale questionnaires. Ophthalmic Epidemiology, 12(2), 103-124.

17.5 Datapoint labels

Several Excel [plots]() have options as to how the points are to be labeled.



Click on:
Marker: plotted point is indicated with a symbol, such as ♦

Entry number: plotted point is indicated with its item or person entry number

Label: plotted point in indicated with its item or person label

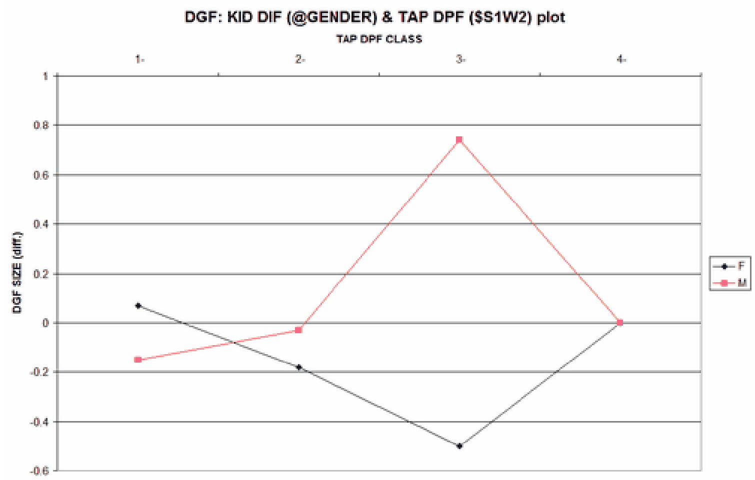
Entry+Label: plotted point is indicated by its entry number and its label

Only part of label? Enter here instructions to select only part of the person or item label, e.g., 2W4 means "starting with column 2 of the label with a width of 4 characters." Then click on "Label"

17.6 DGF DIF-DPF Plot - Table 33.3

From the [Plots menu](), DGF- DIF-DPF Plot 33 produces the plotted output corresponding to [Table 33.3](). It shows Differential Group Functioning (DGF) between classes of items and classes of persons.

The [DGF dialog]() displays when Table 33 is called from the [Output Tables]() or [Plots]() menus.



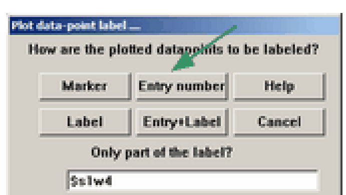
There are six Excel plots. You have the full Excel capabilities to edit the plot, and the Excel worksheet contains the plotted numbers.

DGF SIZE (diff.)-ip = item-person	reports the relative DGF difficulty size of the item classes as points and the person classes as columns
DGF t-value (diff.)-ip	tests the hypothesis that the DIF sizes can be attributed to chance: t-value = DGF size / DGF size S.E. This displays the item classes as points and the person classes as columns
DGF Average Score-points-ip	displays the average difference between the observed score and the expected score for each response on this item CLASS by this person CLASS
DGF SIZE (diff.)-pi = person-item	reports the relative DGF difficulty size of the person classes as points and the item classes as columns
DGF t-value (diff.)-pi	tests the hypothesis that the DIF sizes can be attributed to chance: t-value = DGF size / DGF size S.E. This displays the person classes as points and the item classes as columns
DGF Average Score-points-pi	displays the average difference between the observed response and the expected response for each person CLASS on each item CLASS

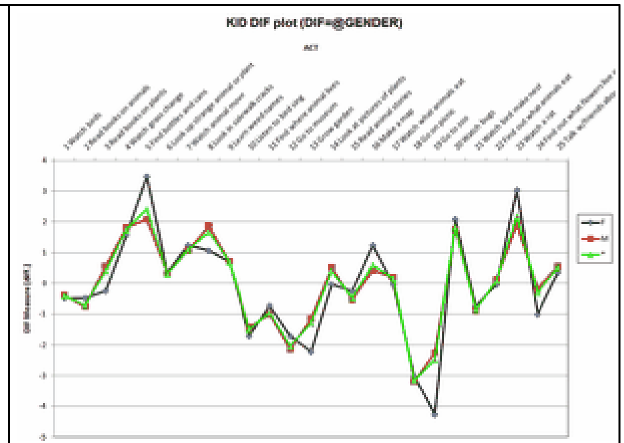
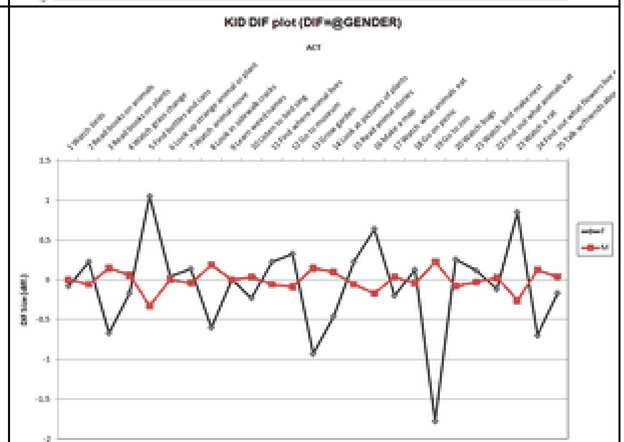
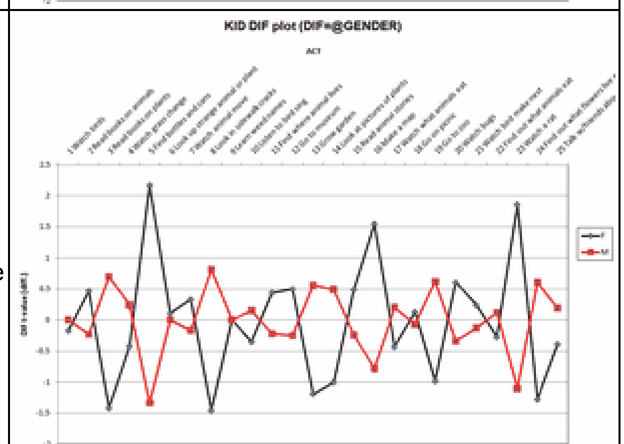
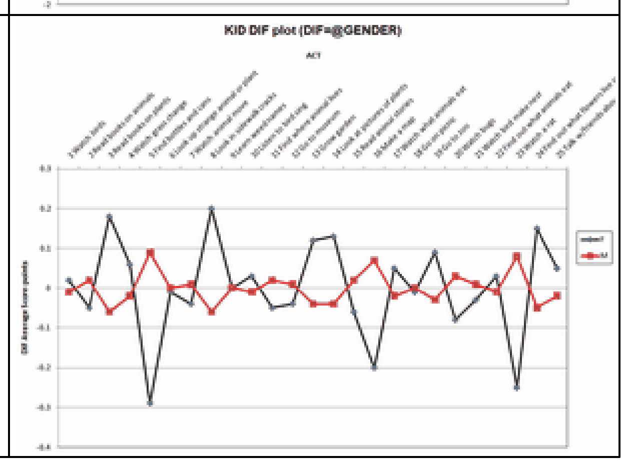
17.7 DIF Plot - Table 30.2

From the Plots menu, DIF Plot 30 produces the plotted output corresponding to Table 30.2. It shows differential item functioning (DIF).

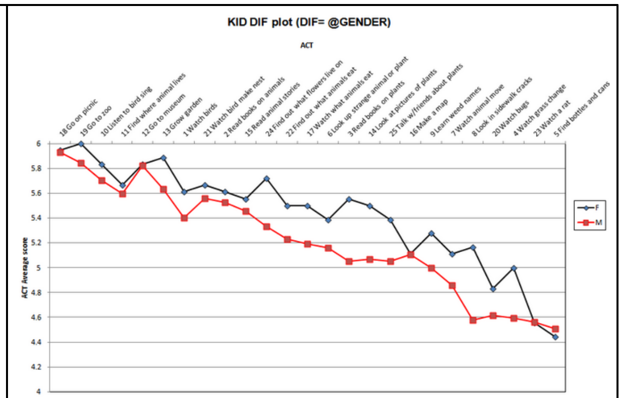
From the Output Tables menu, the DIF dialog is displayed.



Select what data point labels are is to be displayed on the Excel plot. In this case, the item entry number. The person classifications will be identified by their column codes. There are four Excel plots. You have the full Excel capabilities to edit the plot, and the Excel worksheet contains the plotted numbers. The Excel worksheets contain the plotted numbers.

DIF Measure (diff.) reports the difficulty = (diff.) of the item for each person classification: DIF "local absolute" Measure = DIF "relative" Size + Overall "baseline" item difficulty * indicates the baseline measures (no DIF), corresponding to the zero line (x-axis) in the DIF Size plot.	
DIF Size (diff.) reports the size of the item DIF for the person-classification relative to the overall "baseline" item difficulty.	
DIF t-value (diff.) reports a simple approximate t-test of the item DIF against the overall item difficulty. The t-statistic is the statistical probability of the DIF size relative to its measurement error expressed as an approximate unit-normal deviate. A critical values is usually ±2. This tests the hypothesis that the DIF size can be attributed to measurement error. For a test of one group against another group, the joint t-value is usually around 70% of the difference between their t-values on the plot.	
DIF Average Score-point Difference displays the average difference between the observed response and the expected response for each person CLASS on each item.	

Average Score-points
displays the average of the observed responses for each person CLASS on each item. Here the items are in Measure order: easiest items to hardest items.

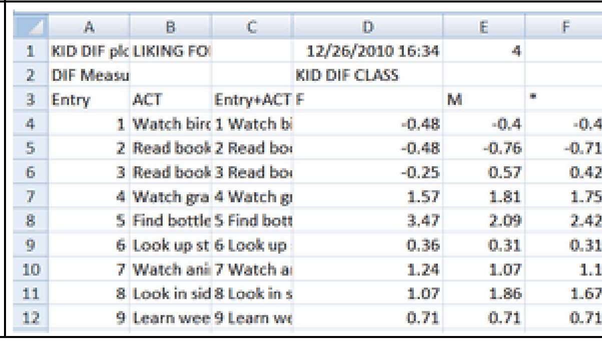


DIF Worksheet

Sort the section of the worksheet to change the left-to-right order of the items in the plots.

Edit the worksheet to change the words shown in the plots.

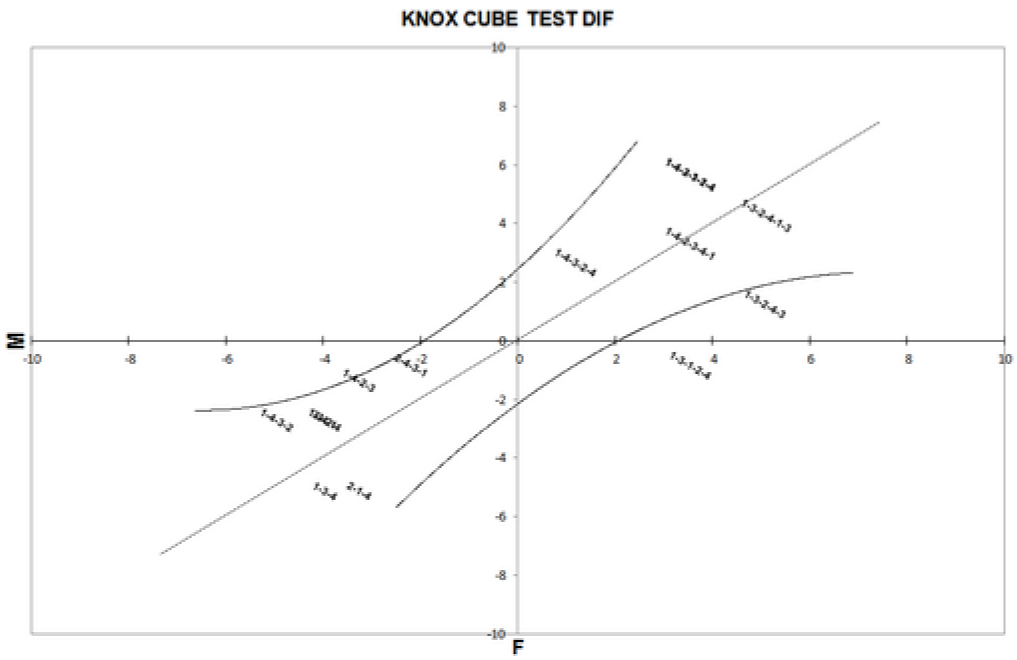
* is the baseline column for "everyone". These are the item difficulties on [Table 14.](#)



	A	B	C	D	E	F
1	KID DIF plc	LIKING FOI		12/26/2010 16:34	4	
2	DIF Measu			KID DIF CLASS		
3	Entry	ACT	Entry+ACT	F	M	*
4	1	Watch birc	1 Watch bi	-0.48	-0.4	-0.4
5	2	Read book	2 Read boo	-0.48	-0.76	-0.71
6	3	Read book	3 Read boo	-0.25	0.57	0.42
7	4	Watch gra	4 Watch gı	1.57	1.81	1.75
8	5	Find bottle	5 Find bott	3.47	2.09	2.42
9	6	Look up st	6 Look up	0.36	0.31	0.31
10	7	Watch ani	7 Watch ai	1.24	1.07	1.1
11	8	Look in sid	8 Look in s	1.07	1.86	1.67
12	9	Learn wee	9 Learn we	0.71	0.71	0.71

17.8 DIF/DPF/DTF Scatterplots of paired measures - Table

The DIF/DPF item measure pairs in [Table 30.1](#), [31.1](#), are [scatterplotted](#). The confidence bands and empirical slope (correlation) are also shown. The diagonal line is a joint trend line. The curve lines are smoothed 95% confidence intervals.



[DTF](#) changes the spread (range) of the person measures in the two groups.

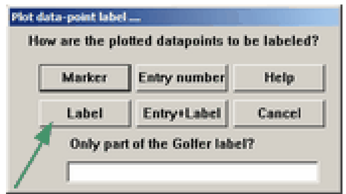
1. Analyze the two groups separately.
2. Output the [TCCFILE=](#) from the two analyses
3. Scatterplot the two sets of measures for the scores.
4. The scatterplot will show you how DTF changes the measure for each score.

17.9 DPF Plot - Table 31.2

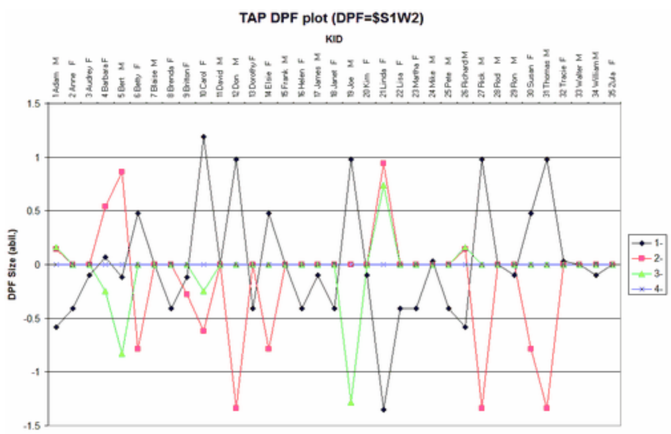
From the Plots menu, DPF Plot 31 produces the plotted output corresponding to Table 31.2. It shows differential person functioning (DPF).

From the Output Tables menu, the DPF dialog is displayed.

In the DPF= box specify the column in the item label that identifies the DPF classification for each person.



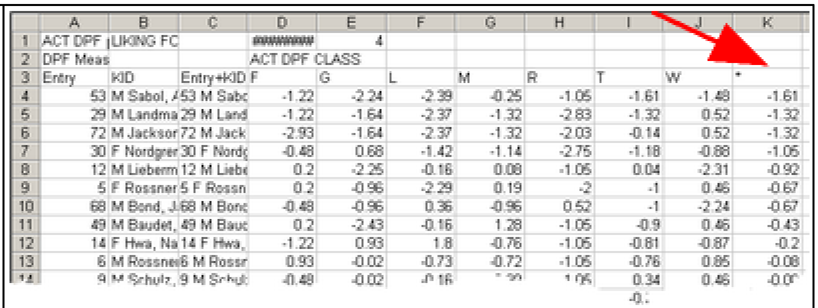
Select what data point labels are to be displayed on the Excel plot. In this case, the person label. The item classifications will be identified by their column codes. You have the full Excel capabilities to edit the plot, and the Excel worksheet contains the plotted numbers. The plotted numbers are contained in the Excel worksheet.



There five Excel plots:

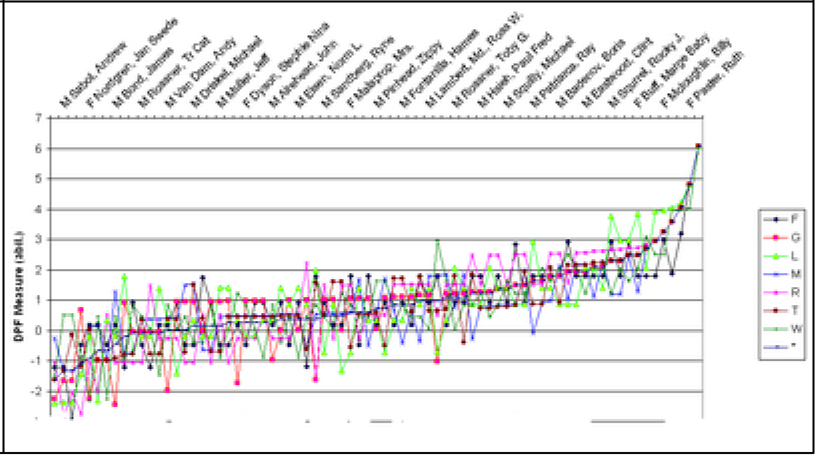
DPF Measure (abil.) "*" indicates the baseline measures (no DPF) , corresponding to the zero line (x-axis) in the DPF Size plot.	reports the ability of the person for each item classification: DPF "local absolute" Measure = DPF "relative" Size + Overall "baseline" person ability
DPF Size (abil.)	reports the size of the person DPF for the item classification relative to the overall "baseline" person ability
DPF t-value (abil.)	reports a simple approximate t-test of the person DPF against overall ability. The t-statistic is the statistical probability of the DPF size relative to its measurement error expressed as an approximate unit-normal deviate. A critical values is usually ±2. This tests the hypothesis that the DPF size can be attributed to measurement error.
DPF Average Score-point difference	displays the average difference between the observed response and the expected response for each person on each item CLASS.
DPF Average Score-points	displays the average of the observed responses for each person on each item CLASS.
Worksheet	contains the numbers that are plotted. Sort the section of the worksheet to change the left-to-right order of the persons in the plots. Edit the worksheet to change the words shown in the plots.

Example: In the Excel worksheet,
sort the DPF Measure block, Ascending on overall measure (the * column)



	A	B	C	D	E	F	G	H	I	J	K
1	ACT DPF	LIKING FC		########	4						
2	DPF Meas			ACT DPF CLASS							
3	Entry	KID	Entry+KID	F	G	L	M	R	T	W	*
4	53	M Sabol, A	53 M Sabc	-1.22	-2.24	-2.39	-0.25	-1.05	-1.61	-1.48	-1.61
5	29	M Landma	29 M Land	-1.22	-1.64	-2.37	-1.32	-2.83	-1.32	0.52	-1.32
6	72	M Jacksor	72 M Jack	-2.93	-1.64	-2.37	-1.32	-2.03	-0.14	0.52	-1.32
7	30	F Nordgrer	30 F Nordg	-0.48	0.68	-1.42	-1.14	-2.75	-1.18	-0.88	-1.05
8	12	M Lieberm	12 M Liebe	0.2	-2.25	-0.16	0.08	-1.05	0.04	-2.31	-0.92
9	5	F Rossner	5 F Rossn	0.2	-0.96	-2.29	0.19	-2	-1	0.46	-0.67
10	68	M Bond, J	68 M Bonc	-0.48	-0.96	0.36	-0.96	0.52	-1	-2.24	-0.67
11	49	M Baudet,	49 M Bauc	0.2	-2.43	-0.16	1.28	-1.05	-0.9	0.46	-0.43
12	14	F Hwa, Na	14 F Hwa,	-1.22	0.93	1.8	-0.76	-1.05	-0.81	-0.87	-0.2
13	6	M Rossne	6 M Rossr	0.93	-0.02	-0.73	-0.72	-1.05	-0.76	0.85	-0.08
14	9	M Schulz,	9 M Schul	-0.48	-0.02	-0.16	[illegible]	-1.05	0.34	0.46	[illegible]

Then look at the DPF measure plot, the persons are ordered by performance on the items, revealing any trends.



Unexpected Subset Connection

Your test design predicts subsets, but fewer subsets than predicted are reported.
Yes, this is perplexing as it may require only one person to connect the subsets.

Code the items according to the different subsets you are expecting,
Use the Tables menu to output a Differential Person Table: persons by item code: Table 31 to "Display graphs, Entry order" in Excel.
That is, say, 100,000 rows and a column for each code (= CLASS).
Look at the Excel Worksheet.
Delete the columns for codes (CLASSes) that were subsetted as expected.
Delete all rows after row 100,000 or so, when the rows start again.
Sort the Excel Worksheet by a suspect code (CLASS)
Delete the zero rows for the code. Everyone left has the code.
Are there any non-zero rows for other codes? These persons responded to items with that other code and the suspect code.
Investigate the responses by those persons. Are there data entry errors?

17.10 Incremental person measures - Table 45

See Table 45

17.11 Keyform plot

See also Tables 37, 38, 39, 40, 41 - Person Keyforms

From the Plots menu, Keyforms are self-measuring and diagnosing forms, such as the KeyMath diagnostic profile, and the KeyFIM. These are a powerful application of Rasch measurement for instantaneous use. These are plotted in horizontal or vertical format using Excel - but be patient, Excel is somewhat slow to display them. The Keyform can be plotted with either horizontal or vertical orientation. In earlier version of Winsteps, these were specified by KEYFORM=

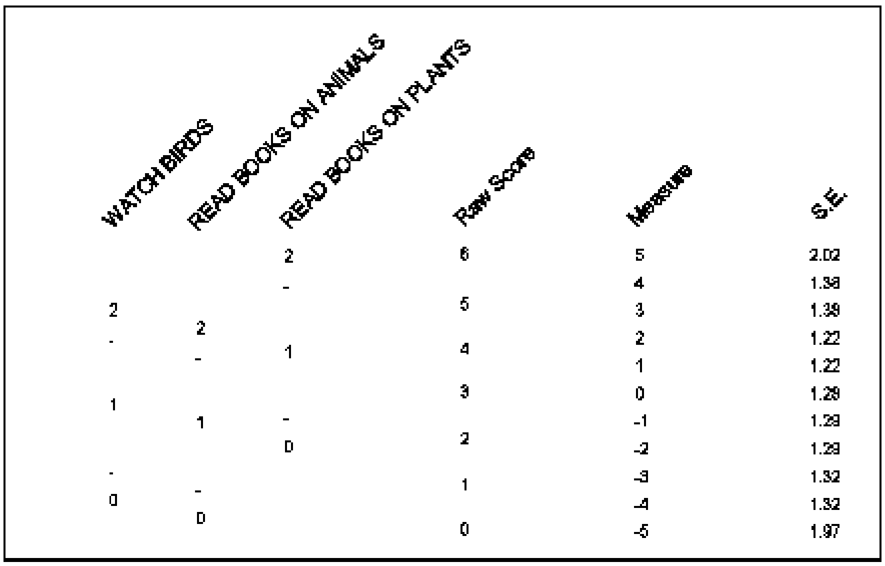
For an explanation of Keyforms, please see www.rasch.org/memo60.htm - "Instantaneous Measurement and Diagnosis".

The 7 columns in the Excel Worksheet are:

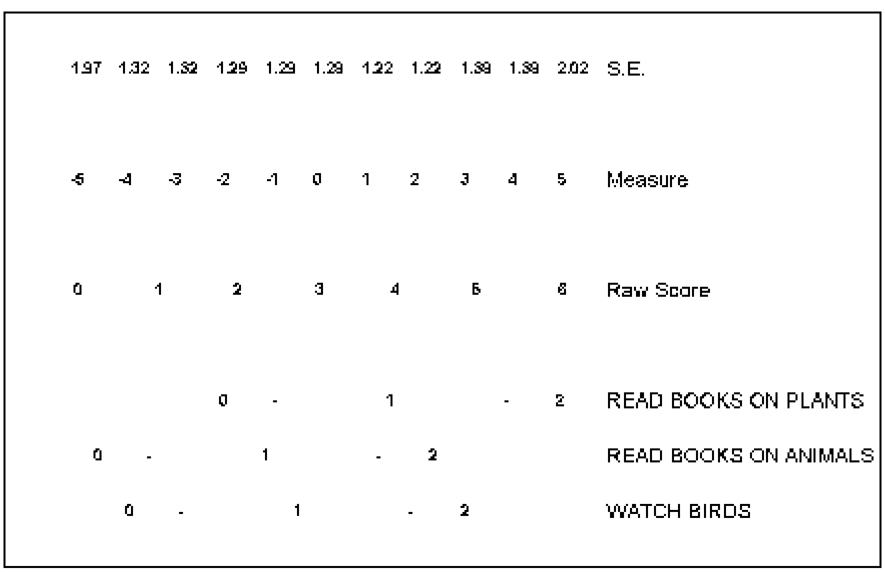
For points in the Keyform:
COLUMN The horizontal location (x-axis) in the vertical layout or vertical location (y-axis) in the horizontal layout.
MEASURE The measure (y-axis) in the vertical layout or (x-axis) in the horizontal
POINT-LABEL The value with which to label the point. Use the Excel point-label add-in at www.winsteps.com/ministep.htm

For column (row headings)
COLUMN The horizontal location (x-axis) in the vertical layout or vertical location (y-axis) in the horizontal layout.
HEAD-MEASURE The top-of-column measure (y-axis) in the vertical layout or end-of-row (x-axis) in the horizontal
ITEM-ID The item number
ITEM-LABEL The item identifying label

Example: For the first 3 items of the "Liking For Science" Data
with Excel, produces vertical plots like: (These can be plotted directly from the Plots menu.)
The columns can be sorted in Excel as desired.



with Excel, produces horizontal plots like: (These can be plotted directly from the Plots menu.)

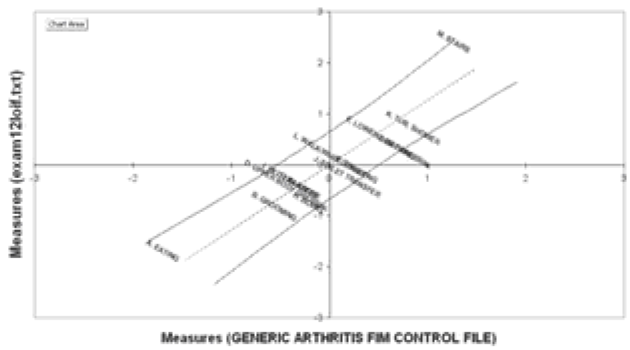


Adding person-measure-related information to the Keyform plot:

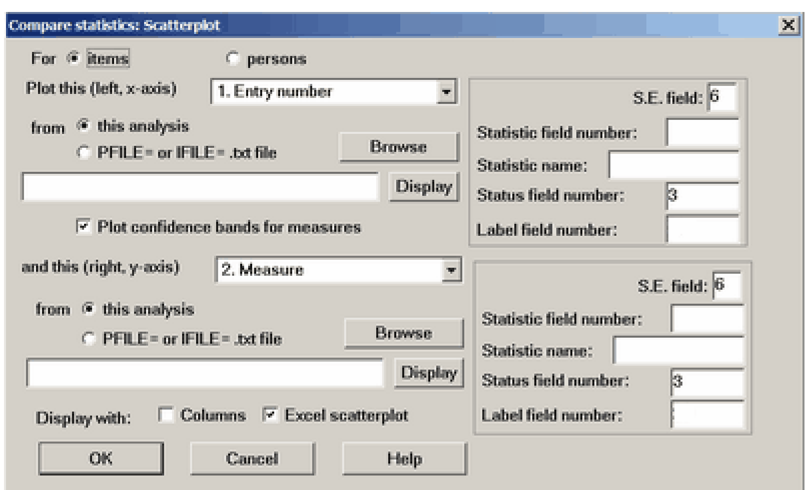
1. Run Winsteps, "Plots", "Vertical Keyform". This gives you am Excel plot with raw scores down the right-hand side.
2. Click on the Excel worksheet tab (usually below the plot).
3. The "raw scores" are in a block below the items.
4. Insert more blank rows below the raw score block (and above the next block) the same as the raw score block with a blank row each side.
5. Copy the raw score block into the inserted rows, with a blank row beneath the raw score block and a blank row above the next block.
6. Add 2 to the highest value in column A and put this value in column A of your new block.
7. Replace the raw score in your new block with the information you want for each raw score
8. The plot should now show the person information to the right of the raw scores.

17.12 Scatterplot: Compare statistics

From the Plots menu, this enables the simple graphical or tabular comparison of equivalent statistics from two runs using a scatterplot (xy plot) produced by Excel. For most versions of Excel, the maximum number of items or persons that can be plotted is 32,000.



To automatically produce this Excel scatterplot of two sets of measures or fits statistics:
Select **Compare Statistics** on the Plots pull-down menu. If this dialog box is too big for your screen see Display too big.



Measures, standard errors, fit statistics indicate which statistics are to be compared.

Display with columns generates a line-printer graphical-columns plot. It is displayed as Table 34.
The first column is the Outfit Mean-Square of this analysis.
The third column is the Outfit Mean-Square of the Right File (exam12lopf.txt in this case)
The second column is the difference.
The fourth column is the identification, according to the current analysis.

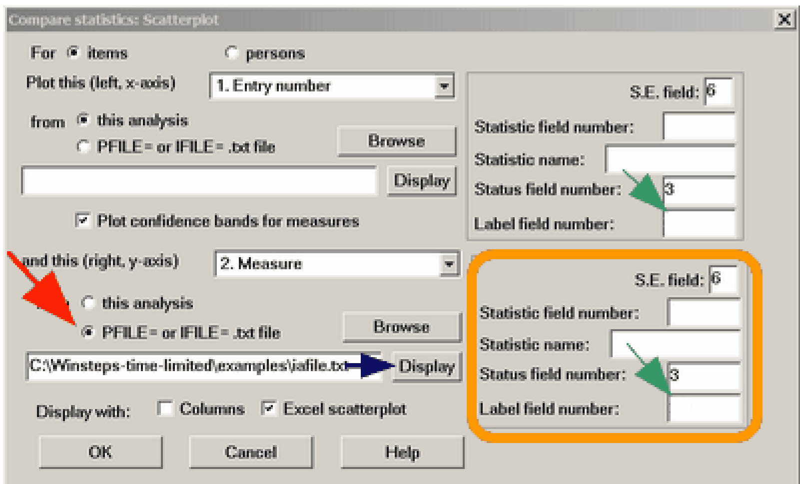
Persons or items are matched and listed by Entry number.

Table 34.1

```
+---------------------------------------------------------------------------------+
|      PERSON       | Outfit MnSq Difference  |  exam12lopf.txt    | File Compa|
|0     1           3|-2           0          2|0     1            3| NUM  LABEL|
|-------------------+-------------------------+-------------------+-----------|
|      .   *        |      *     .            |   *  .            |  1  21101 |
|      .       *    |         *  .            |      .      *     |  2  21170 |
|  *   .            |            .*           |   *  .            |  3  21174 |
....
|     *.            |            *            |     *.            | 35  22693 |
+---------------------------------------------------------------------------------+
```

Display with Excel scatterplot initiates a graphical scatterplot plot. If the statistics being compared are both measures, then a 95% confidence interval is shown. This plot can be edited with all Excel tools.

Comparing with files



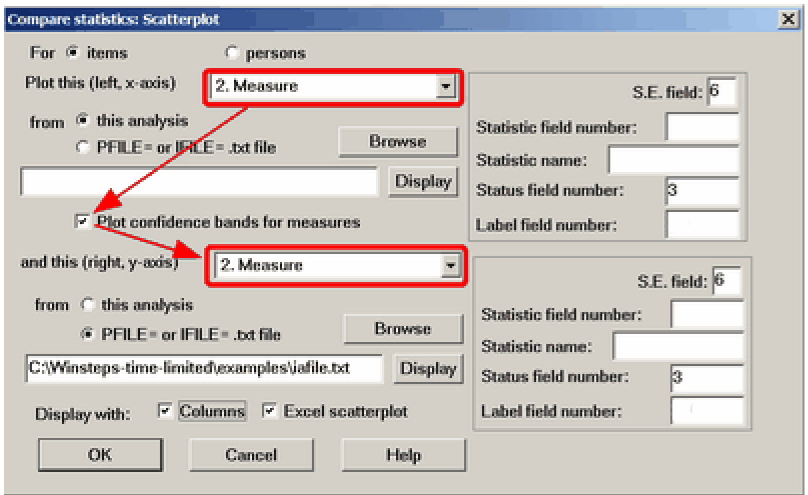
One or both sets of statistics can be in a IFILE= or PFILE= file (red arrow). Since these files can have different formats, please check that the selected field number matches the correct field in your file by clicking on the Display button (blue arrow). This displays the file. Count across the fields to your selected statistic. If your field number differs from the standard field number, please provide the correct details for your field in the selection box (orange box).

If two files are cross-plotted, please enter the Label field number in one of the files (either of the green arrows). Click on Display for one one of the files, and count across the fields to the Label field.

There are several decisions to make:
1. Do you want to plot person (row) or item (column) statistics?
2. Which statistic for the x-axis?
3. Which statistic for the y-axis?
4. Do you want to use the statistic from this analysis or from the PFILE= or IFILE= of another analysis?
5. Do you want to display in the statistics as Columns in a Table or as an Excel scatterplot or both?

If you are using the statistic from a PFILE= or IFILE= and Winsteps selects the wrong column, then identify the correct column using the "Statistic field number" area.

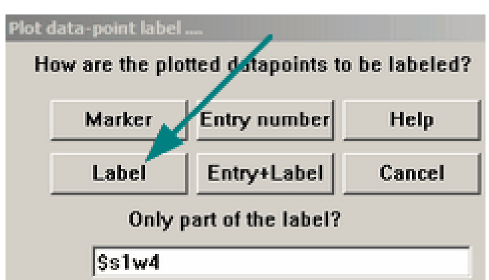
When two measures are compared, then their standard errors are used to construct confidence bands when "Plot confidence bands" is checked:



Here the item calibrations in the current analysis are being compared with the item calibrations in file IFILE=SFIF.txt from another analysis. This is the columnar output:

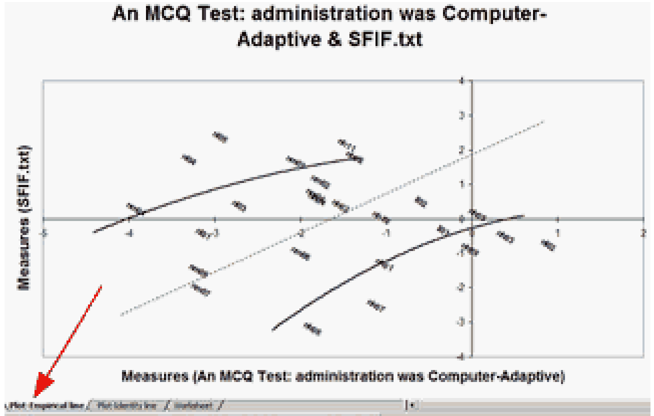
```
TABLE 34.1 An MCQ Test: administration was Comput ZOU630WS.TXT Apr 21  2:21 2006
INPUT: 30 STUDENTS  69 TOPICS  REPORTED: 30 STUDENTS  69 TOPICS  2 CATS     3.60.2
--------------------------------------------------------------------------------

+----------------------------------------------------------------------------------------------------+
|     Measures       |       Differences        |     Measures      | Comparison                      |
|                    |                          |     SFIF.txt      |                                 |
|-4                 1|-2                       5|-3                2| NUM TOPIC                       |
|-------------------+--------------------------+-------------------+---------------------------------|
|   *          .    |       .         *        |          *.       |  1  nl01  Month                 |
|              .  * |  *    .                  |         * .       |  2  nl02  Sign                  |
|    *         .    |       .          *       |           .*      |  3  nl03  Phone number          |
|  *           .    |       .                * |           .    *  |  4  nl04  Ticket                |
|    *         .    |       .                 *|           .      *|  5  nl05  building              |
|*             .    |       .              *   |           .*      |  6  nm01  student ticket        |
|        *     .    |       .        *         |           .  *    |  7  nm02  menu                  |
|       *      .    |       .           *      |           .   *   |  8  nm03  sweater               |
|        *     .    |       .        *         |           . *     |  9  nm04  Forbidden City        |
|   *          .    |       .      *           |      *    .       | 10  nm05  public place          |
|       *      .    |       .   *              |        *  .       | 11  nm06  post office           |
|   *          .    |       .    *             |     *     .       | 12  nm07  sign on wall          |
|          *   .    |       *                  |       *   .       | 13  nh01  supermarket           |
|         *    .    |       .      *           |           .*      | 14  nh02  advertisement         |
|              .*   |    *  .                  |         * .       | 15  nh03  vending machine       |
|        *     .    |       .       *          |           .*      | 16  nh04  outside store         |
|              *    |       *                  |           *       | 17  nh05  stairway              |
|        *     .    |    *  .                  | *         .       | 18  nh06  gas station           |
|          *   .    |    *  .                  |   *       .       | 19  nh07  Taipei                |
|         *    .    |       .         *        |           .    *  | 20  nh08  window at post office |
|              *    |     * .                  |        *  .       | 21  nh09  weather forecast      |
|          *   .    |       .   *              |           *       | 22  nh10  section of newspaper  |
|         *    .    |       .           *      |           .     * | 23  nh11  exchange rate         |
|             *.    |       *                  |          *.       | 24  il01  open                  |
|            * .    |       .   *              |           .*      | 25  il02  vending machine       |
+----------------------------------------------------------------------------------------------------+
```

and the plotted output:

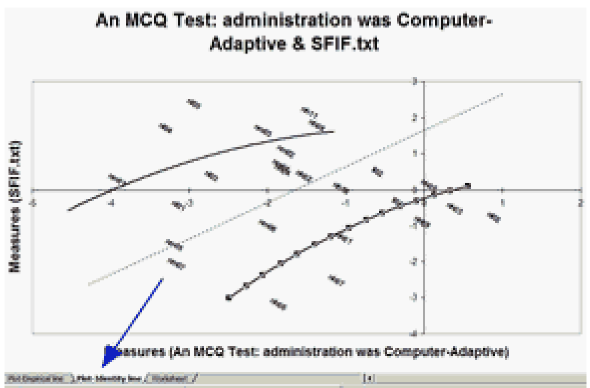


We are selecting only the first 4 characters of the item label, e.g., "nl01" and plotting only the Label:

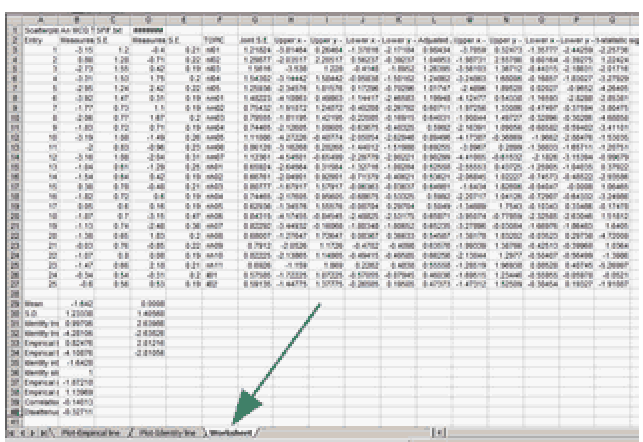
1. Plots with confidence bands:



The points are plotted by their labels by Excel. The curved lines are the approximate 95% two-sided confidence bands (smoothed across all the points). They are not straight because the standard errors of the points differ. In this plot called "Empirical" (red arrow), the dotted line is the empirical equivalence line, the linear regression line for y-values on x-values. Right-click on a line to reformat or remove it.



A line parallel to the identity line is shown on the "Identity" plot (blue arrow) by selecting the tab on the bottom of the Excel screen. This line is parallel to the standard identity line (of slope 1) which goes through the origin of the two axes. This parallel-identity line goes through the mean of the two sets of measures (vertical and horizontal).



The plotted points are in the Excel Worksheet (green arrow). You can edit the data points and make any other changes you want to the plots.

Cell and Column Descriptions for Scatterplots of Measures with Confidence Bands

Cell	Description	
A1	Scatterplot	
B1	TITLE=	
D1	Date and time	
F1	CI= (Confidence Interval is)	
G1	1.96 (normal deviate for 95% 2-sided confidence bands)	
H1	68%=1.00, 90%=1.65, 95%=1.96, 99%=2.58 (Typical normal deviates for 2-sided confidence bands)	
B22 (or similar), B23	Mean of Measure 1 in Column B and its population S.D.	
D22 (or similar), D23	Mean of Measure 2 in Column D and its population S.D.	
Column	**Meaning**	**Formula for Row B**
A	Entry	Entry number of Person or Item
B	Measure 1	Measure on y-axis
C	S.E. 1	Standard Error of Measure in column B
D	Measure 2	Measure on y-axis
E	S.E. 2	Standard Error of Measure in column D
F	PERSON or ITEM	Person or Item Label
G	C.I. - Identity (for Identity-line Confidence Band)	=SQRT(C3^2+E3^2)*G1*0.5
H	Upper x - Identity (for upper Confidence Band on Identity-line plot)	=((B22+B3+D3-D22)/2-G3)
I	Upper y - Identity	=((D22+B3+D3-B22)/2+G3)
J	Lower x - Identity (for lower Confidence Band on Identity-line plot)	=((B22+B3+D3-D22)/2+G3)
K	Lower y - Identity	=((D22+B3+D3-B22)/2-G3)
L	C.I. - Empirical (for Empirical-line Confidence Band)	=SQRT((C3/B23)^2+ (E3/D23)^2)*G1*0.5
M	Upper x - Empirical (for upper Confidence Band on Empirical-line plot)	=(B22+((((B3-B22)/(2*B23))+((D3-D22)/(2*D23))-L3)*B23))
N	Upper y - Empirical	=(D22+((((B3-B22)/(2*B23))+((D3-D22)/(2*D23))+L3)*D23))
O	Lower x - Empirical	=(B22+((((B3-B22)/(2*B23))+((D3-D22)/(2*D23))+L3)*B23))
P	Lower y - Empirical	=(D22+((((B3-B22)/(2*B23))+((D3-D22)/(2*D23))-L3)*D23))
Q	*t*-statistic (of difference between Measures relative to their means)	=((B3-B22+D22-D3)/SQRT(C3^2+E3^2))

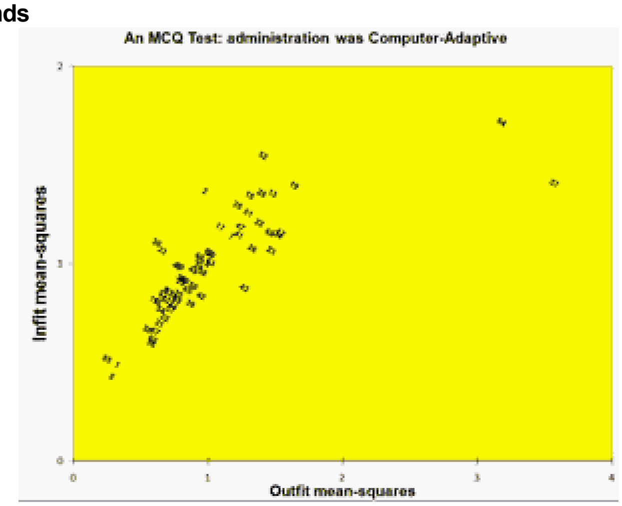
Entry	Measure	S.E.	Measure
Mean	0.3812		0.0008
S.D.	1.851301		1.40568
Identity trend	3.63818		3.25778
Identity trend	-2.87578		-3.25618
Empirical trend	4.083802		0.50081
Empirical trend	-3.3214		-0.49921
Identity intercept	0.3804		
Identity slope	1		
Empirical intercept with x-axis	0.375276		
Empirical intercept with y-axis	-0.05068		
Empirical slope	0.135043		
Correlation	0.135043		
Reliability x	0.875797		
Reliability y	0.972948		
Disattenuated Correlation	0.146294		

The relationship between the variables is summarized in the lower cells.
Empirical slope = Correlation between x-values and y-values
Intercept = intersection of the line with empirical slope through the point: mean(x-values), mean(y-values)
Predicted y-value = intercept with y-axis + x-value * empirical slope
Predicted x-value = intercept with x-axis + y-value / empirical slope
Disattenuated correlation approximates the "true" correlation without measurement error.
Disattenuated correlation = Correlation / sqrt (Reliability(x-values) * Reliability(y-values))

E	F	G	H
	CI=	1.96	68%=1.00
.	ACT	Joint S.E.	Upper x -
0.21	Watch bir	0.291045	-0.69105
0.22	Read bool	0.304904	-1.0149

In Row 1, the worksheet allows for user-adjustable confidence bands.

2. Plots without confidence bands



The plot can be edited with the full functionality of Excel.

The Worksheet shows the correlation of the points on the two axes.

	A	B	C	D	E	F
1	Scatterplo	An MCQ Te		8/30/08 11:08 PM	Correlatio	0.782639
2	Entry	Outfit mea	Infit mean	TOPIC		

18 Plots - R Statistics

18.1 R Statistics Interface

Winsteps interacts with R Statistics through Windows.

On screen:

```
 R Statistics launched. Please wait for display.
     Problems? See Winsteps Help: R Statistics interface
```

Internally:

1. Winsteps writes temporary data files to the %temp% user's temporary folder in tab-separated .txt format.

2. Winsteps writes R Statistics instructions to the .Profile file in %temp%

3. Winsteps checks that file WINSTEPS-ZERO.rdata exists in %temp%. If not, either copies it from the c:\Winsteps folder or calls R Statistics rterm.exe to create it.

4. Winsteps asks Windows to launch WINSTEPS-ZERO.rdata.
4.1 R Statistics actions the .Profile file.
4.2 Needed R Statistics packages are installed if not already installed
4.3 .rdata files are created from the .txt files
4.4 R packages are launched

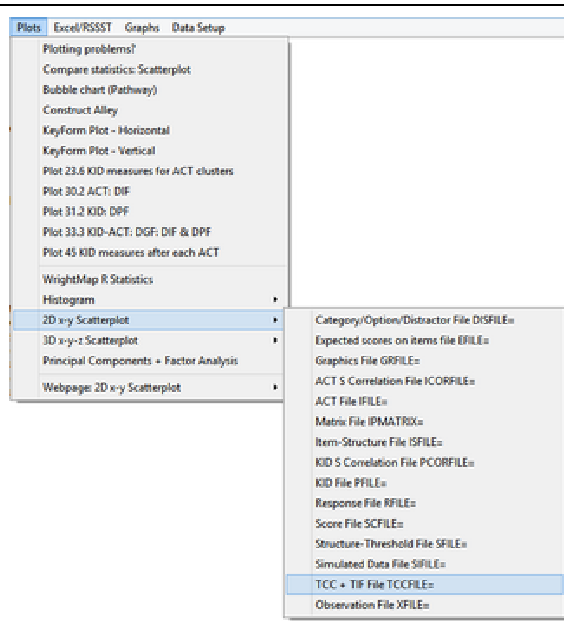
5. The R Window opens and package output is displayed. The most important data frame is called "data".

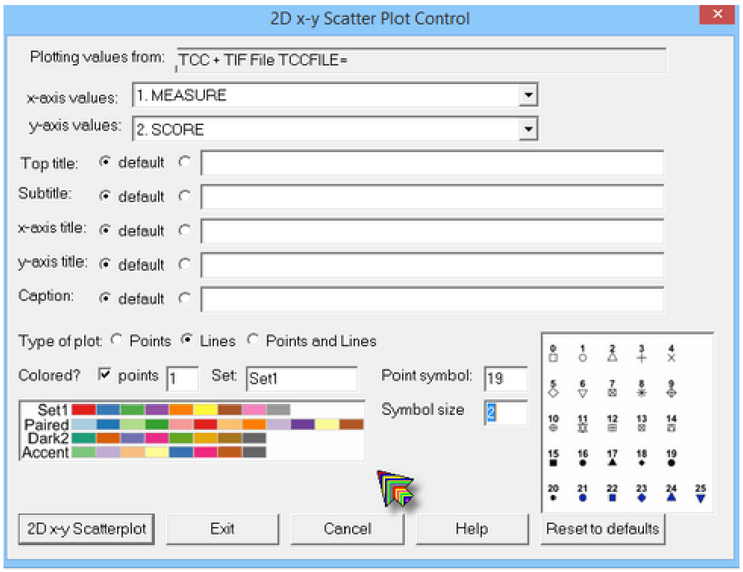
If the R Window does not open, then open your %temp% folder with Windows Explorer or the Windows Start or Run box. Then double-click on WINSTEPS-ZERO.rdata. This takes you to step 4. If R Statistics does not launch, check that R Statistics is installed and extension .rdata is opened with R Statistics (Rgui.exe or Rstudio.exe).

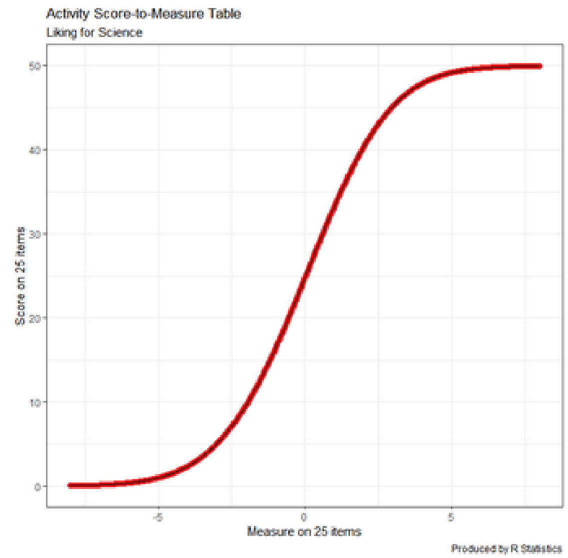
18.2 2D x-y Scatterplot - R Statistics

Produces a 2-dimensional scatterplot using R Statistics.

1. Install R-Statistics (once only)
2. Run the Winsteps analysis.
3. Plots menu
4. Click on *2D x-y Scatterplot*
   Submenu of Output Files displays
5. Click on the Output File containing the 2 columns of numbers you want to scatterplot
6. 2D x-y Scatterplot Control dialog box displays







7. Choose the variables for the x- and y-axis values
8. Make other changes (if any)
9. Click on '2D x-y Scatterplot" button
10. R Statistics launches
11. 2D x-y Scatterplot displays.

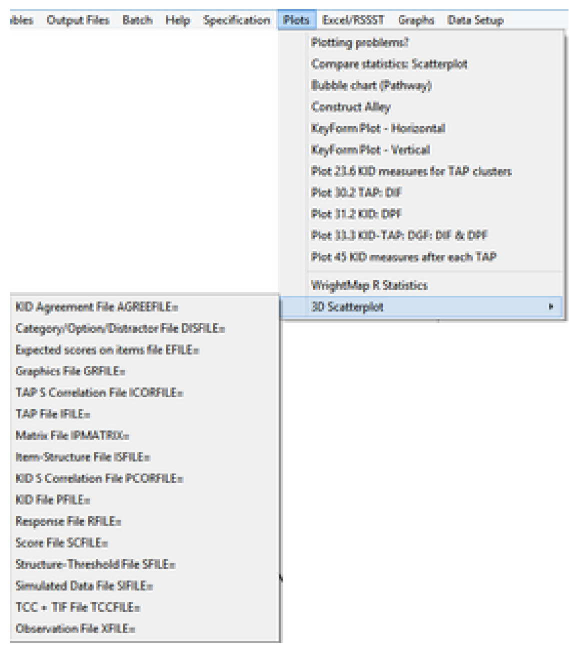
2D x-y Scatterplot Control	ggplot2 instruction	Meaning	Default:
Plotting values from:	ggplot (xy, xy is generated from a Winsteps output File.	Input file containing two columns of numbers	DISFILE= distractor file
x-axis values	aes(x= first column in xyz	values on x-axis	column 1 in output file
y-axis values	y= second column in xyz	values on y-axis	column 2 in output file
Top title	labs(title=	title above scatterplot.	TITLE=
Subtitle	subtitle=	subtitle above scatterplot	(none)
Caption	caption=	title at bottom-right beneath scatterplot	name of Output file
x-axis title	x=	label for x-axis	title of x-value column
y-axis title	y=	label for y-axis	title of y-value column
Type of plot: Points, Lines, Points and lines	geom_points() or geom_lines() or geom_points() +geom_lines()	how the points are displayed on the plot	Points
(none)	theme_bw()	box drawn around plot	Yes
Colored? points	color=	color chosen for plotted points	Set 1, colors 1
Set:	RColorBrewer pallette	range of colors for Colored? Some palettes are listed	Set1.

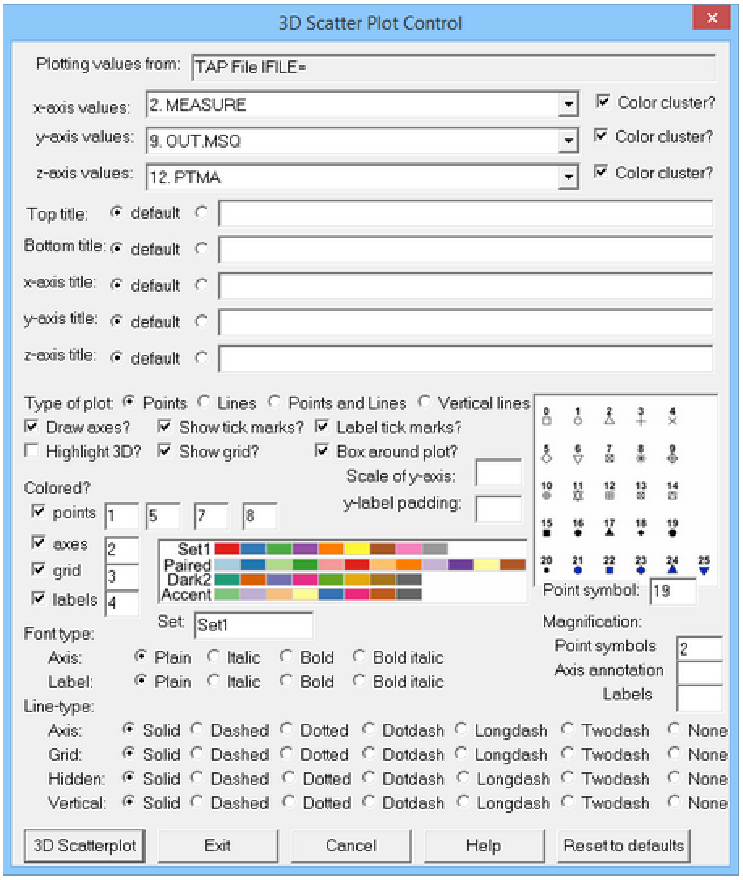
Point symbol	shape=	symbol ot use for plotted points	19, dot
Point size	size=	set size of symbols	2 on scale 1 to 5
2D x-y Scatterplot	launch R statistics: ggplot	2d x-y scatterplot is displayed	library(ggplot) > ggplot(....
Exit		current dialog box setting are saved and dialog box is closed	
Cancel		dialog box is closed. Setting of most recent displayed scatterplot are saved.	
Reset to defaults		all values are reset to their default values	settings are always reset to default values when Winsteps is launched

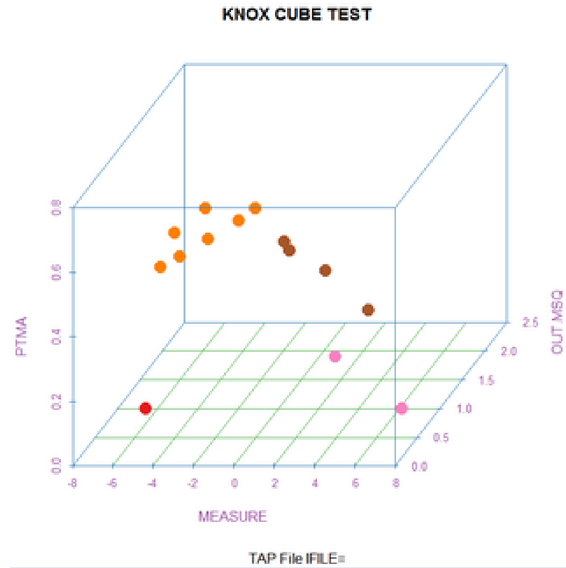
18.3 3D x-y-z Scatterplot - R Statistics

Produces a 3-dimensional scatterplot using R Statistics.

1. Install R-Statistics (once only)
2. Run the Winsteps analysis.
3. Plots menu
4. Click on the 3D Scatterplot
   Submenu of Output Files displays
5. Click on the Output File containing the 3 columns of numbers you want to scatterplot
6. 3D Scatterplot Control dialog box displays







7. Choose the variables for the x-, y- and z-axis values
8. Select Color cluster? and choose Colored? points.
9. Make other changes (if any)
10. Click on '3D Scatterplot" button
11. R Statistics launches
12. 3D Scatterplot displays.

3D Scatterplot Control	scatterplot3d instruction	Meaning	Default:
Plotting values from:	scatterplot3d (xyz, xyz is generated from a Winsteps output File.	Input file containing 3 columns of numbers	DISFILE= distractor file
x-axis values	first column in xyz	values on x-axis	column 1 in output file
y-axis values	second column in xyz	values on y-axis	column 2 in output file
z-axis values	third column in xyz	values on z-axis	column 3 in output file
Color cluster?	color=	use values to construct colored clusters of points	yes
Top title:	main=	title above scatterplot.	TITLE=
Bottom title	sub=	title beneath scatterplot	name of Output file
x-axis title	xlab=	label for x-axis	title of x-value column
y-axis title	yab=	label for y-axis	title of y-value column

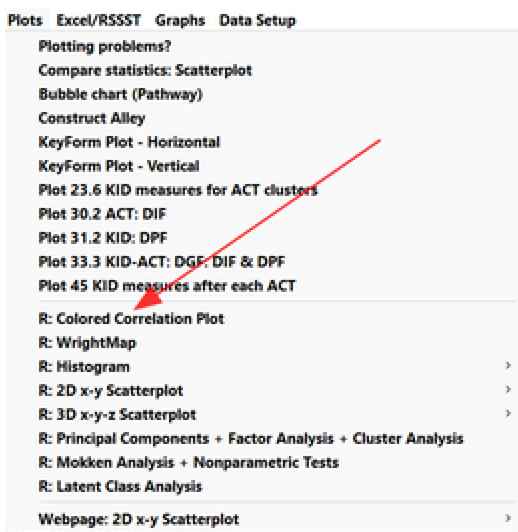
z-axis title	zlab=	label for z-axis	title of z-value column
Type of plot: Points, Lines, Points and lines, Vertical lines	type=	how the points are displayed on the plot	Points
Draw axes?	axis=	are the x-, y-, z- axes shown	Yes
Show tick marks?	tick.marks=	are the tick marks shown on the axes?	Yes
Labels tick marks?	label.tick.marks=	do the tick marks have numerical labels?	Yes
Highlight 3D?	highlight.3d=	some points emphasized in black	No
Show grid?	grid=	gridlines shown on x, z axis plane	Yes
Box around plot?	box=	enclose plotted points in a box?	Yes
Scale of y-axis	scale.y=	scale of y-axis relative to x-axis	set by software
y-label padding	y.margin.add=	extra gap between y-axis label and y-axis	set by software
Colored? points	color=	up to 4 colors for 4 clusters of points. For black: Set: Greys Color number: 9	Set 1, colors 1, 5, 7, 8
Colored? axes, grid, labels	col.axis=m col.grid=, col.lab=	color to use when displaying these elements. If blank, the color is black.	Set 1, colors 2, 3, 4
Set:	RColorBrewer palette. .	range of colors for Colored? Some palettes are shown. For all, type at the R prompt: > display.brewer.all()	Set1. Colors in each set are numbered from 1 onwards.
Font type: axis, label	font.axis=, font.grid=	font style on for axis labels and other labels	Plain
Plain, Italic, Bold, Bold Italic	values for font.axis=, font.grid=	font style on plot	Plain
Point symbol	pch=	symbol ot use for plotted points	1, small circle
Magnification: Point symbols, Axis annotation, Labels	cex.symbol=, cex.axis=, cex.lab=	change size of symbols and letters	set by software
Line-type: Axis, Grid, Hidden, Vertical	lty.axis=, lty.grid=, lty.hide=, lty.hplot=	format of plotted lines	solid
Solid, Dashed, Dotted, Dotdash, Longdash, Twodash, None	available line options	formatted of plotted lines. None = no line shown	solid

3D Scatterplot	launch R statistics: scatterplot3d	3D x-y-z scatterplot is displayed	library(scatterplot3d) > scatterplot3d(...
Exit		current dialog box setting are saved and dialog box is closed	
Cancel		dialog box is closed. Setting of most recent displayed scatter box are saved.	
Reset to defaults		all values are reset to their default values	settings are reset to default values when Winsteps is launched

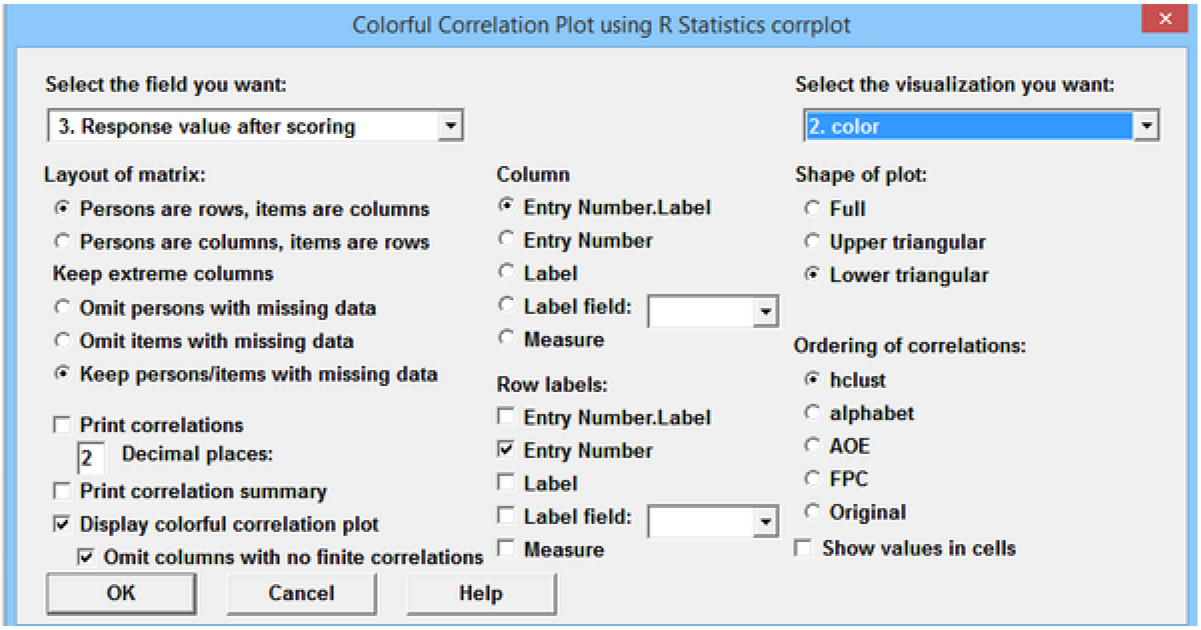
18.4 Colored Correlation Plot - R Statistics

Uses R Statistics to display the colored correlation plot - correlogram- in corrplot.pdf

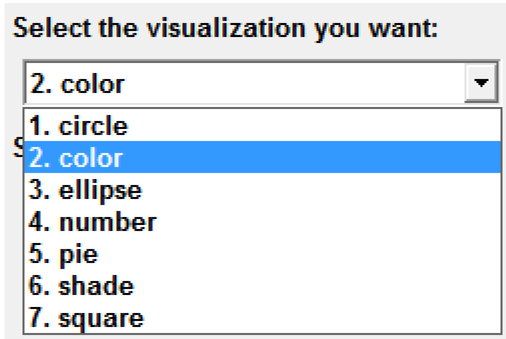
From the Plots menu:



The Colorful Correlation Plot dialog w indow :



Option	Description
Select field: 7. Standardized Score Residual	Numerical data accepted.
Persons are rows, items are columns Persons are columns, items are rows	The columns are treated as items (variables) in this analysis.
Omit persons with missing data Omit items with missing data Keep persons/items with missing data	Missing data is allowed
Column labels	Shown in plot
Row labels	included in R data frame but ignored for correlations
Print correlations	A correlation matrix is displayed in the R analysis window
Decimal places	Number of decimal places to be shown for each correlation
Print correlation summary	A few summary statistics of the correlation matrix
Display colorful correlation plot	Plot is shown in an R Graphics window
Omit columns with no finite correlations	missing and incalculable correlations are shown as blanks spaces. Blank rows and columns can be hidden from the display

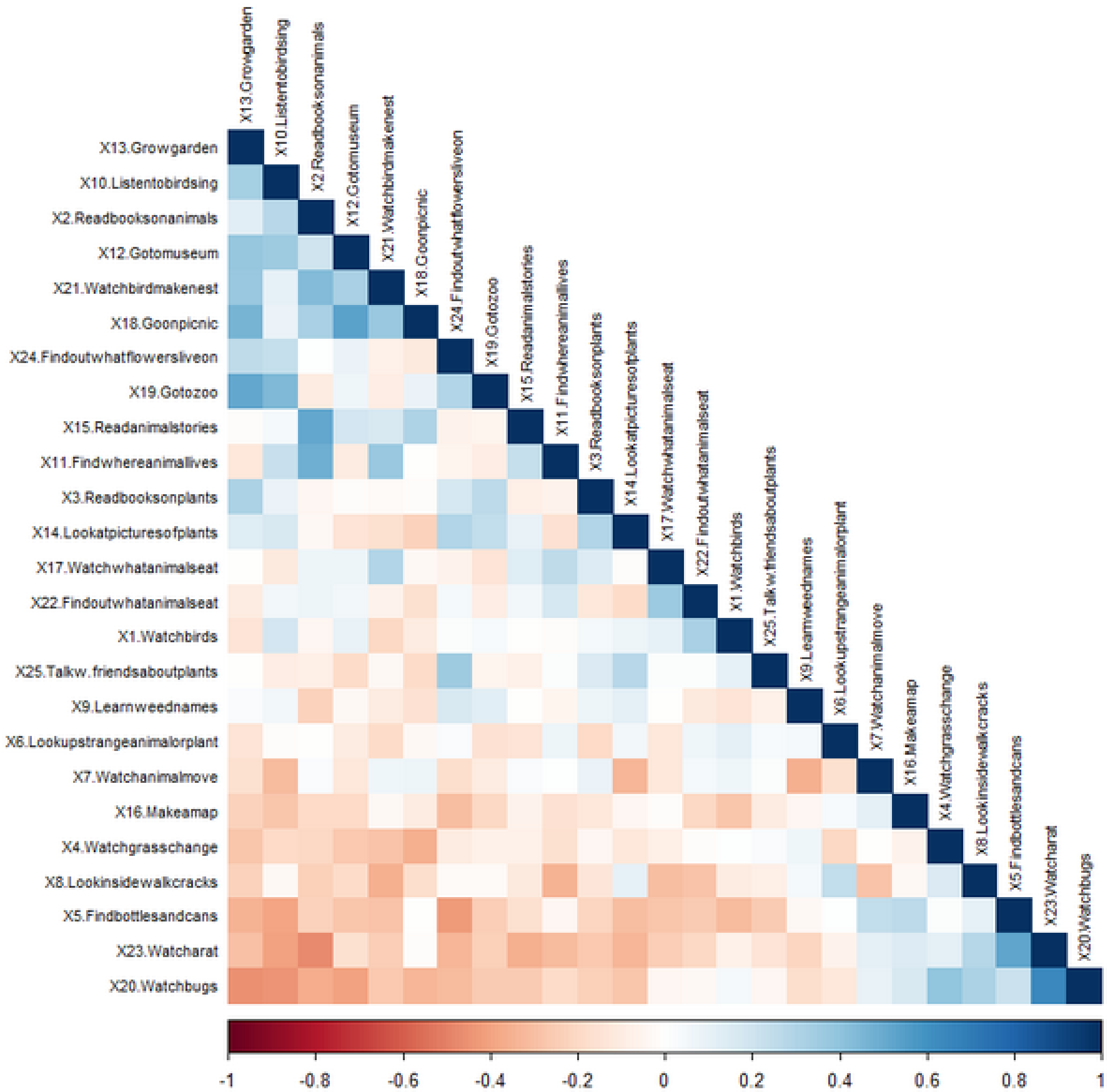
Select the visualization you want:	 The colored shape in the correlation matrix plot
Shape of plot	Shape of the displayed correlation matrix: Full, Upper Triangular, Lower Triangular.
Ordering of correlation rows in plot	For technical details, see An Introduction to corrplot Package
Show values in cells	Also displays numerical correlation in each cell

Output from R Statistics:

Correlation matrix:

```
                         X1.Watchbirds X2.Readbooksonanimals
X1.Watchbirds                   1.0000               -0.0452
X2.Readbooksonanimals          -0.0452                1.0000
X3.Readbooksonplants            0.0447               -0.0449
```

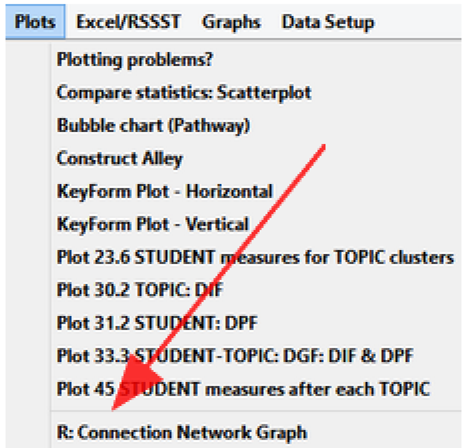
Colorful correlation plot - visualization "color" with option hclcust so that similar correlations are clustered together.
:



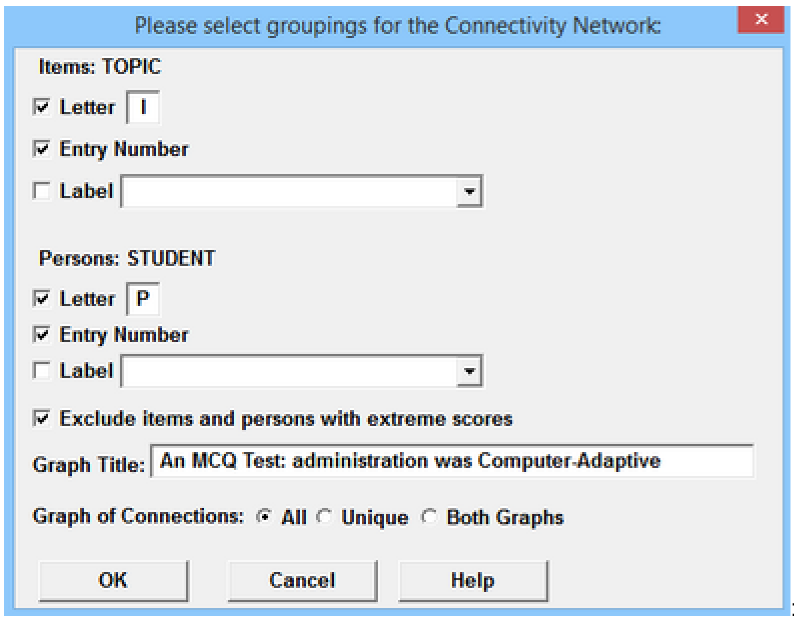
18.5 Connection Network Graph - R Statistics

The R Statistics package "igraph" displays the network of connections between persons and items. This shows the number of connections between items and persons and also identifies disconnected subsets of persons and items. The network is based on the data. Anchoring and missing data are ignored.

From the [Plots menu]:



Connection Network dialog box:

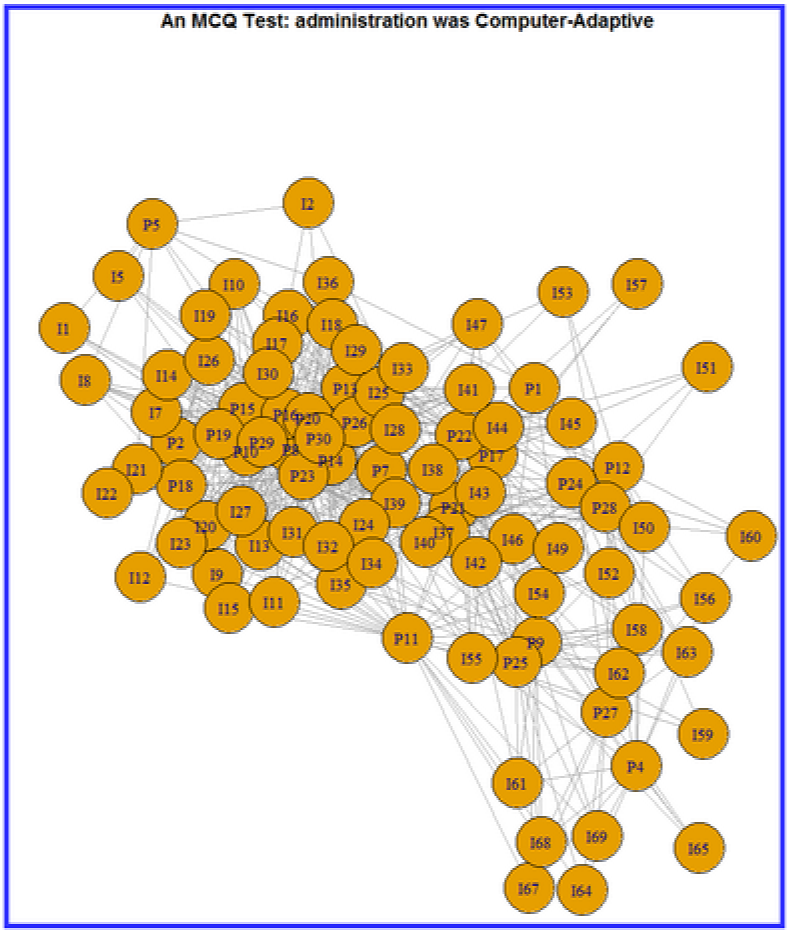


:

Connectivity Network Dialog Box	
Items:	Columns in the data
Persons:	Rows in the data
Letter:	.One letter to identify items or persons in the graph
Entry number	Is the item or persons entry number to be shown on the graph?
Label	Is the item or person label (or part of it) to be shown on the graph?
Exclude items and persons with extreme scores	Items and persons with maximum possible and minimum possible scores are not used for connecting subsets
Graph title:	Wording at the top of the graph
Graph of Connections	All: all connections between elements in the data Unique: only one connection shown between elements in the data Both Graphs: All and Unique graphs
OK	display the "igraph" network graphs

Cancel/End	exit
Help	this page

Example **from Exam5.txt: multiple-choice computer-adaptive test.**

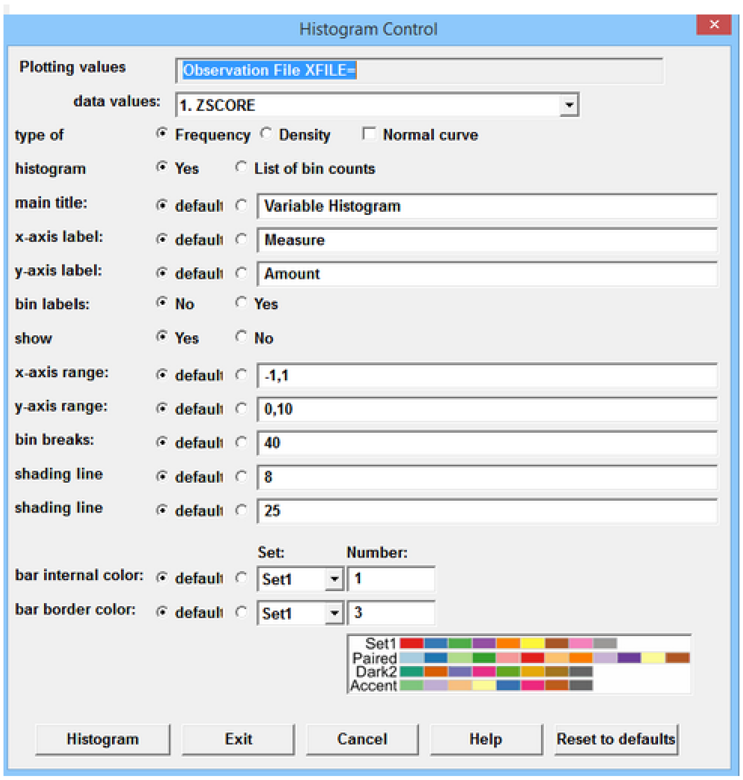


Example **with Subsets.**

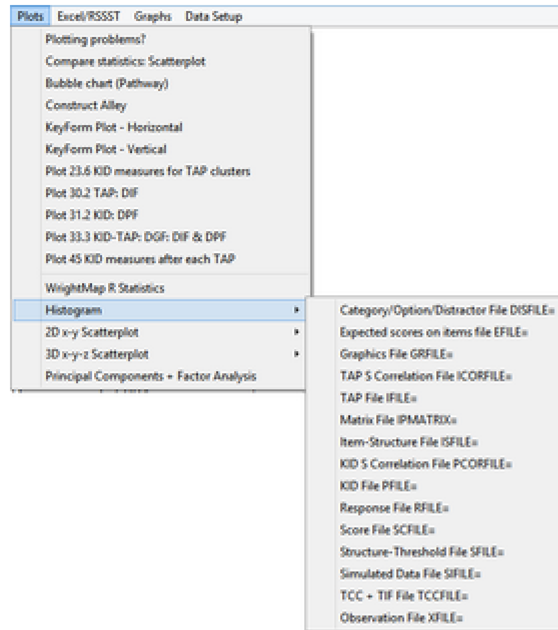
18.6 Histogram - R Statistics

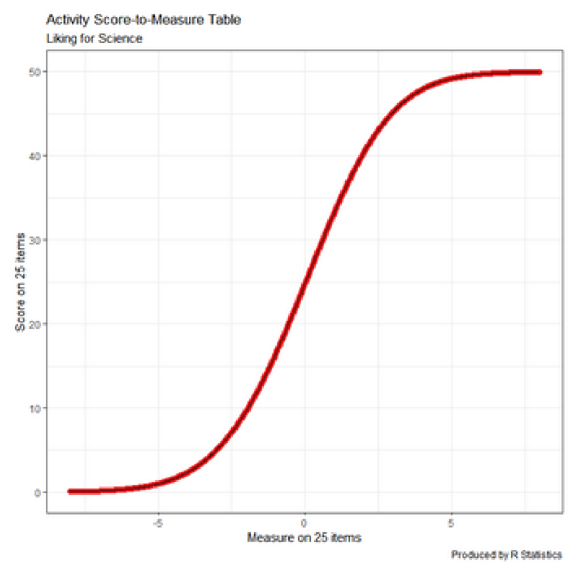
Produces a histogram using R Statistics.

1. [Install R-Statistics](#) (once only)
2. Run the Winsteps analysis.
3. [Plots](#) menu
4. Click on *Histogram*
   Submenu of Output Files displays
5. Click on the Output File containing the 1 column of numbers you want to histogram
6. Histogram Control dialog box displays



7. Choose the variables for the values
8. Make other changes (if any) - Examples of each option are shown. For more details, see [hist()](#) documentation. Try the Example value so that you can see what it does.
9. Click on 'Histogram" button
10. R Statistics launches
11. Histogram displays.





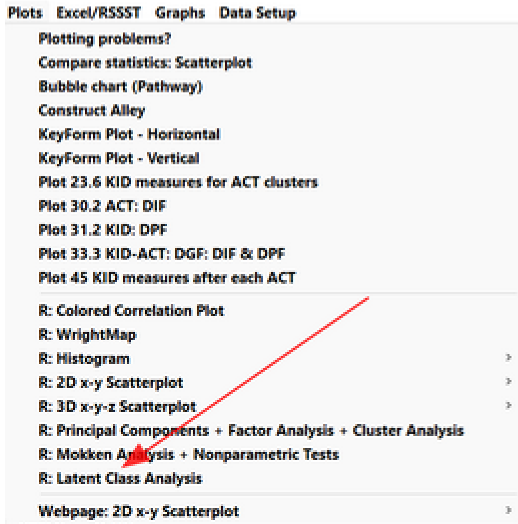
Histogram Control	[hist()](#) instruction	Meaning	Default:
Plotting values from:	hist(*data* *data* is generated from a Winsteps output File.	Input file containing columns of numbers	[DISFILE=](#) distractor file
data values	hist(data$variable	values for histogram	column 1 in output file
type of histogram	freq=	Frequency or Probability Density	Frequency
Normal curve		Overlay normal N(0,1) curve	(none)
main title	main=	title above histogram	Histogram of data$variable

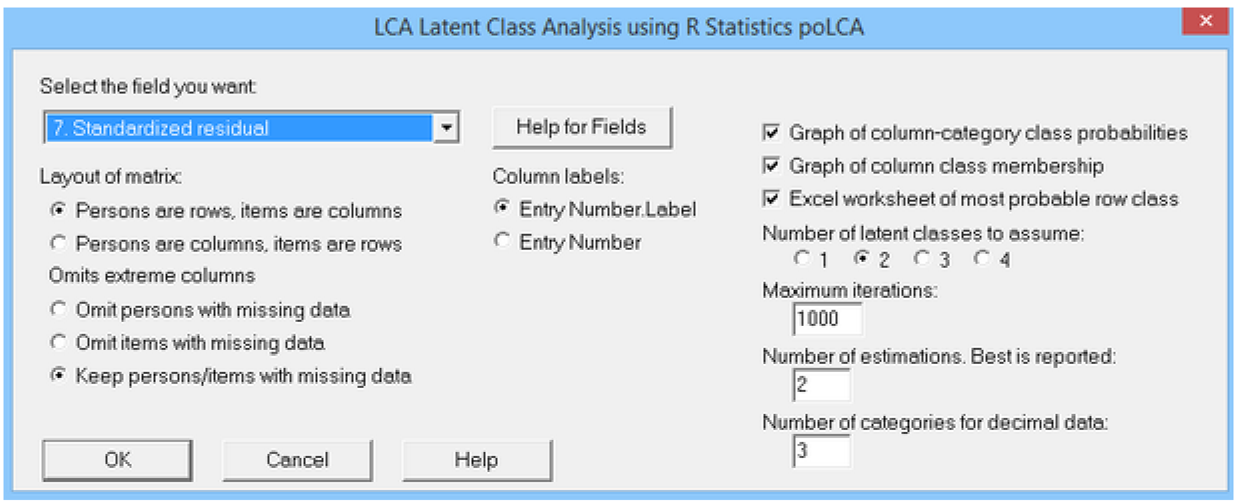
x-axis label	xlab=	label for x-axis	"data$variable"
y-axis label	ylab=	label for y-axis	Frequency
bin labels	labels=	counts above histogram bars	(none)
show axes	axes=	display x- and y-axis with numerical intervals	(display)
x-axis range	xlim=	range of the x-axis	(from the data)
y-axis range	ylim=	range of the y-axis	(from the data)
bin breaks	breaks=	number of bins	(from the data)
shading line density	density=	lines per inch in bars	5 when displayed
shading line angle	angle=	slope of the shading lines	45 degrees when displayed
Set:	RColorBrewer palette.	palette of colors	Set1
Number:	RColorBrewer color in palette	each palette has several colors starting with color number 1	1 - color number 1 in the palette, counting colors from the left in the picture
bin internal color	col=	color inside the bin bar	(none)
bin border color	border=	color of the edge of the bin bar	black
Histogram	launch R statistics: histt	Histogram is displayed	library(graphics) > hist(....)
Exit		current dialog box setting are saved and dialog box is closed	
Cancel		dialog box is closed. Setting of most recent displayed Histogram are saved.	
Reset to defaults		all values are reset to their default values	settings are always reset to default values when Winsteps is launched

18.7 Latent Class Analysis

Uses R Statistics to perform Latent Class Analysis (LCA) described in poLCA.pdf

From the Plots menu:



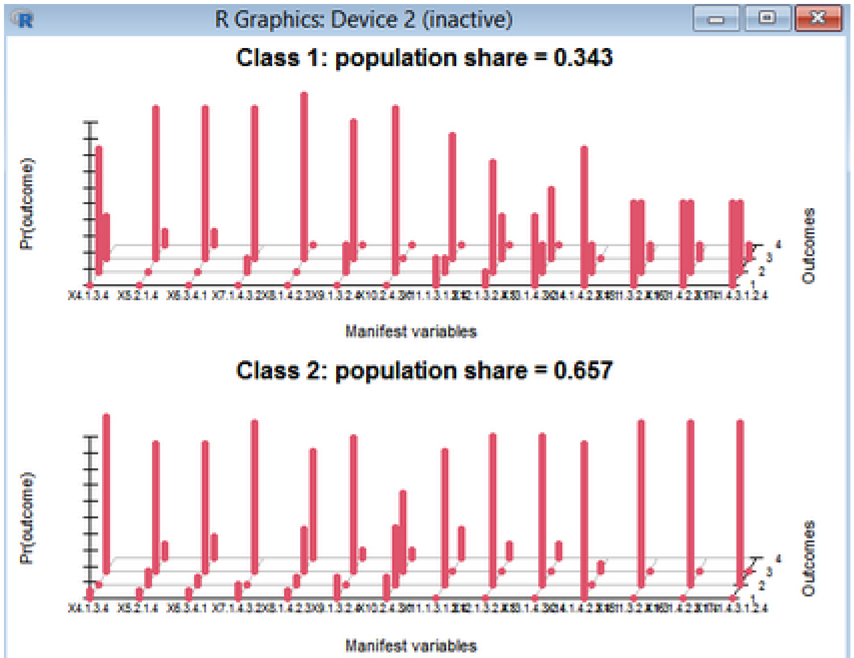


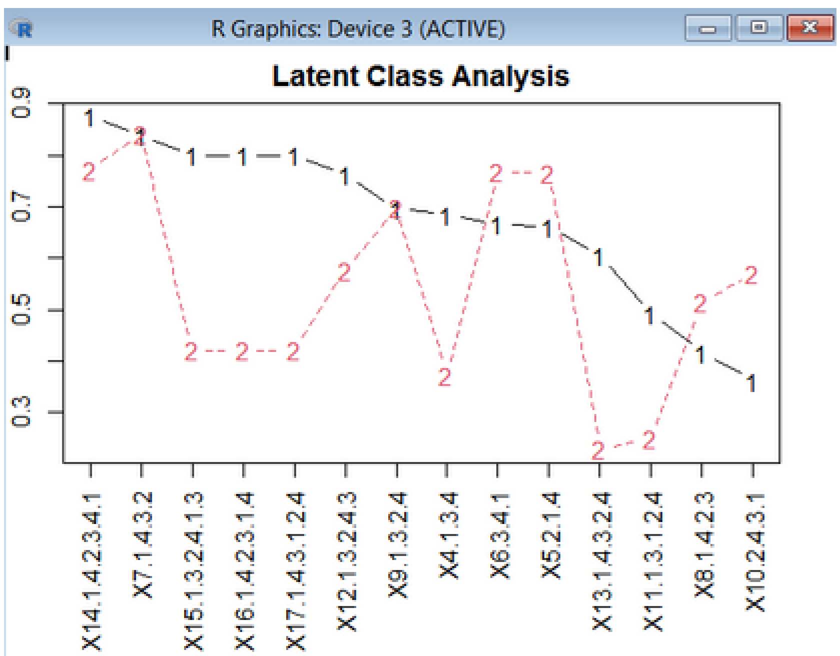
Option	Description
Select field: 7. Standardized Score Residual	Numerical data accepted.
Persons are rows, items are columns Persons are columns, items are rows	The columns are treated as items (variables) in this analysis.
Omit persons with missing data Omit items with missing data Keep persons/items with missing data	Missing data is allowed
Column labels	in R Statistics "data" dataframe and output
Graph of column-category class probabilities	Item data is stratified into categories. The categories are analyzed as nominal, not ordinal. Each category of each item is reported with a probability for each class
Graph of column class membership	The category probabilities are summarized by column
Excel worksheet of most probable row class	The most probable row for each row is reported together with the person PFILE= or item IFILE= data by Excel
Number of latent classes to assume	"1" reports the log-linear independence model

	"2", "3", "4" report latent classes
Maximum iterations	poLCA usually requires only a few iterations
Number of estimations. Best is reported.	Starting values are random. Multiple estimations guard against false estimates.
Number of categories for decimal data	Data are stratified into categories, which are treated as nominal.

```
Output from R Statistics:
Model 1: llik = -1014.741 ... best llik = -1014.741
Model 2: llik = -988.4622 ... best llik = -988.4622
Conditional item response (column) probabilities,
 by outcome variable, for each class (row)

$X4.1.3.4
          Pr(1) Pr(2)  Pr(3)
class 1:  0.0000  0.75 0.2500
class 2:  0.0435  0.00 0.9565
.....
$X17.1.4.3.1.2.4
         Pr(1)  Pr(2)  Pr(3)
class 1:    0.5 0.4167 0.0833
class 2:    0.0 1.0000 0.0000

Estimated class population shares
 0.3429 0.6571

Predicted class memberships (by modal posterior prob.)
 0.3429 0.6571

=========================================================
Fit for 2 latent classes:
=========================================================
number of observations: 140
number of estimated parameters: 73
residual degrees of freedom: 67
maximum log-likelihood: -988.4622

AIC(2): 2122.924
BIC(2): 2337.664
G^2(2): 1161.126 (Likelihood ratio/deviance statistic)
X^2(2): 8334110 (Chi-square goodness of fit)

summary of column class probabilities
                   [,1]      [,2]
X14.1.4.2.3.4.1 0.8757764 0.7714286
...
X10.2.4.3.1     0.3614907 0.5714286
```

Graphs:





Excel worksheet:

	A	B	C	D	E
1	CLASS	ENTRY	MEASURE	STATUS	COUNT
2	2	1	-2.94	1	18
3	2	2	-0.26	1	18
4	2	3	0.92	1	18
5	2	4	-3.61	1	18

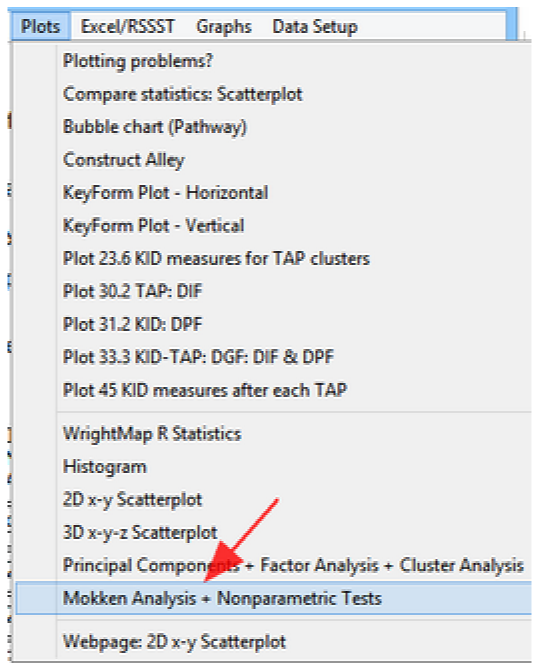
18.8 Mokken Analysis and Nonparametric Tests

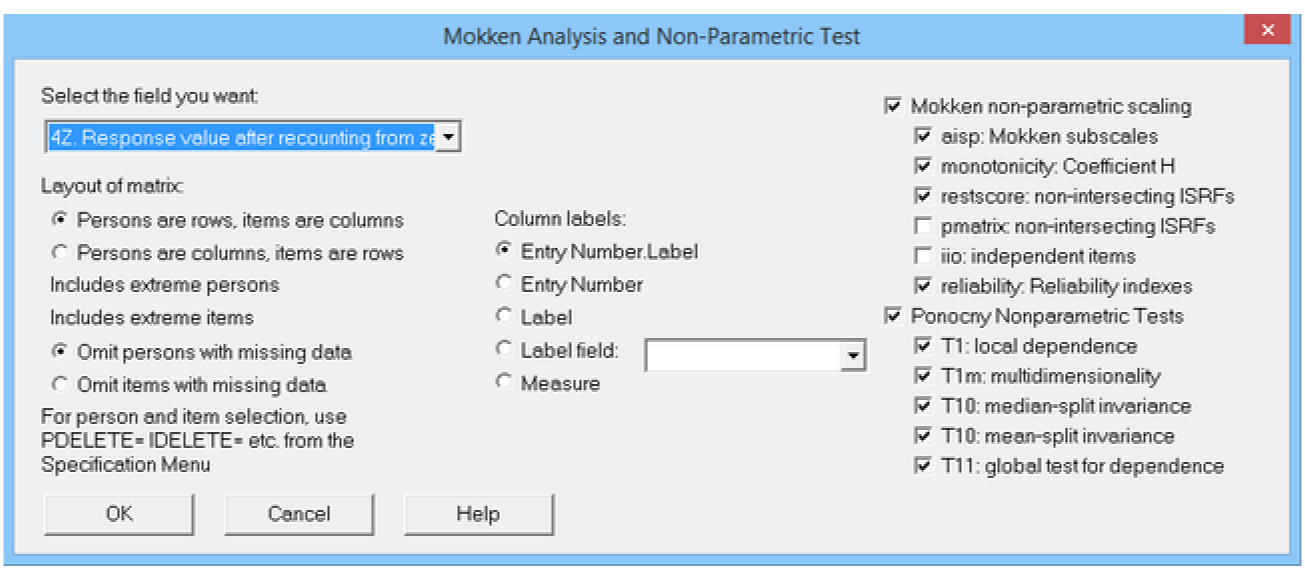
Uses R Statistics to perform the nonparametric analysis described in mokken.pdf and eRm-NPtest.

Please Google "introduction to Mokken analysis" for Mokken-analysis instructions. *Please tell mike@winsteps.com which instructions are the best for you.* Here is a video: Running a Mokken scaling analysis

Wind, S.A. (2014) Examining rating scales using Rasch and Mokken models for rater-mediated assessments Journal of Applied Measurement 15(2):100-32. Link
van der Ark, L. A. . (2012). New Developments in Mokken Scale Analysis in R. Journal of Statistical Software, 48(5), 1–27. Link
Ponocny, I. (2002) Nonparametric goodness-of-fit tests for the Rasch model. Psychometrika 67(2):315-315. Link

From the Plots menu:





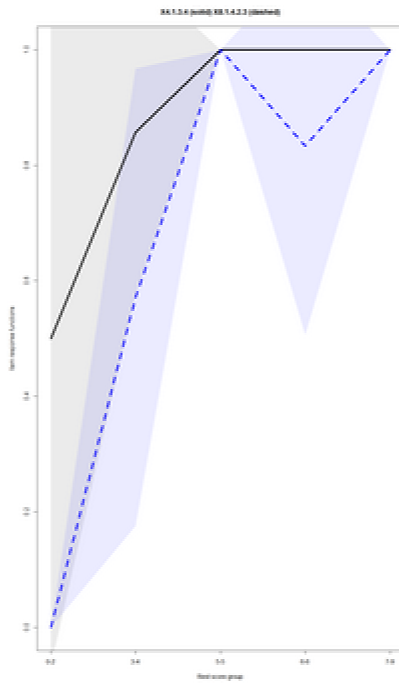
Option	Description

Select field: 4Z. Response value after recounting from zero	Nonparametric analysis requires simple ordinal data.
Persons are rows, items are columns Persons are columns, items are rows	The columns are treated as items (variables) in this analysis.
Omit persons with missing data Omit items with missing data	Missing data is not allowed
Column labels	shown in reports and plot headings
Mokken Nonparametric Scaling (dichotomous or polytomous data)	Mokken tests Loevinger's Coefficient H reported as ItemH ISRF: item-step response function IIO: invariant item ordering
Ponocny Nonparametric Tests (dichotomous data only)	Ordinal tests of dependence and invariance
There are more nonparametric tests available from the R Statistics > prompt, e.g., T1l (learning)	See mokken.pdf and eRm-NPtest.

```
Output from R Statistics:
[1] "Mokken Scaling (R Statistics package: mokken)"
[1] "Mokken-consistent Subscales: aisp"
[1] "subscales numbered 1 and up. 0 = not in subscale"
          0.3
X4.1.3.4    1
X5.2.1.4    1
.....

[1] "Ponocny Nonparametric Tests only for dichotomous data (R Statistics package: eRm)"
[1] "Local dependence = overfit (T1)"
.....

[1] "available Mokken plots:"
[1] "plot(monotonicity.list)"
[1] "plot(restscore.list)"
[1] "plot(pmatrix.list)"
[1] "plot(iio.list)"
```

Plots are usually many pages (R Statistics windows) requiring one click for each page. Escape key and window ☒ to exit.

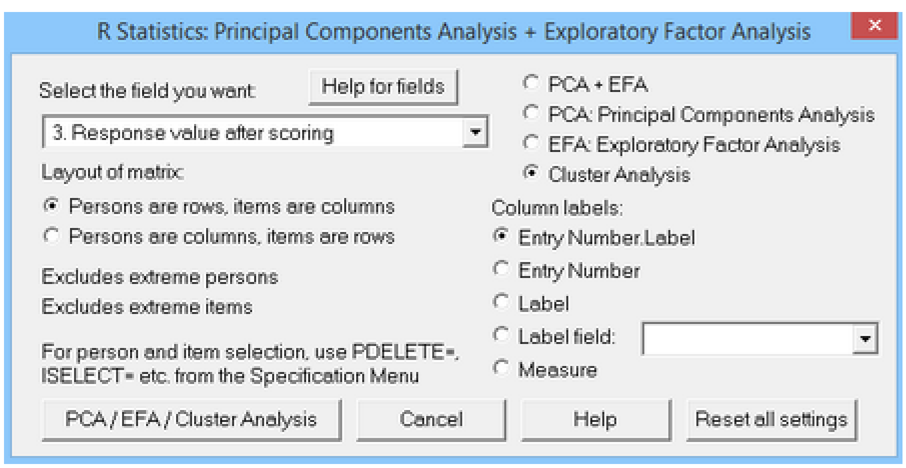
```
> plot(iio.list)
```



18.9 PCA, EFA, Cluster Analysis - R Statistics

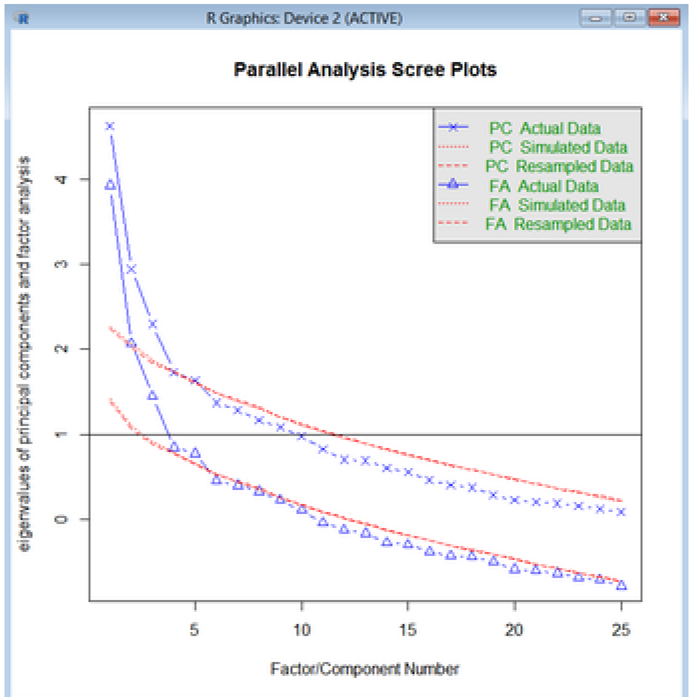
This is called from the Plots menu and performs Principal Components Analysis and Exploratory Factor Analysis using R Statistics. This confirms and complements Table 23, Item dimensionality, and Table 24, Person dimensionality. For more information, please see the R Statistics documentation for packages "psych" (scree plot, factor analysis) at cran.r-project.org/web/packages/psych/psych.pdf and "FactoMineR" (principal components analysis). cran.r-project.org/web/packages/FactoMineR/FactoMineR.pdf

This plot is added to Winsteps because:
1. analysts asked for a neater scree plot of the PCA contrasts in Table 23.0
2. analysts asked for confirmation of the Winsteps PCA results
3. analysts asked "If we used EFA instead of PCA, would the results be different?"



For most fields, see IPMATRIX=.

R Statistics packages are launched to perform PCA, EFA or both. A scree plot of the eigenvalues is shown.



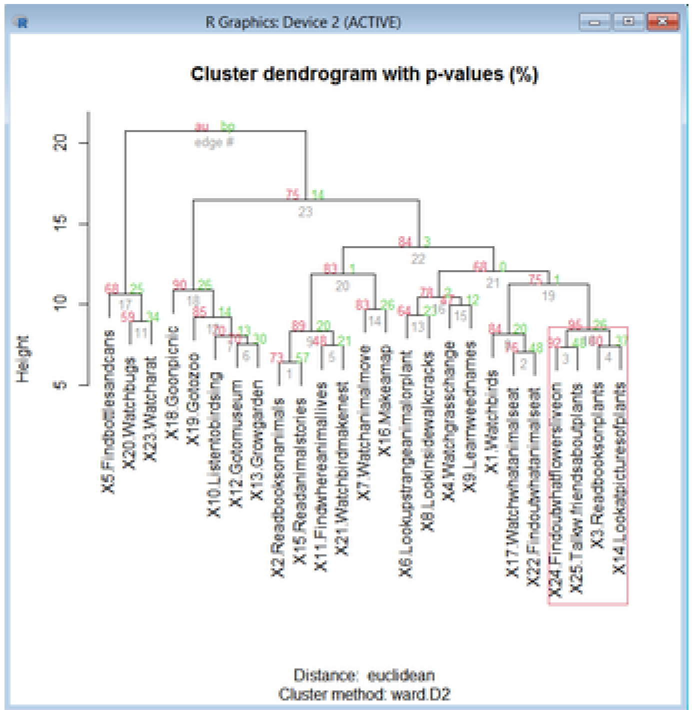
For PCA of Standardized Residuals, the eigenvalues are shown in the R Console Window (scroll up). The observed and expected (simulated) eigenvalues confirm and augment Tables 23.0 and 24.0. In R Console window:

```
Eigenvalues of real data
[1] 4.62622943 2.94277448 2.29809661 1.73152686 1.63418344 1.37225606
Eigenvalues of simulated data = expected values
[1] 2.2386962 2.0245066 1.8715678 1.7194308 1.6214343 1.5075780 1.3897111
```

PCA Component in Standardized Residuals	Eigenvalue: Table 23	Eigenvalue: R	Simulated: R
Unexplned variance in 1st contrast =	4.6287	4.62622943	2.2386962
Unexplned variance in 2nd contrast =	2.9434	2.94277448	2.0245066
Unexplned variance in 3rd contrast =	2.2957	2.29809661	1.8715678
Unexplned variance in 4th contrast =	1.7322	1.73152686	1.7194308
Unexplned variance in 5th contrast =	1.6327	1.63418344	1.6214343

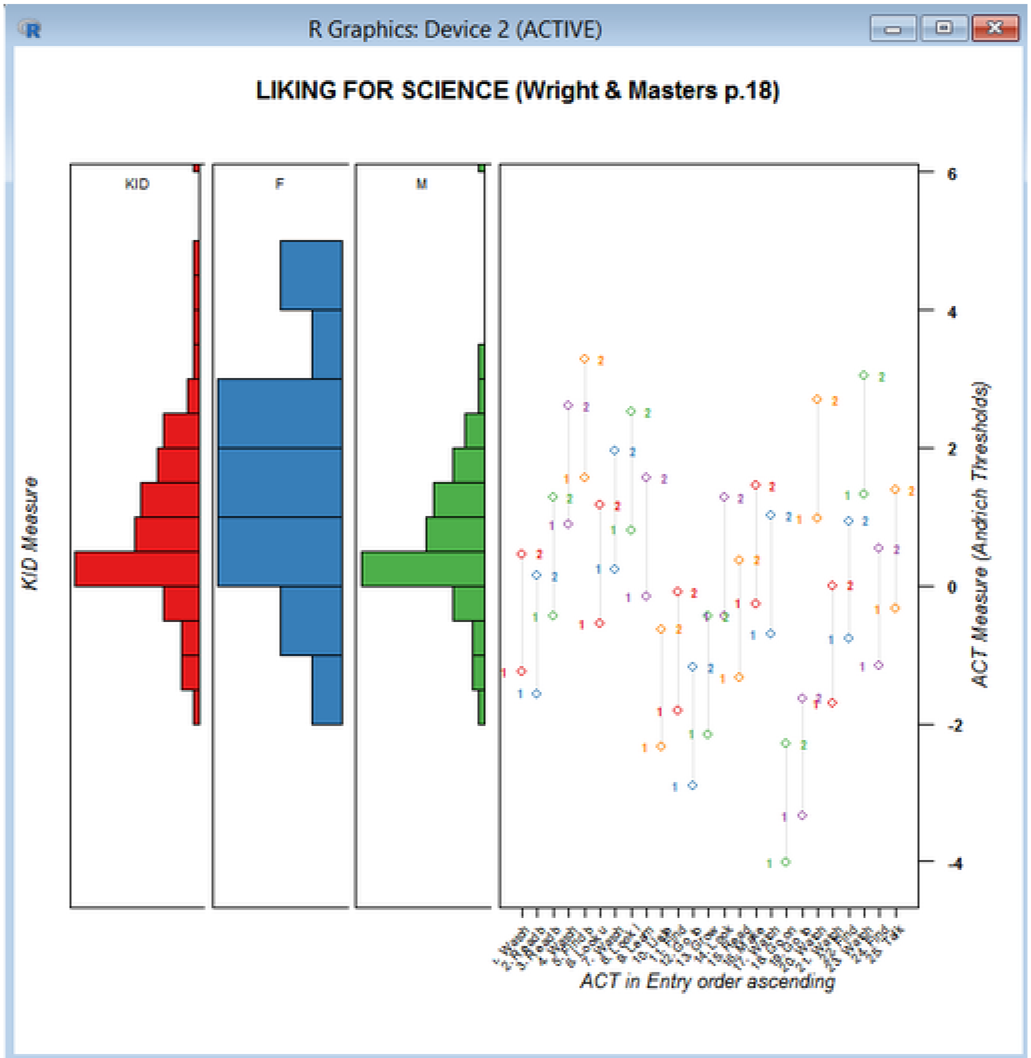
Cluster Analysis

R Statistics is launched with the package "pvclust" to produce a dendrogram, here for Example0, "Liking for Science". The probability of each cluster is shown in blue, red or green. Clusters wih probabilities >= 90% are boxed in red. See pvclust documentation. Notice here that the three most misfitting items are separately clustered to the left side.

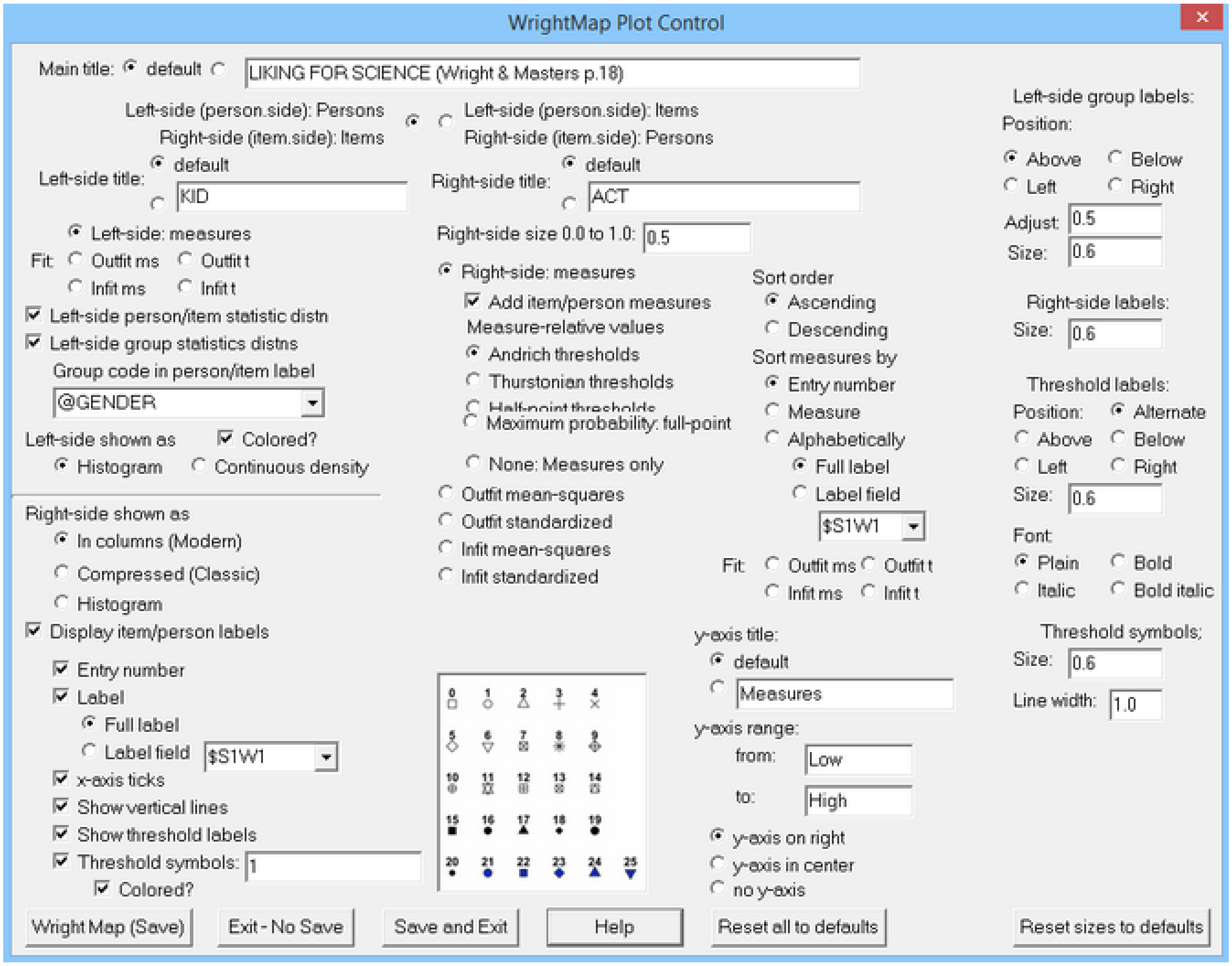


18.10 WrightMap - R Statistics

R Statistics WrightMap produced from the Winsteps "Plots" menu using Example0.txt and the default values for the Winsteps-produced WrightMap. WrightMap is courtesy of Torres Irribarra, D. & Freund, R. (2014). Wright Map: IRT item-person map with ConQuest integration. Available at https://github.com/david-ti/wrightmap.



To save plot to Desktop, right-click on plot or, at the R Statistics prompt, > dev.print(pdf, 'filename.pdf')



With the Winsteps WrightMap interface, **no knowledge or R action is required**. The WrightMap is produced like this:
1. Install R Statistics (once only)
2. Launch Winsteps
3. Do an analysis
4. Winsteps Plots menu, "Wright Map"
5. Let's go with the defaults: click on "WrightMap (Save)" ***- One Click!***
6. R Statistics launches automatically. (No action needed by you.)
7. WrightMap displays. (No action needed by you.)
8. To save the WrightMap to your Desktop, right-click on it, or at the R Statistics prompt, > **dev.print(pdf, 'filename.pdf')**
9. When finished with R: click on the R-window top-right close box.

Notes:
1. You can have several plots open at once. Each has a new instance of R.
2. *Andrich thresholds:* they are shown at their numerical value, whatever their ordering, except for thresholds for unobserved categories. These should be at infinity, but are shown at the item difficulty.

WrightMap Plot Control	**WrightMap command - see WrightMap/WrightMap.pdf**	**Purpose**
Top:		
Main title	main.title =	Main title at the top of the Wright Map Default: TITLE=

Left-side (person.side) Persons Right-side (item.side) Items	wrightMap (thetas, thresholds,	Person distributions on left side. Item columns on right side of Wright Map
Left-side (person.side) Items Right-side (item.side) Persons	wrightMap (thresholds, thetas,	Item distributions on left side. Person columns on right side of Wright Map
1st Column:	***person.side***	***Left-side of Wright Map***
Left-side title	axis.persons =	Subtitle for left side Default: PERSON=/ITEM= and name of statistic
Left-side: measures		the histograms on the left-side are of measures.
Fit: Outfit mean-square Outfit standardized Infit mean-squares Infit standardized		the histograms on the left-side are of fit statistics
Left-side person/item statistic distn	first column of thetas/thresholds	Are the all the person/items the first distribution on the left side
Left-side group statistic distns	more columns of thetas/thresholds	Are there distributions on the left side for person/item groups
Group code in person/item labels	dim.names =	Codes in person/item labels identifying person/item groups
Colored?	dim.color =	Are the person/item distributions colored?
Left-side shown as: Histogram	person.side = personHist	Show person/item distributions as historgrams. Distributions with only one person/item are increased to two for display purposes only.
Continuous density	person.side = personDens	Show person/item distributions as smoothed curves. Distributions with only one person/item are increased to two for display purposes only.
1st Column:	***item.side***	***Right-side of Wright Map***
Right-side shown as In columns (Modern)	item.side = itemModern	each item/person has a column
Compressed (Classic)	item.side = itemClassic	items/persons compressed into one column
Histogram	item.side = itemHist	items/persons shown as a histogram
Display item/person labels	label.items=	item/person labels displayed below columns
Entry number		include item/person entry number in column label
Label		include item/person label in column label

Full label		include as much of item/person label as possible
Label field		include this part of item/person label
x-axis ticks	label.items.ticks =	show a tick on the x-axis for each item/person
Show vertical lines	vertLines =	connect plotted threshold values with a faint line for eahc item/person
Show threshold labels	show.thr.lab =	label the item/person thresholds with their threshold numbers
Threshold symbols:	show.thr.sym=	mark the item/persons threshold with symbols
(symbol box)	thr.sym.pch =	symbol(s) to use. Available symbols, 1-25, are shown. For instance, 3, 4
Colored?	thr.sym.col.fg= thr.lab.col=	threshold labels and symbols are colored
2nd Column:	***item.side***	***Right-side of Wright Map***
Right-side title	axis.items =	Subtitle for right side Default: ITEM=/PERSON= and ordering
Right-side size 0.0 to 1.0	item.prop =	right-side proportion of the whole plot
Right-side measures		the display on the right-side is of measures
Add item/person measures	thresholds	item/person measures are added to the threshold values
Measure-relative values Andrich thresholds	thresholds	threshold values are Andrich thresholds relative to item/person measures
Thurstonian thresholds	thresholds	threshold values are Thurstonian thresholds relative to item/person measures
Half-point thresholds	thresholds	threshold values are Half-point thresholds relative to item/person measures
Maximum probability full-point	thresholds	threshold values are points of maximum probability for the categories relative to item/person measures, where observed score on the item = the expected score, corrected for extreme categories
None: Measures only	thresholds	threshold values are not added to the item/person measures
Outfit mean-square Outfit standardized Infit mean-squares Infit standardized		the display on the right-side is of fit statistics
(symbol box)	thr.sym.pch =	symbol(s) to use. Available symbols, 1-25, are shown. For instance, 3, 4

3rd Column:	item.side	Right-side of Wright Map
Sort order: Ascending Descening	thresholds	order of item/person columns
Sort measures by Entry number Measure Alphabetically Fit: Outfit mean-square Outfit standardized Infit mean-squares Infit standardized	thresholds	values to use when ordering the item/person columns. Alphabetically: see right-side Label
y-axis label	axis.logits =	Title of y-axis, such as "Logits" Default: ITEM=/PERSON= and name of statistic
y-axis range from: (Low) to: (High)	min.l= max.l=	Sets the extremes of the y-axis. Blank or non-numeric for the default values
y-axis on right, y-axis in center, no y-axis	show.axis.logits = "L", "R" or "N"	placement of y-axis on plot
4th Column:	***person.side***	***Left-side of Wright Map***
Left-side group (dimension) labels position: Above, Below, Left, Right	dim.lab.side =	Placement of the labels for the left-side histograms
Left-side group (dimension) labels Adjust 0.0 to 1.0	dim.lab.adj =	Adjust position of labels for the left-side histograms: 0.5 = middle position, 0.0 = left position, 1.0 = right position
Left-side group (dimension) labels Size 0.1 upwards	dim.lab.cex =	Font size of labels for left-side histograms. 0.6 is the default.
4th Column:	***item.side***	***Right-side of Wright Map***
Right-side column labels Size 0.1 upwards	label.items.cex =	Font size of labels for right-side histograms. 0.6 is the default.
Threshold label position: Alternate, Above, Below, Left, Right	thr.lab.pos =	Placement of the labels for the right-side thresholds
Threshold labels Size 0.1 upwards	thr.lab.cex =	Font size of labels for thresholds. 0.6 is the default.
Threshold labels Font: Plain, Bold, Italic, Bold Italic	thr.lab.font =	Font style of labels for thresholds. Plain is the default.
Threshold symbols Size 0.1 upwards	thr.sym.cex =	Font size of symbols for thresholds. 0.6 is the default.
Vertical lines between thresholds Width	thr.sym.lwd =	Width of vertical light-grey lines between thresholds.
Push buttons:		
Wright Map (Save)	wrightMap(....) To save the displayed plot, right-click in the plot window.	launches R Statistics WrightMap function and saves the settings in the Dialog box.

Exit-No Save		Closes the Dialog Box without saving any changed settings since the last Wright Map output
Save and Exit		Saves the settings and closes the Dialog Box.
Help		Displays this page
Reset to defaults		Sets all WrightMap settings to their default values
Reset sizes to defaults		Sets sizes of fonts, symbols and lines to their default values

Notes:
1. WrightMap requires that R Statistics is installed: cran.rstudio.com/bin/windows/base/

2. The WrightMap will be slow to display the first time because the required R Statistics packages will be installed automatically. WrightMaps are never fast to display.

3. If your WrightMap appears wrong, please allow Winsteps to install the most recent relevant version of the WrightMap package. In your R window:
> remove.packages("WrightMap")
then the correct package will be installed automatically by Winsteps when you launch the next WrightMap.

5. After viewing the WrightMap, you can use all the R Statistics functions, or close the R windows. Respond "No" if there is a "Save workspace" message.

6. To change the titles, etc.

Make the plot in R, then do > ls() to see where all the labels etc. are stored:

```
> ls()
[1] "colors" "dimnames" "labels" "q" "quit"
[6] "thetas" "thresh" "threshlabels" "titles" "zero"
```

for the item labels:

```
> labels
[1] "1. Watch" "2. Read b" "3. Read b" "4. Watch" "5. Find b" "6. Look u"
[7] "7. Watch" "8. Look i" "9. Learn" "10. Liste" "11. Find" "12. Go to"
[13] "13. Grow" "14. Look" "15. Read" "16. Make" "17. Watch" "18. Go on"
[19] "19. Go to" "20. Watch" "21. Watch" "22. Find" "23. Watch" "24. Find"
[25] "25. Talk"
> labels <- c("label1", "label2", ........, "labelast")
```

You may want to remove the x-axis label:

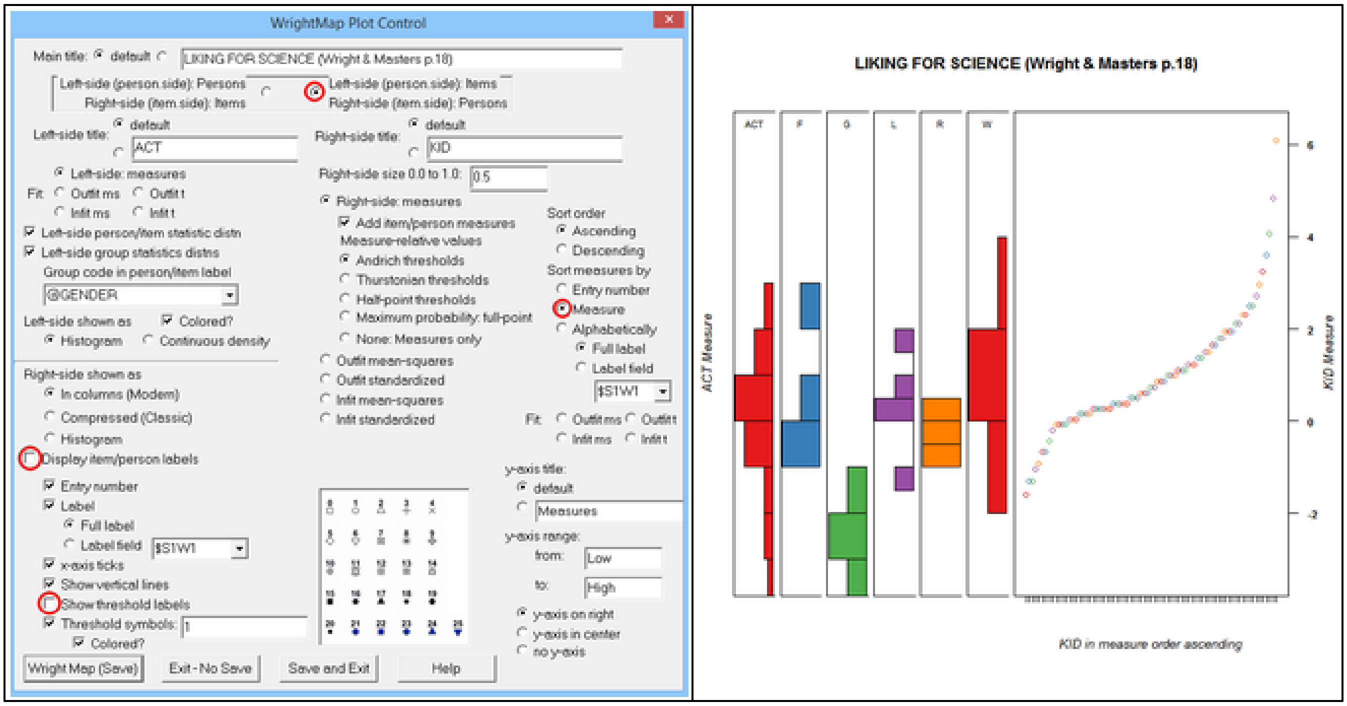
```
> titles
TITLES
1 LIKING FOR SCIENCE (Wright & Masters p.18)
2 KID Measure
3 ACT in Entry order ascending <- this will overlay longer labels
4 ACT Measure (Andrich Thresholds)
```

You can change the left-hand column headings "dimnames"

```
dimnames <- c("heading 1", "heading 2", "heading 3")
```

Then copy the very long line on the R screen starting "wrightMap ...."
and paste it at the >
to make the plot again

Example 2: WrightMap of groups of item difficulties w ith person measures ascending.

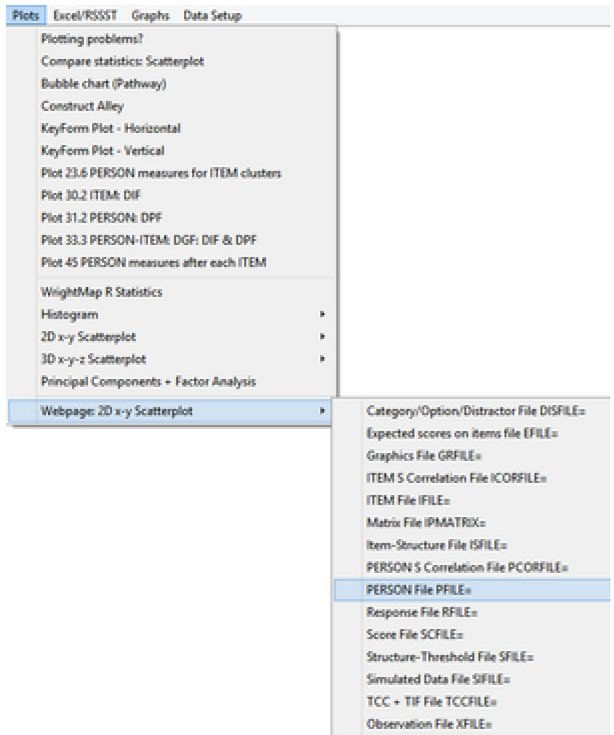


19 Plots - Webpage Browser

19.1 Webpage 2D x-y Scatterplot

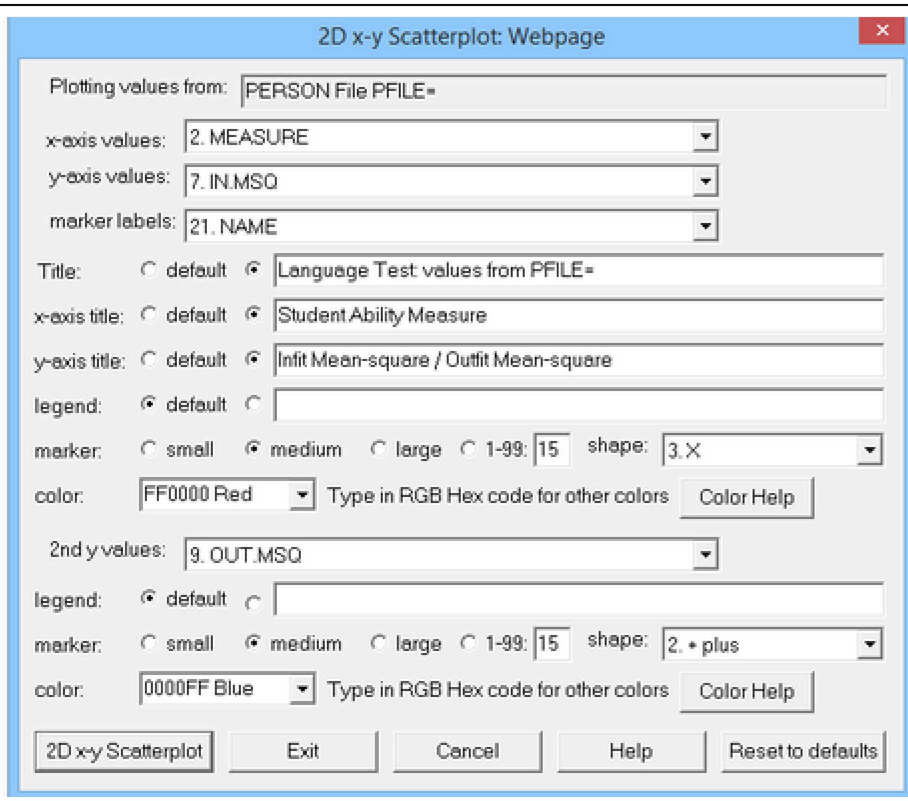
Produces a 2-dimensional scatterplot using your web browser. Mouse pointer over plotted points to see the point labels. You can "Save As" "Web Page, HTML only"the webpage with full functionality after Winsteps closes. Color Help: www.rapidtables.com/web/color/RGB_Color.html

This uses the javascript from file Winsteps.js (if available) or from Chart.js.

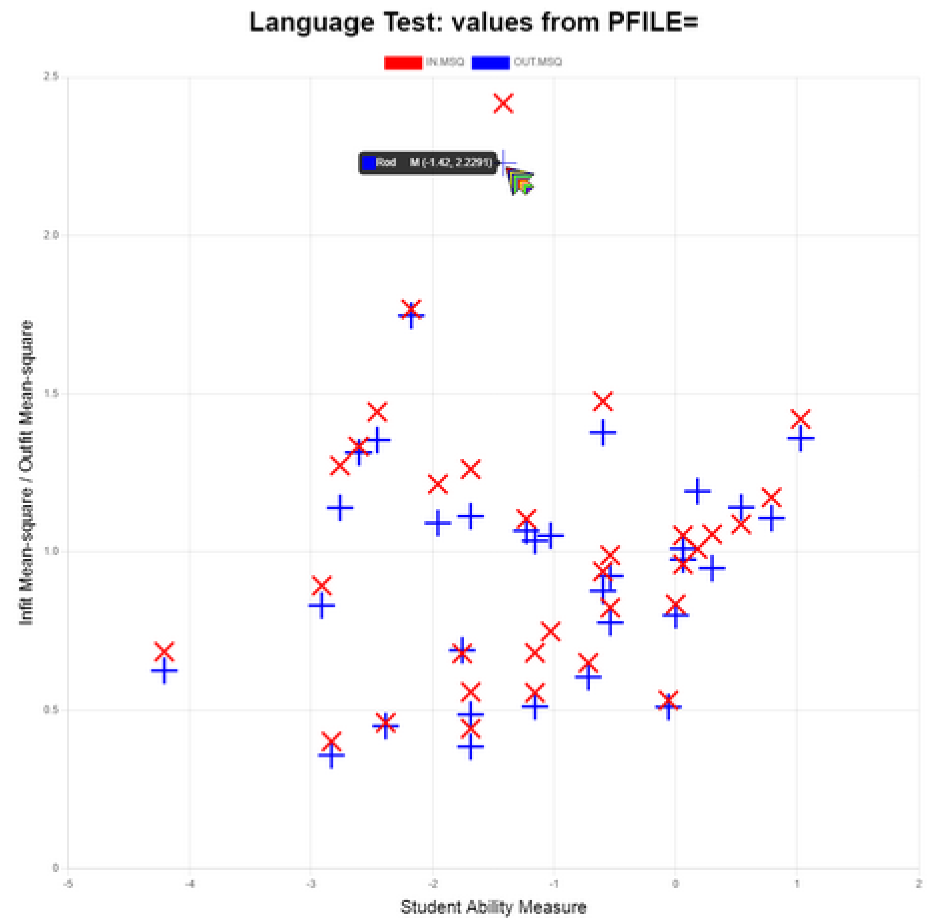


Personal Note: **This is fun! I learned something new about this very familiar dataset while adding this feature to Winsteps. I'm sure you will do the same with your data.**

Try this interactive plot for real at
Webpage 2D x-y Scatterplot Example



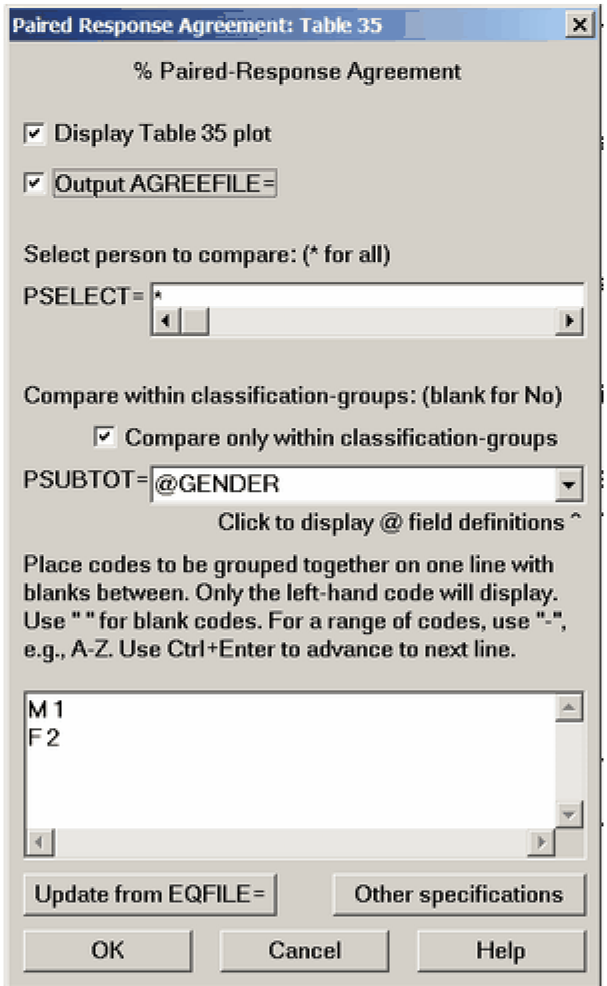
1. Run the Winsteps analysis.
2. Plots menu
3. Click on *Webpage 2D x-y Scatterplot*
   Submenu of Output Files displays
4. Click on the Output File containing the 2 columns of numbers you want to scatterplot
5. 2D x-y Scatterplot Control dialog box displays
6. Choose the variables for the x- and y-axis values
7. Make other changes (if any)
8. Click on '2D x-y Scatterplot" button
9. Your webpage browser launches
10. 2D x-y Scatterplot displays.
11. Mouse over a point to see the point-label
12. You can "Save As" (ctrl+s) "Web Page, HTML only" with full functionality.



20 Output dialogs

20.1 AGREEFILE and Table 35 Specifications

This is the dialog box for Table 35 from the Output Tables menu, and AGREEFILE= from Output Files menu.



% Paired Response Agreement
Display Table 35 plot: check this box to output Table 35, "Paired-person (cheating) agreement"
Output AGREEFILE=: check this box to output the AGREEFILE= agreement file.

Select persons to compare: enter the PSELECT= value, or * to select all persons. This compares all persons selected and omits everyone else. To omit persons from selection using PDELETE=, click on "Other Specifications" push-button.

Compare only within classification groups:
Compare only within their own classification-groups (AGREEGROUP=). For the overall plots in Table 35, and AGREEFILE=, check the box if persons are to be compared only with others in their own classification groups, and not across classification-groups.

PSUBTOT=:
enter PSUBTOTAL= value to specify the groups. Leave blank if all persons are to be part of one classification-group.

Place codes to be grouped together on the same line. This allows multiple classification groups to be combined into one group.

Update from EQFILE= re-initializes the equivalent codes from the EQFILE= information in the control file.

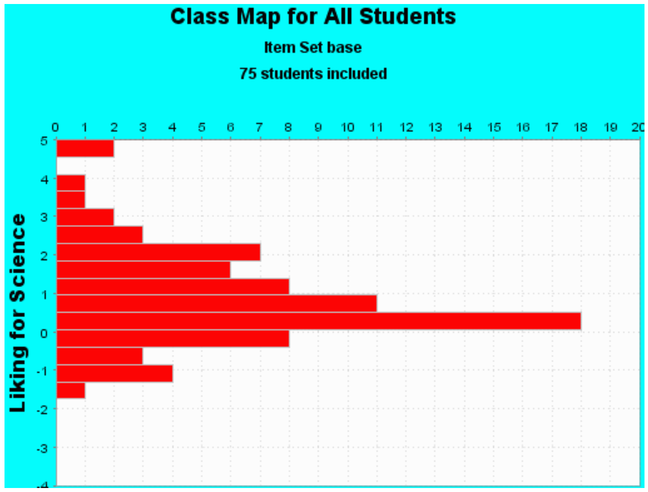
Other Specifications: other control variables can be changed.

OK - launch the paired-agreement computation

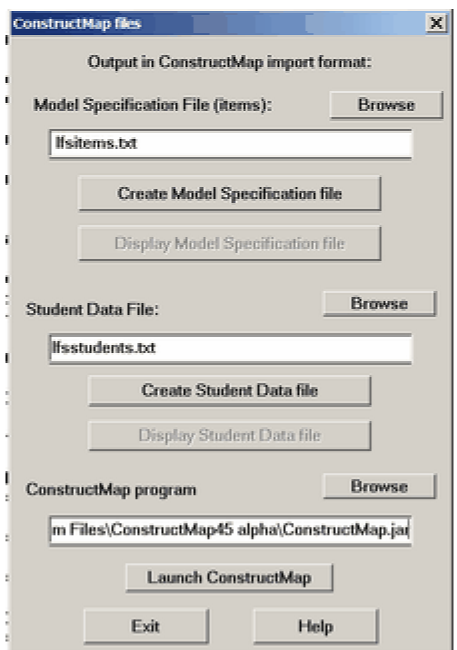
20.2 Compare statistics

See Scatterplot: Compare statistics

20.3 ConstructMap (GradeMap) interface



To produce this plot from ConstructMap (formerly GradeMap), an analysis and graphical program distributed in association with the book "Constructing Measures: An Item Response Modeling Approach" by Mark Wilson (2004) Mahwah NJ: Lawrence Erlbaum Associates.



The ConstructMap option on the Output Files menu displays this box which enables a simple conversion of Winsteps control and data files into ConstructMap format. These files can then be imported by ConstructMap - see the ConstructMap User Guide. The files can be displayed after they are created by Winsteps. Excel is used if it is available. You can edit the files if you wish. If changes are made, save the files in tab-separated .txt format - which is expected by ConstructMap.

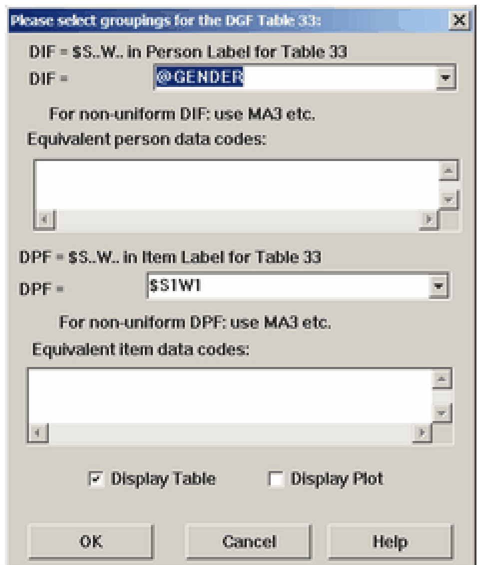
Example ConstructMap Dialog:
Winsteps: Create Model Specification file: lfsitems.txt
Winsteps: Create Student Data file: lfsstudents.txt
Winsteps: Launch ConstructMap

ConstructMap screen displays:
User name: admin
Password: bear

Please follow the ConstructMap instructions in the documentation at bearcenter.berkeley.edu/software/constructmap

You will notice that Winsteps can analyze datasets which ConstructMap cannot (without editing).
Hint: click on ConstructMap item-column headings to deactivate items causing errors.

20.4 DGF specifications



This is displayed from the Output Tables or Plots menus for Differential Group Functioning DGF Table 33 between classification groups of persons and classification groups of items.

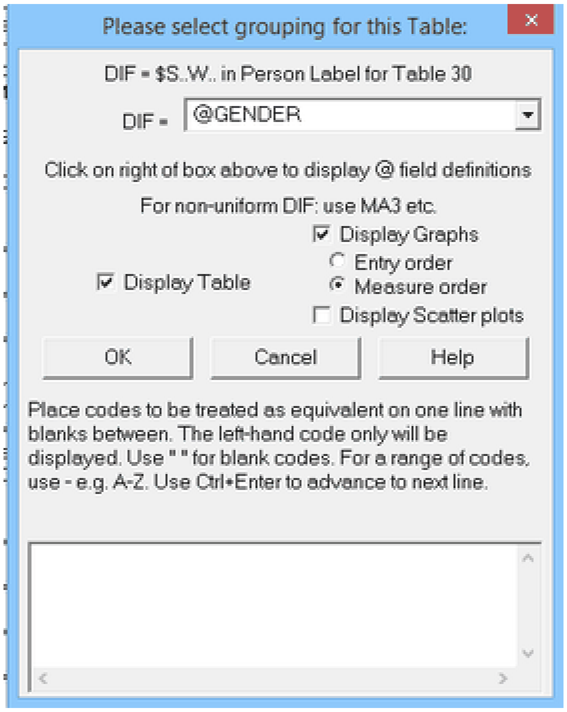
In the DIF= box specify the column in the **person** label that identifies the DIF classification for each person. Enter the column of the DIF field in the person label. This is in the format $S9W1 or @GENDER or $MA3

In the DPF= box specify the column in the **item** label that identifies the DPF classification for each person. Enter the column of the DPF field in the item label. This is in the format $S9W1 or @ITEM-TYPE or $MA3

Check "Display Table" for DGF Table 33.
Check "Display Plot" for the DGF Excel Plot.

Please also see DIF Specifications

20.5 DIF specifications

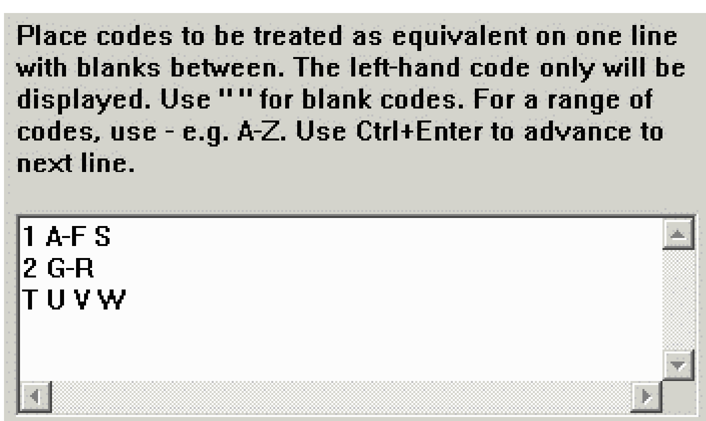


This is displayed from the Output Tables or Plots menus for Differential Item Functioning DIF Table 30.

In the DIF= box specify the column in the **person** label that identifies the DIF classification for each person. Enter the column of the DIF field in the person label. This is in the format $S9W1 or @GENDER or $MA3

Check "Display Table" for DIF Table 30.
Check "Display Graphs" for the DIF Excel plots.
Graphs can be displayed with the items in Entry order or Measure (difficulty) order
Check "Display Scatter plots" for the DIF Excel scatter plots.

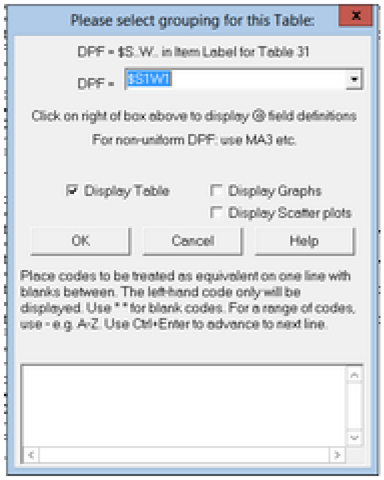
Transformation: Selected DIF=, DPF=, ISUBTOTAL=, PSUBTOTAL= codes can be transformed into other codes (of the same or fewer characters) for Tables 27, 28, 30, 31, 33. These can also be specified in EQFILE=.



First produce the Table with the transformation box blank. Inspect the reported codes. Transform and combine them using the transformation box in a second run. In this example, codes 1,A,B,C,D,E,F,S will all be converted to 1. 2,G,H,I,J,K,L,M,N,O,P,Q,R will all be converted to 2. T,U,V,W will all be converted to T. Codes X,Y,Z and any others will be unchanged.

In each line in the transformation box, the code at the beginning (extreme left) of each line is the code into which it and all other blank-separated codes on the line are transformed. Ranges of codes are indicated by -. To specify a blank or hyphen as a code, place them in quotes: " " and "-". Codes are matched to the transformation box starting at the top left and line by line until a match is found, or there is no match.

20.6 DPF specifications



This is displayed from the Output Tables or Plots menus for Differential Person Functioning DPF Table 31.

In the DPF= box specify the column in the **item** label that identifies the DPF classification for each person. Enter the column of the DPF field in the item label. This is in the format $S9W1 or @ITEM-TYPE or $MA3

Check "Display Table" for DPF Table 31.
Check "Display Graphs" for the DPF Excel plots.
Check "Display Scatter plots" for the DPF Excel scatter plots.

Please also see DIF Specifications

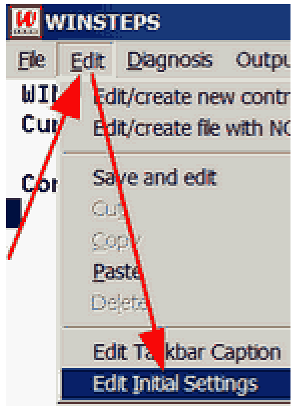
20.7 Edit Initial Settings (Winsteps.ini) file

To change the Winsteps control & data directory/folder from a short-cut icon:

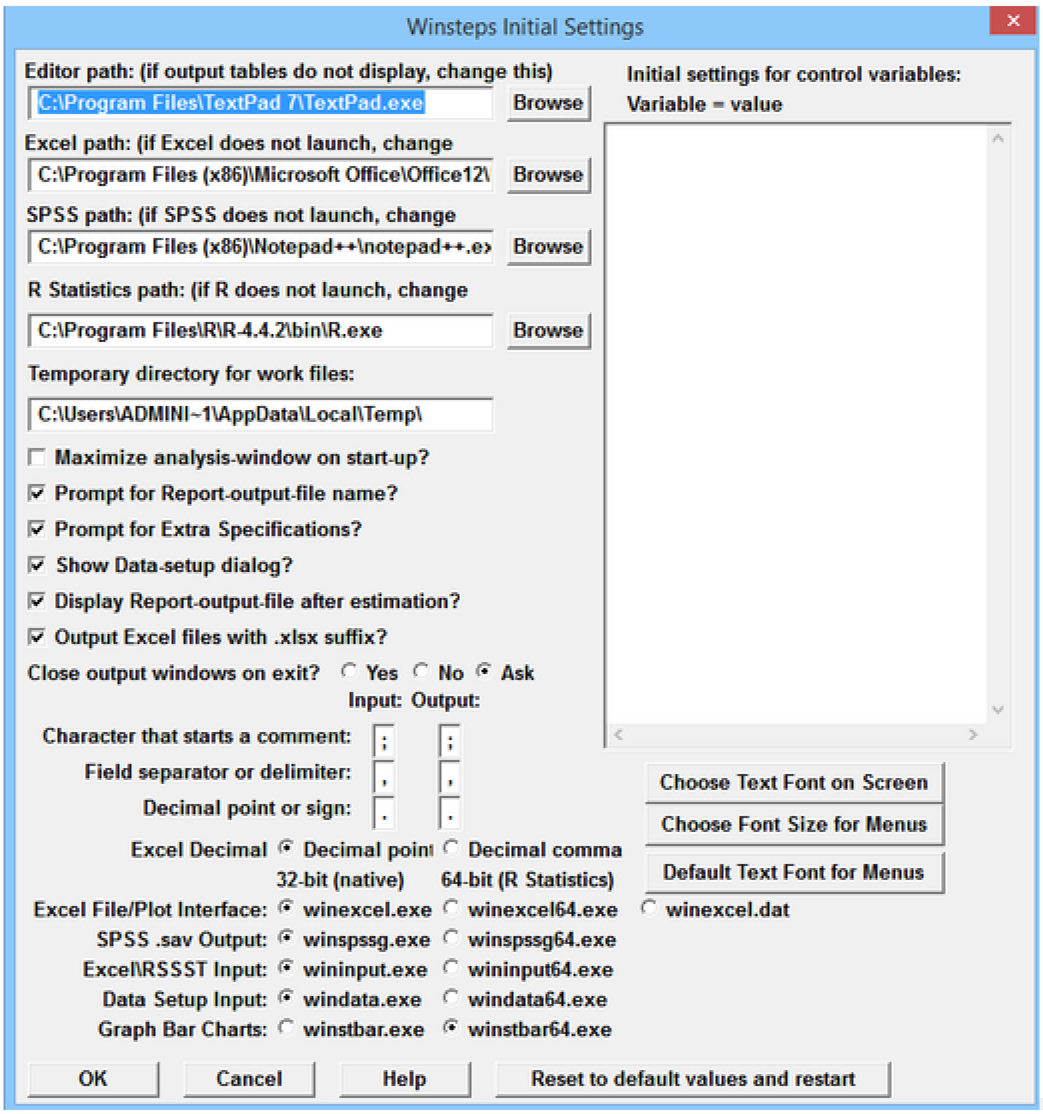
Use an existing short-cut to Winsteps (e.g., on your Start menu or Desktop)
or create a new short-cut to Winsteps by right-clicking on Winsteps.exe, SendTo, Create shortcut
Right-click the short-cut to Winsteps
Click on "Properties"
Select "Shortcut"
Type the desired directory into "Start in"
Click on "Apply"

Altering the Initial Settings

1) Pull-down the "Edit" menu



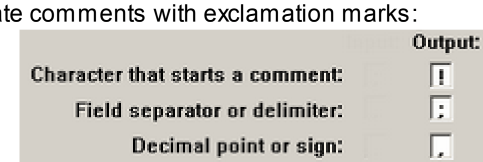
2) Click on "Edit initial settings"



3) The Settings display. If this is too big for your screen, see Display too big.

(1) **Editor path:** Editor=NOTEPAD	This specifies the word processor or text editor that is to be used by Winsteps. It is usually your Windows text editor. If Output Tables do not display, please change this text editor. You can make Winsteps use your own text editor or word processor by changing the Editor in

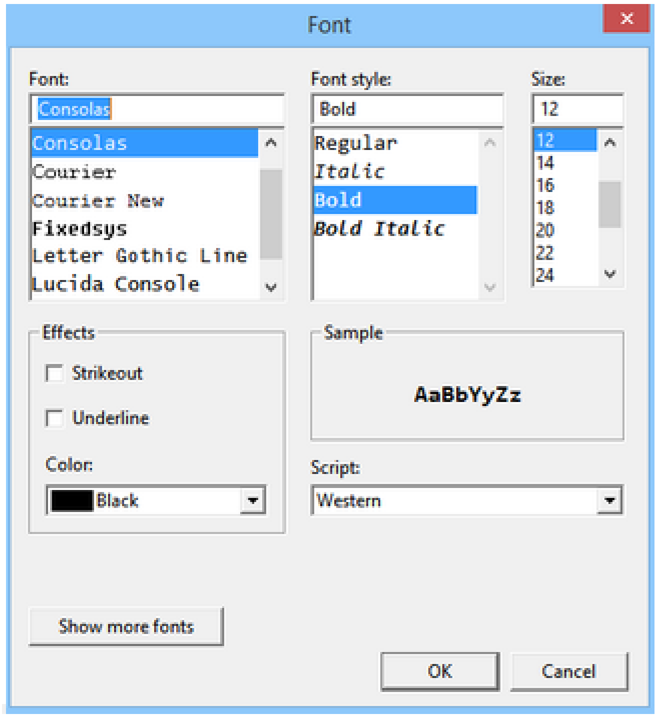
	Edit initial settings or editing Winsteps.ini in your Winsteps folder. Put the full pathname of your editor in place of Notepad, e.g., for WordPad it could be: "C:\Program Files\Windows NT\Accessories\wordpad.exe" for Word 6.0, it could be: "C:\MSOFFICE\WINWORD\WINWORD.EXE" You can find the full path to your word processor by doing a "Find" or "Search" for it from the "Start" menu. Useful replacements for Notepad (maximum file size 45K) include NotePad++ freeware (maximum file size 2GB) which can be downloaded from notepad-plus-plus.org which may be in the "C:\Program Files (x86)\Notepad++" folder. "Provide instructions for each user to change the Editor Path for their own Winsteps?" You could send a .cmd file to all your end-users which appends to the Winsteps.ini "Initial Settings" file. For instance, to change all end-user text editors to Notepad. The file could be: EditorUpdate.cmd and contain this one line: echo Editor=Notepad.exe >> %AppData%\..\Local\Winsteps.com\Winsteps\Winsteps.ini Then, the next time Winsteps launches, it will use Notepad.
(2) **Excel path:** Excel=C:\Program Files\Microsoft Office\Office12\EXCEL.EXE	This provides a fast link to Excel from the File pull-down menu. The path to any program can be placed here. If Winsteps does not find Excel automatically, please go to the Windows "Start" menu, do a "Find" or "Search" for "Files and Folders" to locate it, and enter its path here. Excel is not part of Winsteps, and may not be present on your computer. If this malfunctions, a) check that the Windows filetypes are correct, by creating a .xls file, then double-clicking on it. Does it open in Excel? If not, then Excel is not properly installed. b) Launch Winsteps c) blank out the Excel path in "Edit menu", "Initial settings" d) click on OK e) "Edit menu", "Initial settings" should now show the correct path to Excel. If the path is wrong or blank, then please update the .xls file association in the Windows Registry - Google can help with this.
(3) **SPSS path:** SPSS=C:\SPSS.EXE	This provides a fast link to SPSS from the File pull-down menu. The path to any program can be placed here. If Winsteps does not find SPSS automatically, please go to the Windows "Start" menu, do a "Find" or "Search" for "Files and Folders" to locate it, and enter its path here. SPSS is not part of Winsteps, and may not be installed on your computer.
(4) **R Statistics path:** RSTAT=C:\R\bin\R.exe	This provides a fast link to R Statistics from the File pull-down menu. The path to any program can be placed here. If Winsteps does not find R Statistics automatically, please go to the Windows "Start" menu, do a "Find" or "Search" for "Files and Folders" to locate it, and enter its path here. R Statistics is not part of Winsteps, and may not be installed on your computer.
(5) **Temporary directory for work files:** Default Windows temporary directory/folder = %temp%	Temporary Output and Table files are placed in the same directory as your Input file (if possible), or in the "Temporary directory". Other temporary files are placed in the "Temporary directory." Files ending "....ws.txt" can be deleted when Winsteps is not running. If the temporary directory does not change when you type in a new one, and click OK: 1. The desired temporary folder does not exist: please create it. 2. You do not have write permission for the desired temporary folder: please give yourself write-permission 3. You do not have write-permission for Winsteps.ini in the Winsteps.exe folder: please give yourself write-permission You could also: 1. Change the Windows temporary folder: how_do_i_change_the_location_of_windows_temporary_files

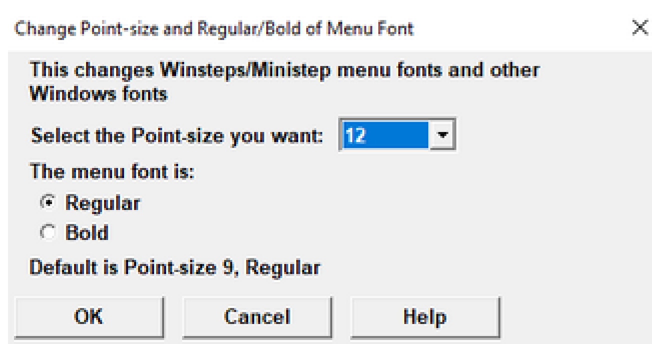
	2. Delete Winsteps.ini in the Winsteps.exe folder 3. Launch Winsteps
(6) **Maximize analysis-window on start-up?**	When checked, the analysis window is displayed maximized (filling your screen). Unchecked, the window size is normal (big enough for practical purposes).
(7) **Prompt for Report-output-file name?**	With an unchecked box, this specifies that your standard report output file will be a temporary file. A checked box produces a prompt for a file name on the screen. You can always view the Report output file from the Edit menu, and save it as another file.
(8) **Prompt for Extra Specifications:?**	unchecked specifies that there will be no extra specifications to be entered.
(9) **Show Data-setup dialog?**	When the box is checked the Data-setup dialog box displays.
(10) **Display the Report-output-file after estimation?**	When checked, this automatically shows the report output file if TABLES= or TFILE= is active in the Control file or at Extra Specifications. The Report Output File can always be displayed from the Edit menu.
(11) **Output Excel files with .xlsx suffix?**	Uncheck this box to output .xls Excel files
(12) **Close output windows on exit?** Closeonexit=Yes or No or Ask	This choice can be overridden when Winsteps stops.
(13) **Character that starts ....** SIGNS=;;,,..	This enables the processing of files in accordance with international usages. For instance, it may be more convenient to output files with decimal commas, use semicolons as separators, and indicate comments with exclamation marks: 
(14) **Excel decimal separator**	Excel decimal separator is a decimal point or decimal comma: EXCELDECIMAL=
32-bit (native) **64-bit (R Statistics)**	**Interface modules:** ***If the 32-bit or 64-bit module fails, click on the other module.*** **It is activated immediately.** The 32-bit modules have been running successfully for 20 years, but do not support international character sets and recent changes in Windows and other software. The 64-bit modules support international character sets and other recent changes. Some of these modules use R Statistics packages to support a wider range of functionality.
(15) **Excel File/Plot Interface**	See Excel Plot interface - Excelplot32=Yes is the 32-bit interface
(16) **SPSS.sav Output**	See SPSS functional check - SPSS32=Yes is the 32-bit interface
(17) **Excel\RSSST Input**	Selects the 32-bit (wininput.exe) or 64-bit (wininput64.exe) conversion routine - XLRSSST32=Yes is the 32-bit module. XLRSSST32=No is the 64-bit module (requires R Statistics) . The **64-bit option accepts more file formats** than the 32-bit option.
(18) **Data Setup Input**	32-bit (windata.exe) and 64-bit (windata64.exe) modules with similar functionality
Graph Bar Charts	32-bit (winstbar.exe) and 64-bit (winstbar64.exe) modules with similar functionality, but different appearance

<table>
<tr><td colspan="2"></td></tr>
<tr><td>(19) Initial settings for control variables:
Variable = value</td><td>Control variables and their settings entered into this box are pre-pended to the settings in your control file. This enables you to set values which apply to all analyses. They are reported first in Table 0.3</td></tr>
<tr><td>(20) "Choose Text Font on Screen" for the Winsteps Analysis window:

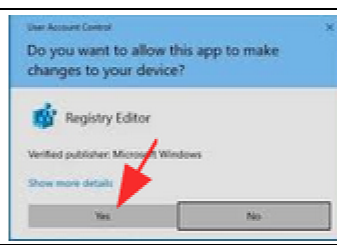
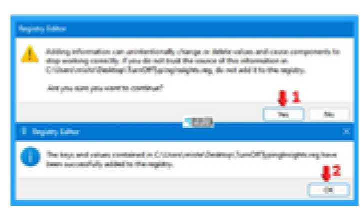
Default is Fixedsys

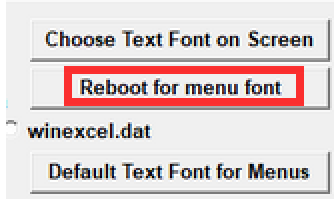
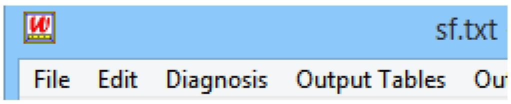
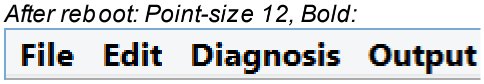
Font details are kept in the Windows Registry.

The font for Winsteps output files is set in the application that displays the files, such as NotePad.</td><td>
</td></tr>
<tr><td>(21) "Choose Font Size for Menus" for the Winsteps Analysis window and other Windows applications:</td><td>This works for me on Windows 11, but not on Windows 8.1.
The default menu font is Segoe UI, font style: Regular, size 9. This setting is in the Windows Registry. You can change this for Winsteps and some other Windows apps here. The font size box displays.



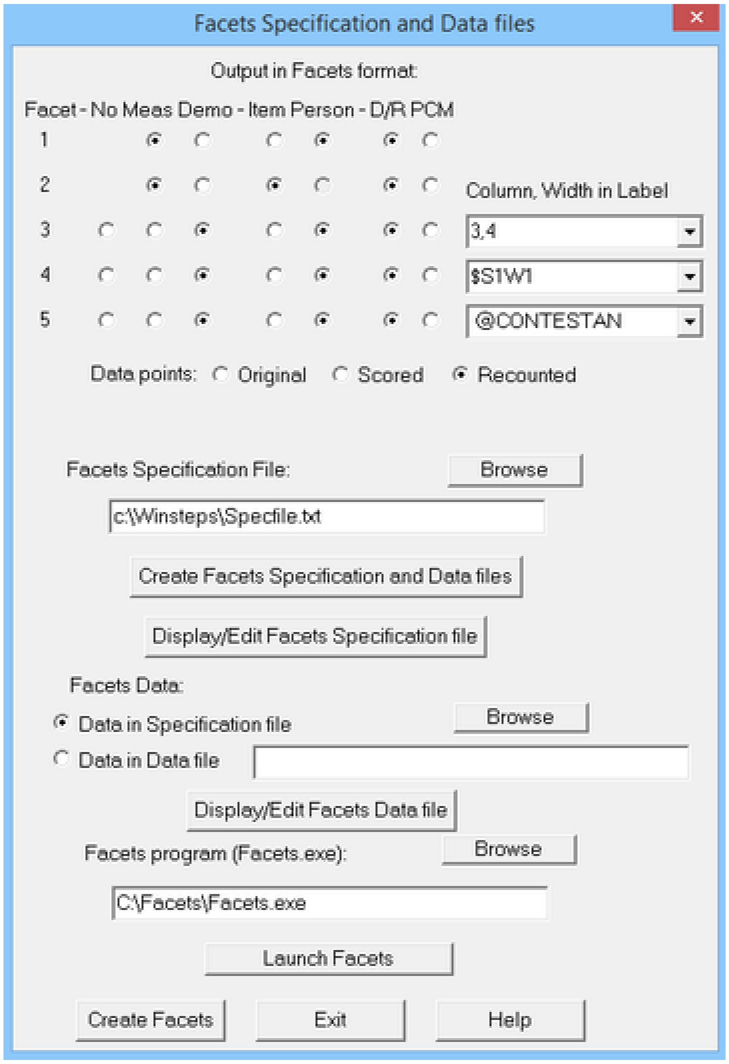
When you click OK, Windows asks you to confirm that you want to change the Windows registry.

<table><tr><td>
</td><td>
</td></tr></table></td></tr>
</table>

	The font change is made when *you* reboot your computer.  Windows uses this font size in many places. If you do not want it, then click on "Default Text Font for Menus", and reboot your computer again. *Before:*  *After reboot: Point-size 12, Bold:* 
(22) **"Default Text Font for Menus"** for the Winsteps Analysis window and other Windows applications:	This resets the Winsteps menu font to the Windows default. Then reboot your computer.
OK:	Click on this to accept the settings. Some settings go into effect the next time you start Winsteps. The changes are permanent until you change them again.
Cancel:	Do not change the previous settings.
Help:	Displays this page of the Help file
Reset to default values and restart:	Resets these settings to their default values, then restart Winsteps. Current settings are in file *Winsteps.ini* in your Windows AppData area.

20.8 Facets interface: this requires Facets software

From the Output Files menu, Facets Specification and Data files can be constructed after Winsteps estimation completes.



In Facets dialog box	Instructions
Facet 1 2 3 4 5	Up to 5 facets can be defined
No	this facet is not used: Facets 1 and 2 are always used for the item and person. Set to Demo if not to be used for measurement.
Meas	this is a measurement facet
Demo	this is a demographic (dummy facet) anchored at 0 or Umean=
Item	this facet's elements are based on the Winsteps items
Person	this facet's elements are based on the Winsteps persons
D/R	Dichotomy / Rating Scale Model: this facet is modeled with "?".
PCM	Partial Credit Model: this facet is modeled with "#".
Column, Width in Label 3,4 starting column, width in columns format $S1W1 format	element is column, width in label of Winsteps person or item label

@CONTESTAN format	When Facets analyzes the data, the actual element labels are in Facets Table 2. Copy these into Labels= in the Facets specification file.
Data points: Original	facets data points are the original values in the Winsteps data file
Scored	the data values after scoring with KEY1=, IVALUE=, etc.
Recounted	if there are unobserved intermediate categories, and STKEEP=No, then the resulting values.
(Error or Information Message)	Messages display here, such as "Specification file created"
Facets Specification File	this text file is created to contain Facets specifications, ready to run, or to be further edited. Path can be typed in or Browsed to.
Create Facets Specification and Data files	create these from the Winsteps control and data files
Display/Edit Facets Specification file	this file is displayed when it is created. It can be redisplayed here.
Data in Specification file	If this is selected, then the Facets data follow the specifications in the specification file. No Facets data file is needed.
Data in Data file	If this selected then the Facets data is in a separate file. A data file name must be typed in or Browse to.
Display/Edit Facets Data file	the Facets Data file is displayed with this
Facets program (Facets.exe)	Path to Facets.exe (or Minifac.exe) on your computer. Typed in or Browsed Facets software is available from www.winsteps.com/winbuy.htm
Launch Facets	Analyze the Facets specification and data files
Create Facets	same as Create Facets Specification and Data files
Exit	Close the window. All current settings are saved, but lost when Winsteps closes.
Help	Clicking Help displays this page

Example: using Masterchef.txt and the instructions in the Dialog Box.

```
Title= C:\e\www\winsteps\a\Masterchef-2020.txt 5/5/2020    Masterchef 2020 May 4
Facets= 5
Positive= 1
Noncenter= 1
Arrange= N
Models= ?, ?, ?, ?, ?, R8
Delements=NL
Dvalues=
3,1 ,3,4
4,1 ,1,1
5,1 ,1,20
*
Labels=
3,, D ; demographic/dummy COOK May 4 3,4
; Paste in the element list from Facets Table 2
*
```

4,, D ; demographic/dummy COOK May 4 1,1
; Paste in the element list from Facets Table 2
*
5,, D ; demographic/dummy COOK May 4 1,20
; Paste in the element list from Facets Table 2
*
1, KID
1= M Rossner, Marc Daniel
....
75= M Pauling, Linus
*
2, ACT
1= Watch birds
....
25= Talk w/friends about plants
*
Data=
1,1, 0
....
75,25, 1

20.9 Output file formats

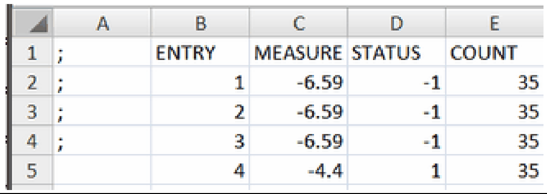
Several output file formats are available from the Output Files menu, or by specifying the output filename with the appropriate suffix in your control file.

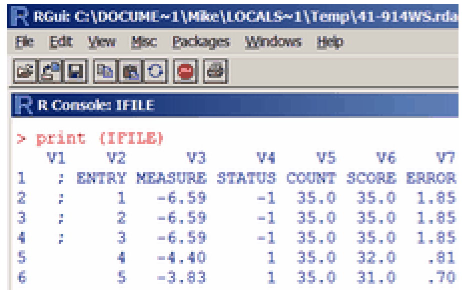
For Output Table formats, see ASCII=

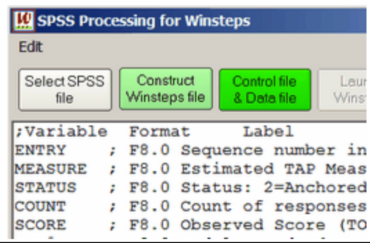
Text file - fixed fields:
Suffix: .txt
CSV=N
HLINES=Yes
	`; TAP  KNOX CUBE TEST  Nov 20  2:54 2008`
	`;ENTRY MEASURE ST   COUNT    SCORE  ERROR`
	`;     1   -6.59 -1    35.0     35.0   1.85`
	`;     2   -6.59 -1    35.0     35.0   1.85`
	`;     3   -6.59 -1    35.0     35.0   1.85`
	`      4   -4.40  1    35.0     32.0    .81`
	`      5   -3.83  1    35.0     31.0    .70`
	`      6   -3.38  1    35.0     30.0    .64`
	`      7   -3.83  1    35.0     31.0    .70`

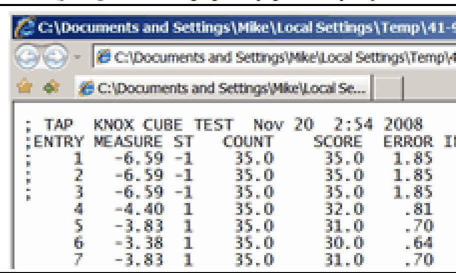
Text file - tab-delimited:
Suffix: .txt
CSV=T
HLINES=Yes
 	
ROW1HEADING=No omits the first heading line
	`";TAP  KNOX CUBE TEST  Nov 20  2:54 2`
	`";"     "ENTRY" "MEASURE"       "STAT`
	`";"       1       -6.59   -1      35.0`
	`";"Tabs  2       -6.59   -1      35.0`
	`";"       3       -6.59   -1      35.0`
	`" "       4       -4.40   1       35.0`
	`" "       5       -3.83   1       35.0`
	`" "       6       -3.38   1       35.0`

Text file - comma-separated:
Suffix: .txt
CSV=Y
HLINES=Yes
	`";TAP  KNOX CUBE TEST  Nov 2`
	`";","ENTRY","MEASURE","STATU`
	`";",1,-6.59,-1,35.0,35.0,1.8`
	`";",2,-6.59,-1,35.0,35.0,1.8`
	`";",3,-6.59,-1,35.0,35.0,1.8`
	`" ",4,-4.40,1,35.0,32.0,.81,`
	`" ",5,-3.83,1,35.0,31.0,.70,`

<table>
<tr><td>Excel file:
Suffix: .xls</td><td>
</td></tr>
<tr><td>R-Statistic file:
Suffix: .rdata

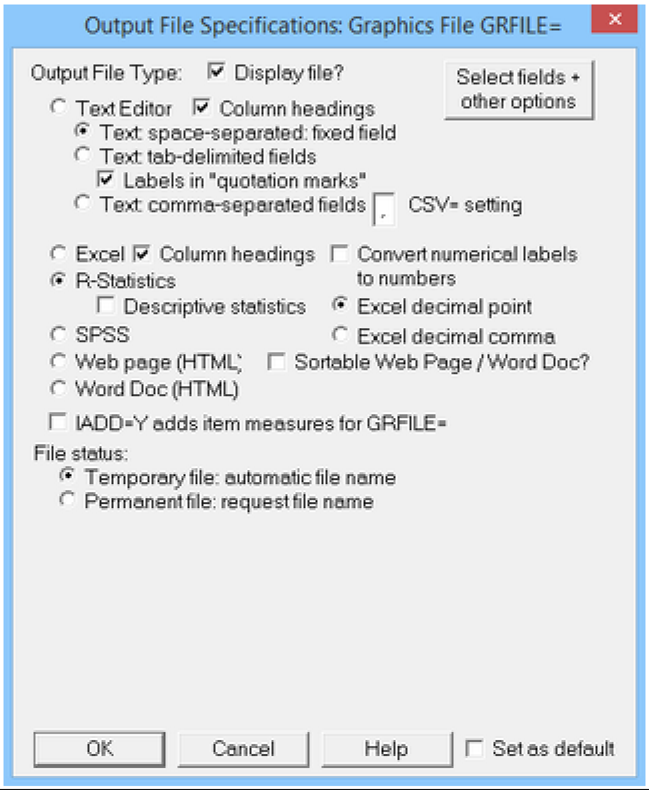
Quick R commands:
> ls.str()
> print(IFILE)</td><td>
</td></tr>
<tr><td>SPSS file:
Suffix: .sav

Suitable for input in AMOS</td><td>
</td></tr>
<tr><td>Webpage (HTML):
Suffix: .htm

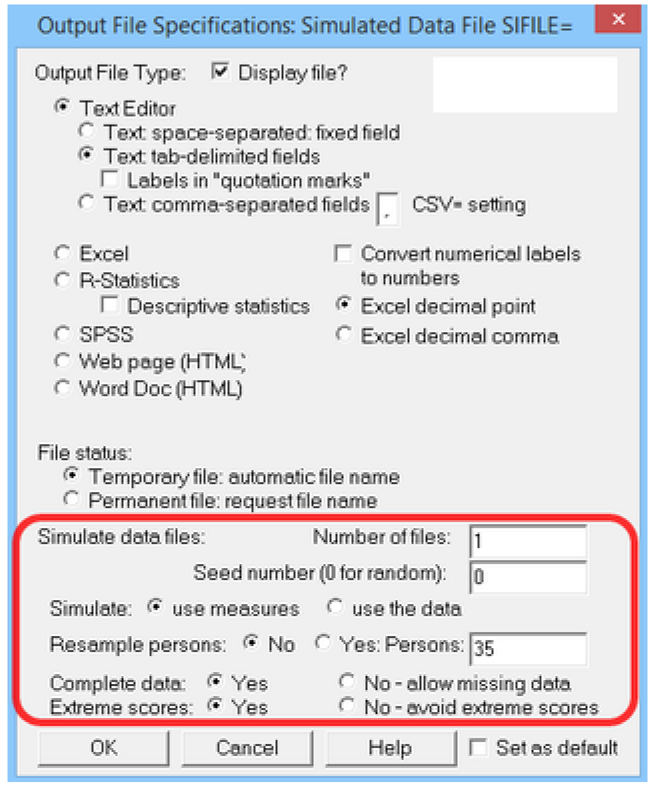
Can have sortable columns when launched from Output File Specifications</td><td>
</td></tr>
</table>

20.10 Output file specifications

Output files can be written in several formats, and called with different programs, so a dialog box is shown when output files are requested from the Output Files menu:



Dialog box for most output files



Dialog box for SIFILE=

Output File Type:	output file formats are shown here.
Display file?	check (tick) if the output file is to be displayed by the relevant program.
Select fields + other options	IFILE=/PFILE= field selection
Text Editor	Output is a .txt file. If *Display file?* is checked, then the file is automatically displayed by Notepad or your own text editor.
Column headings	check to produce column headings in the output file
Text: space-separated: fixed field	output file is organized in columns. This is usually easiest to look at.
Text: tab-delimited	columns are separated by Tab characters, which is useful for importing into modern software
Text: comma-separated fields	columns are separated by commas or other characters equivalents, which may be required for importing into software
Separator character	character to use instead of , for comma-separated fields
Labels in "quotation marks"	place non-numeric values within quotation marks, required for correct importing of data into some software.
Text: for scatter-plots	Chooses default settings for the IFILE= or PFILE=, suitable for scatter-plotting. These can be overridden using **Select fields**
Excel	Output is a .xls file. Excel must be installed on your computer. If *Display file?* is checked, then Excel is also activated on the Windows task bar, and the file may display. This message is in the Analysis Window:

<table>
<tr><td></td><td>

"Excel will activate soon. Please continue ..."

If the Excel file does not display, but you want it to, then please change the Windows Registry (at your own risk):
a. Windows: Start >> Run >> *regedit*
b. Navigate to the following path: *HKEY_CURRENT_USER\Control Panel\Desktop*
c. Modify the value named *ForegroundLockTimeout* to 0
If *ForegroundLockTimeout* does not exist, then create *ForegroundLockTimeout* with DWORD value 0

Do you want numerical person and item labels to become numbers (not text) in Excel? Then check "**Convert numerical labels to numbers**", see EXCELNUMBER=Yes
Select **decimal point**s or **decimal comma**s for your Excel numbers, see EXCELDECIMAL=
</td></tr>
<tr><td>Column headings</td><td>check to produce column headings in row 1 of the Excel worksheet.</td></tr>
<tr><td>R-Statistics</td><td>Output is an R Statistics .rdata file. If Display file? is checked, then the file is automatically displayed by RGui (if available). If this malfunctions, check that the path to R is correct with Edit Initial Settings.
When the RGui window opens, type > print(data) # data is the name of a data.frame</td></tr>
<tr><td>Descriptive statistics</td><td>

This produces descriptive summary statistics for the R Statistics file using the "describe" function of the R Statistics "psych" package *(courtesy of William Revelle).*
Example:

```
"data" IFILE data frame:
         vars  n   mean     sd median trimmed
      mad     min     max  range
MEASURE     2 18 -0.757  4.386 -1.960  -0.823
    6.012  -6.590   6.130 12.720
           skew kurtosis    se  Q0.25  Q0.75
MEASURE   0.145   -1.578 1.034 -3.830  3.087
```

Statistics are:

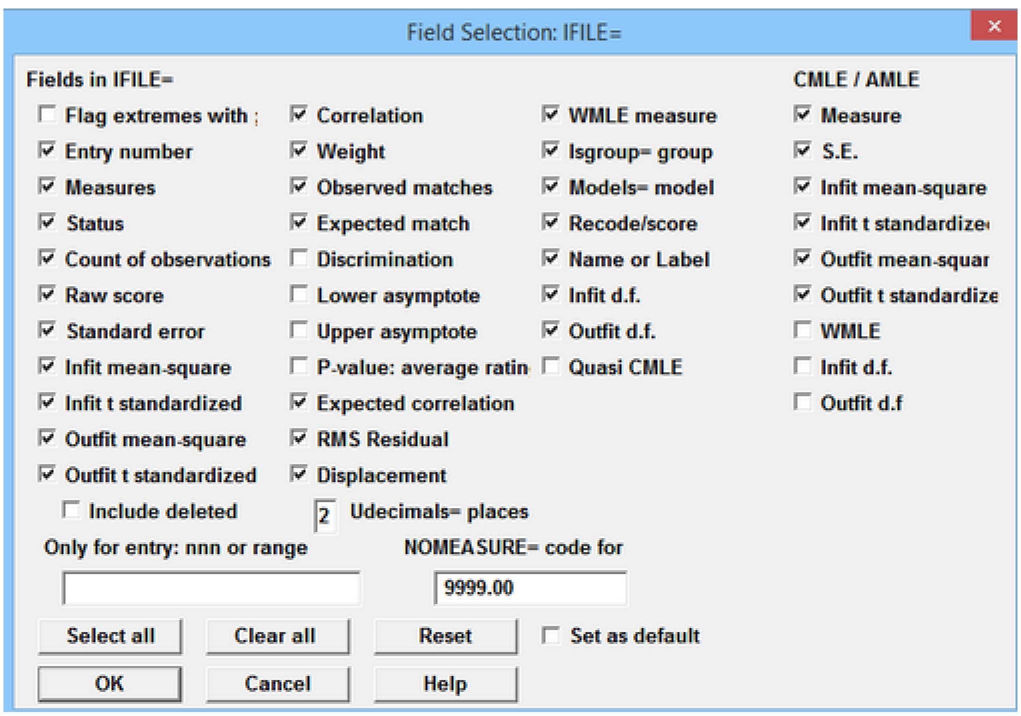
MEASURE	variable name
vars	variable number
n	number of valid cases
mean	mean
sd	standard deviation
median	median (standard or interpolated
trimmed	trimmed mean (with trim defaulting to .1)
mad	median absolute deviation pseudo-S.D.
min	minimum
max	maximum
range	range
skew	skew
kurtosis	kurtosis
se	standard error
Q0.25	lower inter-quartile
Q0.75	upper inter-quartile

The median and the "mad", the mean of their absolute deviation from the median, multiplied by 1.4826, giving a "mad" value equivalent to an S.D. (Huber, 1981). For application, see "A Robust Method for Detecting Item Misfit in
</td></tr>
</table>

	Large Scale Assessments" (2021) M. von Davier & U. Bezirhan
SPSS	Output is a .sav file. If *Display file?* is checked, then the file is automatically displayed by SPSS (if available). If this malfunctions, check that the path to SPSS is correct with Edit Initial Settings.
Web page (HTML)	Output is a .htm file. If *Display file?* is checked, then the file is automatically displayed by your Internet browser.
Sortable Web page (HTML)	File output is a webpage with sortable columns
Word Doc (HTML)	Output is a .htm file. If *Display file?* is checked, then the file is automatically displayed by Microsoft Word as a .doc
IADD=Y add item measures for GRFILE=	Displayed only for GRFILE= graph file output. When checked, add the item difficulty to the measures shown in GRFILE=. Same as IADD=Yes.
File status:	
Temporary file: automatic file name	the file will be deleted when Winsteps terminates. "Save as" to make the file permanent.
Permanent file: request file name	the file will not be deleted when Winsteps terminates. Type in the filename of your choice when Winsteps requests it
Buttons:	
OK	Perform the indicated actions
Cancel	Return to Winsteps processing
Help	Display this documentation
Set as default	Make the select actions the permanent selections

20.11 IFILE=/PFILE= field selection

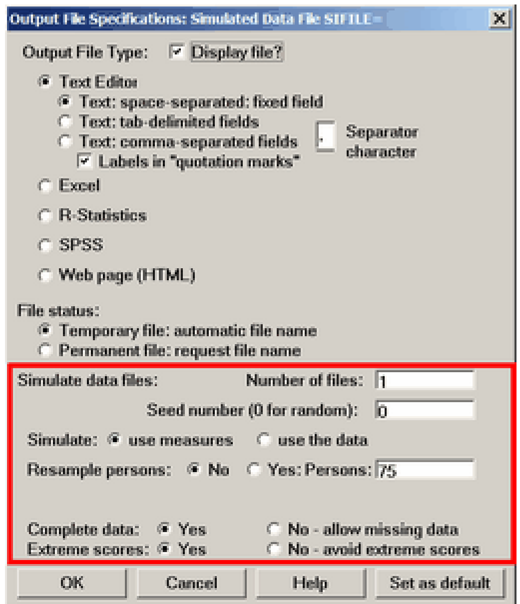
On the Output Files menu, click on IFILE= or PFILE= Field Selection to choose which fields are to be included in the IFILE= or PFILE=. Also you can select specific item or person entry numbers to display and change the values of Udecimals= and Nomeasure=



20.12 Simulated file specifications

Winsteps uses two methods to simulate data:
1) probabilistically-generated data based on anchored parameter estimates
2) re-sampling-with-replacement from the current dataset

Winsteps uses the estimated (or anchored) person, item and Andrich Thresholds or person-response-string re-sampling-with-replacement to simulate a data file equivalent to the raw data. This can be used to investigate the stability of measures, distribution of fit statistics and amount of statistical bias. Each time SIFILE= is run, or selected from the Output Files pull-down menu, a simulated data file produced. Do simulated analyses with several simulated datasets to verify their overall pattern.



The parts of the dialog box outside the red rectangle are described in Output file specifications. The file format matches the input data file if both are in fixed-field format. When SIFILE= is written with CSV=Y, comma-separated or CSV=T, tab-separated, the item responses precede the person label.	
Simulated data files:	invoked with SIFILE=
Number of files:	SINUMBER=, specifies the number of simulated files to produce. If SINUMBER= is greater than 1, then the data file name is automatically incremented, and so is the SISEED= pre-set seed value
Seed number (0 for random):	SISEED=, controls whether the pseudo-random number generator is seeded with the system clock (0 or 1), or with a user-chosen value, (2 and above)
Simulate: use measures or use the data	SIMEASURE=, chooses whether the simulated data is generated from the estimated measures (use measure), or by re-sampling from the observed data (use the data). If you wish to over-ride the estimated measures, then use IAFILE=, PAFILE= and SAFILE=
Re-sample persons: No or Yes: Persons	SIRESAMPLE=, controls whether re-sampling occurs (sampling with or without replacement), and, if it does, how many person records to include in the simulated data file
Complete data: Yes or No - allow missing data	SICOMPLETE=, Yes for complete data. No for missing data patterns to be repeated in the simulated data file

Extreme scores: Yes or No - avoid extreme scores	SIEXTREME=, Yes to allow the simulated data to include extreme (zero, minimum possible or perfect, maximum possible) scores. No to avoid generating extreme scores (when possible)

Winsteps simulates data two ways:

i) the default: using the parameter values (persons, items, Andrich thresholds) from the current analysis. This way generates simulated data according to the probabilistic distributions defined by the Rasch model and the generating Rasch parameters. This is for investigations relating to exact Rasch conditions.

ii) by resampling (with replacement) the data (observations, responses) in the current analysis. This way generates data according to the empirical distribution of the generating data so pervasive misfit, such as DIF, is replicated.

Example 0 . KCT.txt simulated with CSV=N fixed field format (re-sampling response strings):

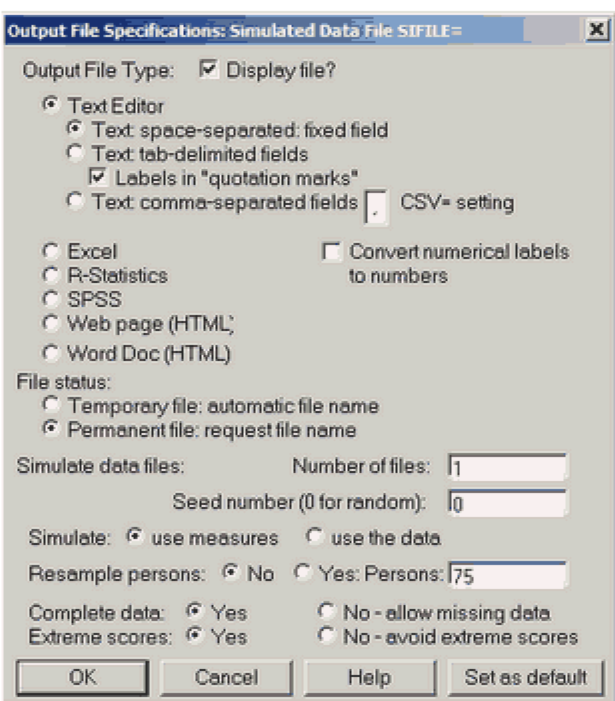
Person label - simulated data - original person measure - original person entry number

```
Dorothy F 111111111100000000       -.2594         13
Elsie   F 111101111100000000      -1.3696         14
Thomas  M 111111111010000000       -.2594         31
Rick    M 111111111010000000       -.2594         27
```

KCT.txt simulated with comma-separated, CSV=Y, HLINES=Y, QUOTED=Y format (re-sampling person measures):

```
"1-4","2-3","1-2-4","1-3-4","2-1-4", ... ,"KID","Measure","Entry"
1,1,1,1,1,1,0,1,1,1,0,0,0,0,0,0,0,0,"Rick    M",-.2594,27
1,1,1,1,1,1,1,1,1,0,1,0,0,0,0,0,0,0,"Helen   F",-.2594,16
1,1,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,"Rod     M",1.9380,28
1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0,0,"William M",.9229,34
```

Example 1. It is desired to **investigate the stability of Rasch measures.**
(1) Estimate measures from your control and data files (e.g., SF.txt)
(2) Choose SIFILE= from the Output Files menu.
(3) Choose to output a permanent file:



(4) Simulated data filename: SFSIMUL.TXT
(5) Rerun Winsteps with your Winsteps control file and DATA=SFSIMUL.TXT on the "Extra Specifications" line.
(6) Compare person, item and Andrich Thresholds.

Example 2. To **estimate the measure standard errors in a linked equating design**.
1. Do a concurrent calibration with Winsteps
2. Simulate data files SIFILE= from the Output Files menu.
Specify "complete data" SICOMPLETE= as "No" to maintain the same data pattern.
Save 10 simulated sets, SINUMBER=, as S.txt S2.txt .....
3. Rerun your Winsteps analysis 10 times
Specify in Extra Specifications "DATA=S.txt PFILE=P1.txt CSV=TAB" etc.
This will produce 10 PFILE=s. Export them in Excel format.
4. Use Excel to compute the standard deviation of the measures for each person based on the 10 person measures
5. These are the model standard errors for the equating design for the measures.
6. Inflate these values by 20%, say, to allow for systematic equating errors, misfit, etc.

Example 3. If you do need estimation-bias-correction (STBIAS=) that is as accurate as possible with your data set, you will need to **discover the amount of bias in the estimates and correct for it:**
1. In your control file, STBIAS=No and USCALE=1
2. Obtain the Winsteps estimates for your data
3. Simulate many datasets using those estimates. (SIFILE= on the Winsteps Output Files menu).
4. Obtain the Winsteps estimates from the simulated data sets
5. Regress the simulated estimates on your initial estimates. These will give a slope near 1.0.
6. Obtain the Winsteps estimates for your data with USCALE = 1/slope. The set of estimates in 6 is effectively unbiased.

Example 4. **You need to simulate data from generating values.** You can use Winsteps to simulate a dataset.

1. Obtain the generating item difficulties, person abilities and threshold values. If you need a normal distribution of person abilities, you can generate this with Excel.

a. From your standard analysis, output IFILE=if.txt, SFILE=sf.txt

b. Use Excel or similar to simulate a normal distribution of person abilities with the mean and S.D. that you want.
In Excel:
Cell A1 = Mean
Cell B1 = S.D.
Cell A2 = =ROW()-1
Cell B2 = =NORMSINV(RAND())*$B$1 +$A$1
then copy A2, B2 for as many rows as you want the sample size.

c. Copy Columns A and B into a text file, pf.txt. Delete row 1.

For a random uniform distribution of item difficulties, use the Excel formula:
=(item difficulty range)*(RAND() - 0.5) + (mean item difficulty)

d. In your Winsteps control file:
IAFILE=if.txt
SAFILE=sf.txt
PAFILE = pf.txt
SIFILE= simulated.txt

2. Construct a Winsteps control file including the generating values in IAFILE=, PAFILE=, SAFILE=

3. Make a rectangular dataset with a row of valid responses (can be the same one) as wide as the number of items and with a column of valid responses (can be the same one) as long as the number of persons.

For instance, number of persons = 2000, number of items =100, then an artificial dichotomous Winsteps control file and dataset can be:

ITEM1=1

```
NAME1=101
NI=100
CODES=01
EDFILE=*     ; every person and item much have non-extreme data
1-1000 1-50 1
1-1000 51-100 0
1001-2000 1-50 0
1001-2000 51-100 1
*
IAFILE=*
1 2.3
2 1.5
.....
*
PAFILE=*
1 3.1
2 -2.8
.....
*
SAFILE=*
0 0
1 0
*
&END
END LABELS
```

and nothing else.

4. Run Winsteps. Ignore the results of this analysis. Choose SIFILE= option from the output files menu. Click on "complete data" to simulate the entire data matrix.

Example 5. Bootstrap estimation of the confidence interval for a reliability.
Bootstrapping is based on generating new datasets using "sampling with replacement" from the current dataset. The new datasets can be generated in Winsteps using:
Simulate: use the data
Re-sample persons: yes, with same number of rows as the original data.

Compute the reliability of each new dataset. See "**Performing multiple simulations in Batch mode**".

After transformation with Fisher's *z*, the distribution of the linearized reliabilities (mean and S.D.) are the linearized expected value and linearized S.E. of the observed linearized reliability for the original data set. Transform the linearized (mean-S.D.), mean, and (mean+S.D.) back to the original reliability metric by reversing the Fisher 's *z* transformation.

Example 6. Multiple simulations in Batch mode. See BATCH=
These can construct bootstrap confidence intervals for DIF estimates, etc.
Set up 100 simulations in a batch file, and extract the relevant numbers from the 100 output DIF tables.
PowerGREP (or its freeware equivalents) is great software for extracting values from files. For instance:
To pick out lines 10-35 in the output files (after line 9, for 26 lines):

    Action type: Search
    File sectioning: Search and collect sections
    Section search: \A([^\r\n]*+\r\n){9}(([^\r\n]*+\r\n){0,26})
    Section collect: \2
    Search: the search string: .* for everything

Example 7. Simulate with more data lines than the original data.
Simple solution: copy and paste the exisiting data after itself in the data file as many times as required to obtain the desired number of data lines: Analyze with all the data lines, then Specification dialog box: PDELETE=+1-desired number of data lines. And Output Files menu, SIFILE=

Example 7. Simulate DIF - Differential Item Functioning

Method:, simulate two datasets then append them.
Example:
1. Take any dataset.
In the person label, set column 1 = A
Estimate persons, items and thresholds: PFILE=pf.txt, IFILE=if.txt, SFILE=sf.txt
Simulate a new dataset from the Output Files menu: A.txt

2. Adjust items difficulties in a few items in if.txt - these have DIF
In the person label, set column 1 = B
Analyze the same dataset: PAFILE=pf.txt, IAFILE=if.txt, SAFILE=sf.txt
Simulate a new dataset from the Output Files menu: B.txt

3. Analyze dataset Data=A.txt+B.txt
DIF=1 ; column 1 of the person label
report Table 30

Performing multiple simulations in Batch mode
1. Use NotePad to create a text file called "Simulate.bat"
2. In this file:

```
REM - produce the generating values: this example uses example0.txt:
START /WAIT c:\Winsteps\Winsteps BATCH=YES  example0.txt example0.out.txt PFILE=pf.txt
    IFILE=if.txt SFILE=sf.txt

REM - initialize the loop counter
set /a test=1
:loop

REM - simulate a dataset - use anchor values to speed up processing (or use SINUMBER= to avoid
    this step)
START /WAIT c:\Winsteps\Winsteps  BATCH=YES example0.txt example0%test%.out.txt PAFILE=pf.txt
    IAFILE=if.txt SAFILE=sf.txt SIFILE=SIFILE%test%.txt SISEED=0

REM - estimate from the simulated dataset
START /WAIT c:\Winsteps\Winsteps BATCH=YES example0.txt data=SIFILE%test%.txt SIFILE%test
    %.out.txt pfile=pf%test%.txt ifile=if%test%.txt sfile=sf%test%.txt TFILE=* 3.1 *
REM - do 100 times
set /a test=%test%+1
if not "%test%"=="101" goto loop
PAUSE
```

3. Save "Simulate.bat", then double-click on it to launch it.
4. The simulate files and their estimates are numbered 1 to 100.

5. The files of estimates can be combined and sorted using MS-DOS commands, e.g.,
Copy if*.txt combinedif.txt
Sort /+(sort column) <combinedif.txt >sortedif.txt

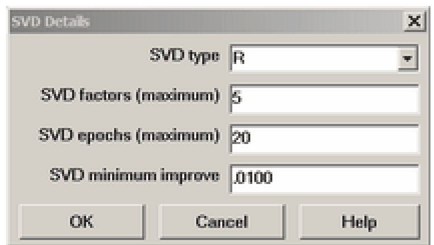
6. Individual lines from the output files can be written to one file using MS-DOS batch commands. For instance, using an MS-DOS batch routine (.bat or .cmd), the same text line can be extracted from many text files and output into a new text file. The new text file can be be pasted into Excel. Save these MS-DOS commands as *extract.bat* in the folder that has the files of statistics. Double click on *extract.bat* to execute it.

```
rem replace 2 with the number of lines to skip before the line you want
@echo off
setlocal EnableDelayedExpansion
if exist result.csv del result.csv
```

```
for %%f in (*.txt) do (
  echo %%f
  set i=a
  for /F "skip=2 delims=" %%l in (%%f) do (
    if "!i!" == "a" echo %%f, %%l >> result.csv
    set i=b
  )
)
notepad result.csv
```

20.13 SVD specifications

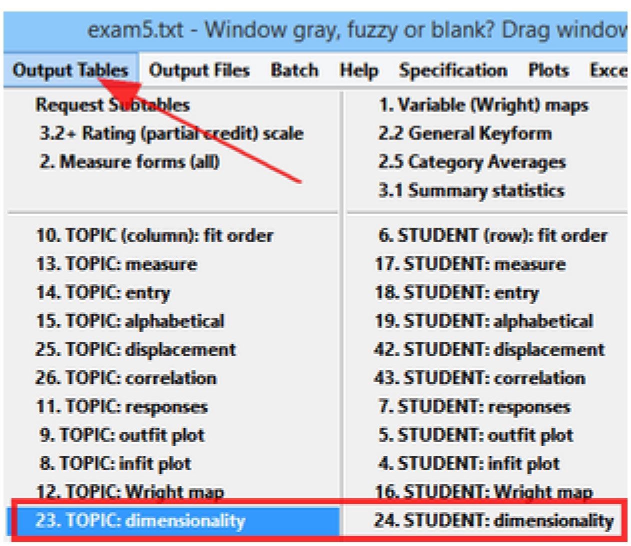
This menu is called from the Output Files menu.



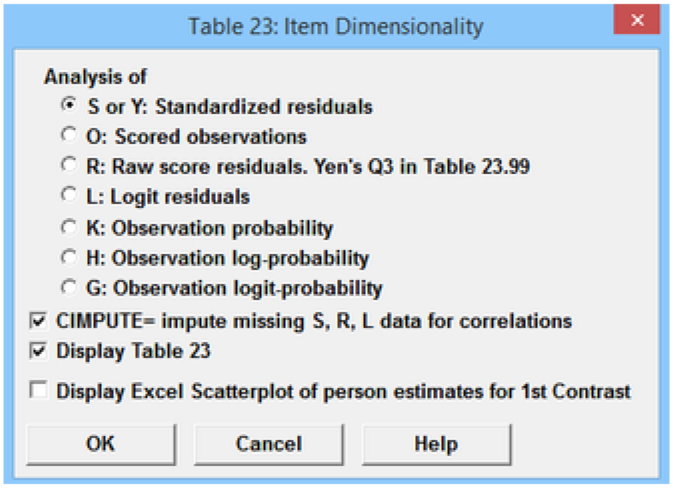
For the meaning of these settings, please see SVDFILE=.
Click on OK to see the Output file specifications dialog box to produce the SVDFILE=.

20.14 Table 23/24/Plot specifications

Called from the Output Tables menu:



This dialog box selects the type of correlations to compute:



Options are PRCOMP= and CIMPUTE=

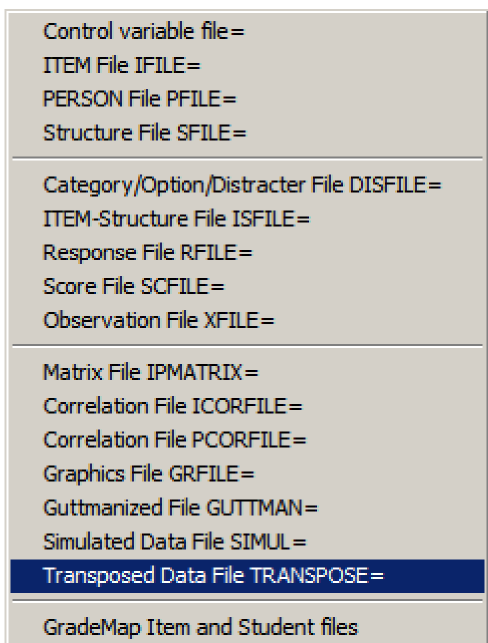
The Excel Scatterplot is the Cluster Measure Plot

20.15 Table/Plot 45 specifications

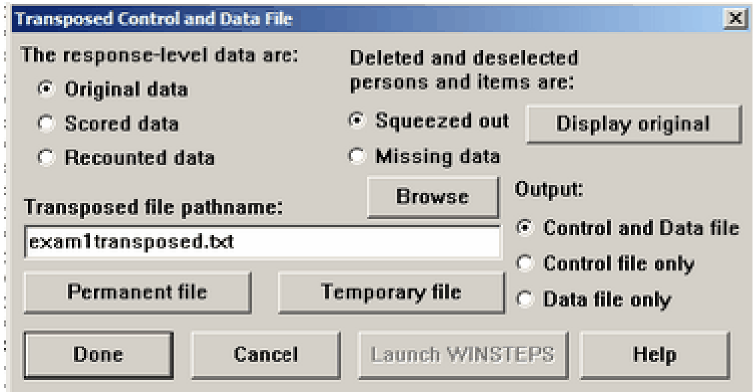
See Table 45

20.16 Transpose file specifications

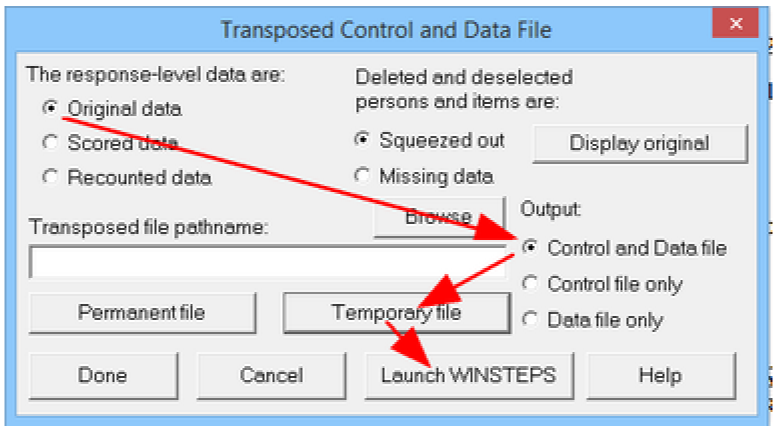
To transpose the rows and columns of the data matrix, select Transpose on the Output Files menu or specify TRPOFILE= in your control file.



then



example:



This section corresponds to TRPOTYPE=.
The response-level data are:
Original data: data codes are those in the data file.
Scored data: data after applying NEWSCORE=, IVALUE=, KEY=, etc.
Recounted data: the data recounted upwards from 0 after applying STKEEP=No, etc.

Deleted and deselect persons and items are: (IDFILE=, IDELETE=, ISELECT=, PDFILE=, PDELETE=, PSELECT=)
Squeezed out: deleted and deselected items and persons are omitted from the transposed file.
Missing data: deleted and deselected items and persons remain in the transposed file, but all their responses are indicated as missing data, "."

Output:
Control and Data file: the transposed file can be analyzed. Additional control instructions may be required in the control section in order for the analysis to proceed correctly.
Control file only: Only the control file for the transposed data is output. The transposed data are not output.
Data file only: Only the transposed data are output. The control instructions are not.

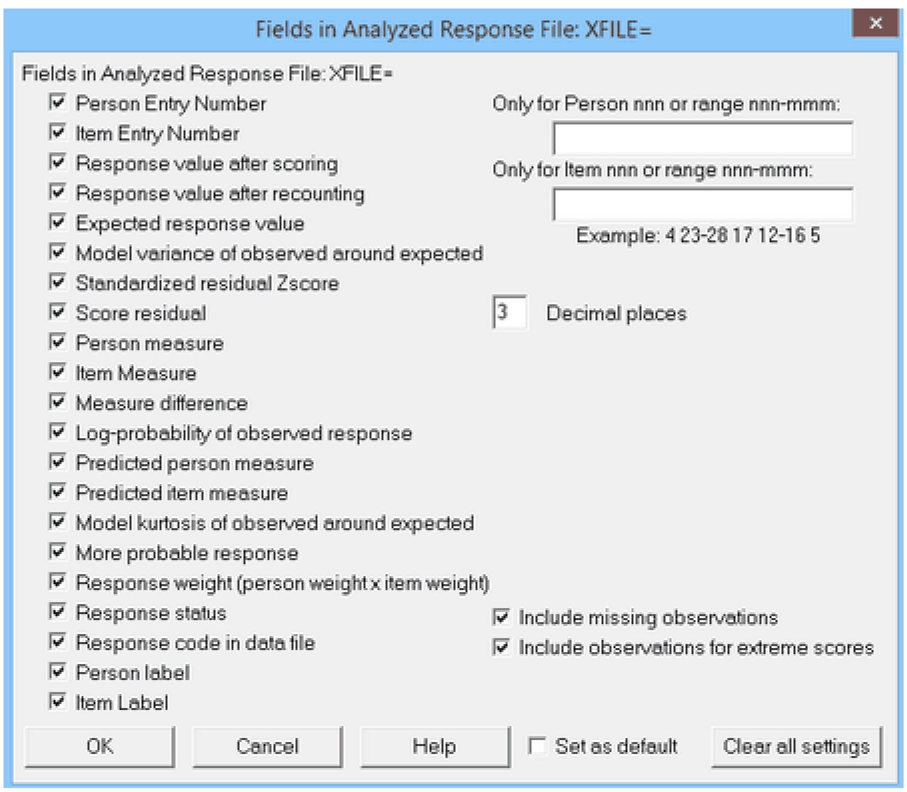
Display original: show the original, un transposed, control file.
Permanent file: file name for the transposed file. Enter in the white box, or use the "**Browse**" function to locate the desired folder.
The transposed file is created and displayed.
Temporary file: use a temporary file: this can be "saved as" a permanent file.
The transposed file is created and displayed.
Done: transposing actions completed
Cancel: exit from this routine
Launch Winsteps: launch Winsteps with the permanent transposed file as its control file.
Help: show this Help file entry

Example: This produces, for Exam1.txt, the equivalent to TRPOFILE=exam1transposed.txt and TRPOTYPE=OSB:

```
; Transposed from: C:\Winsteps\examples\exam1.txt
&INST
TITLE = "TRANSPOSED: KNOX CUBE TEST"
ITEM = KID
PERSON = TAP
NI = 35             ; ACTIVE PERSONS BECOME COLUMNS
;NN = 18             ; ACTIVE ITEMS BECOME ROWS
ITEM1 = 1
XWIDE = 1
NAME1 = 37
NAMLEN = 16              ; ends at 52
CODES = 01
STKEEP = Y
; Add here from original control file: C:\Winsteps\examples\exam1.txt
&END
Richard M  1
...... (more item labels)
Helen   F  35
END NAMES
11111111111111111111111111111111111 1-4           1
...... (more data records)
 00000000000000000000000000000000000 4-1-3-4-2-1-4 18
```

20.17 XFILE= field selection

This is called from the Output Files menu. You can select what fields to include in the XFILE= file. And you can also specify particular persons and/or items. If this is too big for your screen see Display too big. See XFILE= for the descriptions of the fields.



Only for Person nnn or range nnn-mmm: *Only for Item nnn or range nnn-mmm:*	this allows selection of particular items and persons. Example in the "Only for Person" box: 4 11-13 6 20-23

	will list those persons in that order in the XFILE=
Decimal places	controls the number of decimal places in the XFILE file.
Set as default	make this field selection the default setting for future Winsteps analyses.

21 Special Topics

21.1 Advice to novice analysts

Start with the Diagnosis menu ... Work your way down it.

In test construction, the guiding principle is "all items must be about the same thing, but then be as different as possible"! The central idea is that there is a latent variable which we are attempting to measure people on. The empirical definition of the latent variable is the content of the items. Essentially, we should be able to summarize on the items into a sentence which matches our intended definition of the latent variable. Latent variables can be very broad, e.g., "psychological state" or "educational achievement", or very narrow, e.g., "degree of paranoia" or "ability to do long division".

In other words, all items share something in common, but each item also brings in something that the others don't have.

Of course, this never happens perfectly. So what we need is:

(!) the CODES= statement contains the valid data codes in the data and nothing else.

(a) all items to point in the same direction, so that a higher rating (or "correct" answer) on the item indicates more of the latent variable. The first entry on the Diagnosis menu displays correlations. Items with negative correlations probably need their scoring reversed with IVALUE=.

(b) what the items share overwhelms what they don't share

(c) what the items don't all share, i.e., what is different about each of the items, is unique to each item or shared by only a few items.

What they all (or almost all) share, is usually thought of as the "test construct", the "major dimension", or the "Rasch dimension", or the "first factor in the data". This is what test validation studies focus on. Evaluating or confirming the nature of this construct.

What is unique to each item, or to clusters of only a few items, are "subdimensions", "secondary dimensions", "secondary contrasts", "misfit to the Rasch dimension", etc. We are concerned to evaluate: (i) are they a threat to scores/measures on the major dimension? (ii) do they manifest any useful information?

There are always as many contrasts in a test as there are items (less one). So how do we proceed?

(a) We want the first dimension to be much larger than all other dimensions, and for all items to have a large positive loading on it. This is essentially what the point-biserial correlation tells us in a rough way, and Rasch analysis tells us in a more exact way.

(b) We want so few items to load on each subdimension that we would not consider making that subdimension into a separate instrument. In practice, we would need at least 5 items to load heavily on a contrast, maybe more, before we would consider those items as a separate instrument. Then we crossplot and correlate scores or measures on the subdimension against scores on the rest of the test to see its impact.

(c) When a contrast has 2 items or less heavily loading on it, then it may be interesting, but it is only a wrinkle in this test. For instance, when we look at a two item contrast, we may say, "That is interesting, we could make a test of items like these!" But to make that test, we would need to write new items and collect more data. Its impact on this test is obviously minimal.

In reporting your results, you would want to:

(a) Describe, and statistically support, what most items share: the test construct.

(b) Identify, describe and statistically support, sub-dimensions big enough to be split off as separate tests. Then contrast scores/measures on those subdimensions with scores/measures on the rest of the test.

(c) Identify smaller sub-dimensions and speculate as to whether they could form the basis of useful new tests.

In all this, statistical techniques, like Rasch analysis and factor analysis, support your thinking, but do not do your thinking for you!

In what you are doing, I suggest that you choose the simplest analytical technique that enables you to tell your story, and certainly choose one that you understand!

Question: How do I know when to stop removing badly-fitting items and persons from my analysis?

Answer: You need to ask yourself a practical question: Why am I removing items and persons?

Is this your answer? "To improve the measurement of the persons!"

OK - then here is the strategy.

1. Estimate the person measures from the original analysis.

Remove whatever you see to be really, really bad.

2. Estimate the person measures again.

Cross-plot the two sets of person measures. Are there any noticeable changes that matter to you?

No. Then the really, really bad wasn't so bad after all. Keep everything. Stop here.

Yes. Now remove the really bad.

3. Estimate the person measures again.

Cross-plot the two sets of person measures (2. and 3.). Are there any noticeable changes that matter to you?

No. Then the really bad wasn't so bad after all. Analysis 2 is what you want. Stop here.

Yes. Now remove the somewhat bad.

4. Estimate the person measures again.

Cross-plot the two sets of person measures (3. and 4.). Are there any noticeable changes that matter to you?

No, then the somewhat bad wasn't so bad after all. Analysis 3 is what you want. Stop here.

Yes, ... (and so on)

It is usual to discover that the recommended fit criteria are much too tight. That is because those criteria were formulated by statisticians concerned about model-fit. They were not formulated by practical people who are concerned about measurement quality.

There is an interesting parallel to this in industrial quality-control. Part of the reason for the huge advance in the quality of Japanese cars relative to American cars was because Japanese quality-control focused on the overall quality of the car (which is what the consumer wants), while American quality-control focused on the quality of individual components (which is what the automotive engineers want).

21.2 Anchored estimation

How many anchor items or anchor persons?

The **percent** of anchor items is less important than the **number** of anchor items. We need enough anchor items to be statistically certain that a large incorrect value of one anchor item will not distort the equating. In my experiments, 10 were needed in order to prevent large accidental deviation in one from distorting the measurement. Please remember that the choice of 10 anchor items is before cleaning. We expect the 10 anchor items to malfunction somewhat. If we did not, only one anchor item would be needed.

Suppose that we have 10 anchor items. Then we discover one anchor item has changed its difficulty in the new test administration. In our analysis of the new test administration, we unanchor that item, so that there now only 9 anchor items. Have we failed the 10-anchor-item criterion? No! The remaining 9 anchor items are now better than the original 10 anchor items.

Anchoring or fixing parameter estimates (measures) is done with IAFILE= for items, PAFILE= for persons, and SAFILE= for response structures.

The anchor values are assigned to the anchored parameters (persons, items, steps). Then the estimation routine skips over estimating the anchored parameters, except for "displacement" values which are estimated during the fit-analysis phase. Displacements are the approximate differences between the anchor values and their freely estimated values. The anchor value for an anchored parameter participates in the estimation of all the other parameters in the same way as the current estimate of a free parameter does.

From the estimation perspective under JMLE, anchored and unanchored items appear exactly alike. The only difference is that anchored values are not changed at the end of each estimation iteration, but unanchored estimates are. JMLE converges when "observed raw score = expected raw score based on the estimates". For anchored values, this convergence criterion is never met, but the fit statistics etc. are computed and reported by Winsteps as though the anchor value is the "true" parameter value. Convergence of the overall analysis is based on the unanchored estimates. if large displacements are shown for the anchored items or persons, try changing the setting of ANCESTIM=.

Using pre-set "anchor" values to fix the measures of items (or persons) in order to equate the results of the current analysis to those of other analyses is a form of "common item" (or "common person") equating. Unlike common-item equating methods in which all datasets contribute to determining the difficulties of the linking items, the current anchored dataset has no influence on those values. Typically, the use of anchored items (or persons) does not require the computation of equating or linking constants. During an anchored analysis, the person measures are computed from the anchored item values. Those person measures are used to compute item difficulties for all non-anchored items. Then all non-anchored item and person measures are fine-tuned until the best possible overall set of measures is obtained. Discrepancies between the anchor values and the values that would have been estimated from the current data can be reported as displacements. The standard errors associated with the displacements can be used to compute approximate t-statistics to test the hypothesis that the displacements are merely due to measurement error.

Example: I have a study in which an instrument is administered serially over time to each participant. I want to estimate the trait for subsequent occasions treating the baseline parameter estimates as fixed.

Here's an approach:
1. Format the so that each data row is a set of 7 items followed by a person label containing a time-point code (say, 01,02,03,04,..) in the first two columns and a participant number.
2. Analyze each time-point in a separate file or separately in a combined file using PSELECT=01 then PSELECT=02, etc. to verify that the data for each time-point is correctly entered.
3. Analyze the time-point 01 file or separately in a combined file using PSELECT=01. Output IFILE=01if.txt SFILE=01sf.txt
4. Analyze all the data in separate files or combined files with no PSELECT= and IAFILE=01if.txt SAFILE=01sf.txt
   Output PFILE= filename.txt or PFILE=filename.xls containing a measure for every time-point + participant using the time-point 01 parameter values.

Analysis Procedure with Anchored Items

If one set of item parameter estimates is treated as the "truth" (definitive), then here is the procedure I recommend:
1. a free analysis of new data be performed first to verify that the new data is correct, e.g., no item miskeys, data entry errors, miscoding, etc.
2. an item-anchored analysis of the new data. Item displacements will tell us if items have drifted, e.g., due to item exposure. Action can be taken, such as deleting the exposed item in the new data, or coding the drifted item as a new item in the new data.
3. the final item-anchored analysis of the new data which is used for reporting etc., and which also produces the person measures on the same measurement scale as all other datasets using the anchored items. Reliability indexes, fit statistics, etc., require the final person measures so are reported here.

Estimation with anchored items (or persons)

1. the anchor values for the items (or persons) are treated as their "true" values. Other items start at 0 logits.
2. during the estimation:
a) all the item difficulties -> the person estimates
b) for anchored items, their displacements are estimated and averaged. All the person estimates are adjusted by the average anchored item displacement
c) all the person estimates -> updated item difficulties (except anchor values)
d) (a) and (b) and (c) repeat until the biggest change in any estimate is less than LCONV= value

21.3 Annotating graphics and tables

Microsoft Word can be used to anootate graphics and tables with boxes, circles, arrows, text, etc.

www.howtogeek.com/222341/how-to-annotate-an-image-in-word/

21.4 Arithmetical expressions

Many input values can be entered as expressions, for instance
USCALE = 100*2

Allowed operators are: + - * /

1) - as a range separator takes precedence over - as a negative.
IAFILE=*
1-10 2-2
*
1-10 is the item range 1 to 10, and then 2-2 is the value 0.

2) no blanks or tabs are allowed between operators and numbers:
valid: 2*2
invalid: 2 * 2

3) error codes include:
1: one of ^*/-+ followed by one of /^
2: one of ^*/-+" followed by *, or ***
4: floating point operators d, e, D, E must be followed by + or -
8: leading or trailing operators not allowed: ^*/-+
9: division by zero /0
10: operator ^*/-+ expected between numbers. No blanks allowed.
11: parenthesis or blank in unexpected place
13: unexpected character, such as A, in your arithmetic expression

21.5 Automating file selection

Use the Winsteps "Batch" pull-down menu to do this.

Assigning similar names to similar disk files can be automated using Batch commands.

For example, suppose you want to analyze your data file, and always have your output file have suffix "O.TXT", the PFILE have suffix ".PF" and the IFILE have suffix ".IF". Key in your control file and data, say "ANAL1", omitting PFILE= and IFILE= control variables. Then key in the following Batch script file, called, say, MYBATCH.BAT (for Windows-98 etc.) or MYBATCH.CMD (for Windows-2000 etc.), using your word processor, saving the file as an ASCII or DOS text file:

```
REM     the MYBATCH.BAT batch file to automate Winsteps
START /w ..\Winsteps BATCH=YES %1 %1O.TXT PFILE=%1.PF IFILE=%1.IF
```

For Winsteps, specify BATCH=YES to close all windows and terminate the program when analysis is complete.

To execute this, type at the DOS prompt (or using the Winsteps "Batch" pull-down menu:
C:> MYBATCH ANAL1 (Press Enter Key)
This outputs the tables in ANAL1O.TXT, PFILE= in ANAL1.PF and IFILE= in ANAL1.IF.

You can also edit the files WINBATCH.BAT or WINBATCH.CMD. These can be executed from the DOS prompt or from the Winsteps Batch pull-down menu. See Running Batch Files.

21.6 Average measures, distractors and rating scales

The "average measure" for a category is the average ability of the people who respond in that category or to that distractor (or distracter. The term "distractor" has been in use since at least 1934). This is an empirical value. It is **not** a Rasch-model parameter.

The Rasch-Andrich threshold (step difficulty, step calibration, etc.) is an expression of the log-odds of being observed in one or other of the adjacent categories. This is a model-based value. It is a Rasch-model parameter.

In Table 2.5, 14.3 and similar Tables describing the items, the "observed average" measure is: sum (person abilities) / count (person abilities) for each response option or rating-scale category.

In Table 3.2 and similar Tables describing the response structures, the "observed average" measure is: sum (person abilities - item difficulties) / count (person abilities) for each response option or rating-scale category.

Our theory is that people who respond in higher categories (or to the correct MCQ option) should have higher average measures. This is verified by "average measure".

Often there is also a theory about the rating scale, such as "each category in turn should be the most probable one to be observed as one advances along the latent variable." If this is your theory, then the "step difficulties" should also advance. But alternative theories can be employed. For instance, in order to increase item discrimination one may deliberately over-categorize a rating scale - visual-analog scales are an example of this. A typical visual analog-scale has 101 categories. If these functioned operationally according to the "most probable" theory, it would take something like 100 logits to get from one end of the scale to the other.

The relationship between "average measure" and Andrich thresholds or "item difficulties" is complex. It is something like:

Andrich threshold = log ((count in lower category) / (count in higher category)) + (average of the measures across both categories) - normalizer

normalized so that: sum(Andrich thresholds) = 0

So that,
the higher the frequency of the higher category relative to the lower category, the lower (more negative) the Andrich threshold (and/or item difficulty)

and the higher the average of the person measures across both categories, the higher (more positive) the Andrich threshold (and/or item difficulty)

but the Andrich thresholds are estimated as a set, so that the numerical relationship between a pair of categories is influenced by their relationships with every other category. This has the useful consequence that even if a category is not observed, it is still possible to construct a set of Andrich thresholds for the rating scale as a whole.

Suggestions based on researcher experience:
In general, this is what we like to see:
(1) More than 10 observations per category (or the findings may be unstable, i.e., non-replicable)
(2) A smooth distribution of category frequencies. The frequency distribution is not jagged. Jaggedness can indicate categories which are very narrow, perhaps category transitions have been defined to be categories. But this is sample-distribution-dependent.
(3) Clearly advancing average measures. The average measures are not disordered.
(4) Average measures near their expected values.
(5) Observations fit with their categories: Outfit mean-squares near 1.0. Values much above 1.0 are much more problematic than values much below 1.0.

21.7 Batch mode example: Score Tables

Winsteps produces a Score Table in Table 20 which is for responses to every active item. You can use the Batch File feature to automate the production of Score Tables for subtests of items.

(1) Do the calibration run:

```
 title="Item calibration"
 ni=3             ; these match your data file
 item1=1
 name1=1
 codes=123
 ISGROUPS=0
 ifile= if.txt  ; item calibrations
 sfile= sf.txt  ; rating (or partial credit) scale structure
 data=data.txt
 &end
 ......
 END LABELS
```

(2) Set up the control file for the batch run:

```
 ; This is scon.txt
 title="Produce score table"
 ni=3                ; match your data file
 item1=1
 name1=1
 codes=123
 ISGROUPS=0
 iafile = if.txt ; item anchor file
 safile = sf.txt ; rating (or partial credit) scale structure anchor file
 pafile=*
 1 0   ; dummy person measures
 2 0
 *
 CONVERGE=L  ; only logit change is used for convergence
 LCONV=0.005  ; logit change too small to appear on any report.
 &end
....
END LABELS
121.... ; two lines of dummy data - such that every item has a non-extreme score.
212....
```

(3) Set up the Batch (.bat or .cmd) file and run it. Use IDFILE=* to select the items you want (or ISELECT=)

```
rem this is score.cmd
del sc*.txt
start /w ..\Winsteps sc.txt dummy SCOREFILE=sc001.txt batch=yes idfile=* +3 * title=item3
start /w ..\Winsteps sc.txt dummy SCOREFILE=sc010.txt batch=yes idfile=* +2 * title=item2
start /w ..\Winsteps sc.txt dummy SCOREFILE=sc100.txt batch=yes idfile=* +1 * title=item1
start /w ..\Winsteps sc.txt dummy SCOREFILE=sc011.txt batch=yes idfile=* +2 +3 * title=items23
start /w ..\Winsteps sc.txt dummy SCOREFILE=sc101.txt batch=yes idfile=* +1 +3 * title=item13
start /w ..\Winsteps sc.txt dummy SCOREFILE=sc110.txt batch=yes idfile=* +1 +2 * title=items12
start /w ..\Winsteps sc.txt dummy SCOREFILE=sc111.txt batch=yes idfile=* +1 +2 +3 *
        title=items123
.....
copy sc*.txt scores.txt
```

(4) The Score Tables are in file scores.txt

Batch command to select one line from a file.

Save the code below as oneline.bat
Then
c:>oneline 23 infile.txt >>outfile.txt
selects line 24

```
@echo off
rem select one line  from a file
setlocal enabledelayedexpansion
if [%1] == [] goto usage
if [%2] == [] goto usage
for /f "skip=%1 delims=" %%a in (%2) do (
echo %%a
goto exit
)
goto exit
:usage
echo Usage: oneline.bat  linebefore infile   >>outfile
:exit
```

21.8 Bayesian prior distributions

Winsteps does not support Bayesian prior distributions directly, but the effect of a Bayesian prior on the final estimates can be obtained in other ways. However,
"For the Rasch model, an explicit pattern [= prior distribution] that could be used to obtain more accurate item parameter estimates was not found." (Karadavut, T. (2019). The Uniform Prior for Bayesian Estimation of Ability in Item Response Theory Models. International Journal of Assessment Tools in Education, 6(4), 568-579.)

Example 1: You have predicted the item difficulties based on your construct theory. You want to use these predicted difficulties as Bayesian Priors on the estimation of the empirical Item Difficulties

1. Constructing some dummy person records. These persons would respond to your items in the way predicted by your desired Bayesian prior.

2. Analyze the dummy person records by themselves. Add and alter dummy person records until the estimated item difficulties match your Bayesian predictions.

3. Analyze the dummy records with your actual sample. PWEIGHT= the dummy records until the influence of the dummy records on the final estimates is the same as your desired hypothetical Bayesian prior.

Illustration: There are 6 items. Our theory says: items 1-2 are easy, items 3-4 are moderate, items 5-6 are hard. Dummy data records could be these. Notice that they all have the same raw score. Fit to the Rasch model is irrelevant for dummy data.
101010
110100

110100
011001

Example 2: You want to impose a Bayesian prior on the person-ability distribution.
There are usually two noticeable effects of a Bayesian prior:
(i) extreme person scores participate in the estimation of item difficulties in the same way as non-extreme scores.
(ii) the person-ability estimates are more central with a smoother distribution.
These two effects can be obtained by adding item records to the dataset.

1. Analyze the dataset without the Bayesian prior. Verify that all is correct.

2. Define two more dichotomous items in the control file. These are dummy items. Use ISGROUPS= to place the dummy items in a separate item-group.

3. Append to each person's response string two responses. "01" for the first half of the person sample. "10" for the second half.
Illustration: the original control file has 100 dichotomous items and 500 persons:
CODES=01
NI=100
the Bayesian control file has 102 dichotomous items
CODES=01
NI=102 ; two more items
ISGROUPS=*
1-100 A ; all the original dichotomous items in one group
101-102 D ; the dummy items in their own group
*
EDFILE=* ; using EDFILE=, we don't change the actual data
1-250 101 0
1-250 102 1
251-500 101 1
251-500 102 0
*
IWEIGHT=*
101 1
102 1
*

4. Analyze the enlarged dataset. Verify that (i) all previously extreme scores are not shown as extreme, Table 17, and (ii) the person-ability S.D. has reduced. We expect that the fit statistics for all the items, except for the two dummy items, are tending towards overfit (lower mean-squares).

5. Adjust the weighting of the dummy items using IWEIGHT= until the influence of the dummy records on the final estimates is the same as your desired hypothetical Bayesian prior.

21.9 Between-group and Within-group fit statistics

Richard Smith (1982, 2009) proposes group-level fit statistics. These statistics indicate more or less consistency across CLASSes. Lack of consistency may indicate DIF or DPF or some other interaction across CLASSes or inside of CLASSes.

For each item, the persons are segmented into CLASSes using DIF=

Table 30.4 - Between-group fit statistic for person CLASSes:
"This fit statistic is based on the difference between an item's observed score on a subset of persons and the score on that subset as predicted by the item's overall difficulty estimate."

Table 30.5 - Within-group outfit statistic for a person CLASS for an item:
The outfit mean-square statistic for the item computed only across persons in the person CLASS.

Table 30.5 - Within-group infit statistic for an item CLASS for a person:
The infit mean-square statistic for the item computed only across persons in the person CLASS.

For each person, the items are segmented into CLASSes using DPF=

Table 31.4 - Between-group fit statistic for item CLASSes:
"This fit statistic is based on the difference between a person's observed score on a subset of items and the score on that subset as predicted by the person's overall ability estimate."

Table 31.5 - Within-group outfit statistic for an item CLASS for a person:
The outfit mean-square statistic for the person computed only across items in the item CLASS.

Table 31.5 - Within-group infit statistic for an item CLASS for a person:
The infit mean-square statistic for the person computed only across items in the item CLASS.

Smith RM, Hedges LV. Comparison of Likelihood Ratio χ^2 and Pearsonian χ^2 Tests of Fit in the Rasch Model. Education Research and Perspectives, 1982; 9(1):44-54

Smith RM, Plackner C. The family approach to assessing fit in Rasch measurement. Journal of Applied Measurement. 2009;10(4):424-37

21.10 Big / Huge / Maximum Datasets

Winsteps can analyze datasets with up to 9,999,999 persons and 64,000 items, but this can take days to analyze. For datasets with more than 2GB observations, please request a high-capacity version of Winsteps.

RAM Memory: Winsteps may require your PC to have at least 8GB RAM memory

Disk memory: You may require up to 10GB to hold the input data files. Winsteps may require up to 5 GB for temporary work files. Change the temporary folder in Edit Initial Settings if there is not enough space on your c:\ disk drive.

Settings to speed things up:

SUBSETS= No	check for subsets only once, or never if you are certain that the data are fully connected.
MPROX= 1	run the minimum number of PROX iterations
CMLE= No ;	CMLE= Yes only works to about NI=300 items. Results of CMLE the same as JMLE from about NI=100 items
DISTRACTORS= No	do distractors only in the final analysis run
CONVERGE= B LCONV= 0.01 RCONV= 0.1	Set reasonable convergence criteria for the estimation. Ctrl+f to force convergence

Here are some possible datasets with the maximum 2,147,483,647 observations:

File type	XWIDE=1		XWIDE=2	
DATA= or EDFILE=	**64,000 items**	**9,999,999 persons**	**32,000 items**	**9,999,999 persons**
Complete: no missing data	33,554 persons	214 items	67,000 persons	214 items
99% missing data	3,355,400 persons	21,470 items	6,700,000 persons	21,470 items
99.7% missing data	9,999,999 persons	64,000 items	Example 18 demonstrates this	

Winsteps will operate with a minimum of two observations per item or person, or even 1 observation with anchoring. This is useful for producing score tables with anchored items and dummy response strings. For statistically stable measures to be estimated, 30 observations per element (item or person) are needed: www.rasch.org/rmt/rmt74m.htm

The maximum number of reportable persons is 9,999,999 persons. The maximum number of items (NI=) is near 65,000 items. The maximum length of an item or person label is 300 ASCII characters. The maximum printable line is 3,003 characters.

There can be up to 32,768 ordinally numbered categories per item (polytomies, rating scales, partial credit etc.).

Subset evaluation: up to 50,000 potential subsets, depending on available computer memory.

The widest logit range of measures that maintains computational precision is 90 logits, but useful results can be reported with a measure range up to 700 logits wide.

In order to maintain high computational precision, while maintaining computational speed, Winsteps implements West, D.H.D. (1979), "Updating Mean and Variance Estimates An Improved Method," Communications of the Association for Computing Machinery, 22, 532-535.

Example: a dataset of almost 500,000 persons and 20,000 items was analyzed with Winsteps. The data were 99% missing. This type of analysis can take several hours, depending on your computer hardware.

21.11 Biserial correlation

If the sample is normally distributed (i.e., conditions for the computation of the biserial exist), then to obtain the biserial correlation from the point-biserial for dichotomous data:
Biserial = Point-biserial * f(proportion-correct-value)

Example: Specify PTBISERIAL=Yes and PVALUE=Yes. Display Table 14.

```
+-----------------------------------------------------------------------------------+
|ENTRY    RAW                     MODEL|   INFIT  |  OUTFIT  |PTBSE| P-  |              |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.|VALUE| TAP          |
|------------------------------------+----------+----------+-----+-----+--------------|
|     8     27     34    -2.35      .54| .59  -1.3| .43   -.2|  .65|  .77| 1-4-2-3      |
```

Point-biserial = .65. proportion-correct-value = .77. Then, from the Table below, f(proportion-correct-value) = 1.3861, so Biserial correlation = .65 * 1.39 = 0.90

Here is the Table of proportion-correct-value and f(proportion-correct-value).

p-va	f(p-val)	p-va	f(p-val)
0.99	3.7335	0.01	3.7335
0.98	2.8914	0.02	2.8914
0.97	2.5072	0.03	2.5072
0.96	2.2741	0.04	2.2741
0.95	2.1139	0.05	2.1139
0.94	1.9940	0.06	1.9940
0.93	1.8998	0.07	1.8998
0.92	1.8244	0.08	1.8244
0.91	1.7622	0.09	1.7622
0.90	1.7094	0.10	1.7094
0.89	1.6643	0.11	1.6643
0.88	1.6248	0.12	1.6248
0.87	1.5901	0.13	1.5901
0.86	1.5588	0.14	1.5588
0.85	1.5312	0.15	1.5312
0.84	1.5068	0.16	1.5068
0.83	1.4841	0.17	1.4841
0.82	1.4641	0.18	1.4641
0.81	1.4455	0.19	1.4455
0.80	1.4286	0.20	1.4286
0.79	1.4133	0.21	1.4133

```
0.78 1.3990   0.22 1.3990
0.77 1.3861   0.23 1.3861
0.76 1.3737   0.24 1.3737
0.75 1.3625   0.25 1.3625
0.74 1.3521   0.26 1.3521
0.73 1.3429   0.27 1.3429
0.72 1.3339   0.28 1.3339
0.71 1.3256   0.29 1.3256
0.70 1.3180   0.30 1.3180
0.69 1.3109   0.31 1.3109
0.68 1.3045   0.32 1.3045
0.67 1.2986   0.33 1.2986
0.66 1.2929   0.34 1.2929
0.65 1.2877   0.35 1.2877
0.64 1.2831   0.36 1.2831
0.63 1.2786   0.37 1.2786
0.62 1.2746   0.38 1.2746
0.61 1.2712   0.39 1.2712
0.60 1.2682   0.40 1.2682
0.59 1.2650   0.41 1.2650
0.58 1.2626   0.42 1.2626
0.57 1.2604   0.43 1.2604
0.56 1.2586   0.44 1.2586
0.55 1.2569   0.45 1.2569
0.54 1.2557   0.46 1.2557
0.53 1.2546   0.47 1.2546
0.52 1.2540   0.48 1.2540
0.51 1.2535   0.49 1.2535
0.50 1.2534   0.50 1.2534
```

To obtain the biserial correlation from a point-biserial correlation, multiply the point-biserial correlation by SQRT(proportion-correct-value*(1-proportion-correct-value)) divided by the normal curve ordinate at the point where the normal curve is split in the same proportions.

There is no direct relationship between the point-polyserial correlation and the polyserial correlation.

21.12 Bonferroni - Multiple t-tests

The exact statement of your null hypothesis determines whether a Bonferroni correction applies. If you have a list of t-tests and a significant result for even one of those t-tests rejects the null-hypothesis, then Bonferroni correction (or similar).

Let's assume your hypothesis is "this instrument does not exhibit DIF", and you are going to test the hypothesis by looking at the statistical significance probabilities reported for each t-test in a list of t-tests. Then, by chance, we would expect 1 out of every 20 or so t-tests to report p≤.05. So, if there are more than 20 t-tests in the list, then p≤.05 for an individual t-test is a meaningless significance. In fact, if we don't see at least one p≤.05, we may be surprised!

The Bonferroni correction says, "if any of the t-tests in the list has p≤.05/(number of t-tests in the list), then the hypothesis is rejected".

What is important is the number of tests, not how many of them are reported to have p≤.05.

If you wish to make a Bonferroni multiple-significance-test correction, compare the reported significance probability with your chosen significance level, e.g., .05, divided by the number of t-tests in the Table. According to Bonferroni, if you are testing the null hypothesis at the p≤.05 level: "There is no effect in this test." Then the most significant effect must be p≤.05 / (number of item DIF contrasts) for the null hypothesis of no-effect to be rejected.

Question: **Winsteps Tables report many t-tests. Should Bonferroni adjustments for multiple comparisons be made?**

Reply: It depends on how you are conducting the t-tests. For instance, in Table 30.1. If your hypothesis (before examining any data) is "there is no DIF for this CLASS in comparison to that CLASS on this item", then the reported probabilities are correct.

If you have 20 items, then one is expected to fail the p ≤ .05 criterion. So if your hypothesis (before examining any data) is "there is no DIF in this set of items for any CLASS", then adjust individual t-test probabilities accordingly.

In general, we do not consider the rejection of a hypothesis test to be "substantively significant", unless it is both very unlikely (i.e., statistically significant) and reflects a discrepancy large enough to matter (i.e., to change some decision). If so, even if there is only one such result in a large data set, we may want to take action. This is much like sitting on the proverbial needle in a haystack. We take action to remove the needle from the haystack, even though statistical theory says, "given a big enough haystack, there will probably always be a needle in it somewhere."

A strict Bonferroni correction for *n* multiple significance tests at joint level *a* is *a/n* for each single test. This accepts or rejects the entire set of multiple tests. In an example of a 100 item test with 20 bad items (.005 < p < .01), the threshold values for cut-off with p ≤ .05 would be: p ≤ .0.0005, so that the entire set of items is accepted.

Benjamini and Hochberg (1995) suggest that an incremental application of Bonferroni correction overcomes some of its drawbacks. Here is their procedure:
i) Perform the n single significance tests.
ii) Number them in ascending order by probability P(i) where i=1,n in order.
iii) Identify k, the largest value of i for which P(i) ≤ α * i/n where α = .05 or α = .01
iv) Reject the null hypothesis for i = 1, k

In an example of a 100 item test with 20 bad items (with .005 < p < .01), the threshold values for cut-off with α = .05 would be: 0.0005 for the 1st item, .005 for the 10th item, .01 for the 20th item, .015 for the 30th item. So that k would be at least 20 and perhaps more. All 20 bad items have been flagged for rejection.

Benjamini Y. & Hochberg Y. (1995) Controlling the false discovery rate: a practical and powerful approach to multiple testing. Journal of the Royal Statistical Society B, 57,1, 289-300.

Example of whether to Bonferroni or not ...

Hypothesis 1: There is no DIF between men and women on item 1.
This is tested for item 1 in Table 30.1
or there is no DPF between "addition items" and "subtraction items" for George
This is tested for George in Table 31.1

Hypothesis 2: There is no DIF between men and women on the 8 items of this test.
Bonferroni correction:
Look at the 8 pair-wise DIF tests in Table 30.1
Choose the smallest p-value = p
Divide it by 0.5/8 = p/8
If p ≤.05/8 then reject hypothesis 2.

Or there is no DPF between "addition items" and "subtractions items" across the 1000 persons in the sample. - Bonferroni applied to Table 31.1.

Question: "Does this mean that if one or a few t-tests turn out significant, you should reject the whole set of null hypotheses and you cannot tell which items have DIF?"

Answer: You are combining two different hypotheses. Either you want to test the whole set (hypothesis 2) or individual items (hypothesis 1). In practice, we want to test individual items. So Bonferroni does not apply.

Let's contrast items (each of which is carefully and individually constructed) against a random sample from the population.

We might ask: "Is there Differential Person Functioning by this sample across these two types of items?" (Hypothesis 2 - Bonferroni) because we are not interested to (and probably cannot) investigate individuals.

But we (and the lawyers) are always asking "is there Differential Item Functioning on this particular item for men and women?" (Hypothesis 1 - not Bonferroni).

21.13 Bradley-Terry model and paired comparisons

Follow "Paired Comparison with Standard Rasch Software" - www.rasch.org/rmt/rmt113o.htm - see Winsteps command: [PAIRED]=Yes

21.14 Category boundaries and thresholds

Conceptualizing rating scales and partial-credit response structures for communication can be challenging. Rasch measurement provides several approaches. Choose the one that is most meaningful for you.

Look at this edited excerpt of Table 3.2:

```
-------------------------------------------------------------------------------------
|      DATA             |  QUALITY CONTROL   |   Andrich     |  EXPECTATION  |50% Cumulat|
| Category Counts  Cum.| Avge  Exp.  OUTFIT| Thresholds    |  Measure at   |Probability|
|Score    Used   %     % | Meas  Meas   MnSq |Measure   S.E.|Category  Zone |      at   |
-------------------------------------------------------------------------------------
|  0      891   6%    6%|  -.04   -.07  1.3 |               |( -2.27)       |    low    |
|  1      383   3%    9%|   .47    .51  1.3 |  -.91     .04|   -.68   -1.53|   -1.23   |
|  2     1017   7%   15%| 1.07    1.17   .8 |  -.15     .04|    .63    -.03|    -.07   |
|  3    12683  85% 100%| 2.15    2.14  1.0 |  1.06     .03|(  2.34)   1.55|    1.29   |
-----------------------------------------------------------(Mean)---------(Median)---
```

Here are three ways of conceptualizing and communicating the transition, threshold, boundary between category 1 and category 2:

1.1) Rasch-half-point thresholds (Zone). Someone at the boundary between "1" and "2" would have an expected rating of 1.5, or 1000 persons at the boundary between "1" and "2" would have an average rating of 1.5. This boundary is the "zone" = "Expected Measure at 1+0.5 or 2 -0.5" which is -.03 logits, the Rasch-half-point threshold. To illustrate this, use the model item characteristic curve. The expected score ogive / model ICC (Table 21.2 - second on list in Graphs menu). The CAT+.25, CAT-0.5, AT CAT, and CAT-.25 columns in the [ISFILE=] plot points on this ogive. The expected score ogive relates most directly to the estimation of the Rasch parameters. Since it is only one line, it is also convenient for summarizing performance at any point on the latent variable by one number. Crucial points are the points on the variable corresponding to the lower category value + 0.5, i..e, more than the higher adjacent category value - 0.5. These Rasch-half-point thresholds are "average score thresholds" or "Rasch-ICC thresholds".

1.2) Rasch-Thurstonian thresholds (50% Cumulative Probability). Someone at the boundary between "1" and "2" would have a 50% chance of being rated 1 or below, and a 50% chance of being rated 2 or above. This is the Rasch-Thurstonian threshold of -.07 logits. To illustrate this, use the cumulative probability curves. The cumulative probability curves (Table 21.3 - and third on list in Graphs menu). The 50%PRB columns in the ISFILE= are the crucial points on these curves. and are the Rasch-Thurstonian thresholds, useful for identifying whether a person is most likely to respond below, at or above a certain category.

1.3) Rasch-Andrich thresholds. Someone at the boundary between "1" and "2" would have an equal chance of being rated 1 or 2. This is the Rasch--Andrich Threshold of -.15 logits. To illustrate this, use the category probability curves. The probability curves (Table 21.1 - and top of list in Graphs menu). The Andrich Threshold in the [ISFILE=] gives the point of equal probability between adjacent categories. The points of highest probability of intermediate categories are given by the AT CAT values. These probability curves relate most directly to the Rasch parameter values, also called Rasch-Andrich thresholds. They are at the intersection of adjacent probability curves, and indicate when the probability of being observed in the higher category starts to exceed that of being observed in the adjacent lower one. This considers the categories two at a time, but can lead to misinference if there is Rasch-Andrich threshold [disordering.]

Here are two ways of conceptualizing the measure corresponding to a category:
2.1) The peak of the category probability curve and
2.2) The point on the latent variable at which the expected score on the item has the value of the category number.

2.1) and 2.2) are the same location on the latent variable. For extreme categories, these locations are infinite, so they are usually replaced by the location for 0.25 score units away from the extreme. For example, the locations on the latent variable for a 1,2,3 rating scale are the measures corresponding to 1.25, 2, 2.75.

3.1) Empirical average measures. For any particular sample, there is the average ability of the people who scored in any particular category of any particular item. This is the "Average Measure" reported in Table 3.2. This is entirely sample-dependent. It is not reported in ISFILE=. In the Table, the empirical average measure of the persons responding in category 1 is .47 logits, and in category 2 is 1.07 logits. An empirical boundary between these two categories could be half-way between those values, which is .77 logits.

In summary,

What some authors call the "Category Gap" is the interval on the latent variable in which the category is the most likely category to be observed. Ben Wright used to call this the "modal category interval", because the mode is the most likely value in a distribution to be observed. The interval is between Andrich thresholds, and requires advancing Andrich thresholds, because the threshold is the point on the latent variable at which adjacent categories are equally probable to be observed. This interval is particularly useful if we want to make the interpretation "ability level <=> most likely category on the item".

There are also "mean category intervals", which is the interval on the latent variable in which the expected score (= average score for an ability level) is in the range (category number - 0.5) to (category number + 0.5). The expected scores on the items are used in the Rasch-estimation process. They are also useful when the interpretation is something like "this ability level averages 3 on this item", "ability level <=> average score on the item" . The ends of this category interval can be called the half-point thresholds.

The "median category interval" is the interval on the latent variable from the location at which there is a 50% or more chance of being observed in a category below the target category up to a 50% or more chance of being observed above the target category. The ends of this interval are called the Thurstonian Thresholds. The Thurstonian Thresholds are particularly useful when there are many rarely observed categories in a rating scale. This causes the Andrich thresholds to be jumbled and uninterpretable. The Thurstonian Thresholds are always ordered. "ability level <=> more than the categories below, less than the categories above."

Category Intervals and Rasch-model Parameters

Let's distinguish between "parameters of the Rasch model" and "category intervals on the latent variable (Rasch dimension)".

Parameters of the Rasch model: the Andrich thresholds (ordered or disordered) are parameters of the usual formulations of Rasch polytomous models. There is no mathematical requirement that they are ordered, and there is a mathematical requirement that they are allowed to take any value, including -infinity and +infinity, that accords with the matching sufficient statistic, which is the count of the observations in the category, whether that produces ordered Andrich thresholds or not.

Category intervals on the latent variable: these can be defined in several ways and their values obtained from the parameter values of the Rasch model and vice-versa. For instance, suppose we start by looking at the latent variable. We choose a point for the end of a category. We say "everyone to the left of this point is probably in a lower category" and "everyone to the right of this point is probably in this category or above". We give this point a numerical value. We do the same thing for every other category boundary on the latent variable. Then we decide to simulate data that matches these point definitions. Now we need to change the definition of those points on the latent variable into a mathematical formula from which the generating parameters of the Rasch model can be obtained. Yes, we can do it. This definition of the category boundaries matches the Rasch-Thurstone thresholds, and the matching Rasch-Andrich thresholds (parameter values) are given by the formula in www.rasch.org/rmt/rmt164e.htm

21.15 Category mean-square fit statistics

Computation of Category Mean-Square fit statistics:

For all observations in the data:

X_{ni} is the observed value
E_{ni} is the expected value of X_{ni}
W_{ni} is the model variance of the observation around its expectation
P_{nik} is the probability of observing X_{ni}=k

Category Outfit Mean-Square statistic for category k =
[sum ((k-E_{ni})²/W_{ni}) for all X_{ni}=k] / [sum (P_{nik} * (k-E_{ni})²/W_{ni}) for all X_{ni}]

Category Infit statistic for category k =
[sum ((k-E_{ni})²) for all X_{ni}=k] / [sum (P_{nik} * (k-E_{ni})²) for all X_{ni}]

The expected values of the category mean-squares are 1.0.

For dichotomies, with categories 0 and 1:

For category 0: k = 0, Eni = Pni = 1 - Pni

Category Outfit Mean-Square statistic for category 0
= [sum (P_{ni}/(1-P_{ni})) for all X_{ni}=0] / [sum (P_{ni}) for all X_{ni}]

Category Infit statistic for category 0
= [sum (P_{ni}^2) for all X_{ni}=0] / [sum ((1-P_{ni})*P_{ni}^2) for all X_{ni}]

For category 1: k = 1

Category Outfit Mean-Square statistic for category 0
= [sum ((1-P_{ni})/P_{ni}) for all X_{ni}=0] / [sum (1-P_{ni}) for all X_{ni}]

Category Infit statistic for category 0
= [sum ((1-P_{ni})²) for all X_{ni}=1] / [sum (P_{ni}*(1-P_{ni})²) for all X_{ni}]

21.16 Chi-squares, d.f., probabilities and Mean-squares

Winsteps reports mean-square fit statistics. These are chi-square fit statistics divided by their degrees of freedom.

Mean-squares: the expected value of a mean-square is 1.0. When the mean-square = 1.0, then the unexplained variance in the data is the same size as the unexplained variance (randmness) predicted by the Rasch model. Mean-squares < 1.0 indicate over-fit of the data to the model = the Rasch model is explaining the data too well. Mean-squares > 1.0 indicate under-fit of the data to the model = there is too much unexplained variance in the data.

Unexpectedness: Winsteps test the hypothesis that the mean-square = 1.0 except for the predicted statistical variability. The outcome of the hypothesis test is reported as a unit-normal deviate, ZSTD. Values outside ±1.96 indicate p<.05 for the double-sided test, and the null hypothesis of "model fit" is rejected. Always investigate underfit (Mean-square > 1.0, ZSTD >0) before overfit. Underfit is a much greater threat to measurement than overfit.

Chi-squares, d.f., probabilities: instead of mean-squares and ZSTD, you may want to report these.
Chi-square = Mean-square * d.f.
d.f. are not usually integers, because of the ordinal, non-linear nature of the data.

To report probabilities, LOCAL=Prob. For instance, in Table 14:

```
-----------------------------------------------------------------------------------------------------
|ENTRY   TOTAL  TOTAL           MODEL|   INFIT  |  OUTFIT  |PTMEASUR-AL|EXACT MATCH|                  |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  PROB|MNSQ  PROB|CORR.  EXP.| OBS%  EXP%| ACT              |
|------------------------------------+----------+----------+-----------+-----------+------------------|
|     1    109     75     -.40   .21| .55 .0005| .49 .0105|  .64   .49| 77.0  61.7| Watch birds      |
|     2    116     75     -.71   .22| .93 .7009| .72 .3107|  .58   .46| 74.3  64.4| Read books on animals |
```

To report probabilities, LOCAL=Prob, and d.f., IFILE= or PFILE=, and the Field Selection Dialog Box

```
;ENTRY MEASURE ST   COUNT    SCORE MODLSE IN.MSQ IN.PRO OUT.MS OUT.PR   INDF OUTDF G M R NAME
     1    -.40  1    75.0    109.0    .21    .55  .0005    .49  .0105  82.54 34.51 1 R . Watch birds
     2    -.71  1    75.0    116.0    .22    .93  .7009    .72  .3107  72.81 26.16 1 R . Read books on animals
```

To report Chi-squares in IFILE= or PFILE=, instead of Mean-squares: LOCAL=Prob, Chisquare = Yes

```
;ENTRY MEASURE ST   COUNT    SCORE MODLSE IN.CHI IN.PRO OUT.MS OUT.PR   INDF OUTDF G M R NAME
     1    -.40  1    75.0    109.0    .21  45.00  .0005  17.05  .0105  82.54 34.51 1 R . Watch birds
     2    -.71  1    75.0    116.0    .22  67.60  .7009  18.92  .3107  72.81 26.16 1 R . Read books on animals
```

Winsteps Chi-squared values and Excel CHISQ.DIST.RT(VALUE, DF) and CHISQ.INV.RT(PROB., DF)

I checked two values in the Winsteps output, one has low d.f. and the other high d.f., and they agreed with CHISQ.INV.RT(PROB., DF) to within the rounding error.

Winsteps approximates the chi-squared function using an algorithm from Abramovitz and Stegun "Handbook of Mathematical Functions" p.299. The book was published in 1964, but is still considered authoritative. Winsteps accepts real values for the d.f., but Excel truncates real d.f. values to integers (and probably computes the gamma function). Consequently Winsteps and Excel output may differ slightly.

21.17 CMLE, MMLE, PMLE: Using estimates from other software in Winsteps

Winsteps does Joint Maximum Likelihood Estimation (JMLE) and Conditional Maximum Likelihood Estimation (CMLE) with CMLE=Yes. As with all estimation methods, JMLE has strengths and weaknesses. You may prefer CMLE (eRm R Statistics), MMLE (ConQuest), PMLE (RUMM2030) or other estimates, but you also want the comprehensive analysis and reporting features of Winsteps. Here is what to do:

1) Analyze your data with the other software. It may be convenient to pre-process it with Winsteps, then output an RFILE= or IPMATRIX= for analysis by the other software.

2) From the other software, output the item difficulties (deltas), person abilities (thetas) and, for polytomies, the Andrich thresholds (taus).

3) Anchor the estimates for Winsteps. Format the item difficulties as an IAFILE= anchor text file, the person abilities as a PAFILE= and the thresholds as an SAFILE=.

4) Analyze your data with Winsteps using those anchor files. All the analysis and reporting features of Winsteps are available.

Example: CMLE using R Statistics eRm package (Patrick Mair, *et al.*)

<table>
<tr><th>Winsteps control and data file</th><th>Item (delta) JMLE estimates</th><th>Person (theta) JMLE estimates</th></tr>
<tr><td><pre>title=4x4
ni=4
name1=1
item1=1
codes=01
&END
END LABELS
1000
0110
0111
0011</pre></td><td><pre>------------------------------
|ENTRY   TOTAL TOTAL
|NUMBER SCORE COUNT MEASURE
|-----------------------------
| 1   1   4   1.26
| 2   2   4   .00
| 3   3   4   -1.26
| 4   2   4   .00</pre></td><td><pre>------------------------------
|ENTRY   TOTAL TOTAL
|NUMBER SCORE COUNT MEASURE
|-----------------------------
| 1   1   4   -1.25
| 2   2   4   .00
| 3   3   4   1.26
| 4   2   4   .00</pre></td></tr>
</table>

<table>
<tr><td>Data are symmetric
Estimates are symmetric</td><td>Range of JMLE delta estimates = 2.52 logits</td><td>Range of JMLE theta estimates = 2.51 logits</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>eRm data file</td><td>Item (delta) CMLE (eRm)</td><td>Person (theta) AMLE (eRm)</td></tr>
<tr><td><pre>
  X1 X2 X3 X4
1 1 0 0 0
2 0 1 1 0
3 0 1 1 1
4 0 0 1 1
</pre></td><td><pre>
          Estimate
delta X1   0.955
delta X2   0.000
delta X3   -0.955
delta X4   0.000
</pre></td><td><pre>
          Estimate
theta P1 -1.208
theta P2   0.000
theta P3   1.208
theta P4   0.000
</pre></td></tr>
<tr><td>Data are symmetric
Estimates are asymmetric</td><td>Range of CMLE delta estimates = 1.91 logits
JMLE bias correction = 1.91/2.52 = 0.76
predicted bias correction = (4-1)/4 = 0.75</td><td>Range of AMLE theta estimates = 2.42 logits
Almost the same as the JMLE estimates
AMLE = Anchored Maximum Likelihood Estimation</td></tr>
<tr><td>Response probabilities:

CMLE probabilities are almost symmetric

AMLE probabilities are obviously biased. The item totals are wrong.</td><td>at end of the item CMLE computation
<table>
<tr><td></td><td>X1</td><td>X2</td><td>X3</td><td>X4</td><td>Total</td></tr>
<tr><td>P1</td><td>0.077</td><td>0.201</td><td>0.521</td><td>0.201</td><td>1.000</td></tr>
<tr><td>P2</td><td>0.222</td><td>0.500</td><td>0.778</td><td>0.500</td><td>2.000</td></tr>
<tr><td>P3</td><td>0.479</td><td>0.799</td><td>0.923</td><td>0.799</td><td>3.000</td></tr>
<tr><td>P4</td><td>0.222</td><td>0.500</td><td>0.778</td><td>0.500</td><td>2.000</td></tr>
<tr><td>Total</td><td>1.000</td><td>2.000</td><td>3.000</td><td>2.000</td><td></td></tr>
</table></td><td>after AMLE computation (eRm)
<table>
<tr><td></td><td>X1</td><td>X2</td><td>X3</td><td>X4</td><td>Total</td></tr>
<tr><td>P1</td><td>0.10</td><td>0.23</td><td>0.44</td><td>0.23</td><td>1.00</td></tr>
<tr><td>P2</td><td>0.28</td><td>0.50</td><td>0.72</td><td>0.50</td><td>2.00</td></tr>
<tr><td>P3</td><td>0.56</td><td>0.77</td><td>0.90</td><td>0.77</td><td>3.00</td></tr>
<tr><td>P4</td><td>0.28</td><td>0.50</td><td>0.72</td><td>0.50</td><td>2.00</td></tr>
<tr><td>Total</td><td>1.22</td><td>2.00</td><td>2.78</td><td>2.00</td><td></td></tr>
</table></td></tr>
<tr><td>For comparison,
from the JMLE estimation - IPMATRIX= expected response values

CMLE probabilities are close to JMLE probabilities</td><td>from JMLE computation
<table>
<tr><td></td><td>X1</td><td>X2</td><td>X3</td><td>X4</td><td>Total</td></tr>
<tr><td>P1</td><td>0.075</td><td>0.222</td><td>0.501</td><td>0.222</td><td>1.000</td></tr>
<tr><td>P2</td><td>0.222</td><td>0.500</td><td>0.778</td><td>0.500</td><td>2.000</td></tr>
<tr><td>P3</td><td>0.501</td><td>0.778</td><td>0.925</td><td>0.778</td><td>3.000</td></tr>
<tr><td>P4</td><td>0.222</td><td>0.500</td><td>0.778</td><td>0.500</td><td>2.000</td></tr>
<tr><td>Total</td><td>1.000</td><td>2.000</td><td>3.000</td><td>2.000</td><td></td></tr>
</table></td><td>Person (theta) CMLE estimates obtained by
1) transpose the data
2) perform item CMLE computation
3) in this example, the delta and theta estimates are the same.</td></tr>
<tr><td>Quasi-CMLE estimates from JMLE probabilities</td><td>For dichotomous data, CMLE item (delta) estimates can be deduced from</td><td>For dichotomous data, CMLE person (theta) estimates can be deduced from</td></tr>
</table>

	the CMLE item probabilities for a person with score 1. Since JMLE probabilities are close to CMLE item probabiities, approximate item deltas, QCMLE estimates, can be calculated from JMLE probabilities	the CMLE person probabilities for an item with score 1. Since JMLE probabilities are close to CMLE person probabiities, approximate person thetas, QCMLE estimates, can be calculated from JMLE probabilities

How to do this example with Winsteps and R Statistics, eRm package:

With Winsteps control file:

```
title=4x4
ni=4
name1=1
item1=1
codes=01
lconv=.0001
rconv=.0001
converge=b
&END
END LABELS
1000
0110
0111
0011
```

after the analysis phase:
Output Files menu: IPMATRIX=.
Options:
 3. Response value after scoring
 Uncheck "Also include Person Entry Number"
 Uncheck "Include extreme persons"
 Uncheck "Include extreme items"
 Click on OK
Output File Specifications::
 R Statistics
 Temporary
 OK

R Statistics window opens:

"data" dataset is loaded, see ls()
[Previously saved workspace restored]

```
>data     # let's see what the data look like in R
  X1 X2 X3 X4
1  1  1  1  0
2  1  1  0  0
3  1  0  0  0
4  0  0  0  1

> require("eRm") # install eRm if not already installed
> library(eRm) # activate eRm
> res <- RM(data) # CMLE estimation of item easinesses for dichotomies
                  # RSM() and PCM() for polytomies
> coef(res) # or summary(res) # report the items
      beta X1       beta X2       beta X3       beta X4
-9.550007e-01 -2.322257e-07  9.550012e-01 -2.314972e-07
```

```
> pres <- person.parameter(res)  # AMLE estimation of person abilities (thetas)
> coef(pres)  # or summary(pres)  # report the person estimates
           P1            P2            P3            P4
-1.208460e+00 -4.741322e-07  1.208459e+00 -4.741322e-07
```

Then use these values as anchor values in a Winsteps analysis:

```
IAFILE=*
1   0.955  ; item difficulty is -item easiness
2   0.000
3  -0.955
4   0.000
*
PAFILE=
1  -1.208
2   0.000
3   1.208
4   0.000
*
```

For true CMLE ability estimates, transpose the data:

```
> transp <- t(data)
> theta <- RM(transp)  # CMLE estimation of person abilities
> coef(theta)
```

21.18 Column and classification selection and transformation

Selection: Several specifications require or allow the choice of columns in the item label, person label or data record. There are several formats:

Specification=	DGF=, DIF=, DPF=, EQFILE=, IAFILE=, IMAP=, IPMATRIX=, ISORT=, ISUBTOT=, IWEIGHT=, PAFILE=, PKMAP=, PMAP=, PSORT=, PSUBTOT=, PWEIGHT=, @Fieldname=
Specification=S...W... Specification=S...E... Specification=...-...	S or s is the starting column in the person or item **label** W or w is the width in columns E or e is the ending column in the label - indicates the column range
DPF=$S1W1 or DIF= DPF=S1W1 DPF=1W1 DPF=1	means "use the section of the item (or person) label starting in column 1 of the label with a width of 1 column". To select all the items (or persons), DPF= column number higher than length of label
DPF=$S3W2 DPF=S3W2 DPF=3W2	means "use the section of the item (or person) label starting in column 3 of the label with a width of 2 columns".
DPF=$S3E4 DPF=S3E4 DPF=3E4 DPF=3-4	means "use the section of the item (or person) label starting in column 3 of the label and ending in column 4".
Specification=C...W...	C or c is the starting column in the item label or person **data record**

Specification=C...E... Specification=c...w... Specification=c...e...	W or w is the width in columns E or e is the ending column in the data record This always works if the columns are within the person or item label. If the columns referenced are in the data record, but outside the person label, the information may not be available.
PWEIGHT = $C203W10 PWEIGHT = C203W10 PWEIGHT = C203E212	means "person weighting is in column 203 of the data record, with a width of 10 columns, ending in column 212"
Specification=$N Specification=@ILABEL Specification=@PLABEL	entry number this matches the length of the longest item label this matches the length of the longest person label
Specification = @Fieldname	selects one or a block of columns as specified by a prior @Fieldname= instruction
@AGE = 2E3 PSUBTOTAL = @AGE	the person's age is in columns 2 and 3 of the person label: subtotal the persons by age classifier
Specification=MA3 Specification=MD2	M = Measure A = Ascending or D = Descending 1 or higher integer: number of strata e.g., MA3 = Measures Ascending in 3 ability strata
Specification=OMA3 Specification=ILD4	I = Infit, O = Outfit M = Mean-square, L = Log-mean-square, Z = ZSTD A = Ascending or D = Descending 1 or higher integer: number of strata e.g., FILD2 = Fit - Infit - Log-scaled - Descending -2 fit strata
Strata: MA3, etc.	Strata are equally long divisions of the reported range of the statistic. Stratum number for this value = Max(1+ Number of strata * (Current value - Lowest reported value)/(Highest reported value - Lowest reported value), Number of strata)
DIF=MA3 Table 30 PSUBTOTAL=MA3 Table 28 PMAP=MA3 Table 16	Non-uniform DIF for 3 ability strata Output DIF Table Person sub-total for same 3 ability strata Output subtotal Table Show ability strata on the person map Output person map
Specification = selection + selection	+ signs can be used to concatenate selections
IMAP = 3-4 + 8W3	show in Table 12 columns 3, 4, 8, 9, 10 of the item label.
Specification = "..." Specification = '...'	constants in quotes can be included with selection.
PMAP = 3 + "/" + 6	show in Table 15 column 3, a slash, and column 6 of the person label, e.g., F/3
Multiple-format specifications:	
IAFILE = *	the item anchor values follow this specification in a list
IAFILE = 3-7	the item anchor values are in columns 3-7 of the item label
IAFILE = filename.txt	the item anchor values are in the file called "filename.txt"

21.19 Combining items into superitems and testlets

See Testlets and Super-items

21.20 Comparing estimates with other Rasch software

There are many Rasch-specific software packages and IRT packages which can be configured for Rasch models. Each implements particular estimation approaches and other assumptions or specifications about the estimates. Comparing or combining measures across packages can be awkward. There are three main considerations:

(a) choice of origin or zero-point
(b) choice of user-scaling multiplier.
(c) handling of extreme (zero, minimum possible and perfect, maximum possible) scores.

Here is one approach:

Produce person measures from Winsteps and the other computer program on the same data set. For Winsteps set USCALE=1 and UIMEAN=0.
Cross-plot the person measures with the Winsteps estimates on the x-axis. (This is preferential to comparing on item estimates, because these are more parametrization-dependent.)
Draw a best-fit line through the measures, ignoring the measures for extreme scores.
The slope is the user-scaling multiplier to apply. You can do this with USCALE= slope.
The intercept is the correction for origin to apply when comparing measures. You can do this with UIMEAN= y-axis intercept.
The departure of extreme scores from the best-fit line requires adjustment. You can do this with EXTRSCORE=. This may take multiple runs of Winsteps. If the measures for perfect, maximum possible scores are above the best-fit line, and those for zero, minimum possible scores are below, then decrease EXTRSCORE= in 0.1 increments or less. If vice-versa, then increase EXTRSCORE= in 0.1 increments or less.
With suitable choices of UIMEAN=, USCALE= and EXTRSCORE=, the crossplotted person measures should approximate the identity line.
The item estimates are now as equivalent as they can be even if, due to different choice of parametrization or estimation procedure, they appear very different.

You may notice scatter of the person measures around the identity line or obvious curvature. These could reflect differential weighting of the items in a response string, the imposition of prior distributions, the choice of approximation to the logistic function, the choice of parametrization of the Rasch model or other reasons. These are generally specific to each software program and become an additional source of error when comparing measures.

There are technical details at Estimation.

Winsteps (JMLE) vs. CMLE and RUMM (PMLE) estimates. CMLE and RUMM estimates are more central than Winsteps estimates. Winsteps estimates can be adjusted using STBIAS=.

Winsteps (JMLE) vs. ConQuest (MMLE), the estimate differences are primarily because:
1. ConQuest assumes a regular shape to the person-ability distribution. Winsteps does not.
2. ConQuest includes extreme person scores (zero and perfect) when estimating item difficulties. Winsteps does not.
There are also other technical differences, but these are usually inconsequential with large datasets.

Maximum Likelihood Estimates (MLE of any type) vs. Warm's Mean Weighted Likelihood Estimates (WMLE): Warm estimates are usually slightly more central than MLE estimates.

21.21 Comparing tests or instruments

Is there a way to compare two different instruments in the same Rasch analysis using Winsteps?

Let us assume a sample of persons been administered both instruments:

If so
1. analyze the two instruments separately, and produce PFILE=s.
2. cross-plot the person measures, e.g., with the Winsteps "Plots", "Compare" plot.
3. does the empirical trend line on the plot have the slope of an identity line (i.e., the line is: y = x +a) ?

4. If so, all the data can be analyzed together as one long "super test".
To produce comparable results for the two instruments:
Write out anchor files: IFILE= and SFILE=
Then anchor IAFILE= and SAFILE= and delete the items for each instrument in turn, IDFILE=, to produce comparable results for the instruments.

5. If not, then you are in a "Celsius to Fahrenheit" situation.
The instruments cannot be combined into one analysis.
Use USCALE= and UIMEAN= to adjust the measures in one instrument so that the relationship between the measures on analyses of the two instruments becomes y=x, the identity line.
Then the person and item hierarchies can be compared directly using their PFILE= and IFILE=

21.22 Computer-Adaptive Testing (CAT)

If you are analyzing CAT data with Winsteps, the easiest way to enter the data into Winsteps is with EDFILE=.
EDFILE=filename, e.g., edfile.txt

In edfile.txt, the data lines look like
Person-entry-number   Bank-number-for-the-item   Person-response
the person responses can be in any order.

List the person labels in entry order using PLFILE=
List the item labels using ILFILE=

21.23 ConQuest Rasch analysis software, Quest and Winsteps

ConQuest Rasch analysis software was launched in 1997. Its current version is ACER ConQuest 5 (Adams, R.J, Wu, M.L, Cloney, D., and Wilson, M.R., 2020). It implements MMLE, and is the successor to Quest which implemented JMLE. Features of ConQuest include unidimensional and multidimensional Rasch models, and also the ability to estimate group-level ability estimates based on person response strings that are too sparse to support precise individual-person estimation. ConQuest can be used for the analysis of large sparse international datasets, such as TIMSS and PISA. ConQuest implements many estimation and IRT (non-Rasch) statistical methods not available in Winsteps, but has fewer input, output, plotting and analysis-control options. The standard maximum dataset size is 3,000 persons by 100 items. The extended maximum dataset size is 1,000,000,000 persons by 10,000 items. ConQuest can be operated interactively or in batch mode using a command file.

21.24 Consecutive Dichotomies (Polytomous) Model

MODELS = C
the rating scale for each item is analyzed as a set of consecutive dichotomies with one dichotomy for each category boundary, CDM - Consecutive Dichotomies Model. This is similar to MSD, see Bradley C., Massof R. (2018) Method of successive dichotomizations: An improved method for estimating measures of latent variables from rating scale data. PLoS One.

Similarly to MSD, "consecutive dichotomies" replaces the rating scale with a set of dichotomous items. This was one of the ways that rating scales were analyzed before David Andrich devised his model in 1977. Dichotomization of rating scales has recently been reintroduced because of its conveniences. An effect of this dichotomization is to widen the logit range of the measures. In the example analysis below , the Andrich range is 1.4 logits, but the dichotomized range is 3.2 logits. So, if you are using a rule such as "DIF begins at 0.5 logits" then more instances of DIF will be reported with dichotomization than with the Andrich model. Accordingly, we need to adjust the DIF criteria to match the new situation.

Suggestion: identify DIF in a dataset with the Andrich model. Reanalyze with consecutive dichotomies. You will now be able to construct DIF criteria for the MSD situation which match the Andrich situation. If you do this, please do write a short research note about this for publication in *Rasch Measurement Transactions* or inclusion in Winsteps Help and, of course, there are many Journals where you could publish a larger paper about this.

MSD vs. Consecutive Dichotomies Model, CDM:
MSD: Chris Bradley emailed me on 4-4-2025: "Regarding the approximation technique (the implemented MSD code in R), the concept is quite simple. Let’s say the rating scale has 5 categories, so 4 thresholds. MSD dichotomizes the rating scale data for each threshold and applies the original dichotomous Rasch model to each dichotomization. The result in this case is 4 sets of estimated person and item measures. If there [is no missing data] in any set of item or person measures, the average of the 4 sets gives you the final set of MSD person and item measures. Once person and item measures are estimated, each threshold is estimated one at a time using the corresponding dichotomized data (only one unknown remains once all person and item measures are fixed)."

CDM: estimation is done with a tweak of Masters' PCM algorithm. PCM compares frequencies of adjacent categories for an item. Consecutive dichotomies compare frequencies of all categories above with all categories below each threshold for an item. Thus each original item is equivalent to a set of dichotomous items estimated together in one analysis.

Andrich RSM, Masters' PCM and polytomous PROX are difficult to explain to the non-technical. In the Masters' PCM, the threshold (category) parameters for each item are determined by the relative frequencies of the category immediately above vs. the frequency of the category immediately below each threshold of the rating scale. In the Consecutive Dichotomization Model, CDM, the parameters are determined by the frequencies of all categories above vs. all categories below the threshold for the rating scel of each item. CDM makes the parameters immediately interpretable on the latent variable as category boundaries (unlike RSM or PCM). There are no disordered thresholds. Categories can be split or combined without altering the relationships between the other thresholds. In RSM or PCM, splitting or combining categories changes the relationships between all the thresholds.

The Andrich Rating-Scale Model, the Masters' Partial Credit Model and the Linacre Grouped-Rating-Scale Model can all be written in this way:

$$P_{nij} = \frac{e^{j(B_n - D_i) - \sum_{k=0}^{j} F_k}}{\sum_{h=0}^{m} e^{h(B_n - D_i) - \sum_{k=0}^{h} F_k}} \qquad (1)$$

where Fk indicates RSM, which can be written as Fik for PCM and Fgk for GRSM with Dgi where g indicates the item belongs to item-group g. The number of categories is m+1, and F0 = 0 or any convenient constant (it cancels out of the algebra).

Equation (1) hides the fundamental structure of these Rasch models, which is revealed when we rewrite this equation in logit-linear form:

$$log\left(P_{nij}/P_{ni(j-1))}\right) = B_n - D_i - F_j \qquad (2)$$

We can see here the simple additive (linear) form of a Rasch model so that each parameter has a "sufficient statistic" (= raw score or count in the data).

We can write the CDM model in the same way conceptually. This is not an exact algebraic representation of the CDM model. The P_{nij} values are inferred from the frequency of the categories, 0 to m, in the data.

$$log\left(\sum_{k=j}^{m} P_{nik} \Big/ \sum_{k=0}^{j-1} P_{nik}\right) = B_n - D_i - F_j \qquad (3)$$

with the same options for F_j as RSM, PCM and GRSM. Then the CDM thresholds correspond to a sequence of dichotomized items of equal or ascending difficulty, Fj >= Fj-1.

In practical terms,CDM is similar to the Samejima (1969) Graded Response Model with discrimination set to 1.0.

Pni0 is the probability of failing the easiest dichotomy.

$$P_{ni0} = {}^{1}/\left(1 + e^{B_n - D_i - F_1}\right) \qquad (10)$$

Pni1 is the probability of failing the second easiest dichotomy, but not failing the easiest dichotomy. This probability must be greater or equal to zero because the dichotomies are ordered.

$$P_{ni1} = {}^{1}/\left(1 + e^{B_n - D_i - F_1}\right) - P_{ni0} \qquad (11)$$

Pni2 is the probability of failing the third easiest dichotomy, but not failing the easier dichotomies,

$$P_{ni2} = {}^{1}\!/\!\left(1 + e^{B_n - D_i - F_2}\right) - P_{ni1} - P_{ni0} \qquad (12)$$

and so until the incremental probability of failing all the dichotomies is known. Then the probability of succeeding on the most difficult dichotomy, m, is the remaining probability Pnim.

$$P_{nim} = 1 - \sum_{j=0}^{m-1} P_{nij} \qquad (13)$$

The reported person and item Standard Errors for CDM are estimated the same way as PCM.

See Example at Models-

21.25 Convergence considerations

For early runs, set the convergence criteria loosely, or use Ctrl+F to stop the iterations.

If in doubt, set the convergence criteria very tightly for your final report, e.g.,
CONVERGE=B ; both LCONV= and RCONV= apply
LCONV= .0001 ; largest logit change .0001 logits
RCONV= .01 ; largest score residual .01 score points
MJMLE= 0 ; unlimited JMLE iterations
and be prepared to stop the iterations manually, if necessary, using "Finish Iterating", Ctrl+F, on the File pull-down menu

Remember that convergence criteria tighter than the reported standard error of a measure are somewhat of a numerical fiction.

The Rasch model is non-linear. This means that estimates cannot be obtained immediately and exactly, as can be done with the solution of simultaneous linear equations. Instead, estimates are obtained by means of a series of guesses at the correct answer.

The initial guess made by Winsteps is that all items are equally difficult and all persons equally able. The expected responses based on this guess are compared with the data. Some persons have performed better than expected, some worse. Some items are harder than expected, some easier. New guesses, i.e., estimates, are made of the person abilities and item difficulties, and also the rating (or partial credit) scale structures where relevant.

The data are again examined. This is an "iteration" through the data. Expectations are compared with observations, and revised estimates are computed.

This process continues until the change of the estimates is smaller than specified in LCONV=, or the biggest difference between the marginal "total" scores and the expected scores is smaller than specified in RCONV=. The precise stopping rule is controlled by CONVERGE=. When the estimates are good enough, the iterative process has "converged". Then iteration stops. Fit statistics are computed and the reporting process begins.

There are standard convergence criteria which are suitable for most small and medium-sized complete data sets. LCONV= is harder to satisfy for small complete data sets and many sparse data designs, RCONV= for large complete data sets.

The "least converged" persons (and items) are those that Winsteps is having the most difficulty estimating. This is not usually because their responses misfit the model but because their scores are extreme. It is more difficult to estimate the measure for a person who scores 1 out of 20 than of a person who scores 10 out of 20 (even if the 10 out of 20 greatly misfit the model). This is because Rasch estimation is done as though the data fit the model. Then, after the estimates have been made, the data are evaluated to determine the extent to which the data do fit the model. It is the same process in linear regression. The parameters are estimated as though the data fit the linear regression model. Then the data are investigated to see whether they do. It is at this later stage that outliers are detected. The Rasch model is a special case of logit-linear regression.

Anchored analyses

Anchor values always misalign somewhat with the current dataset unless they are estimated from it. Thus, the maximum residuals can never reduce to zero. Convergence occurs when the maximum logit change is too small to be meaningful. Accordingly, RCONV= is unproductive and only LCONV= is useful. Suggested specifications are:

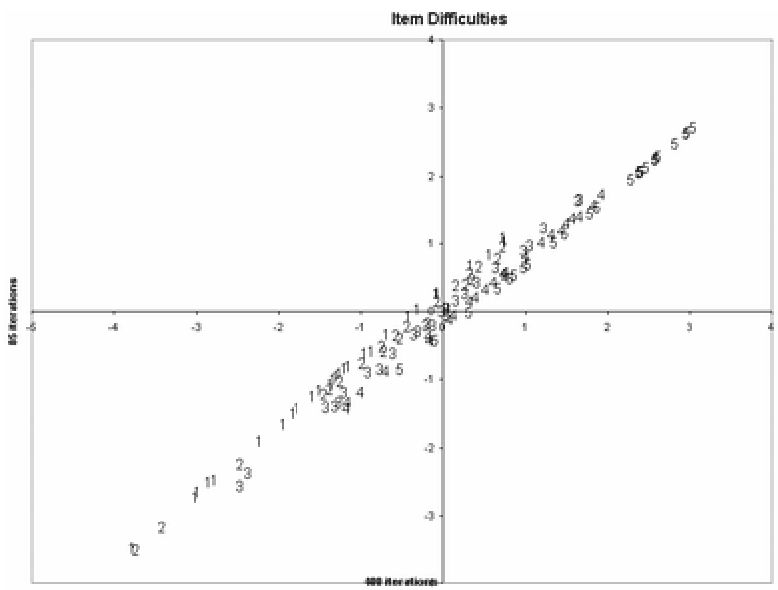
CONVERGE = L ; only LCONV is operative
LCONV = .005 ; smaller than visible in standard, two decimal, output.

Missing data

For some data designs much tighter criteria are required, particularly linked designs with large amounts of missing data. For instance, in a vertical equating design of 5 linked tests, standard convergence occurred after 85 iterations. Tightening the convergence criteria, i.e., using smaller values of LCONV= and RCONV=, convergence occurred after 400 iterations. Further iterations made no difference as the limit of mathematical precision in the computer for this data set had been reached. The plot shows a comparison of the item difficulties for the 5 linked tests estimated according to the standard and strict convergence criteria.

CONVERGE = B
LCONV = .001 ; 10 time stricter than usual
RCONV = .01 ; 10 times stricter than usual

Note that convergence may take many iterations, and may require manual intervention to occur: Ctrl+F.



21.26 Correlations: point-biserial, point-measure, residual

In Rasch analysis, we use item correlations as an immediate check that the response-level scoring makes sense. If the observed correlation is negative, something may have gone wrong (MCQ miskey, reversed survey item, etc.)

In general, correlations are much too difficult to interpret, so we switch over to using mean-squares. The "expected correlation" indicates when conventional rules such as eliminate items with point-biserials less than 0.2 are misleading.

Item correlations are difficult to interpret because they are influenced by:
1. predictability of the data
2. targeting of the item on the person sample
3. distribution of the person sample

In Rasch analysis, we are chiefly concerned about the predictability of the data when assessing item quality, so we examine the predictability directly using the mean-square statistics, rather than indirectly through the correlations.

All correlations are computed as Pearson product-moment correlation coefficients. If you wish to compute other correlations, the required data are in XFILE= IPMATRIX=, IFILE= or PFILE=. The Biserial correlation can be computed from the point-biserial.

Point-Biserial and Point-Measure Correlations			
Control Instruction	**Column Label**	**Explanation**	**Expected value (EXP.)**
PTBISERIAL= Yes PTBISERIAL= Exclude	PBSX PTBISERL-EX	Point-biserial (or point-polyserial) correlation **excluding** the current observation from the raw score. Computes the point-biserial or point-polyserial correlation coefficients, r_{pbis}, for persons and items. This is the Pearson product-moment correlation between the scored responses (dichotomies and polytomies) and the "rest scores", the corresponding total (marginal) scores **excluding** the scored responses to be correlated. This is a point-biserial correlation for dichotomies, or a point-polyserial correlation for polytomies. Extreme (perfect, maximum possible and zero, minimum possible) scores are included in the computation, but missing observations are omitted pairwise. The Biserial correlation can be computed from the Point-biserial. This correlation loses its meaning when there are missing data or with CUTLO= or CUTHI=. Specify PTBISERIAL=X instead. In Table 14.1, etc., and IFILE= For each item, this correlates the current observation with the (raw score - current observation) The actual number of observations summed into the raw score is ignored. In Table 14.3, etc., and DISFILE= For each item, each possible response option is evaluated in turn. • If the option matches the current observation and is not missing, then the option is score 1, if not the option is scored 0. Missing observations are ignored. Then the scored option is correlated with the (raw score - current observation) . • if the option matches the current observation and is missing, then the option is score 1, if not the option is scored 0 including different missing observation options. :Then the scored option is correlated with the raw score.	PBSX-E PBX-E
PTBISERIAL= All PTBISERIAL= Include	PBSA PTBISERL-AL	Point-biserial correlation for all observations **including** the current observation in the raw score. Computes the Pearson correlation between the total (marginal) scores including all responses and the responses to the targeted item and person. This is a point-biserial correlation for dichotomies, or a point-polyserial correlation for polytomies. This correlation loses its meaning when there are missing data or with CUTLO= or CUTHI=. Specify PTBISERIAL=N instead.	PBSA-E PBA-E
PTBISERIAL= No PTBISERIAL= RPM PTBISERIAL= Measure PTMEASURE=Measu re	PTMA PTMEASUR-AL	Point-measure correlation for all observations. Computes the Pearson point-measure correlation coefficients, r_{pm} between the observations and the measures, estimated from the raw scores **including** the current observation or the anchored values. Measures corresponding to extreme scores are included in the computation.	PTMA-E PMA-E
PTBISERIAL= X PTMEASURE=X	PTMX PTMEASUR-EX	Point-measure correlation **excluding** the current observation from the estimation of the measure. Computes the Pearson point-measure correlation coefficients, r_{pm} between the observations and the measures or anchor values adjusted to exclude the current observation. Measures corresponding to extreme scores are	PTMX-E PMX-E

		included in the computation. This is an approximation to the exact value. See "Numerical Example"	
PTBISERIAL= Skip	----	Point- correlations are not computed. This speeds up estimation process.	----

Point-correlations are always reported for items. Point-correlations are reported for persons when (i) all the items are dichotomies, (ii) all the items have three categories, or (iii) all the items are in the same item group (Andrich Rating Scale Model). Otherwise, the observed and expected correlations are reported as zero in PFILE=.

Example: Here are the point-biserial-type coefficient options for Example0.txt, Item 1 (Watch Birds).

Control Instruction	PTBISERIAL= ALL	PTBISERIAL= YES	PTBISERIAL= NO	PTBISERIAL= X
Calculation: Correlate observation with	raw score	raw score - current observation	Rasch measure	Rasch measure estimated from raw score - current observation
Table 14, etc., Heading	PTBISERL-AL	PTBISERL-EX	PTMEASURE-A	PTMEASUR-EX
IFILE= / PFILE= Heading	PBSA	PBSX	PTMA	PTMX
Observed correlation	.69	.66	.64	.61
Expected correlation (-E)	.53	.47	.49	.48

In Table 14.1 and other measure Tables: **Point-Biserial Correlations for dichotomies, and Point-Polyserial for polytomies**

when PTBISERIAL=Yes
PTBSE is the point-biserial correlation between the responses to this item by each person and the total marginal score by each person (omitting the response to this item). This is the "point-biserial corrected for spuriousness". Henrysson, S. (1963). Correction for item-total correlations in item analysis. Psychometrika, 28, 211-218.

when PTBISERIAL=All
PTBSA is the point-biserial correlation between the responses to this item by each person and the total marginal score by each person (including the response to this item). This is the conventional point-biserial.

In Table 14.3 and other or distractor Tables:
when PTBISERIAL=Yes or PTBISERIAL=All
PTBSD is the distractor point-biserial correlation between the indicated response to this item (scored 1 and other responses scored 0) by each person and the total marginal score by each person.

There is a closer match between Table 14.1 and Table 14.3 when PTBISERIAL=All

PTBIS=Y or E (indicated by PTBSE): The point-biserial correlation r_{pbis} for item i (when i=1,L for persons n=1,N) is the correlation between the observation for each person on item i and the total score for each person on all the items excluding item i (and similarly for the point-biserial for each person):

$$r_{pbis,i} = \frac{\sum_{n=1}^{N}\left(X_{ni} - \sum_{m=1}^{N} X_{mi}/N\right)\left(\sum_{j=1,\sim i}^{L} X_{nj} - \sum_{m=1}^{N}\sum_{j=1,\sim i}^{L} X_{mj}/N\right)}{\sqrt{\sum_{n=1}^{N}\left(X_{ni} - \sum_{m=1}^{N} X_{mi}/N\right)^{2} \sum_{n=1}^{N}\left(\sum_{j=1,\sim i}^{L} X_{nj} - \sum_{m=1}^{N}\sum_{j=1,\sim i}^{L} X_{mj}/N\right)^{2}}}$$

PTBIS=All (indicated by PTBSA): All the observations are included in the total score:

$$r_{XY} = \frac{\sum_{n=1}^{N}\left(X_n - \sum_{m=1}^{N} X_m/N\right)\left(Y_n - \sum_{m=1}^{N} Y_m/N\right)}{\sqrt{\sum_{n=1}^{N}\left(X_n - \sum_{m=1}^{N} X_m/N\right)^2 \sum_{n=1}^{N}\left(Y_n - \sum_{m=1}^{N} Y_m/N\right)^2}}$$

where $X_1,..,X_N$ are the responses, and $Y_1,..,Y_N$ are the total scores. The range of the correlation is -1 to +1.

Under classical (raw-score) test theory conventions, point-biserial correlations should be 0.3, 0.4 or better. Under Rasch conditions, point-biserial (or point-measure) correlations should be positive, so that the item-level scoring accords with the latent variable, but the size of a positive correlation is of less importance than the fit of the responses to the Rasch model, indicated by the mean-square fit statistics.

Point-Measure Correlations

PTBIS=No (indicated by PTMEA): The correlation between the observations and the Rasch measures:

$$r_{XY} = \frac{\sum_{n=1}^{N}\left(X_n - \sum_{m=1}^{N} X_m/N\right)\left(Y_n - \sum_{m=1}^{N} Y_m/N\right)}{\sqrt{\sum_{n=1}^{N}\left(X_n - \sum_{m=1}^{N} X_m/N\right)^2 \sum_{n=1}^{N}\left(Y_n - \sum_{m=1}^{N} Y_m/N\right)^2}}$$

where $X_1,..,X_N$ are the responses by the persons (or on the items), and $Y_1,..,Y_N$ are the person measures (or the item easinesses = - item difficulties). The range of the correlation is -1 to +1.

Jaspen, N. (1946) "Serial Correlation", Psychometrika, 11, 23-30.
Olsson, U., Drasgow, F. and Dorans, N.J. (1982) "The Polyserial Correlation Coefficient", Psychometrika, 47, 337-347.

The Expected Value of a Correlation

Interpreting an observed value is made easier if we can compare it with its expected value. Is is much higher than expected or much lower than expected?

The general formula for a Pearson correlation coefficient is shown above. Suppose that Xn is Xni the observation of person n on item i. Yn is Bn the ability of person n, then the point-measure correlation is:

$$r_{pmi} = \frac{\sum_{n=1}^{N}\left(X_{ni} - \bar{X}_i\right)\left(B_n - \bar{B}\right)}{\sqrt{\sum_{n=1}^{N}\left(X_{ni} - \bar{X}_i\right)^2 \sum_{n=1}^{N}\left(B_n - \bar{B}\right)^2}}$$

According to the Rasch model, the expected value of X_{ni} is E_{ni} and its model variance around the expectation is W_{ni}. For dichotomies, E_{ni} is the Rasch probability of success and $W_{ni} = E_{ni}(1-E_{ni})$. For polytomies, E_{ni} and W_{ni} are given by RSA, p. 100 also at www.rasch.org/rmt/rmt34e.htm. For JMLE estimates, $\mathrm{Sum}(E_{ni}) = \mathrm{Sum}(X_{ni})$ for n=1,N. Thus an estimate of the expected value of the point-measure correlation is given by the Rasch model proposition that: $X_{ni} = E_{ni} \pm \sqrt{Wni}$. Other variance terms are much smaller.

$$E(r_{pmi}) \approx \frac{\sum_{n=1}^{N}\left(E_{ni} \pm \sqrt{W_{ni}} - \bar{X}_i\right)\left(B_n - \bar{B}\right)}{\sqrt{\sum_{n=1}^{N}\left(E_{ni} \pm \sqrt{W_{ni}} - \bar{X}_i\right)^2 \sum_{n=1}^{N}\left(B_n - \bar{B}\right)^2}}$$

$\pm\sqrt{W_{ni}}$ is a random residual with mean 0 and variance W_{ni}. Its cross-product with any other variable is modeled to be zero. Thus, simplifying,

$$E(r_{pmi}) \approx \frac{\sum_{n=1}^{N}\left(E_{ni} - \bar{X}_i\right)\left(B_n - \bar{B}\right)}{\sqrt{\sum_{n=1}^{N}\left(\left(E_{ni} - \bar{X}_i\right)^2 + W_{ni}\right)\sum_{n=1}^{N}\left(B_n - \bar{B}\right)^2}}$$

and similarly for the point-biserial correlations. Here is an example point-measure correlation and its expected value computed with an Excel spreadsheet:

X_{ni}	X_{ni}-X_i	$(X_{ni}-X_i)^2$	B_n	B_n-B	$(B_n\text{-}B)^2$	$(X_{ni}-X_i)(B_n-B)$	E_{ni}	E_{ni}-X_i	$(E_{ni}-X_i)(B_n-B)$	$E_{ni}(1-E_{ni}) = W_{ni}$	$(E_{ni}-X_i)^2 + W_{ni}$
0	-0.50	0.25	-1.33	-1.66	2.74	0.83	0.16	-0.34	0.56	0.13	0.25
1	0.50	0.25	-0.03	-0.36	0.13	-0.18	0.41	-0.09	0.03	0.24	0.25
0	-0.50	0.25	1.33	1.01	1.01	-0.50	0.73	0.23	0.23	0.20	0.25
1	0.50	0.25	1.33	1.01	1.01	0.50	0.73	0.23	0.23	0.20	0.25
average X_i = 0.50		(i) ∑ = 1.00	average B = 0.33		(ii) ∑ = 4.89	(iii) ∑ = 0.65			(iv) ∑ = 1.05		(v) ∑ = 1.00
Observed point-measure Correlation = (iii) / √ ((i)(iii)) =						0.29					
Expected point-measure Correlation = (iv) / √ ((v)(ii)) =									0.47		
Difficulty of item *i* = 0.35 logits											

Table courtesy of Peter Karaffa

Point-Correlations and the Partial Credit Model or Grouped Rating Scale Model: ISGROUPS=

The usual computations for correlation coefficients assume that all scores or measures within each of the two variables is in the same metric. For instance, when correlating age with height for children, the ages are all in months and the heights are all in centimeters. If we mix ages in months with ages in years, or height in centimeters with height in inches, then the age-height correlations can become meaningless.

The same situation can arise when we use the Partial Credit Model (ISGROUPS=0) or Grouped Rating Scale Model (ISGROUPS=AABB..). In particular, the Expected value of a Point-Correlation can be reported as negative. This is a warning is that the reported correlations are meaningless.

Disattenuated correlation coefficients

"Attenuated" means "reduced". "Disattenuation" means "remove the attenuation".

The observed correlation between two variables is attenuated (reduced toward zero) because the variables are measured with error. So, when we remove the measurement error (by a statistical operation), the resulting correlation is disattenuated. Disattenuated correlations are always further from zero.

Algebraically:

{A} and {B} are the "true" values of two variables. Their true (disattenuated) correlation is
Disattenuated ("true") correlation = r(A,B)
But the observed values of the variables are measured with error {A±a}, {B±b}, so the observed correlation is
observed correlation = r(A,B) * √(var(A)*var(B))/√((var(+ a +a ²)*(var(+ b + b ²)).
"Disattenuation" reverses this process.

If the reliability of {A} is RA, and the reliability of {B} is RB, then the disattenuated correlation between {A} and {B} is:
disattenuated r(A,B) = r(A,B) / √(RA*RB).

Point-Correlations in Table 14.1, Table 14.3, etc. and DISFILE= and IFILE=

For the item point-biserial correlations, PTBISERIAL=A and PTBISERIAL=E:, scored observations are correlated with their corresponding person raw scores.For the point-measure correlations, PTBISERIAL=M, scored observations are correlated with their corresponding Rasch measures.

Each response code (scored or "missing") is correlated only with scored response codes. With PTBISERIAL=Yes or All, the correlation is between the occurrence and the person raw score, indicated by PTBSD CORR. When this correlation is high positive for a correct MCQ option, then the item exhibits convergent validity. When this correlation is low or negative for incorrect MCQ options, then the item exhibits discriminant validity. Krus, D. J. & Ney, R. G. (1978) Convergent and discriminant validity in item analysis. Educational and Psychological Measurement, 38, 135-137.
Each scored response code is correlated only with the other scored codes: "1" for target code "0" for other scored codes. . Missing responses are correlated with all responses.
PTBSA CORR is PTBIS = All (include the current item in the person score)
PTBSE CORR is PTBIS = Yes (exclude the current item in the person score)
PTMEA CORR is PTBIS = No (correlate with the person measure)
The "Missing" point-measure correlation is the correlation between the raw scores for the persons and the responses to the item with "missing" scored 1 and the other responses scored 0.
The category (or option) correlation is always computed the same way:
1. We focus on a particular response to a particular item.
2. Everyone who chose that response to the item is scored "1", everyone else is scored "0". Missing data are ignored.
3. The scores of "1" or "0" are correlated with the person measures.
4. We do this for every response to every item.

For the distractor/option correlations reported in Table 14.3 and DISFILE=
For each item and each option, a correlation is computed for each code in CODES= in turn:
If the response in the data file is the current code, then a value of 1 is assigned
If the response in the data file is not the current code but is scored, then a value of 0 is assigned
If the response in the data file is not in CODES= and is scored with MISSING-SCORED=, then a value of 0 is assigned.
If the response in the data file is not in CODES= and is not scored with MISSING-SCORED=, then the response is ignored.
For each value of 0 or 1, the corresponding average response score is computed = (raw score / count scored observations)
The correlation is between the (weighted) values and the average response scores or Rasch measures

For each item, one correlation is computed for all codes in the data not in CODES=
If the response in the data file is not in CODES=, then a value of 1 is assigned
If the response in the data file is in CODES=, then a value of 0 is assigned
For each value of 0 or 1, an average response score is computed = (raw score / count scored observations)
The correlation is between the weighted values and the average response scores or Rasch measures

Point-Correlations with Missing Data
The Point-Biserial is not defined for incomplete data, so Winsteps applies the following formula::
- Missing observations are ignored when calculating the correlation
- Point-measures: Measures are already adjusted for missing data, so they are correlated directly with the scored observations
- Point-biserials: Raw scores are divided by their counts of scored responses, giving an average observation. These averages are correlated with the scored observations.

Suggestion: since the point-biserial is not defined when there is unscored missing data, please use the point-measure correlation, PTBISERIAL=M.

Example 1: Point-Measure Correlations (PTBIS=No) of Person Measures with Item 6 Options a,b,c,d, with b scored 1, and missing data, x.

Person measure	*Score on item 6*	*Person's response to item 6*	*Option a*	*b*	*c*	*d*	*x missing data*
0.5	0	d	0	0	0	1	0
0.8	0	c	0	0	1	0	0
0.9	1	b	0	1	0	0	0
0.4	0	d	0	0	0	1	0
1.0	0	a	1	0	0	0	0
1.2	1	b	0	1	0	0	0
2.0	-	x	-	-	-	-	1
Table 14.1 IFILE=	PTBIS= NO 0.64	Table 14.3 DISFILE=	PTBIS= NO 0.32	0.64	0.00	-0.89	0.85
Item difficulty:	1.50	Mean ability:	1.00	1.05	0.80	0.45	2.00

Example 2: Point-Biserial (Polyserial) Correlations (PTBIS=Yes) of Person Raw Scores (excluding current item) with Item 6 Options a,b,c,d, with b scored 1, and missing data, x.

Person score on all 20 items	*Missing (unscored) responses*	*Average scored response*	*Score on item 6*	*Person score excluding item 6*	*Average scored response excluding item 6*	*Person's response to item 6*	*Option a*	*b*	*c*	*d*	*x missing data*
10	0	10/20	0	10	10/19	d	0	0	0	1	0
11	0	11/20	0	11	11/19	c	0	0	1	0	0
12	0	12/20	1	11	11/19	b	0	1	0	0	0
13	0	13/20	0	13	13/19	d	0	0	0	1	0
14	0	14/20	0	14	14/19	a	1	0	0	0	0
15	1	15/19	1	14	14/18	b	0	1	0	0	0
16	2	16/18	-	16	16/18	x	-	-	-	-	1
Table 14.1 IFILE=		PTBIS= ALL 0.47			PTBIS= YES 0.24	Table 14.3 DISFILE =	PTBIS= YES 0.43	0.24	-0.33	-0.32	0.71

Statistical Significance of a Correlation

Null hypothesis is that the correlation is 0.00.

Student's significance test: t = r / sqrt[(1—r2) / (N—2)] with N-2 d.f. where N is the count of correlated cases.

Null hypothesis is that the correlation is another value, not 1 or -1

1. Use Fisher z' transformation to linearize hypothesized correlation and observed correlation:
z' = .5[ln(1+r) - ln(1-r)]

2. normal z = (z'(observed) - z'(hypothesized)) * sqrt (N-3)

Null hypothesis is that the correlation is 1 or -1

Use a number that means the same thing: 0.99 or -0.99

21.27 Decimal, percentage and continuous data

Winsteps analyzes ordinal data, not decimal data. Typical decimal data is over-precise. Its numerical precision is greater than its substantive precision. Example: I can measure and report my weight to the nearest gram, but my "true" weight has a precision of about 500 grams.

One solution is to use SFUNCTION= with the data transformed to positive integers.

Another solution to this is to discover the precision in the data empirically.

1. Dichotomize the data for each item around the median decimal value into 0 = below median, 1= above median
2. Analyze those data.
3. If the analysis makes sense, then dichotomize each subset of the data again, so that it is now scored 0,1, 2,3
4. Analyze those data.
5. If the analysis makes sense, then dichotomize each subset of the data again, so that it is now scored 0,1, 2,3, 4,5, 6,7
6. Analyze those data.
7. If .... (and so on).

From a Rasch perspective, the relationship between a continuous variable (such as time to run 100 meters) and a Rasch latent variable (such as physical fitness) is always non-linear. Since we do not know the form of the non-linear transformation, we chunk the continuous variable into meaningful intervals, so that the difference between the means of the intervals is greater than the background noise. With percents, the intervals are rarely smaller than 10% wide, with special intervals for 0% and 100%. These chunked data can than be analyzed with a rating-scale or partial-credit model. We can then transform back to continuous-looking output using the item characteristic curve or the test characteristic curve.

Winsteps analyzes ordinal data expressed as integers, cardinal numbers, in the range 0-32,767, i.e., 32,768 ordered categories.

Example: The data are reported as 1.0, 1.25, 1.5, 1.75, 2.0, 2.5, ...
Winsteps only accepts integer data, so multiply all the ratings by 4.
If you want the score reports to look correct, then please use IWEIGHT=
IWEIGHT=*
1-100 0.25 ; 100 is the number of items
*

Percentage and 0-100 observations:
Observations may be presented for Rasch analysis in the form of percentages in the range 0-100. These are straightforward computationally but are often awkward in other respects.

A typical specification is:

```
XWIDE = 3
CODES = "  0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19+
        + 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39+
        + 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59+
        + 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79+
        + 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99100"
STKEEP = Yes ; to keep intermediate unobserved categories
```

Since it is unlikely that all percentages will be observed, the rating (or partial credit) scale structure will be difficult to estimate. Since it is even more unlikely that there will be at least 10 observations of each percentage value, the structure will be unstable across similar datasets.

It is usually better from a measurement perspective (increased person "test" reliability, increased stability) to collapse percentages into shorter rating (or partial credit) scales, e.g., 0-10, using IREFER= and IVALUE= or NEWSCORE=.

Alternatively, model the 0-100 observations as 100 binomial trials. This imposes a structure on the rating scale so that unobserved categories are of no concern. This can be done by anchoring the Rasch-Andrich thresholds at the values: Fj = C * ln(j/(101-j)), or more generally, Fj = C * ln(j / (m-j+1)) where the range of observations is 0-m. Adjust the value of the constant C so that the average mean-square is 1.0.

Decimal observations:
When observations are reported in fractional or decimal form, e.g., 2.5 or 3.9, multiply them by suitable multipliers, e.g., 2 or 10, to bring them into exact integer form.

Specify STKEEP=NO, if the range of observed integer categories includes integers that cannot be observed.

Continuous and percentage observations:
These are of two forms:
(a) Very rarely, observations are already in the additive, continuous form of a Rasch variable. Since these are in the form of the measures produced by Winsteps, they can be compared and combined with Rasch measures using standard statistical techniques, in the same way that weight and height are analyzed.

(b) Observations are continuous or percentages, but they are not (or may not be) additive in the local Rasch context. Examples are "time to perform a task", "weight lifted with the left hand". Though time and weight are reported in additive units, e.g., seconds and grams, their implications in the specific context is unlikely to be additive. "Continuous" data are an illusion. All data are discrete at some level. A major difficulty with continuous data is determining the precision of the data for this application. This indicates how big a change in the observed data constitutes a meaningful difference. For instance, time measured to .001 seconds is statistically meaningless in the Le Mans 24-hour car race - even though it may decide the winner!

To analyze these forms of data, segment them into ranges of observably different values. Identify each segment with a category number, and analyze these categories as rating scales. It is best to start with a few, very wide segments. If these produce good fit, then narrow the segments until no more statistical improvement is evident. The general principle is: if the data analysis is successful when the data are stratified into a few levels, then it may be successful if the data are stratified into more levels. If the analysis is not successful at a few levels, then more levels will merely be more chaotic. Signs of increasing chaos are increasing misfit, categories "average measures" no longer advancing, and a reduction in the sample "test" reliability.

May I suggest that you start by stratifying your data into 2 levels? (You can use Excel to do this.) Then analyze the resulting the 2 category data. Is a meaningful variable constructed? If the analysis is successful (e.g., average measures per category advance with reasonable fit and sample reliability), you could try stratifying into more levels.

Example 1: My 20 items are in an Excel file: 0-0.5 for dichotomies and 0-0.5-1.0 for partial credit items. What should I do?
i) Winsteps only analyzes integers, so multiply all the items by 2 in Excel.
ii) In order for the raw scores to look right, in Winsteps
```
IWEIGHT=*
1-20 0.5
*
```
Do this to verify that the data are being transformed correctly
iii) But, since in the original data, a dichotomous item is 0 - 0.5, instead of the usual 0 - 1,
in order for the Rasch measures to have the correct standard errors and the standardized fit statistics to be valid,
omit IWEIGHT=
iv) Yes, for these data, the partial credit model, which will also process the dichotomous items correctly:
```
ISGROUPS=0
```

Example 2: My dataset contains negative numbers such as "-1.60", as well as positive numbers such as "2.43". The range of potential responses is -100.00 to +100.00.

Winsteps expects integer data, where each advancing integer indicates one qualitatively higher level of performance (or whatever) on the latent variable. The maximum number of levels is 0-32767. There are numerous ways in which data can be recoded. One is to use Excel. Read your data file into Excel. Its "Text to columns" feature in the "Data" menu may be useful. Then apply a transformation to the responses, for instance,

recoded response = integer ((observed response - minimum response)*100 / (maximum response - minimum response))
This yields integer data in the range 0-100, i.e., 101 levels. Set the Excel column width, and "Save As" the Excel file in ".prn" (formatted text) format. Or you can do the same thing in SAS or SPSS and then use the Winsteps SAS/SPSS menu.

Example 3: We want to construct Rasch measures from the values of the indicators to produce a 'ruler'.

There are two approaches to this problem, depending on the meaning of the values:
1. If you consider that the values of the indicators are equivalent to "item difficulties", in the Rasch sense, then it is a matter of finding out their relationship to logits. For this, one needs some ordinal observational data of the data. Calibrate the observational data, then cross plot the resulting indicator measures against their reference values. The best-fit line or simple curve gives the reference value to logit conversion.
or 2. If the values are the observations (like weights and heights), then it is a matter of transforming them into ordinal values, and then performing a Rasch analysis on them. The approach is to initially score the values dichotomously high-low (1-0) and see if the analysis makes sense. If so, stratify the values into 4: 3-2-1-0. If the results still make good sense, then into 6, then into 8, then into 10. At about this point, the random noise in the data will start to overwhelm the categorization so that their will be empty categories and many "category average measures" out of sequence. So go back to the last good analysis. The model ICC will give the relationship between values and logits.

21.28 Decision consistency

Method 1: For "decision consistency" we are not interested in overall reliability, we are interested in a cut-point. We need to know what is the probability that each person will be above or below the cut-point.

Use 100 simulations in Batch= mode. For each person, we compute its frequency of being above the cut-point (score or measure) in all simulations, and its frequency of being below the cut-point. The higher of these two frequencies is the expected decision for each person. We can then use these frequencies to compute the probability of the expected decisions across all simulations:

A. Probability of expected decision for one person = maximum (frequency above cut-point, frequency below cut-point) for the element / (count of simulations)

B. Decision consistency = Probability for all elements = sum(A) / count of persons

If the cut-point is in the tail of theperson distribution, then the Decision Consistency will be high. If the Cut-Point is in the center of the distribution it will be lower.

Example: you have an item bank in which the items have their Rasch difficulties based on earlier analyses..

For each new test form, anchor their items at the item bank difficulties and analyze their new data. This will tell you two things:
1 Items that have displacements. These items have drifted from their anchor values. Output IFILE= to Excel
2. Apply Method 1.

Second analysis: unanchor all items with noticeable displacements. Analyze the data again
1. Output IFILE= to Excel.
2. Apply method 1.

From 1. outputs: plot item difficulties by item number. This will show you how much some items have drifted.

From 2. how much the overall decisions have changed based on the cut-point.

Using this information, you can talk about decision consistency, whether it is based on raw score or logit measure.

21.29 Demographic codes - changing

Question: the demographic codes in my Winsteps control file are gender=1, 2. I want gender = F, M to display in reports.

Answer: Use rectangular copy-and-paste in NotePad++ or TextPad.
1. Open the Winsteps data file in NotePad++ (freeware)

2. Rectangular cut the gender column (use alt+mouse for rectangles)
3. Paste into a new NotePad++ document
4. Global replace 1 with M, 2 with F in the new document
5. Rectangular copy the edited column
6. Paste into the correct column of the Winsteps control file: it now has M, F instead of 1,2

21.30 Dependency and unidimensionality - Repeated measures - Longitudinal studies

If one time-point is crucial, that estimate that time-point and anchor the other. For instance, time-point 1 is usually crucial in medical applications when treatement decisions are made. Time-point 2 is crucial in educational situations when pass-fail decisions are made. In survey situations, 1 and 2 are probably equally important. Analyze them altogether. If time-point dependency is a concern than www.rasch.org/rmt/rmt251b.htm - Repeated measures, Mallinson.

There are three approaches to constructing repetition-bias-free Rasch measures of persons being re-measured.

1. The situations are such that the person being re-measured is substantively different from the original person. Any dependency between the pairs of measures of the persons is below the noise level caused by other activities. For instance, when measuring a child entering the educational system at age 6 and then measuring the child again at age 18, any specific dependency between the two measures will be at the noise level. All person records can be analyzed together.

2. The first of each person measurement is the benchmark. The persons are measured, and the item difficulties and responses structures estimated. For all subsequent time-points, the items are anchored (IAFILE=) at their values for the first time point, and similarly for the response structures (SAFILE=). Since the measurement framework is anchored, no dependency between the measurements biases the measurements. Since the analysis is anchored, all time-points can be analyzed together in one analysis.

3. All measurements of each person are equally important, but it is thought that local dependency between the measurements may bias the measurements or the findings. Then, randomly select the observations at one time-point for each person. Construct a data file with only these observations. Analyze this data set. The random set of person records are measured, and the item difficulties and responses structures estimated. For all other time-points, the items are anchored (IAFILE=) at these "random" values, and similarly for the response structures (SAFILE=). Since the measurement framework is anchored, no dependency between the measurements biases the measurements. Since the analysis is anchored, all time-points can be analyzed together in one analysis.

Question: To calibrate item difficulty, I am using data from 75 subjects. Most of the subjects have been tested repeatedly, between two and 9 times each. The reason for this was that I assumed that by training and time (with natural development) the subjects ability was different between different testing situations. Now the referee has asked me to verify that "the requirement of local independence is not breached". How can I check this?

Unidimensionality can be violated in many different ways. If you run all known statistical tests to check for violations (even with your subjects tested only once), your data would undoubtedly fail some of them - (for technical details of some of these tests see Fischer & Molenaar, "Rasch Models", chapter 5.) Consequently, the question is not "are my data perfectly unidimensional" - because they aren't. The question becomes "Is the lack of unidimensionality in my data sufficiently large to threaten the validity of my results?"

Pre-Test - Post-Test dependency (or any two tests with the same persons)

1. Stack the data: all pre-test data records. Below them, all post-test data records, in the same sequence.
2. Rasch-analyze these data.
3. Output the IPMATRIX= of standardized residuals to Excel
4. For each item, correlate the pre-test standardized residuals with the post-test standardized residuals.
5. Noticeable positive correlations indicate dependency for those items between pre-test and post-test.

Imagine that you accidentally entered all your data twice. Then you know there is a lack of local independence. What would happen? Here is what happened when I did this with the dataset *exam12lo.txt:*

Data in once:

```
     SUMMARY OF 35 MEASURED PERSONS
+-----------------------------------------------------------------------------+
|           RAW                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      38.2      13.0        -.18     .32      1.01    -.1   1.02     .0 |
| P.SD      10.1        .0         .99     .06       .56    1.4    .57    1.3 |
| MAX.      54.0      13.0        1.44     .59      2.36    2.9   2.28    2.5 |
| MIN.      16.0      13.0       -2.92     .29       .23   -2.9    .24   -2.3 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .36 TRUE SD     .92  SEPARATION  2.55  PERSON RELIABILITY  .87 |
|MODEL RMSE    .33 TRUE SD     .94  SEPARATION  2.85  PERSON RELIABILITY  .89 |
| S.E. OF PERSON MEAN = .17                                                   |
+-----------------------------------------------------------------------------+
PERSON RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) PERSON RAW SCORE RELIABILITY = .89

     SUMMARY OF 13 MEASURED ITEMS
+-----------------------------------------------------------------------------+
|           RAW                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     102.9      35.0         .00     .20      1.08    -.2   1.02    -.2 |
| P.SD      23.6        .0         .93     .03       .58    2.3    .53    2.0 |
| MAX.     145.0      35.0        2.45     .31      2.16    3.9   2.42    4.3 |
| MIN.      46.0      35.0       -1.65     .18       .31   -4.2    .39   -3.3 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .24 TRUE SD     .90  SEPARATION  3.81  ITEM   RELIABILITY  .94 |
|MODEL RMSE    .20 TRUE SD     .91  SEPARATION  4.53  ITEM   RELIABILITY  .95 |
| S.E. OF ITEM MEAN = .27                                                     |
+-----------------------------------------------------------------------------+
```

Data in twice:

```
     SUMMARY OF 70 MEASURED PERSONS
+-----------------------------------------------------------------------------+
|           RAW                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      38.2      13.0        -.18     .32      1.01    -.1   1.02     .0 |
| P.SD      10.1        .0         .99     .06       .56    1.4    .57    1.3 |
| MAX.      54.0      13.0        1.44     .59      2.36    2.9   2.28    2.5 |
| MIN.      16.0      13.0       -2.92     .29       .23   -2.9    .24   -2.3 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .36 TRUE SD     .92  SEPARATION  2.55  PERSON RELIABILITY  .87 |
|MODEL RMSE    .33 TRUE SD     .94  SEPARATION  2.85  PERSON RELIABILITY  .89 |
| S.E. OF PERSON MEAN = .12                                                   |
+-----------------------------------------------------------------------------+
PERSON RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) PERSON RAW SCORE RELIABILITY = .89

     SUMMARY OF 13 MEASURED ITEMS
+-----------------------------------------------------------------------------+
|           RAW                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
```

```
| MEAN      205.8       70.0          .00      .14       1.08     -.3   1.02     -.4 |
| P.SD       47.2         .0          .93      .02        .58     3.2    .53     2.9 |
| MAX.      290.0       70.0         2.45      .22       2.16     5.4   2.42     6.1 |
| MIN.       92.0       70.0        -1.65      .13        .31    -6.0    .39    -4.7 |
|-----------------------------------------------------------------------------------|
| REAL RMSE     .17 TRUE SD      .92  SEPARATION  5.48  ITEM   RELIABILITY  .97 |
|MODEL RMSE     .14 TRUE SD      .92  SEPARATION  6.48  ITEM   RELIABILITY  .98 |
| S.E. OF ITEM MEAN = .27                                                         |
+-----------------------------------------------------------------------------------+
```

There is almost no difference in the person report. Person reliability does not change merely because the sample size becomes larger. Person reliability changes when the person distribution changes.

The biggest impact the lack of local independence has in this situation is to make the item standard errors too small. Consequently you might report item results as statistically significant that aren't.

So, with your current data, you could adjust the size of the item standard errors to their biggest "worst case" size:

Compute k = number of observations in your data / number of observations if each person had only been tested once

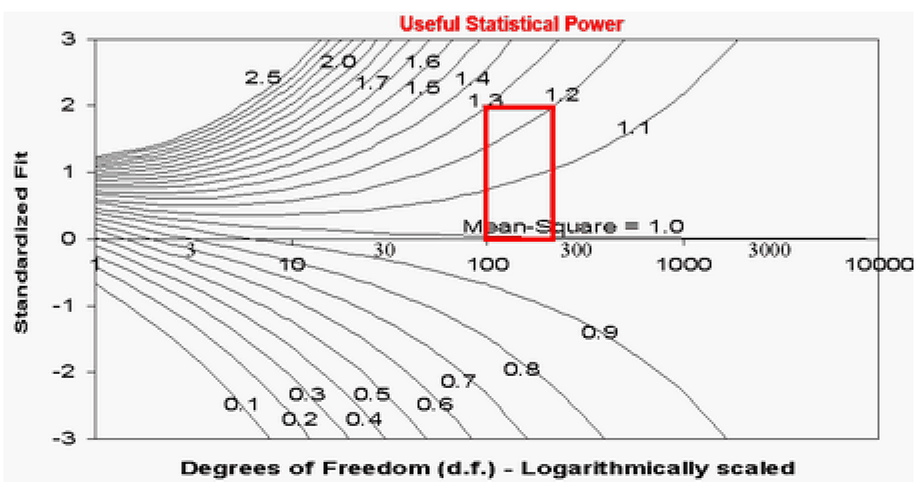
Adjusted item standard error = reported item standard error * sqrt (k).

This would also affect item Reliability computations:
Adjusted item separation coefficient = reported item separation coefficient / sqrt(k)
Adjusted item Reliability (separation index) = Rel. / (k + Rel. - Rel.*k) =TRUE Sep**2 + Adj. + Adj. Sep.**2)

The size of the item mean-square fit statistics does not change, but you would also need to adjust the size of the item t standardized fit statistics (if you use them). This is more complicated. It is probably easiest to read them off the plot from Rasch Measurement Transactions 17:1 shown below.

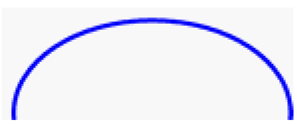
Look at your current item mean-square and significance. Find the point on the plot. Go down to the x-axis. Divide the value there by k. Go to the same mean-square value contour. The "worst case" lower statistical significance value is on the y-axis.

Another noticeable aspect of your current data could be that there are misfitting subjects who were tested 9 times, while fitting persons are tested only twice. This would introduce a small distortion into the measurement system. So, arrange all the Tables in fit order, and look at each end, do some subjects appear numerous times near the end of a Table? If so, drop out those subjects and compare item calibrations with and without those subjects. If there is no meaningful difference, then those subjects are merely at the ends of the probabilistic range predicted by the Rasch model.



21.31 Dichotomous mean-square fit statistics

For a general introduction, see Diagnosing Misfit, also Polytomous mean-square fit statistics.

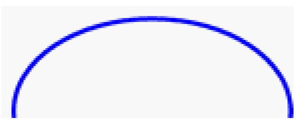
Person Responses to Items: **Easy--Items--Hard**	Diagnosis of Pattern	Person OUTFIT MnSq	Person INFIT MnSq	Point-Measure Correlation
111¦0110110100¦000	Modeled/Ideal	1.0	1.1	0.62
111¦1111100000¦000	Guttman/Deterministic	**0.3**	0.5	**0.87**
000¦0000011111¦111	Miscoded	**12.6**	**4.3**	**-0.87**
011¦1111110000¦000	Carelessness/Sleeping	**3.8**	1.0	0.65
111¦1111000000¦001	Lucky Guessing	**3.8**	1.0	0.65
101¦0101010101¦010	Response set/Miskey	**4.0**	**2.3**	**0.11**
111¦1000011110¦000	Special knowledge	0.9	1.3	0.43
111¦1010110010¦000	Imputed outliers *	0.6	1.0	0.62
Right¦Transition¦Wrong				
 high - low - high	OUTFIT sensitive to outlying observations	>>1.0 unexpected outliers	>>1.0 disturbed pattern	
 low - high - low	INFIT sensitive to pattern of inlying observations	<<1.0 overly predictable outliers	<<1.0 Guttman pattern	
* as when a tailored test (such as a Binet intelligence test) is scored by imputing all "right" responses to un administered easier items and all "wrong" responses to un administered harder items. The imputed responses are indicated by italics				

The exact details of these computations have been lost, but the items appear to be uniformly distributed about 0.4 logits apart, extracted from Linacre, Wright (1994) Rasch Measurement Transactions 8:2 p. 360

The ZSTD Z-score standardized Student's t-statistic report, as unit normal deviates, how likely it is to observe the reported mean-square values, when the data fit the model. The term Z-score is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic value has been adjusted to a unit normal value.

When there is **guessing by a person**, we expect
(1) the person to be on the less-able side
(2) the Outfit Mean-square to be large (much greater than 1.0)
(3) the point-measure correlation to be much less than expected
(4) the estimated lower asymptote for the person to be away from 0.0
(5) individual responses to be among the worst fitting.

Item Responses by Persons: **High-Person-Ability-Low**	Diagnosis of Pattern	Item OUTFIT MnSq	Item INFIT MnSq	Point-Measure Correlation
111¦0110110100¦000	Modeled/Ideal	1.0	1.1	0.62
111¦1111100000¦000	Guttman/Deterministic	**0.3**	0.5	**0.87**
000¦0000011111¦111	Miscoded	**12.6**	**4.3**	**-0.87**
011¦1111110000¦000	Carelessness/Sleeping	**3.8**	1.0	0.65
111¦1111000000¦001	Lucky Guessing Response set	**3.8**	1.0	0.65
000¦0010010001¦110	Miskey	**4.0**	**2.3**	**0.11**

Item Responses by Persons: **High-Person-Ability-Low**	Diagnosis of Pattern	Item OUTFIT MnSq	Item INFIT MnSq	Point-Measure Correlation
111¦1010110010¦000	Imputed outliers *	0.6	1.0	0.62
111¦0101010101¦000	Low discrimination	1.5	**1.6**	0.46
111¦1110101000¦000	High discrimination	0.5	0.7	0.79
111¦1111010000¦000	Very high discrimination	**0.3**	0.5	**0.84**
Right¦Transition¦Wrong				
 high - low - high	OUTFIT sensitive to outlying observations	>>1.0 unexpected outliers	>>1.0 disturbed pattern	
 low - high - low	INFIT sensitive to pattern of inlying observations	<<1.0 overly predictable outliers	<<1.0 Guttman pattern	
* as when a tailored test (such as a Binet intelligence test) is scored by imputing all "right" responses to un administered easier items and all "wrong" responses to un administered harder items. The imputed responses are indicated by italics				

When there is **guessing on an item**, we expect
(1) the item to be on the difficult side
(2) the Outfit Mean-square to be large (much greater than 1.0)
(3) the point-measure correlation to be much less than expected
(4) the estimated lower asymptote to be away from 0.0
(5) the empirical ICC/IRF to have noticeably high lower tail. One glance at this, and we know we are in trouble!

21.32 DIF - DPF - bias - interactions concepts

How to run a DIF analysis

1. Put a classification-group in the person label. In Exam1.txt this "M" or "F" in column 9
2. Specify the classification-group column in your Winsteps control file DIF = 9
3. Output Table 30
   In your control file:
   TFILE=*
   30
   *
   or from the Output Tables menu.

4. If you strongly suspect DIF in some items, and do not want them to influence the person measures until you have checked those items, then weight those items with 0 using IWEIGHT= until you have done your DIF analysis.

The DIF plot is a useful guideline where to look. Table 30.1 is decisive. Look at the two "Person Classes" of interest to you (columns 1 and 4). And at the item (row) of interest. This gives you the exact size and significance of the DIF.
Then (see Table below)
1) we need the DIF to be big enough in size to be noticeable (usually size difference > 0.5 logits, but look at your item map to see what difference between the difficulties of two items indicates a real change in performance level).
2) we need the DIF to be significant enough not to have happened by chance (usually |t| > 2.0)

But both (1) and (2) are general guidelines, which should be adjusted to your situation, in particular the control you have over your data. Most DIF rules are constructed for tightly controlled educational tests. But QOL data is much less controlled, so we must adjust our DIF criteria accordingly. We need to consider whether the DIF is likely to continue into other samples, or is the DIF only an accident of this dataset?

Winsteps reports two sets of DIF/DPF statistics:

Winsteps implements two DIF methods. First, the widely used Mantel-Haenszel and Mantel methods which are (log-)odds estimators of DIF size and significance from cross-tabs of observations of the two groups. Second, a logit-difference (logistic regression) method, which estimates the difference between the Rasch item difficulties for the two groups, holding everything else constant.

1) Mantel tests. The Mantel-Haenszel test is used for dichotomies. The Mantel test is used for polytomies.These methods are generally considered most authoritative, but require complete data in their original form. Winsteps stratifies by theta, instead of raw score, to overcome this limitation.

2) Rasch-Welch (logistic regression) t-test: this estimates a Rasch difficulty for the item for each person group (or person for each item group). The estimation process models the item difficulty according to the type of item (dichotomous, Rating Scale, Partial Credit, etc.) The estimation process does not re-estimate the Andrich thresholds. Only the overall item difficulty is re-estimated using a logistic regression model:
log-odds(data for the classification group) = (previously estimated Rasch effects) + DIF effect for the classification group
DIF MEASURE is the same as doing a full analysis of the data, outputting PFILE=pf.txt and SFILE=sf.txt, then doing another analysis with PAFILE=pf.txt and SAFILE=sf.txt and PSELECT=@DIF=code
DPF MEASURE is the same doing a full analysis of the data, outputting IFILE=if.txt and SFILE=sf.txt, then doing another analysis with IAFILE=if.txt and SAFILE=sf.txt and ISELECT=@DPF=code

---

What is DIF?
Differential Item Functioning, DIF, indicates that one group of respondents is scoring better than another group of respondents on an item (after adjusting for the overall scores of the respondents.)

This could mean
1. One group is performing at its usual "attitude/ability" level on the item, the other is performing better than usual.
2. One group is performing at its usual "attitude/ability" level on the item, the other is performing worse than usual.
3. The item has its usual difficulty for one group, but is more difficult than usual for the other.
4. The item has its usual difficulty for one group, but is easier than usual for the other.
5. ...... etc.

The statistics cannot distinguish between these meanings. Andrich and Hagquist (2012) suggest that "The item with the largest DIF is the one with the real (as opposed to artificial) DIF" (Andrich & Hagquist, 2012). However Luppescu (1993) points out situations in which this is not true.
David Andrich and Curt Hagquist (20120 Real and Artificial Differential Item Functioning. Journal of Educational and Behavioral Statistics, 37, 387-416.
Luppescu S (1993) DIF detection examined. Rasch Measurement Transactions, 7:2 p.285-6

Unfairness comes in when it is thought that the items are selected (accidentally or deliberately) to favor one group or disadvantage the other. This can happen for any of reasons 1-5 and more. When presenting DIF results in a political context, DIF is usually presented as 3. with the "other" group being the politically-disadvantaged group.

DIF statistical significance is influenced by:
1. Size of DIF effect.
2. Size of classification groups.
It is largely uninfluenced by model fit.

ETS DIF Category	with DIF Contrast and DIF Statistical Significance	
C = moderate to large	**|DIF| ≥ 0.64 logits**	**prob(|DIF| ≤ 0.43 logits) ≤ .05 (2-sided)** *approximately: |DIF| > 0.43 logits + 2 * DIF S.E.*

B = slight to moderate	**|DIF| ≥ 0.43 logits**	**prob(|DIF| = 0 logits) ≤ .05 (2-sided)** *approximately: |DIF| > 2 * DIF S.E*
A = negligible	-	-
C-, B- = DIF against focal group; C+, B+ = DIF against reference group		
ETS (Educational Testing Service) use Delta δ units. 1 logit = 2.35 Delta δ units. 1 Delta δ unit = 0.426 logits.		
Zwick, R., Thayer, D.T., Lewis, C. (1999) An Empirical Bayes Approach to Mantel-Haenszel DIF Analysis. . Journal of Educational Measurement, 36, 1, 1-28 More explanation at www.ets.org/Media/Research/pdf/RR-12-08.pdf pp. 3,4		

Suggestion: If your research will be evaluated by a reviewer and you have complete dichotomous data, then report the Mantel-Haenszel statistics .

Minimum Sample Size
"When there was no DIF [for 4-category items], type I error rates were close to 5%. Detecting moderate uniform DIF in a two-item scale required a sample size of 300 per group for adequate (>80%) power. For longer scales, a sample size of 200 was adequate. Considerably larger sample sizes were required to detect nonuniform DIF, when there were extreme floor effects or when a reduced type I error rate was required."
N. Scott, P. Fayers, N. Aaronson, A. Bottomley, A. de Graeff, M. Groenvold, C. Gundy, M. Koller, M. Petersen, M. Sprangers. (2009). A simulation study provided sample size guidance for differential item functioning (DIF) studies using short scales. Journal of Clinical Epidemiology, Volume 62, Issue 3, Pages 288-295. www.jclinepi.com/article/S0895-4356%2808%2900158-3/abstract

This suggests that for dichotomous items, the sample size of each group needs to be around 1,000.

If we want to compare reasonably robust item difficulties for each sub-group in a somewhat informal way, then 30 per group-classification: www.rasch.org/rmt/rmt74m.htm

What if your sample size is smaller? This is not unusual in many content areas, such as medical research into rare diagnoses, but the findings are always statistically tentative. In fact, DIF findings, even with large samples, are notoriously difficult to replicate. Small sample sizes put your work in the category of "pilot test" rather than "large-scale field testing". However, even so, pilot tests are intended to indicate problematic areas before huge resources are expended on them, and items with DIF are a conspicuous problem area.

So my recommendation would be to abandon statistical tests and focus instead on the size of the DIF effects. If there are large effects, even if they could have happened by chance, the sizes of the effects indicate that actions or precautions should be taken when using the assessment. It is the same as driving a car and hearing a strange sound. The sound could be caused by chance, such as a stone from the road, but it could also indicate the start of a major problem. After hearing a strange sound, we are all extra vigilant and may even stop to inspect the car. What DIF size is enough for caution? This depends on your latent variable. How big a movement along your latent variable is important? For many educational variables, one logit = one year, so anything above 0.5 logits is a big jump (= 6 months growth).
The ETS guidelines suggest 0.64 logits, see, for instance, the Zwick table in https://www.rasch.org/rmt/rmt32a.htm

Computation
Winsteps anchors the person estimates at their values from the main analysis. The item difficulties are unanchored. The item difficulties for each DIF group are estimated. So this would be an "anchor person method" or the IRT folks would say an "anchor theta method"

The method (called AMLE or MLE) is shown at www.rasch.org/rmt/rmt102t.htm - but scores are summarized by groups, not individuals. So, according to 6) on that webpage:
Logit DIF Size for group = (observed score for group - expected score for group from main analysis) /(error variance for group)

Winsteps also reports Mantel-Haenszel statistics. The MH method is based on stratifying by person raw scores (or by person estimates when there are missing data). This is equivalent to anchoring the person estimates, so MH is also an "anchor theta method".

The DIF (differential item functioning) or DPF (differential person functioning) analysis proceeds with all items and persons, except the item or person currently targeted, anchored at the measures from the main analysis (estimated from all persons and items, including the currently targeted ones). The item or person measure for the current classification is then computed, along with its S.E. Mathematically, it is unlikely that no bias effects will be observed, or that bias sizes will cancel out exactly. The DIF contrast in Table 30 and 31 is the difference between the DIF sizes, and is a log-odds estimate, equivalent to a Mantel-Haenszel DIF size. The t is the DIF contrast divided by the joint S.E. of the two DIF measures. It is equivalent to the Mantel-Haenszel significance test, but has the advantage of allowing missing data. This analysis is the same for all item types supported by Winsteps (dichotomies, rating (or partial credit) scales, etc.).

To replicate this with Winsteps yourself:

From a run of all the data, produce a PFILE=pf.txt and a SFILE=sf.txt

Then for each person classification of interest:
PAFILE=pf.txt
SAFILE=sf.txt
PSELECT=?????X ; to select only the person classification of interest
IFILE = X.txt ; item difficulties for person classification on interest
CONVERGE=L ; only logit change is used for convergence
LCONV=0.005 ; logit change too small to appear on any report.

Do this for each class.
The IFILE= values should match the values shown in Table 30.2
To graph the ICCs for different non-uniform DIF for different classification groups on the same plot, see DIF item characteristic curves.

Classification sizes
There is no minimum size, but the smaller the classification size (also called reference groups and focal groups), the less sensitive the DIF test is statistically. Generally, results produced by classifications sizes of less than 30 are too much influenced by idiosyncratic behavior to be considered dependable.

Do DIF effects sum to zero?
If the DIF person-classification groups have the same average ability and roughly the same size (see Table 28 - PSUBTOTAL=), then the DIF effects will sum to near 0.0. But if the DIF groups differ in average ability or differ in size, then the DIF terms will not cancel out. This is because the baseline measure is the average of the observed performances.

Example: There are 10 boys and 1000 girls. The baseline measure will be close to the girls' DIF measure. The boys' DIF measure can be considerably different.

Effect of imprecision in person or item estimates
This computation treats the person measures (for DIF) or the item measures (for DPF) as point estimates (i.e., exact). You can inflate the reported standard errors to allow for the imprecision in those measures. Formula 29 of Wright and Panchapakesan (1969), www.rasch.org/memo46.htm, applies. You will see there that, for dichotomies, the most by which imprecision in the baseline measures can inflate the variance is 25%. So, if you multiply the DIF/DPF point estimate S.E. by sqrt(1.25) = 1.12 (and divide the t by 1.12), then you will be as conservative as possible in computing the DIF/DPF significance.

Impact on Person/Item Measurement
Unless DIF/DPF is large and mostly in one direction, the impact of DIF/DPF on person/item measurement is generally small. Wright & Douglas (1976) Rasch Item Analysis by Hand. "In other work we have found that when [test length] is greater than 20, random values of [item calibration mis estimation] as high as 0.50 have negligible effects on measurement."

Wright & Douglas (1975) Best Test Design and Self-Tailored Testing. "They allow the test designer to incur item discrepancies, that is item calibration errors, as large as 1.0. This may appear unnecessarily generous, since it permits use of an item of difficulty 2.0, say, when the design calls for 1.0, but it is offered as an upper limit because we found a large area of the test design domain to be exceptionally robust with respect to independent item discrepancies."

If DIF is large, then splitting the DIF item may be productive.

DIF/DPF statistical significance
Table 30.1 shows pair-wise test of the statistical significance of DIF across classes. Table 30.2 shows statistical significance of DIF for a class against the average difficulty. A statistical test for DIF for multiple classes on one item is a "fixed effects" chi-square of homogeneity. For L measures, Di, with standard errors SEi, a test of the hypothesis that all L measures are statistically equivalent to one common "fixed effect" apart from measurement error is a chi-square statistics with L-1 d.f. where p>.05 (or >.01) indicates statistically equivalent estimates.

$$\chi^2 = \sum_{i=1}^{L} \frac{D_i^2}{SE_i^2} - \left(\left(\sum_{i=1}^{L} \frac{D_i}{SE_i^2} \right)^2 / \sum_{i=1}^{L} \frac{1}{SE_i^2} \right)$$

Non-Uniform DIF or DPF
To investigate this with the Winsteps, include in the item or person label a stratification variable, indicating, low, middle or high performers (or item difficulties). Use this is the classification variable for DIF= or DPF=. Also view the Graphs menu, Non-uniform DIF.

DIF and Extreme Scores
DIF: For non-extreme-score items, extreme-score persons are excluded.
For extreme-score items, everyone is included, but no DIF is computed:

```
 ---------------------------------------------------------------------------------------------------
| KID       OBSERVATIONS    BASELINE       DIF      DIF      DIF   DIF  DIF        TAP             |
| CLASS    COUNT AVERAGE EXPECT MEASURE   SCORE MEASURE   SIZE  S.E.   t   Prob. Number  Name      |
|--------------------------------------------------------------------------------------------------|
```

Item 1 is extreme (everyone succeeded on it). All persons are included in the DIF report

```
| M           17    1.00   1.00   -6.52     .00   -6.52     .00   .00   .00 1.000      1 1-4         |
```

Item 4 is not extreme. Extreme persons (one) is excluded:

```
| M           16    1.00    .96   -4.38     .04   -4.85>  -.47  1.57  -.30 .7695      4 1-3-4       |
```

DPF: For non-extreme-score persons, extreme-score items are excluded.
For extreme-score persons, every items is included, but no DPF is computed:

The Mathematics of Winsteps DIF and DPF Estimation

A first approximation is:
size of interaction (in logits) = (sum of observational residuals) / (sum of model observational variances)
For each observation, its residual and its model variance are reported in the XFILE=

The DIF and DPF are estimated as minor effects in a logit-linear procedure. The major effects are the person abilities, item difficulties, and rating scale structures. The approach in Winsteps parallels the use of logit models in Mellenbergh, G. J. (1982). Contingency table models for assessing item bias. Journal of Educational Statistics, 7, 105-107; Van Der Flier, H., Mellenbergh, G. J., Adèr, H. J. & Wijn, M. (1984). An iterative item bias detection method. Journal of Educational Measurement, 21, 131-145; Kok, F. G., Mellenbergh, G. J. & Van Der Flier, H. (1985). Detecting experimentally induced item bias using the iterative logit method. Journal of Educational Measurement, 22, 295-303.

Algebraically, the general model is in two stages:

Stage 1: Log (Pnij / Pni(j-1)) = Bn - Dgi - Fgj

Where Bn is the ability of person n, Dgi is the difficulty of person i in classification g, Fgj is the Rasch-Andrich threshold measure of category j relative to category j-1 for items in item-grouping g.

For the Rasch dichotomous model, all items are in the same item-grouping (so that g is omitted), and there are only two categories, with F1=0.

For the Andrich rating-scale model, all items are in the same item-grouping (so that g is omitted), and there are more than two categories, with sum(Fj)=0.

For the Masters' partial-credit model, each item is in its own item-grouping (g=i), and there are more than two categories, with sum(Fij)=0. To re-parameterize into the conventional partial-credit model formulation, Di + Fij = Dij.

Estimates of Bn, Dgi and Fgj are obtained.

Stage 2: Table 30: For person-sub-sample (ps) DIF: Log (Pnij / Pni(j-1)) = Bn - Dgi - Fgj - DIF(ps)i
Table 31: For item-sub-sample (is) DPF: Log (Pnij / Pni(j-1)) = Dn - Dgi - Fgj + DPF(is)n
Table 33: For person-sub-sample item-sub-sample (ps)(is) DIPF: Log (Pnij / Pni(j-1)) = Bn - Dgi - Fgj + DIPF(ps)(is)

Estimates of bn, dgi and fgj anchored (fixed) from stage 1. The estimates of DIF, DPF or DIPF are the maximum likelihood estimates for which the marginal residuals for the sub-samples from the stage 1 analysis are the sufficient statistics. All these computations are as sample-distribution-free as is statistically possible, except when the sub-sampling is based on the sample-distribution (e.g., when persons are stratified into sub-samples according to their ability estimates.)

Different forms of DIF detection

The "comparison of item locations with two separate analyses" is what I call "Differential Test Functioning" (DTF). For instance, if the high-performers are more careful in the way they respond to the items than the low performers, then the test will have higher Test Discrimination for the high-performers than the low performers. The spread of the item difficulties for the high performers will be wider than for the low performers. If the mean item difficulty is the same in both analyses, then the highest and lowest difficulty items are most likely to be reported as significantly different. DTF is illustrated at www.rasch.org/rmt/rmt163g.htm

In Winsteps, DIF investigates each item by itself (like Mantel-Haenszel, MH). In MH, the person raw-scores are held constant. In Winsteps, the Rasch ability estimates from the analysis of all the data are held constant (also Andrich Thresholds). The abilities provide the common logit measurement scale. The assumption in this method is that performance on all the items with all the data is the best item-independent indicator of each person's ability measure. The difficulty of each item is then estimated for each group on that common "ability" scale. Advantages for a Rasch approach to DTF or DIF are that the Rasch approach allows for missing data and high-low ability group-splits, but MH does not. Of course, MH has the authority of ETS and that is decisive in legal situations.

DTF: a cross-plot of item difficulties derived from independent runs of the focal and reference classifying-groups, is basically reporting "Is the instrument working differently for the two sample classifications?", and, if so, "Where are the most conspicuous differences?" In the old days, when much analysis was done by hand, this would identify which items to choose for more explicitly constructed DIF tests, such as Mantel-Haenszel. From these plots we can get approximate DIF t-tests. This approach is obviously useful - maybe more useful than the item-by-item DIF tests. But it allows DIF in an item to change the person measures, and to alter the difficulties of other items and to change the rating (or partial credit) scale structure. To apply this "Differential Test Functioning" approach to DIF detection, perform independent analyses of each sample class, produce IFILE= and cross-plot the measures using the Compare Statistics plot.

But, it is the item-by-item DIF tests that have traditional support. So, for these, we need to hold everything else constant while we examine the DIF of each item. This is what Mantel-Haenszel does (using person raw scores), or the Winsteps DIF Table does (using person measures).

The Winsteps DIF table is equivalent to constructing a "ruler" based on the persons, and measuring the items on it, first for one person-group, then for the other person-group. The equivalent procedure is:
(a) The joint run of all person-group classifications, producing anchor values for person abilities and rating (or partial credit) scale structure.
(b) The classification A run with person abilities and rating (or partial credit) scale structure anchored at their joint values to produce person-group classification A item difficulties.
(c) The classification B run with person abilities and rating (or partial credit) scale structure anchored at their joint values to produce person-group classification B item difficulties.
(d) Pairwise item difficulty difference t-tests between the two sets of item difficulties (for person-group classifications A and B).

Lord's Chi-square DIF method takes a different approach, automatically looking for a core of stable items, but it is accident-prone and appears to over-detect DIF. In particular, if items were slightly biased, 50% against boys and 50% against girls, it would be accidental which set of items would be reported as "unbiased" and which as "biased".

Mantel-Haenszel method. See Mantel and Mantel-Haenszel DIF statistics

ANOVA method. This can be facilitated by Winsteps.

Hagquist and Andrich (2017) hqlo.biomedcentral.com/articles/10.1186/s12955-017-0755-0
Pietryka and Macintosh (2024) pie-try-ka.com/dif-in-r#estimate-anovas-to-evaluate-differential-item-functioning-dif
(1) Identify the relevant demographic variable in the person label, and set ITEM1= at the variable, and NAMLEN=1.
(2) Perform a standard Winsteps analysis
(3) Use USCALE=, UMEAN= and UDECIM= to transform the person measures into convenient "class intervals": integers with lowest value 1, and highest value 10 for 10 class intervals (or a different number of intervals, as you prefer).
(4) Write out an XFILE= selecting only:
 person measure (class interval)
 standardized residual
 person label (demographic variable)
(5) Read this file into your statistics software.
(6) Transform the demographic variable into values such as 1 and 2 (whatever is most convenient for your statistical software)
(7) Perform the "fully randomized" ANOVA with standardized residual as the dependent variable, and person measure and person label as the independent variables.

Two-Stage or Multiple-Stage DIF
Zenisky, A. L., Hambleton, R. K., & Robin, F. (2003). Detection of differential item functioning in large-scale state assessments: A study evaluating a two-stage approach. Educational and Psychological Measurement, 63, 51-64.
Stage 1: perform a standard DIF analysis Winsteps Table 30.
Stage 2: for items identified with DIF in Stage 1, say items 8, 10 ,14, give them a weight of zero using IWEIGHT=,
IWEIGHT=*
8 0
10 0
14 0
*
reanalyze the data and produce Winsteps Table 30.
This will show the DIF for all items (include 8, 10, 14) but using the purified scoring.

Resolving DIF

There are several tactics when DIF is discovered.

1. Ignore it as inherent in the measurement system. For instance, in a test of English as a Second Language, different items will exhibit DIF for speakers of different native languages, depending on the relationship of those languages to English. When constructing such tests, content experts should try to balance the DIF across the major groups, but this can never be done perfectly.

2. Remove the item (perhaps rewriting it). This is when the DIF is seen to be a confounding factor which overwhelms the intention of the item. For instance, a mathematics word problem which uses a technical cooking or car-mechanics term better known to girls or boys. IDELETE=

3. Treat the data for one DIF group as missing data. For instance, if a generally good item is misunderstood by speakers of a specific dialect of English, then make the item missing data for them. IPRFILE=

4. Split the item. Make the item two items, each with active data for one group and missing data for the other group. This maintains the same raw scores, but produces different measures for each group. FORMAT= and IPRFILE=

The decision about which approach to use is often driven by political and legal considerations. So the literature either focuses on the mathematics of DIF remedies or contains case studies of the resolution of DIF under specific conditions.

Most important in resolving DIF is that we can communicate our DIF-resolution process simply, clearly and precisely to our audience. This will remove any feeling of unfairness or bias. "Mathe-magical" approaches to DIF resolution may make some in the audience wonder whether something underhanded is being perpetrated upon them.

21.33 DIF for two person groups

You have two person-groups in your DIF analysis. For your two groups on item 1.

Table 30.1

PERSON CLASS	DIF MEASURE	DIF S.E.	PERSON CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	Rasch-Welch t	d.f.	Prob.	MantelHanzl Prob.	Size	ITEM Number
1	-.47	.16	2	-1.57	.51	1.10	.53	2.07	62	.0422	.1986	+.	1

The DIF measure (item difficulty on the latent variable) for Person group 1 on item 1 is -.47 logits
The DIF measure (item difficulty on the latent variable) for Person group 2 on item 1 is -1.57 logits

DIF Contrast = difference between item difficulties for the two groups = -.47 - - 1.57 = 1.10 logits

Table 14.1

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%
1	394	83	-.76	.16	1.07	.3	.77	-.3	.27	.24	81.9	82.1

The baseline difficulty (from Table 14.1) is -0.76 logits.

Table 30.2

PERSON CLASS	OBSERVATIONS COUNT	OBSERVATIONS AVERAGE	BASELINE EXPECT	BASELINE MEASURE	DIF SCORE	DIF MEASURE	DIF SIZE	DIF S.E.	DIF t	Prob.	ITEM Number
1	42	4.57	4.77	-.76	-.19	-.47	.29	.16	1.83	.0751	1
2	41	4.93	4.73	-.76	.20	-1.57	-.81	.51	-1.61	.1158	1

DIF Size = DIF Measure - baseline difficulty

The DIF Size (relative to the baseline item difficulty) for Person group 1 on item 1 is .29 logits = -.47 - - .76
The DIF measure (relative to the baseline item difficulty) for Person group 2 on item 1 is -.81 logits =-1.57 - -.76

DIF Contrast = difference between item difficulties for the two groups =.29 - -.81 = 1.10 logits (same as above) = paired DIF effect for the two groups.

It is easiest to look at the DIF Size plot. The difference between the two lines is the DIF Contrast.
You can plot the difference from the Worksheet column D - column E.

21.34 Dimensionality

See Multidimensionality

21.35 Dimensionality and Structural Validity investigation - an example

"**Structural Validity** is defined as the degree to which the scores of the measurement instrument are an adequate reflection of the dimensionality of the construct being measured." *De Vet HCW , Terwee CB, Mokkink LB, Knol DL. Measurement in Medicine. Cambridge, United Kingdom: Cambridge University Press; 2011.*

Michael Commons asked: "What in Winsteps tells how unidimensional a fit is?"

The Rasch measures estimated by unidimensional Rasch models are forced to be unidimensional. Off-dimensional aspects of the data are in the part of the data not explained by the Rasch measures, i.e., the Rasch residuals. The Rasch residuals decompose into (a) the randomness predicted by the Rasch model, and (b) components on dimensions other than the unidimensional Rasch variable, (c) off-dimensional noise, such as random guessing.

In empirical data, (a) and (c) usually dominate (b), so that item-level or person-level fit statistics tend to be insensitive to multidimensionality, as R.P. McDonald (1985) reports. Accordingly we must focus on techniques that quantify (b), such as PCA of residuals. If the eigenvalues reported by PCA approximate the size predicted by the Rasch model, then the data are effectively unidimensional. Otherwise, the bigger the eigenvalues, the less unidimensional are the data.

Roderick P. McDonald, Factor Analysis and related methods. Hillsdale, NJ: Lawrence. Erlbaum Associates, 1985.

Multidimensionality is complicated, because it depends on the purpose of the instrument.

Here is a multidimensional instrument. It has 5 items: 1 geography item. 1 history item. 1 cooking item. 1 carpentry item. 1 arithmetic item.
This instrument is multidimensional, but none of its dimensions is big enough to make a unidimensional instrument. We cannot split this multidimensional instrument into unidimensional instruments, but that does not make the instrument unidimensional. However, we may decide that this instrument is measuring a general "education" variable, and declare that this instrument is **unidimensional for our purposes.**

For instance, an arithmetic test (addition, subtraction, multiplication, division) is unidimensional from the perspective of school administrators deciding whether a child should advance to the next grade-level, but the same test is multidimensional from the perspective of the school psychologist diagnosing learning difficulties. For instance, learning difficulties with subtraction in young children may indicate social maladjustment.

Also

Here is an example. We can proceed as follows:

a. Compare the Raw Variance explained by items (19.8%) with the Unexplained variance in 1st contrast (7.1%). Is this ratio big enough to be a concern? In your analysis, the Rasch dimension dominates (almost 3 times the secondary dimension), but the secondary dimension is noticeable.

b. Is the secondary dimension bigger than chance? Eigenvalue = 2.8. This is the strength of 3 items. We do not expect a value of more than 2 items by chance. www.rasch.org/rmt/rmt191h.htm - and we would also need at least 2 items to think of the situation as a "dimension" and not merely an idiosyncratic item.

c. Does the secondary dimension have substance? Looking at your plot, we can see that items ABCDE are separated vertically (the important direction) from the other items. They are the core of the secondary dimension. 5 items are enough items that we could split them into a separate instrument (exactly as we could with "subtraction" on an arithmetic test).
Is this secondary dimension important enough, and different enough, that we would consider reporting two measures (one for ABCDE and one for the other items) rather than one measure for all items combined? The content of ABCDE appears to be psycho-social (e.g., one item includes the word "anxious" in this example). The other items are more physical (e.g., one item includes the word "walking" in this example). Consider the purpose of the instrument. Is "anxious" important or not? Is it part of the central purpose for the instrument? Would the instrument be improved or degraded (from a usefulness perspective) if items ABCDE were omitted? Would the instrument be improved or degraded (from a usefulness perspective) if a separate measure was reported for items like ABCDE?

d. Rasch-analyze the sample on the ABCDE items and then on the other items. Cross-plot the person measures.
Look at the correlation of the two sets of person measures (and the correlation disattenuated for measurement error). Is the correlation noticeably low? In this example, the disattenuated correlation was 0.82, indicating that the dimensions share explains about 67% of the person measure variance.
We expect most people to lie along a statistical diagonal. Who is off-diagonal? (Perhaps the people with social problems.) Are they important enough to merit a separate measurement system? For instance, on an English-language test, native-speakers of English, and second-language speakers usually have different profiles. Native speakers speak relatively better. Second-language speaker may spell relatively better. But two measures of English-language-proficiency are rarely reported.

If you decide that the secondary dimension is important enough to merit two measures, or the secondary dimension is off-dimension enough to merit omitting its items, then the instrument is multidimensional (in practice). If not, then the instrument is unidimensional (in practice), no matter what the statistics say.

Tentative guidelines based on the % of the sample are sampling dependent. If you are planning to apply a criterion such as "5% of the sample", then verify that your sample matches the intended target population of the instrument. In general, 5% seems very low. Would we institute a special measurement system for 1 child in a classroom of 20 children? Unlikely? We would probably need at least 4 children = 20% before we would consider reporting (and acting on) two measures.

In the USA, African-Americans comprise 13% of the population, and there is a debate about whether or not they should have special measurement systems. In some situations they do. And, similarly, whether there should be special provision for Spanish-speakers (15% of the USA population). In some situations there are. These percentages suggest that a threshold of about "10% of the sample" may be reasonable for separate measurement procedures.

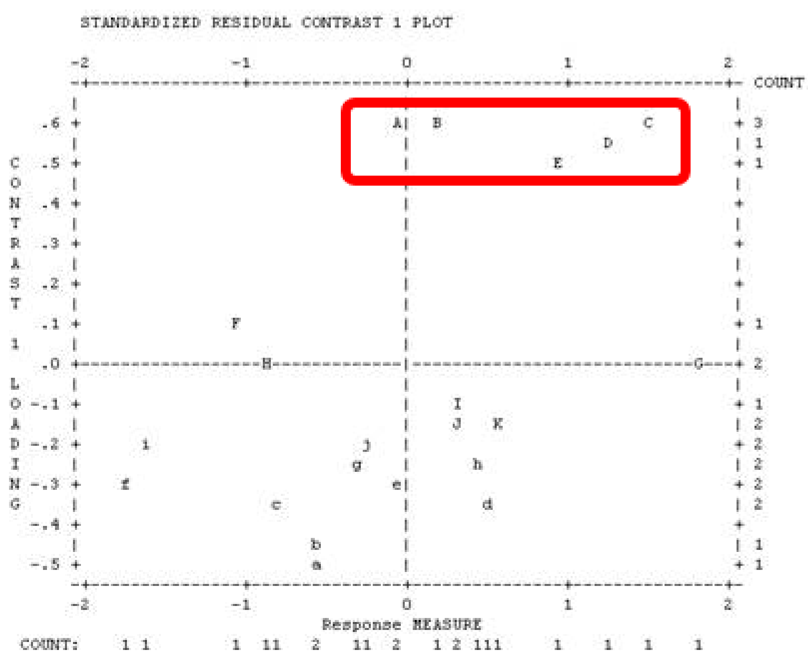
My conclusion about this instrument (knowing nothing about its practical purpose) would be that the instrument is multidimensional and that items ABCDE should be omitted (or rewritten or replaced to emphasize their physical rather than their psychological aspects).

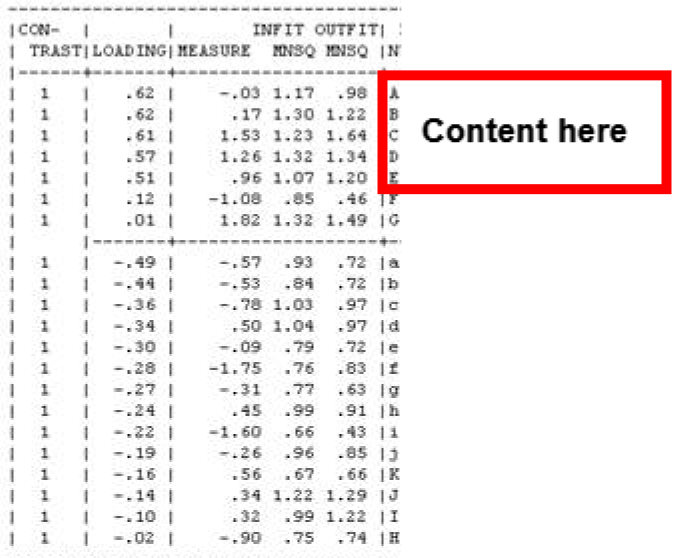
"Unidimensionality" is a choice based on the circumstances, so, if you are writing a paper, then please include a discussion of why (or why not) you decided that the instrument is multidimensional. This would be helpful to other researchers.

Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)

		-- Observed --			Expected
Total raw variance in observations	=	39.8	100.0%		100.0%
Raw variance explained by measures	=	18.8	47.2%		48.0%
Raw variance explained by persons	=	10.9	27.4%		27.8%
Raw Variance explained by items	=	7.9	19.8%		20.1%
Raw unexplained variance (total)	=	21.0	52.8%	100.0%	52.0%
Unexplned variance in 1st contrast	=	2.8	7.1%	13.5%	
Unexplned variance in 2nd contrast	=	2.6	6.5%	12.3%	
Unexplned variance in 3rd contrast	=	2.1	5.4%	10.2%	
Unexplned variance in 4th contrast	=	1.7	4.4%	8.3%	
Unexplned variance in 5th contrast	=	1.6	4.0%	7.6%	

1st contrast:





CON-TRAST	LOADING	MEASURE	INFIT MNSQ	OUTFIT MNSQ	N
1	.62	-.03	1.17	.98	A
1	.62	.17	1.30	1.22	B
1	.61	1.53	1.23	1.64	C
1	.57	1.26	1.32	1.34	D
1	.51	.96	1.07	1.20	E
1	.12	-1.08	.85	.46	F
1	.01	1.82	1.32	1.49	G
1	-.49	-.57	.93	.72	a
1	-.44	-.53	.84	.72	b
1	-.36	-.78	1.03	.97	c
1	-.34	.50	1.04	.97	d
1	-.30	-.09	.79	.72	e
1	-.28	-1.75	.76	.83	f
1	-.27	-.31	.77	.63	g
1	-.24	.45	.99	.91	h
1	-.22	-1.60	.66	.43	i
1	-.19	-.26	.96	.85	j
1	-.16	.56	.67	.66	K
1	-.14	.34	1.22	1.29	J
1	-.10	.32	.99	1.22	I
1	-.02	-.90	.75	.74	H

Question: My instrument has 200 items and my First Contrast has an eigenvalue of 9.2. Could this be explained by the large number of items analyzed?

Answer: Yes, the more items there are, then the more likely that a random cluster of items are inter-correlated by accident.

So, the first step with the potentially 9 or so items in a secondary dimension is to look at the plot in Winsteps Table 23.1. Is there a cluster of items at the top or bottom of the plot that share a content area that differs noticeably from the other items?

If so, this could be a secondary dimension. So, the next thing is to look at the table of correlations in Table 23.0. This reports the correlations of the person measures on the different clusters of items identified in the first contrast. Is the disattenuated correlation between the person measures on the suspect cluster of items and the person measures on the other items low or negative?

If so, the suspect cluster of items is measuring something different. It is a different dimension. When items on this secondary dimension are included with the items on the dominant dimension, then responses to the secondary items look like random noise from the viewpoint of the dominant dimension.

If not, the suspect cluster of items is probably a secondary strand in the content area, similar to "word problems" on an arithmetic test. Performance profiles of the person across strands will not be even, but will also not be contradictory.

The "variance explained" can be somewhat misleading because it is dominated by the variance of the item difficulties and the variance of the person abilities. We may be contrasting a wide range of abilities and/or difficulties on the dominant dimension against a narrow range of abilities and/or difficulties on the secondary dimension.

21.36 Dimensionality: PCAR contrasts & variances

Please explain Rasch PCA of Residuals in plain English for people like me who are not particularly good at mathematical terminology.

Rasch "PCA of residuals" looks for patterns in the part of the data that does not accord with the Rasch measures. This is the "unexpected" part of the data. We are looking to see if groups of items share the same patterns of unexpectedness. If they do, then those items probably also share a substantive attribute in common, which we call a "secondary dimension". Then our questions are:

1. "What is the secondary dimension?" - to discover this we look at the contrast between the content of the items at the top, A,B,C, and the bottom, a,b,c, of the contrast plot in Table 23.2. For instance, if the items at the top are "physical" items and the items at the bottom are "mental" items. Then there is a secondary dimension with "physical" at one end, and "mental" at the other.

2. "Is the secondary dimension big enough to distort measurement?" - usually the secondary dimension needs to have the strength of at least two items to be above the noise level. We see the strength (eigenvalue) in the first column of numbers in Table 23.0.

3. "What do we do about it?" - often our decision is "nothing". On a math test, we will get a big contrast between "algebra" and "word problems". We know that they are conceptually different, but they are both part of math. We don't want to omit either of them, and we don't want separate "algebra" measures and "word problem" measures. So the best we can do is to verify that the balance between the number of algebra items and the number of word-problem items is in accordance with our test plan.

But we may see that one end of the contrast is off-dimension. For instance, we may see a contrast between "algebra items using Latin letters" and "algebra items using Greek letters". We may decide that knowledge of Greek letters is incidental to our purpose of measuring the understanding of algebraic operations, and so we may decide to omit or revise the Greek-letter items.

In summary: Look at the content (wording) of the items at the top and bottom of the contrast: items A,B,C and items a,b,c. If those items are different enough to be considered different dimensions (similar to "height" and "weight"), then split the items into separate analyses. If the items are part of the same dimension (similar to "addition" and "subtraction" on an arithmetic test), then no action is necessary. You are seeing the expected co-variance of items in the same content area of a dimension.

For more discussion see Dimensionality: when is a test multidimensional?

For technical details:
For residuals, see www.rasch.org/rmt/rmt34e.htm
For PCA, builtin.com/data-science/step-step-explanation-principal-component-analysis and many other websites
For the "Variance explained by ...", see www.rasch.org/rmt/rmt173g.htm

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Principal-Components Analysis of Residuals is not interpreted in the same way as Common-Factor Analysis of the original data.

In Common-Factor analysis, we try to optimize the commonalities, maximization, rotation and obliqueness to give the strongest possible factor structure, where the unstandardized "raw" factor loadings are interpreted as the correlations with the latent factors.

In PCA of residuals, we are trying to falsify the hypothesis that the residuals are random noise by finding the component that explains the largest possible amount of variance in the residuals. This is the "first contrast" (or first PCA component in the correlation matrix of the residuals). If the eigenvalue of the first contrast is small (usually less than 2.0) then the first contrast is at the noise level and the hypothesis of random noise is not falsified in a general way. If not, the loadings on the first contrast indicate that there are contrasting patterns in the residuals. The absolute sizes of the loadings are generally inconsequential. It is the patterns of the loadings that are important. We see the patterns by looking at the plot of the loadings in Winsteps Table 23.2, particularly comparing the top and bottom of the plot.

So, if we notice that the 1st contrast has an eigenvalue of 3 (the strength of 3 items), and we see on the contrast plot that there is a group of 3 items (more or less) outlying toward the top or the bottom of the plot, then we attribute the first contrast to the fact that their pattern contrasts with the pattern of the other items. We then look at the content of those items to discover what those items share that contrasts with the content of the other items.

Please do not interpret Rasch-residual-based Principal Components Analysis (PCAR) as a usual factor analysis. These components show contrasts between opposing factors, not loadings on one factor. Criteria have yet to be established for when a deviation becomes a dimension. So PCA is indicative, but not definitive, about secondary dimensions.

In conventional factor analysis, interpretation may be based only on positive loadings. In the PCA of Residuals, interpretation must be based on the contrast between positive and negative loadings.

The "first factor" (in the traditional Factor Analysis sense) is the Rasch dimension. By default all items (or persons) are in the "first factor" until proven otherwise. The first contrast plot shows a contrast within the data between two sets of items orthogonal to the Rasch dimension. We usually look at the plot and identify a cluster of items at the top or bottom of the plot which share most strongly some substantive off-Rasch-dimension attribute. These become the "second factor".

Winsteps is doing a PCA of residuals, not of the original observations. So, the first component (dimension) has already been removed. We are looking at secondary dimensions, components or contrasts. When interpreting the meaning of a component or a factor, the conventional approach is only to look at the largest positive loadings in order to infer the substantive meaning of the component. In Winsteps PCA this method of interpretation can be misleading, because the component is reflecting opposing response patterns across items by persons. So we need to identify the opposing response patterns and interpret the meaning of the component from those. These are the response patterns to the items at the top and bottom of the plots.

Sample size: A useful criterion is 100 persons for PCA of items, and 100 items for PCA of persons, though useful findings can be obtained with 20 persons for PCA of items, and 20 items for PCA of persons.

> Arrindell, W. A., & van der Ende. J. (1985). An empirical test of the utility of the observations-to-variables ratio in factor and components analysis. Applied Psychological Measurement, 9, 165 - 178.

Compatibility with earlier computation: The Winsteps algorithm was changed to align more closely with the usual practice in statistics of explaining raw-score variance (parallel to Outfit). The earlier method in Winsteps was explaining the statistical-information variance (parallel to Infit). Since the outlying observations have high raw-score variance, but low statistical-information variance, the previous computation showed Rasch explaining a higher proportion of the variance.

If you want to do a more conventional interpretation, then output the ICORFIL= correlation matrix from the Output Files menu. You can read this into a factor analysis program, such as SAS or SPSS. You can then do a PCA or CFA (common factor analysis) of the correlation matrix, with the usual obliquenesses, rotations etc.

In Winsteps, you can also do a PCA of the original observations by specifying PRCOMP=Obs

Example from Table 23.0 from Example0.txt:

```
     Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)
                                                -- Observed --    Expected
Total raw variance in observations     =        51.0 100.0%         100.0%
  Raw variance explained by measures   =        26.0  51.0%          50.8%
    Raw variance explained by persons  =        10.8  21.2%          21.2%
    Raw Variance explained by items    =        15.1  29.7%          29.6%
  Raw unexplained variance (total)     =        25.0  49.0% 100.0%   49.2%
    Unexplned variance in 1st contrast =         4.6   9.1%  18.5%
    Unexplned variance in 2nd contrast =         2.9   5.8%  11.8%
    Unexplned variance in 3rd contrast =         2.3   4.5%   9.2%
    Unexplned variance in 4th contrast =         1.7   3.4%   6.9%
    Unexplned variance in 5th contrast =         1.6   3.2%   6.5%
```

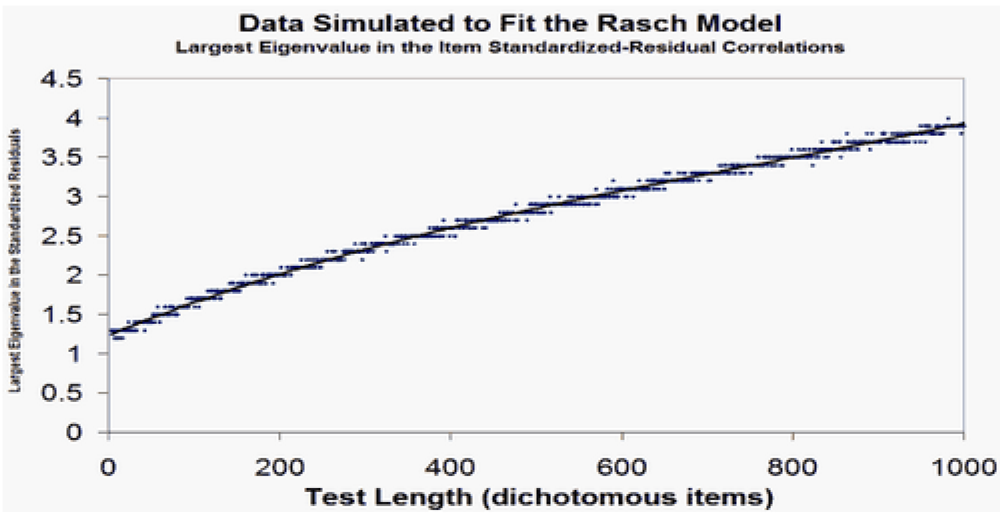
The Rasch dimension explains 51.0% of the variance in the data: good! The largest secondary dimension, "the first contrast in the residuals" explains 9.1% of the variance - somewhat greater than around 4% that would be observed in data like these simulated to fit the Rasch model. Check this by using the SIMUL= option in Winsteps to simulate a Rasch-fitting dataset with same characteristics as this dataset. Then produce this Table 23 for it. Also see: www.rasch.org/rmt/rmt191h.htm

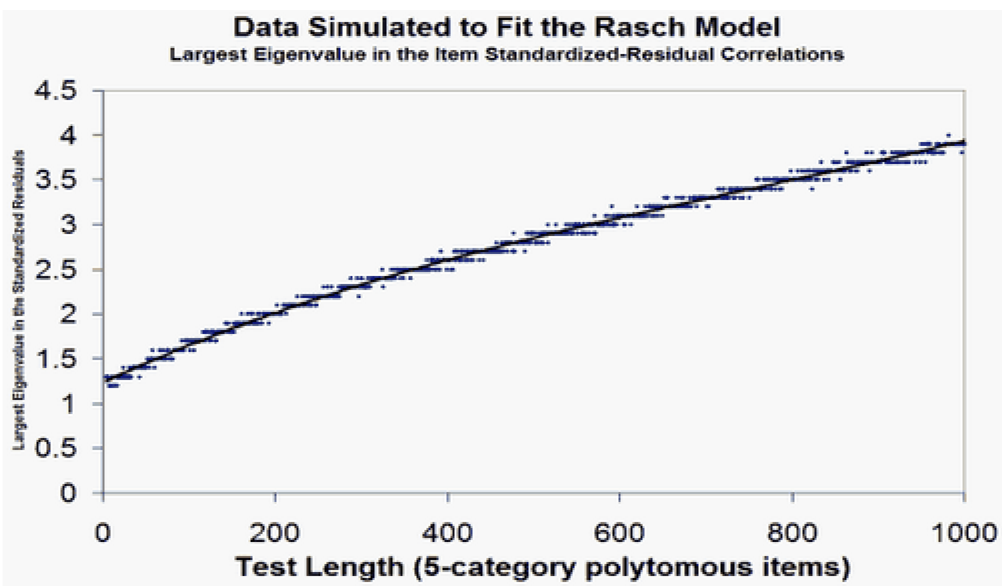
In these data, the variance explained by the items, 29.7% is only three times the variance explained by the first contrast 9.1%, so there is a noticeable secondary dimension in the items. The eigenvalue of the first contrast is 4.6 - this indicates that it has the strength of about 5 items (4.6 rounded to 5, out of 25), somewhat bigger than the strength of two items (an eigenvalue of 2), the smallest amount that could be considered a "dimension". Contrast the content of the items at the top and bottom of the plot in Table 23.2 to identify what this secondary dimension reflects.

Tentative guidelines:
1. Is your person measure S.D. in Table 3 what you expect (or better)?
 Yes, then your "variance explained by persons"is also good.

2. 1. Is your item difficulty S.D. in Table 3 what you expect (or better)?
Yes, then your "variance explained by the items" is also good.

3. Is your unexplained variance explained by 1st contrast (eigenvalue size) < 2.0 ?
Yes, then your biggest secondary dimension has the strength of less than 2 items. Good. For the expected size of the unexplained variance:





4. Now, please simulate Rasch-fitting data like yours, and compare Table 23 and Table 24 with it.

There is a paradox: "more variance explained" ® "more unidimensional" in the Guttman sense - where all unexplained variance is viewed as degrading the perfect Guttman uni-dimension. But "more unidimensional" (in the stochastic Rasch sense) depends on the size of the second dimension in the data, not on the variance explained by the first (Rasch) dimension. This is because most unexplained variance is hypothesized to be the random noise predicted by the Rasch model, rather than a degradation of the unidimensionality of the Rasch measures

Analytical Note:
Winsteps performs an unrotated "principal components" factor analysis. (using Hotelling's terminology). If you would like to rotate axes, have oblique axes, or perform a "common factor" factor analysis of the residuals, Winsteps can write out the matrices of residual item (or person) correlations, see the "Output Files" pull down menu or ICORFIL= and PCORFIL=. You can import these into any statistics software package.

The purpose of PCA of residuals is not to construct variables (as it is with "common factor" analysis), but to explain variance. First off, we are looking for the contrast in the residuals that explains the most variance. If this contrast is at the "noise" level, then we have no shared second dimension. If it does, then this contrast is the "second" dimension in the data. (The Rasch dimension is hypothesized to be the first). Similarly we look for a third dimension, etc. Rotation, oblique axes, the "common factor" approach, all reapportion variance, usually in an attempt to make the factor structure more clearly align with the items, but, in so doing, the actual variance structure and dimensionality of the data is masked.

In Rasch analysis, we are trying to do the opposite of what is usually happening in factor analysis. In Rasch analysis of residuals, we want not to find contrasts, and, if we do, we want to find the least number of contrasts above the noise level, each, in turn, explaining as much variance as possible. This is exactly what unrotated PCA does.

In conventional factor analysis of observations, we are hoping desperately to find shared factors, and to assign the items to them as clearly and meaningfully as possible. In this endeavor, we use a whole toolbox of rotations, obliquenesses and choices of diagonal self-correlations (i.e., the "common factor" approach).

But, different analysts have different aims, and so Winsteps provides the matrix of residual correlations to enable the analyst to perform whatever factor analysis is desired!

The Rasch Model: Expected values, Model Variances, and Standardized Residuals
The Rasch model constructs additive measures from ordinal observations. It uses disordering of the observations across persons and items to construct the additive frame of reference. Perfectly ordered observations would accord with the ideal model of Louis Guttman, but lack information as to the distances involved.

Since the Rasch model uses disordering in the data to construct distances, it predicts that this disordering will have a particular ideal form. Of course, empirical data never exactly accord with this ideal, so a major focus of Rasch fit analysis is to discover where and in what ways the disordering departs from the ideal. If the departures have substantive implications, then they may indicate that the quality of the measures is compromised.

A typical Rasch model is:
log (Pnik / Pni(k-1)) = Bn - Di - Fk

where
Pnik = the probability that person n on item i is observed in category k, where k=0,m
Pni(k-1) = the probability that person n on item i is observed in category k-1
Bn = the ability measure of person n
Di = the difficulty measure of item i
Fk = the structure calibration from category k-1 to category k

This predicts the observation Xni. Then
Xni = Eni ± sqrt(Vni)

where
Eni = sum (kPnik) for k=0,m.
This is the expected value of the observation.
Vni = sum (k^2Pnik) - $(Eni)^2$ for k=0,m.
This is the model variance of the observation about its expectation, i.e., the predicted randomness in the data.

The Rasch model is based on the specification of "local independence". This asserts that, after the contribution of the measures to the data has been removed, all that will be left is random, normally distributed. noise. This implies that when a residual, (Xni - Eni), is divided by its model standard deviation, it will have the characteristics of being sampled from a unit normal distribution. That is:
(Xni - Eni) / sqrt (Vni), the standardized residual of an observation, is specified to be N(0,1)

The bias in a measure estimate due to the misfit in an observation approximates (Xni - Eni) * S.E.²(measure)

Principal Components Analysis of Residuals
"Principal Component Analysis (PCA) is a powerful technique for extracting structure from possibly high-dimensional data sets. It is readily performed by solving an eigenvalue problem, or by using iterative algorithms which estimate principal components [as in Winsteps]. ... some of the classical papers are due to Pearson (1901); Hotelling (1933); ... PCA is an orthogonal transformation of the coordinate system in which we describe our data. The new coordinate values by which we represent the data are called principal components. It is often the case that a small number of principal components is sufficient to account for most of the structure in the data. These are sometimes called factors or latent variables of the data." (Schölkopf, D., Smola A.J., Müller K.-R., 1999, Kernel Principal Component Analysis, in Schölkopf at al. "Advances in Kernel Methods", London: MIT Press).
Pearson, K. (1901) On lines and planes of closest fit to points in space. Philosophical Magazine, 2:559-572.
Hotelling, H. (1933) Analysis of a complex of statistical variables into principal components. Journal of Educational Psychology, 24:417-441, 498-520.

The standardized residuals are modeled to have unit normal distributions which are independent and so uncorrelated. A PCA of Rasch standardized residuals should look like a PCA of random normal deviates. Simulation studies indicate that the largest component would have an eigenvalue of about 1.4 and they get smaller from there. But there is usually something else going on in the data, so, since we are looking at residuals, each component contrasts deviations in one direction ("positive loading") against deviation in the other direction ("negative loading"). As always with factor analysis, positive and negative loading directions are arbitrary. Each component in the residuals only has substantive meaning when its two ends are contrasted. This is a little different from PCA of raw observations where the component is thought of as capturing the "thing".

Loadings are plotted against Rasch measures because deviation in the data from the Rasch model is often not uniform along the variable (which is actually the "first" dimension). It can be localized in easy or hard items, high or low ability people. The Wright and Masters "Liking for Science" data is an excellent example of this.

Total, Explained and Unexplained Variances
The decomposition of the total variance in the data set proceeds as follows for the standardized residual, PRCOMP=S and raw score residual PRCOMP=R, option.

(i) The average person ability measure, b, and the average item difficulty measure, d, are computed.

(ii) The expected response, Ebd, by a person of average ability measure to an item of average difficulty measure is computed. (If there are multiple rating or partial credit scales, then this is done for each rating or partial credit scale.)

(iii) Each observed interaction of person n, of estimated measure Bn, with item i, of estimated measure Di, produces an observation Xni, with an expected value, Eni, and model variance, Vni.
The raw-score residual, Zni, of each Xni is Zni = Xni-Eni.
The standardized residual, Zni, of each Xni is Zni = (Xni-Eni)/sqrt(Vni).

Empirically:
(iv) The piece of the observation available for explanation by Bn and Di is approximately Xni - Ebd.
In raw-score residual units, this is Cni = Xni-Ebd
In standardized residual units, this is Cni = (Xni-Ebd)/sqrt(Vni)
The total variance sum-of-squares in the data set available for explanation by the measures is: VAvailable = sum(Cni²)

(v) The total variance sum of squares predicted to be unexplained by the measures is: VUnexplained = sum(Zni²)

(vi) The total variance sum of squares explained by the measures is: VExplained = VAvailable - VUnexplained
If VEXplained is negative, see below.

Under model conditions:
(viii) The total variance sum of squares explained by the measures is:
Raw-score residuals: VMexplained = sum((Eni-Ebd)²)
Standardized residuals: VMexplained = sum((Eni-Ebd)²/Vni)

(ix) The total variance sum of squares predicted to be unexplained by the measures is:
Raw score residuals: VMunexplained = sum(Vni)

Standardized residuals: VMunexplained = sum(Vni/Vni) = sum(1)

x) total variance sum-of-squares in the data set predicted to be available for explanation by the measures is: VMAvailable = VMexplained + VMUnexplained

Negative Variance Explained

```
Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)
Total variance in observations =  20.3  100.0%
Variance explained by measures = -23.7 -116.2%
```

According to this Table, the variance explained by the measures is less than the theoretical minimum of 0.00. This "negative variance" arises when there is unmodeled covariance in the data. In Rasch situations this happens when the randomness in the data, though normally distributed when considered overall, is skewed when partitioned by measure difference. A likely explanation is that some items are reverse-coded. Check that all correlations are positive by viewing the Diagnosis Menu, Table A. If necessary, use IREFER= to recode items. If there is no obvious explanation, please email your control and data file to www.winsteps.com

Principal Components Analysis of Standardized Residuals
(i) The standardized residuals for all observations are computed. Missing observations are imputed to have a standardized residual of 0, i.e., to fit the model.

(ii) Correlation matrices of standardized residuals across items and across persons are computed. The correlations furthest from 0 (uncorrelated) are reported in Tables 23.99 and 24.99.

(iii) In order to test the specification that the standardized residuals are uncorrelated, it is asserted that all randomness in the data is shared across the items and persons. This is done by placing 1's in the main diagonal of the correlation matrix. This accords with the "Principal Components" approach to Factor Analysis. ("General" Factor Analysis attempts to estimate what proportion of the variance is shared across items and persons, and reduces the diagonal values from 1's accordingly. This approach contradicts our purpose here.)

(iv) The correlation matrices are decomposed. In principal, if there are L items (or N persons), and they are locally independent, then there are L item components (or N person components) each of size (i.e., eigenvalue) 1, the value in the main diagonal. But there are expected to be random fluctuations in the structure of the randomness. However, eigenvalues of less than 2 indicate that the implied substructure (dimension) in these data has less than the strength of 2 items (or 2 persons), and so, however powerful it may be diagnostically, it has little strength in these data.

(v) If items (or persons) do have commonalities beyond those predicted by the Rasch model, then these may appear as shared fluctuations in their residuals. These will inflate the correlations between those items (or persons) and result in components with eigenvalues greater than 1. The largest of these components is shown in Table 23.2 and 24.3, and sequentially smaller ones in later subtables.

(vi) In the Principal Components Analysis, the total variance is expressed as the sum of cells along the main diagonal, which is the number of items, L, (or number of persons, N). This corresponds to the total unexplained variance in the dataset, VUnexplained.

(vii) The variance explained by the current contrast is its eigenvalue.

Sample size: The more, the better .,...
"There are diminishing returns, but even at large subject to item ratios and sample sizes (such as 201 ratio or N > 1000) and with unrealistically strong factor loadings and clear factor structures, EFA and PCA can produce error rates up to 30%, leaving room for improvement via larger samples." Osborne, Jason W. & Anna B. Costello (2004). Sample size and subject to item ratio in principal components analysis. scholarworks.umass.edu/pare/vol9/iss1/11/

Example: Item Decomposition
From Table 23.2: The Principal Components decomposition of the standardized residuals for the items, correlated across persons. Winsteps reports:

```
Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)
                                                    Empirical    Modeled
```

```
Total variance in observations     =       1452.0  100.0%  100.0%
Variance explained by measures     =       1438.0   99.0%   98.6%
Unexplained variance (total)       =         14.0    1.0%    1.4%
Unexpl var explained by 1st contrast =        2.7     .2%
```

The first contrast has an eigenvalue size of 2.7 This corresponds to 2.7 items.
There are 14 active items, so that the total unexplained variance in the correlation matrix is 14 units.

The "Modeled" column shows what this would have looked like if these data fit the model exactly.

Conclusion: Though this contrast has the strength of 3 items, and so might be independently constructed from these data, its strength is so small that it is barely a ripple on the total measurement structure.

Caution: The 1st contrast may be an extra dimension, or it may be a local change in the intensity of this dimension:

```
Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)
                                                Empirical       Modeled
Total variance in observations       =       97.1 100.0%         100.0%
Variance explained by measures       =       58.1  59.8%          59.0%
Unexplained variance (total)         =       39.0  40.2% 100.0%   41.0%
Unexpl var explained by 1st contrast =        2.8   2.9%   7.2%

     -3         -2         -1          0          1          2          3
      ++----------+----------+----------+----------+----------+----------++ COUNT
      |                                 |       A                         | 1
   .7 +                                 |                                 +
      |                                 |  B           C                  | 2
F  .6 +                                 |                                 +
A     |                                 |      D                          | 1
C  .5 +                        E        |                                 + 1
T     |                                 |                                 |
O  .4 +                                 |                                 +
R     |                                 |                                 |
   .3 +                                 |                                 +
1     |                          F      |                                 | 1
   .2 +                                 |                                 +
L     |                                 |                             G   | 1
O  .1 +                       H         |                                 + 1
A     |                     L         I |      J  K                       | 4
D  .0 +----------M-----------------N----|-O-------------------------------+ 3
I     |                 T S      QR     |  P    s                         | 6
N -.1 +                     p          o|          q        r             + 4
G     |                                 |   l      m    n k               | 4
  -.2 +      i             g            |           jh                    + 4
      |  f                  c     e     |b               d                | 5
  -.3 +                                 |                                 +
      |                              a  |                                 | 1
      ++----------+----------+----------+----------+----------+----------++
     -3         -2         -1          0          1          2          3
                                Item MEASURE
```

```
+-----------------------------------------
|CON-  |  RAW  |        INFIT OUTFIT| ENTRY
| TRAST|LOADING|MEASURE  MNSQ MNSQ |NUMBER
|------+-------+-------------------+------
|  1   |   .74 |      .71  .78  .70 |A   26
|  1   |   .65 |      .26  .79  .68 |B   23
|  1   |   .64 |     1.34  .87  .84 |C   25
|  1   |   .56 |      .64  .85  .80 |D   24
|  1   |   .51 |     -.85  .84  .60 |E   22
```

The first contrast comprises items A-E. But their mean-squares are all less than 1.0, indicating they do not contradict the Rasch variable, but are rather too predictable. They appear to represent a local intensification of the Rasch dimension, rather than a contradictory dimension.

Comparison with Rasch-fitting data

Winsteps makes it easy to compare empirical PCA results with the results for an equivalent Rasch-fitting data set.
From the Output Files menu, make a "Simulated Data" file, call it, say, test.txt
From the Files menu, Restart Winsteps. Under "Extra specifications", type in "data=test.txt".
Exactly the same analysis is performed, but with Rasch-fitting data. Look at the Dimensionality table:

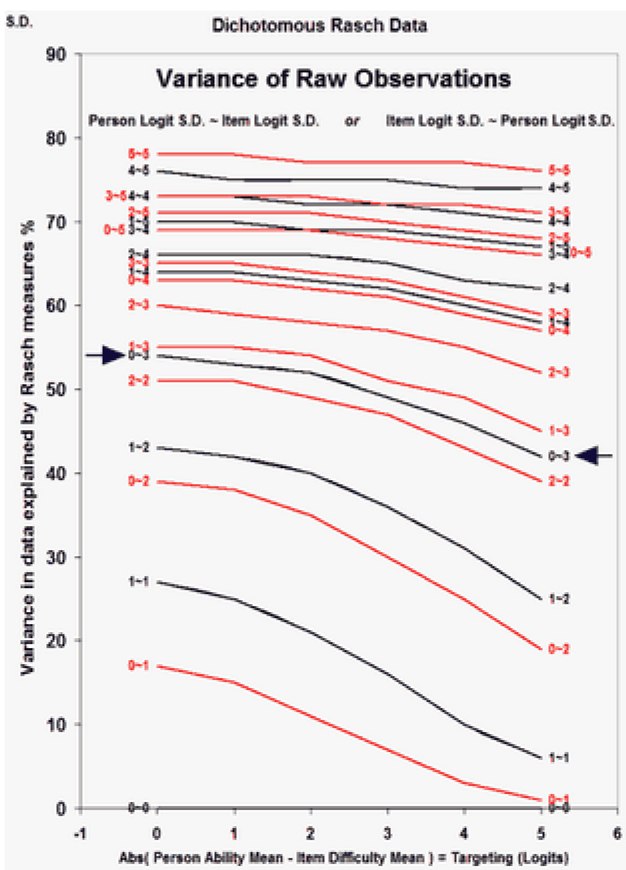
```
Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)
                                           Empirical    Modeled
Total variance in observations     =         576.8  100.0%  100.0%
Variance explained by measures     =         562.8   97.6%   97.1%
Unexplained variance (total)       =          14.0    2.4%    2.9%
Unexpl var explained by 1st contrast =         2.2     .4%
```

Repeat this process several times, simulating a new dataset each time. If they all look like this, we can conclude that the value of 2.7 for the 1st contrast in the residuals is negligibly bigger than the 2.2 expected by chance.

General Advice

A question here is "how big is big"? Much depends on what you are looking for. If you expect your instrument to have a wide spread of items and a wide spread of persons, then your measures should explain most of the variance. But if your items are of almost equal difficulty (as recommended, for instance, by G-Theory) and your persons are of similar ability (e.g., hospital nurses at the end of their training) then the measures will only explain a small amount of the variance.

Winsteps Table 23.6 implements Ben Wright's recommendation that the analyst split the test into two halves, assigning the items, top vs. bottom of the first component in the residuals. Measure the persons on both halves of the test. Cross-plot the person measures. If the plot would lead you to different conclusions about the persons depending on test half, then there is a multidimensionality. If the plot is just a fuzzy straight line, then there is one, perhaps somewhat vague, dimension.



Tentative guidelines:
Please look the nomogram above from https://www.rasch.org/rmt/rmt221j.htm - it indicates the expected relationship between "explained variance" and "unexplained variance". 40%-50% are typical values.

In the unexplained variance, a "secondary dimension" must have the strength of at least 3 items, so if the first contrast has "units" (i.e., eigenvalue) less than 3 (for a reasonable length test) then the test is probably unidimensional. (Of course, individual items can still misfit).

Negative variance can occur when the unexpectedness in the data is not random. An example is people who flat-line an attitude survey. Their unexpected responses are always biased towards one category of the rating (or partial credit) scale.

Simulation studies indicate that eigenvalues less than 1.4 are at the random level. Smith RM, Miao CY (1994) Assessing unidimensionality for Rasch measurement. Chapter 18 in M. Wilson (Ed.) Objective Measurement: Theory into Practice. Vol. 2. Norwood NJ: Ablex.) On occasion, values as high as 2.0 are at the random level. (Critical Eigenvalue Sizes in Standardized Residual Principal Components Analysis, Raîche G., Rasch Measurement Transactions, 2005, 19:1 p. 1012.)

To compute these numbers yourself ...

Let's assume we have a complete dichotomous dataset of N persons and L items. Then, in summary,

1. Do the Rasch analysis. Write out the raw observations, the raw residuals, and the standardized residuals
2. Compute the observed variance of the raw observations = OV = 100% of the variance in the data
3. Compute the unexplained variance = mean-square (raw residuals) = UV = Unexplained %
4. Compute the explained variance in the raw observations = OV-UV = EV = Explained % (can go negative!)
5. The eigenvalue of the item inter-correlation matrix of the standardized residuals = L = UV (rescaled) = Unexplained %
6. In the decomposition of the correlation matrix: Eigenvalue of the component (factor) = G = "strength in item units" = Unexplained% * Number of items

For the plots, the item difficulties are the x-axis, and the component loadings as the y-axis. This is a reminder that the Rasch dimension is the implicit first dimension in the original observations.

You will notice that some of this is statistically approximate, but more exact statistics have produced less meaningful findings. Together with Albert Einstein, trust the meaning more than the numbers!

Will Table 23 work with CMLE=Yes values?

Suppose I anchor IAFILE=, PAFILE= and SAFILE= using the CMLE values from the Output Files? What happens?

Tthough the CMLE estimates are technically more accurate, they do have drawbacks. One is that, for a person or item, the expected raw score is not equal to the observed raw score when it is accumulated across individual responses. Algebraically, sum(Pni) <> Sum(Xni), where Pni = exp(Bn-Di) / (1+ exp(Bn-Di)). The differences (Sum(Pni) - Sum(Xni)) inflates the observed randomness in the data above the model-expected randomness (Sum (Pni*(1-Pni))). This excess randomness may distort the variance computations. See www.rasch.org/rmt/rmt173g.htm

In Table 23.1, look at the Observed and Expected variance columns. If the numbers are not close, then the computation is definitely defective.

Similarly for DIF computations. These are based on the (Sum(Pni) - Sum(Xni)) differences for each group, assuming that (Sum(Pni) - Sum(Xni)) = 0 for all the groups together. Using the CMLE estimates, (Sum(Pni) - Sum(Xni)) <> 0 so the DIF computation is distorted.

In Winsteps Tables 13, etc., with CMLE=Yes, CMLE Infit and Outfit statistics are shown. This computation succeeds because, instead of using the usual Pni, Winsteps substitutes each value from the Pni-equivalent cell that is calculated during CMLE estimation. There is an example at www.rasch.org/rmt/rmt331.pdf page 1759 section 18. Contrast this with section 22. The cell values are different. In section 22, the cells contain the standard Rasch Pni values.

This is a Rasch paradox. During estimation, the marginal totals (person and item raw scores) are the same for CMLE and JMLE, but the individual expected person-item cell values differ. We can save the CMLE values and use them (e.g., for CMLE Infit and Outfit) but recomputing them requires the full set of item difficulties. Section 24 *op.cit.* gives an idea of one approach to this computation.

21.37 Dimensionality: when is a test multidimensional?

For more discussion see dimensionality and contrasts.

Beware of:
1. Accidents in the data generating spurious dimensions
2. Content strands within a bigger content area ("addition" and "subtraction" within "arithmetic") generating generally inconsequential dimensions.
3. Demographic groups within the person sample differential influencing item difficulty, so making a reference-group item dimension and a focal-group item dimension (native and second-language speakers on a language test).

Eugenio Brentani, Silvia Golia (2103) Unidimensionality in the Rasch model: how to detect and interpret. Statistica, 67,.3, 253 – 261. https://doi.org/10.6092/issn.1973-2201/3508

"Variance explained" depends on the spread of the item and person measures. Please see https://www.rasch.org/rmt/rmt221j.htm - For dimensionality analysis, we are concerned about the "Variance explained by the first contrast in the residuals". If this is big, then there is a second dimension at work. Infit and Outfit statistics are too local (one item or one person at a time) to detect multidimensionality productively. They are too much influenced by accidents in the data (e.g., guessing, response sets), and generally do not detect the more subtle, but pervasive, impact of a second dimension (unless it is huge).

Question: "I can not understand the residual contrast analysis you explained. For example, in Winsteps, it gave me the five contrasts' eigenvalues: 3.1, 2.4, 1.9, 1.6, 1.4. (I have 26 items in this data). The result is the same as when I put the residuals into SPSS."

Reply: Unidimensionality is never perfect. It is always approximate. The Rasch model constructs from the data parameter estimates along the unidimensional latent variable that best concurs with the data. But, though the Rasch measures are always unidimensional and additive, their concurrence with the data is never perfect. Imperfection results from multi-dimensionality in the data and other causes of misfit.

Multidimensionality always exists to a lesser or greater extent. The vital question is: "Is the multi-dimensionality in the data big enough to merit dividing the items into separate tests, or constructing new tests, one for each dimension?"

The unexplained variance in a data set is the variance of the residuals. Each item is modeled to contribute 1 unit of information (= 1 eigenvalue) to the principal components decomposition of residuals. So the eigenvalue of the total unexplained variance is the number of items (less any items with extreme scores). So when a component (contrast) in the decomposition is of size 3.1, it has the information (residual variance) of about 3 items.

In your example, the first contrast has eigenvalue of 3.1. Its expected value is near 2.0 - www.rasch.org/rmt/rmt191h.htm. This means that the contrast between the strongly positively loading items and the strongly negatively loading items on the first contrast in the residuals has the strength of about 3 items. Since positive and negative loading is arbitrary, you must look at the items at the top and the bottom of the contrast plot. Are those items substantively different? Are they so different that they merit the construction of two separate tests?

It may be that two or three off-dimension items have been included in your 26 item instrument and should be dropped. But this is unusual for a carefully developed instrument. It is more likely that you have a "fuzzy" or "broad" dimension, like mathematics. Mathematics includes arithmetic, algebra, geometry and word problems. Sometimes we want a "geometry test". But, for most purposes, we want a "math test".

If in doubt,

1. Split your 26 items into clusters (subtests), based on positive and negative loadings on the first residual contrast. Winsteps does this in Table 23.1 with "cluster" numbers.
2. Measure everyone on each of the clusters. Table 23.6
3. What is the correlation of the person measures for pairs of clusters? Table 23.1
4. Do the clusters display two versions of the same story about the persons, or are they different stories?
"The correlation coefficient corrected for attenuation between two tests *x* and *y* is the correlation between their true scores [or true measures]. If, on the basis of a sample of examinees, the corrected coefficient is near unity, the experimenter concludes that the two tests are measuring the same trait." (p. 117) in Joreskog, K.G. (1971) Statistical analysis of sets of congeneric tests, *Psychometrica 36,* 109-133.
5. Copy the person measures from Table 23.6 into Excel, and cross-plot the numbers. Which people are off-diagonal? Is that important? If only a few people are noticeably off-diagonal, or the off-diagonal deviance would not lead to any action, then you have a substantively unidimensional test. You may have a "Fahrenheit-Celsius" equating situation if the best fit line on the plot departs from a unit slope.

You can do a similar investigation for the second contrast of size 2.4, and third of size 1.9, but each time the motivation for doing more than dropping an off-dimension item or two becomes weaker. Since random data can have eigenvalues of size 1.4, there is little motivation to look at your 5th contrast.

Question: Why are my adaptive-test observations always reported to be unidimensional?

Reply: Unobserved data are modeled at their Rasch-predicted values. In an adaptive test these overwhelm the observed data, so the data are reported as unidimensional using standard criteria.
Solution: use the Winsteps "Simulate data" function (Complete Data - No) to obtain a baseline for the unidimensional eigenvalues for your data. These will be much lower than the standard criterion of 2.

"Variance explained" is a newly developing area in Rasch methodology. We learn something new about it every month or so. Perhaps you will contribute to this. So there are no rules, only tentative guidelines based on the current state of theory and empirical experience.

1. Originally Winsteps implemented 3 algorithms for computing variance-explained. Most people used the default algorithm (based on standardized residuals). User experience indicates that one of the other two algorithms was much more accurate in apportioning explained and unexplained variance. So, in the current version of Winsteps, this other algorithm (based on raw residuals) had become the algorithm for this part of the computation. The three algorithms are still implemented for the decomposition of the unexplained variance into contrasts (raw residuals, standardized residuals and logit residuals), and the default remains the standardized residuals for this part of the computation.

2. www.rasch.org/rmt/rmt221j.htm shows the expected decomposition of raw variance into explained variance and unexplained variance under different conditions.

Since the rules are only guidelines, please always verify their applicability in your particular situation. A meaningful way of doing this is to compute the person measures for each of what might be the biggest two dimensions in the data, and then to cross-plot those measures. Are the differences between the measures big enough, and pervasive enough, to be classified as "two dimensions" (and perhaps reported separately) or are they merely a minor perturbation in the data. For instance, in arithmetic, word-problems, abstract-problems and concrete-problems have different response profiles (and so noticeable contrasts), but they are rarely treated as different "dimensions".

21.38 Disjoint strings of responses

When the responses are not arranged in one continuous string in the record, instruct Winsteps to skip over or ignore the gaps.

Example: The 18 item string is in columns 40 to 49 and then 53 to 60 of your data file. The person-id is in columns 11-30. Data look like:
xxxxxxxxxPocahontas Smith, Jrxxxxxxxxx1001001110xxx11001110

Method a: Delete unwanted "items" in columns 50, 51, 52 using an item delete file, IDFILE=.

NAME1 =11 in original record
NAMLEN=20 length in original record
ITEM1 =40 in original record
NI =21 include deleted items
IDFILE =DEL5052 file of deletions
The contents of DEL5052 are:
11 - 13 Cols 50-52 are items 11-13

Method b: Rescore "items" in columns 50, 51, 52 as missing values with RESCORE=.
NAME1 =11 in original record
NAMLEN=20
ITEM1 =40
NI =21 include rescored items
RESCORE=000000000011100000000 rescore 50-52
CODES =01 (the standard)
NEWSCORE=XX non-numerical characters specify "missing"

Method c: Make the items form one continuous string in a new record created with FORMAT=. Then the item string starts in the 21st column of the new record. Reformatted record looks like: Pocahontas Smith, Jr100100111011001110
FORMAT=(T11,20A,T40,10A,T53,8A) reformatting
NAME1 =1 in the formatted record
ITEM1 =21 in the formatted record
NI =18 the actual number of items

21.39 Disordered Andrich Thresholds and disordered rating categories

Andrich thresholds: disordered thresholds are no problem for the formulation of polytomous Rasch models, nor for estimating Rasch measures, nor do they cause misfit to the Rasch model. They are only a problem if the Andrich thresholds are conceptualized as the category boundaries on the latent variable.

The reason for rescoring disordered thresholds is not to improve data-to-model fit, nor to improve the precision (reliability) of the Rasch measures (rescoring reduces precision). The reason is to simplify inference from the Rasch person measures to the more probable categories of the rating scale.

So, when you explain your rating scale to your audience or use it in a practical situation, will the inferences be better if you rescore all items or apply different rescoring to different items? If every item is designed to use the same rating scale, then your audience will probably be confused about the rating scale if the rating scale is rescored in different ways for different items. Further, rescoring the items in different ways for different items will change the relationship between the original raw scores and the Rasch measures. Some different raw scores as originally scored will have the same measures, and some different measures will have the same original raw scores.

Andrich thresholds (step values) are parameters of the Rasch Rating-Scale and Partial-Credit models. They are the points on the latent variable where adjacent categories of the item are equally probable. Their locations are estimated primarily from the category frequencies. So, if the intermediate category has a relatively high frequency, the thresholds will advance, but if the intermediate category has a relatively low frequency, then the thresholds will be reversed (disordered). This is illustrated in a youtube video. https://www.youtube.com/watch?v=Rs3F7a6I8_0

If you need to interpret the partial-credit rating scale, e.g., 0-1-2, as "a person will go from 0 to 1 to 2 as they advance", then you need the items to have ordered thresholds, but if "a person will go from 0 to 1or2 to 2 as they advance" is good enough, then the threshold ordering does not matter. This is usually the case with partial-credit items. Regardless of the threshold ordering, we need the average ability of the persons who respond in each category to advance. This indicates that the categories represent advancing levels of the latent variable.

Summary: If the average measures for the person sample advance across categories for an item or rating scale, then the categories support the Rasch axiom that: "higher scores on the item <-> higher measures for the sample".

The chief purpose for collapsing categories is to enable inferences to be made at the item-category-level:

"as person measures increase, each category in turn is more probable than any one of the others to be observed".

If you want to make this statement, please collapse categories adjacent to disordered thresholds (and lose some measurement information). Otherwise, not.

"Disordering" is a contentious issue in Rasch analysis. It is often misunderstood by novice analysts, the type of analysts eager to get papers published and their feet firmly on the academic/professional ladder. More experienced analysts would tend to produce more ambivalent findings, suggesting alternate interpretations and actions. This type of finding is less likely to be submitted/accepted for publication because it appears to be wishy-washy. My own recommendation is usually that "threshold disordering" is a minor problem, (only relevant if category-level inferences are to be drawn from the data about individuals,) provided that "category disordering" (disordering of the substantive meanings of the categories) is not observed in the data. Unfortunately novice analysts may confuse "threshold disordering" with "category disordering" and so make incorrect statements about the data and the rating scales that generate it.

In my experience, category disordering is observed when
(1) raters are asked to rate in more categories than they can discriminate, e.g., "on a scale from 0-100, rate the person's cheerfulness".
(2) category definitions are not clearly ordered, e.g.,
1=never, 2=rarely, 3=occasionally, 4=sometimes, 5=often, 6=frequently, 7=always
(3) arbitrary rules distort the rating-scale, e.g., "if the behavior is not observed by the rater or not allowed or not possible, then rate the person 1=never". So that "does the person use the stairs" is rated "1" for all persons in a facility without stairs.

"Threshold disordering" occurs when a category corresponds to a narrow interval of the latent variable, e.g., "almost always" in
1=never, 2=sometimes, 3=often, 4=almost always, 5=always
Here the threshold between categories 3 and 4 will be disordered, even if the raters can clearly discriminate the 5 different levels.

Disordered Andrich thresholds indicate that a category occupies a narrow interval on the latent variable (usually because the category is observed relatively rarely). This is not a problem unless you need advancing abilities to probably increment smoothly up the categories of the rating scale without skipping narrow categories.

If this is a problem for you, then please collapse categories. This usually requires some experimenting to find the best solution:
1) Look at the average measures for each category. Combine categories with disordered average measures
2) Look at the category frequency. Combine categories with low frequencies

Disordered Andrich thresholds indicate that some categories on the latent variable are narrow. Disordered Andrich thresholds do not violate Rasch models, but they may impact our interpretation of how the rating scale functions.

Example: Imagine a location on the latent variable that is the boundary between two categories. If there are exactly 1,000 people with measures at that boundary. We would expect to observe 500 of them in categories below the boundary and 500 of them in categories above the boundary. Dichotomous items function exactly this way.

dichotomous item 0-1	
category 0 on latent variable	category 1 on latent variable
1000 persons here →	
500 persons observed here as 0	500 persons observed here as 1
dichotomous item difficulty →	

Polytomous items (RSM, PCM) are move complex. RSM and PCM predict that some of the 1000 will be observed in categories next to the boundary, and some in categories further away, so that there will be 500 in total above the boundary and 500 below the boundary. OK so far?

polytomous item 0-1-2 (ordered categories, ordered Andrich thresholds)		
category 0	category 1 (wide)	category 2
1000 persons here →	←	
500 persons observed here as 0	490 persons observed here as 1	10 persons observed here as 2
|← Andrich threshold → | (ordered)		

For 3 rating-scale categories 0,1,2 our first boundary is between 0 and 1. If category 1 is very wide, almost all the 500, say 490, will be observed in category 1 and 10 in category 2. The Andrich threshold corresponding to each boundary is basically ln(frequency of category below/frequency of category above), so the Andrich threshold for our first boundary 0-1 is something like ln(500/490) = 0.0 and for the next boundary, 1-2, ln(490/10) = 3.9. The Andrich thresholds are in ascending order.

polytomous item 0-1-2 (ordered categories, disordered Andrich thresholds)		
category 0	category 1 (narrow)	category 2
1000 persons here →	←	
500 persons observed here as 0	10 persons as 1	490 persons observed here as 2
→ | Andrich threshold |← (disordered)		

But if category 1 is very narrow, only 10 of the 500 may be observed in category 1, and 490 in category 2 above the narrow category 1. The Andrich threshold for our first boundary 0-1 is something like ln(500/10) = 3.9 and for the next boundary, 1-2, ln(10/490) = -3.9. So the categories are disordered, even though the data fit the Rasch model perfectly!

Disordered Andrich thresholds indicate narrow categories on the latent variable. Statistically, these are no problem, but for practical purposes we may want all the categories to be wide enough that the Andrich thresholds are ordered.

The category boundaries in this example are reported as the "Rasch-Thurstonian thresholds".

Effect of collapsing categories on measurement

In general, reducing the number of categories tends to improve the fit of the data to the model at the expense of losing some of the statistical information in the ratings. You will probably see the impact of the loss of information in the Person Reliability value.

For instance, if the person reliability drops from 0.9 to 0.8, we can use the Spearman-Brown Prophecy Formula to tell us what the loss of information is equivalent to in terms of items lost. If the original number of items is, say, 10, then reducing the number of categories in the rating scale is equivalent to reducing the number of items to:
Items = 10 * 0.8 * (1-0.9) / ((1-0.8)*0.9) = 4.4, so items lost = 10 - 4.4 = 5.6

In general, we expect: items lost = (original item count)*(original category count - new category count) / (original category count - 1)

This only matters if the effect of the reduction in categories is to make the Person Reliability too small to discriminate the desired number of ability strata in the target person population. www.rasch.org/rmt/rmt63i.htm

---

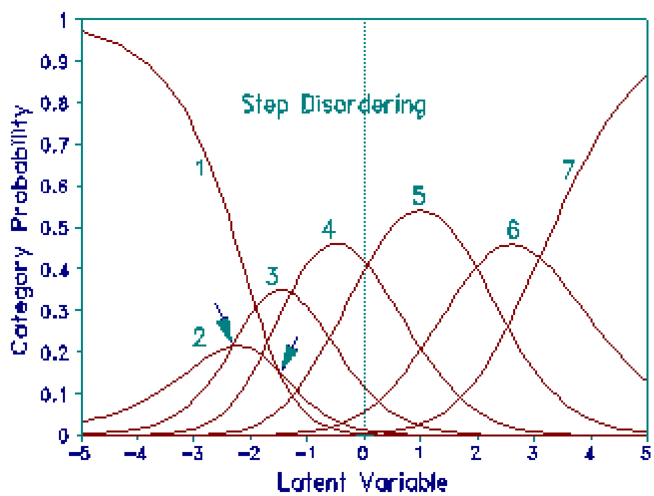
There is considerable debate in the Rasch community about the meaning of rating (or partial credit) scales and polytomies which exhibit "disorder". Look at Table 3.2, distractor/option analysis. Two types of disorder have been noticed:

(i) Disorder in the "average measures" of the categories can imply disorder in the category definitions.

FIM LEVEL	COUNT	AVERAGE MEASURE	INFIT MNSQ	OUTFIT MNSQ	STEP CALIBRATN
1 (2)	88	-1.97	**1.47**	**1.41**	NONE
2 (1)	96	**-2.18**	.54	.69	-2.08
3	101	-.95	1.05	1.02	-1.49
4	168	-.25	.91	.99	-1.24
5	210	.80	.97	.87	.08
6	146	2.14	.66	.75	1.87
7	101	3.02	.83	.86	2.86

In this example, from Linacre, J.M. (1999) Category Disordering vs. Step Disordering, Rasch Measurement Transactions 13:1 p. 675, "FIMÔ Level" categories have been deliberately disordered in the data. It is seen that this results in disordering of the "average measures" or "observed averages", the average abilities of the people observed in each category, and also large mean-square fit statistics. The "Rasch-Andrich thresholds", also called "step calibrations", "step difficulties", "step measures", "deltas", "taus", etc., remain ordered.

(ii) Disordered Rasch-Andrich thresholds imply less frequently observed intermediate categories, i.e., that they correspond to narrow intervals on the latent variable.



In this example, the FIM categories are correctly ordered, but the frequency of level 2 has been reduced by removing some observations from the data. Average measures and fit statistics remain well behaved. The disordering in the Andrich thresholds now reflects the relative infrequency of category 2. This infrequency is pictured in plot of probability curves which shows that category 2 is never a modal category in these data. The Andrich Threshold values do not indicate whether measurement would be improved by collapsing levels 1 and 2, or collapsing levels 2 and 3, relative to leaving the categories as they stand.

FIM LEVEL	COUNT	AVERAGE MEASURE	INFIT MNSQ	OUTFIT MNSQ	STEP CALIBRATN
1	96	-2.81	.90	.96	NONE
2	**44**	-1.96	.88	.92	-1.49
3	101	-1.03	1.02	.98	**-2.33**
4	168	-.30	1.07	1.22	-1.29
5	210	.82	.96	.88	.05
6	146	2.30	.75	.82	1.97
7	101	3.27	.87	.89	3.09

Example: Here are the category probability curves for a Likert rating scale: 1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree. 3="Neutral" is relatively rarely observed. It has disordered thresholds. The point of equal probability between categories 3 and 4, the Rasch-Andrich threshold for category 4, is less than the point of equal probability between categories 2 and 3, the Rasch-Andrich threshold for category 3.

```
        CATEGORY PROBABILITIES: MODES - Andrich Thresholds at intersections
P      -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-
R  1.0 +                                                             +
O      |111111                                                5555555|
B      |      111                                          555       |
A      |         111                                    55           |
B   .8 +            1                                 55             +
I      |             11                              5               |
L      |               1                            55               |
I      |                1                          5                 |
T   .6 +                 11                       5                  +
Y      |                   1                     5                   |
    .5 +                    1 22222        444  5                    +
O      |                    2*     22    44   4*                     |
F   .4 +                  22  1      2  4     5 44                   +
       |                 2     1      24     5    4                  |
R      |               22       1     42    5      44                |
E      |              2          1   4  2  5         44              |
S   .2 +            22            13*3333*5            44            +
P      |         222             33*1   55*33            44          |
O      |      222             33344  1 5   2 33            444       |
N      |222222           33333444   55*11   22233333          4444444|
S   .0 +**********************555555     111111**********************+
E      -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-
```

There are several options:

1. Do not change the rating scale. We do this when recoding the categories in any way would confuse our audience, or the threshold disordering is not important for our inferences. For example: scoring Olympic Ice-Skating in Exam15.txt. This has a very long rating-scale for a small sample of skaters, so that there are many disordered thresholds and unobserved categories.
2. Rewrite the rating scale in the attitude survey without category 3: 1=Strongly disagree, 2=Disagree, 3=Agree, 4=Strongly Agree. This changes the meaning of all the categories, so we must then re-administer the survey.
3. Recode "Neutral" as missing (not administered) data. We do this when we think "Neutral" means "I do not want to tell you what I really think."
4. Recode "Neutral" as "Disagree". We do this when we want to be sure that "Agree" means that respondents truly agree.
5. Recode "Neutral" as "Agree". We do this when we want to be sure that "Disagree" means that respondents truly disagree.
6. Recode "Neutral" as the nearer of "Disagree" and "Agree" according to the empirical data. Please look at the "Observed Average Measures" (OBSVD AVRGE) for each category, and recode "Neutral" accordingly. In this example, Neutral (.12) is nearer to Disagree (-.96) than to Agree (1.60)

```
---------------------------------------
|CATEGORY   OBSERVED|OBSVD  | ANDRICH |
|LABEL  SCORE COUNT %|AVRGE  |THRESHOLD|
|-------------------+-------+---------+
...
|  2    2     453  32|  -.96 |   -1.37 | 2 Disagree
|  3    3      35   2|   .12 |    0.58 | 3 Neutral
|  4    4     537  37|  1.60 |   -0.42 | 4 Agree
...
```

21.40 Displacement measures

DISPLACE column should only appear with anchored or TARGET= runs. Otherwise its appearance indicates lack of convergence. If small displacements are being shown, try tightening the convergence criteria, LCONV=.

Anchored analyses, IAFILE=, PAFILE=: if large displacements are shown for the anchored items or persons, try changing the setting of ANCESTIM=.

The displacement is an estimate of the amount to add to the MEASURE to make it conform with the data.

Positive displacement for a person ability indicates that the observed person score is higher than the expected person score based on the reported measure (usually an anchor value).

Positive displacement for an item difficulty indicates that the observed item score is lower than the expected item score based on the reported measure (usually an anchor value).

Anchored item difficulties with Displacements: what Item Difficulty for next time?

1. Do the analysis that produces the displacements with IAFILE= (and SAFILE=). Output PFILE=pf.txt.
2. Treat these person abilities as "true", especially if you are reporting them.
3. Reanalyze the data with PAFILE=pf.txt and IAFILE=nothing (and SAFILE=nothing). This will produce an IFILE= (and SFILE=) with no displacements for which the item difficulties are the best match to the anchored person abilities.
4. You can compare the IFILE= from 3 with the (difficulty and displacement) from 1. The values should be close, but the IFILE= values from 3. will produce the same person abilities from the same data next time as they do this time. (difficulty and displacement) will produce different sets of person abilities in this situation.

Displacement Computation

The displacement for each item or person, with all the items, persons, thresholds anchored at their final values.

The computation uses iterative curve-fitting. For an item (or similarly a person)
1. Compute the expected score for (final item difficulty= D0) = E0
2. Compute the expected score for (final item difficulty+1 logit = D1) = E1
3. Points (D0,E0) and (D1,E1) are on a logistic score-to-measure ogive:
4. the observed score for this item is S. The matching point on the logistic ogive is DS.
5. the displacement is (DS-D0).

Since we do not want to recalibrate all the items, we are only worried about items (persons) that have drifted too far from their difficulties in the anchor set. These are items with big displacements.

If there is a high proportion of drifted items (or even 1 drifted item in high stakes situations), then apply this method. The change using this method will be bigger than the displacement because the drifted item has influenced all the other measures.

1) Reanalyze the data with all other items anchored, unanchoring the suspect item(s) and giving them a weight of zero (IWEIGHT=), and unanchoring the persons.
2) The persons get new measures based on the good anchored items
3) The suspect items get difficulties based on the new person measures.
4) The zero weights of the items allows them to be estimated from the new person measures without influencing the item or person measures.
5) Drift = estimated value - anchored value

Faster computation with complete data:
Compare the anchor value with the measure for the observed score in Table 20.3 (items) or Table 20.1 (persons)

The DISPLACE value is the size of the change in the parameter estimate that would be observed in the next estimation iteration if this parameter was free (unanchored) and all other parameter estimates were anchored at their current values.

For a parameter (item or person) that is anchored in the main estimation, DISPLACE indicates the size of disagreement between an estimate based on the current data and the anchor value.

For an unanchored item, if the DISPLACE value is large enough to be of concern, then the convergence criteria are not tight enough LCONV=, RCONV=, CONVERGE=, MJMLE=

DISPLACE approximates the displacement of the estimate away from the statistically better value which would result from the best fit of your data to the model. Each DISPLACE value is computed as though all other parameter estimates are exact. Only meaningfully large values are displayed. They indicate lack of convergence, or the presence of anchored or targeted values. The best fit value can be approximated by adding the displacement to the reported measure or calibration.

Note: Winsteps uses a logistic-curve-fitting approach to estimation. This has proved more robust than Newton-Raphson for badly-behaved data (long rating scales with missing categories, sparse datasets, etc.). Essentially, we know that all the underlying functions in Rasch estimation are logistic ogives, so we can take advantage of this to predict the next (improved) estimate based on the current estimate, its expected score, and the observed score. For computing displacements, logistic-curve-fitting can be replicated in Excel. You have the expected scores for the persons on the anchored item from the XFILE=. Then compute the expected scores for the person on the anchored item difficulty + 1 logit using the person and item measures in the XFILE=. This gives two total expected item scores. For each total expected item score and the total observed item score, compute the log odds: ln (value/(max possible item score - value)). This gives 3 log odds: E0, E1 and O. Then displacement is (O - E0)/(E1 - E0) logits. This value of the displacement is usually very close to the Newton-Raphson value.

Standard Error of the Displacement Measure

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	DISPLACE	TAP
3	35	35	2.00A	.74	.69	-.6	.22	.5	.00	-3.90	1-2-4

Since the reported "measure" is treated as a constant when "displacement" is computed, the S.E. of the reported "measure" actually is the same as the S.E. of the displacement. The DISPLACE column shows the displacement in the same units as the MEASURE. This is logits when USCALE=1, the default. If the anchored measure value is considered to be exact, i.e., a point-estimate, then the S.E. standard error column indicates the standard error of the displacement. The statistical significance of the Displacement is given by

t = DISPLACE / S.E. with approximately COUNT degrees of freedom.

This evaluates how likely the reported size of the displacement is, if its "true" size is zero. But both the displacements and their standard errors are estimates, so the t-value may be slightly mis-estimated. Consequently allow for a margin of error when interpreting the *t*-values.

If the anchored measure value has a standard error obtained from a different data set, then the standard error of the displacement is:

S.E. (Displacement) = Sqrt(S.E.^2 + S.E.^2(anchor value from original data))

When does large displacement indicate that an item or person should be unanchored or omitted?
This depends on your purpose. If you are anchoring items in order to measure three additional people to add to your measured database of thousands, then item displacement doesn't matter.

Anchor values should be validated before they are used. Do two analyses:
(a) with no items anchored (i.e., all items floating), produce person and item measures.
(b) with anchored items anchored, produce person and item measures.

Then cross-plot the item difficulties for the two runs, and also the person measures. The person measures will usually form an almost straight line.

For the item difficulties, unanchored items will form a straight-line. Some anchored items may be noticeably off the line. These are candidates for dropping as anchors. The effect of dropping or un-anchoring a "displaced" anchor item is to realign the person measures by roughly (displacement / (number of remaining anchored items)).

Random displacements of less than 0.5 logits are unlikely to have much impact in a test instrument.

> "In other work we have found that when [test length] is greater than 20, random values of [discrepancies in item calibration] as high as 0.50 [logits] have negligible effects on measurement." (Wright & Douglas, 1976, "Rasch Item Analysis by Hand")
>
> "They allow the test designer to incur item discrepancies, that is item calibration errors, as large as 1.0 [logit]. This may appear unnecessarily generous, since it permits use of an item of difficulty 2.0, say, when the design calls for 1.0, but it is offered as an upper limit because we found a large area of the test design domain to be exceptionally robust with respect to independent item discrepancies." (Wright & Douglas, 1975, "Best Test Design and Self-Tailored Testing.")
>
> "To this issue, Wright and Douglas (1976) found that random displacement of less than .5 logits have little effect on the test instrument. Draba (1977) recommends 0.5 logits based upon the rationale that item difficulties typically range between -2.5 and +2.5 logits, thus a shift of 0.5 logits represents a 10 percent shift within that range. Other studies (Jones & Smith, 2006; Stahl & Muckle, 2007) have found that displacement values symmetrically distributed around zero have very little impact." How much item drift is too much? T. O'Neill, M. Peabody, Rachael Jin Bee Tan, Ying Du ... Rasch Measurement Transactions, 2013, 27:3 p. 1423-4

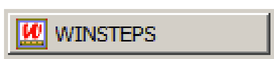
Most DIF work seems to be done by statisticians with little interest in, and often no access to, the substantive material. So they have no qualitative criteria on which to base their DIF acceptance/rejection decisions. The result is that the number of items with DIF is grossly over-reported (Hills J.R. (1989) Screening for potentially biased items in testing programs. Educational Measurement: Issues and practice. 8(4) pp. 5-11).

21.41 Edit taskbar caption

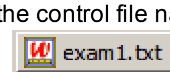
The Windows taskbar is usually at the bottom of your screen. It can display the program icons with short captions. If you want short captions,

a. Right click on Windows Taskbar and click on Properties.
b. In the Taskbar tab, Taskbar buttons: Select "Combine when taskbar is full" or "Never combine"
c. Click on Apply and OK.

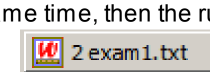
When Winsteps starts it displays:



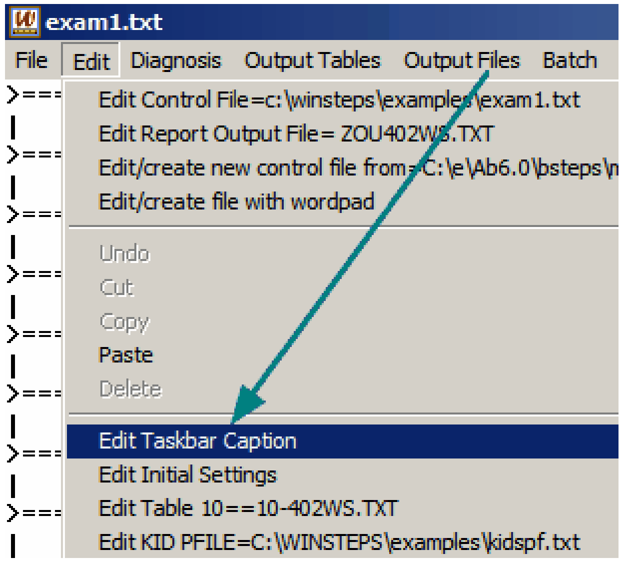
After a control file has been selected, e.g., exam1.txt, the control file name is displayed on the task bar:



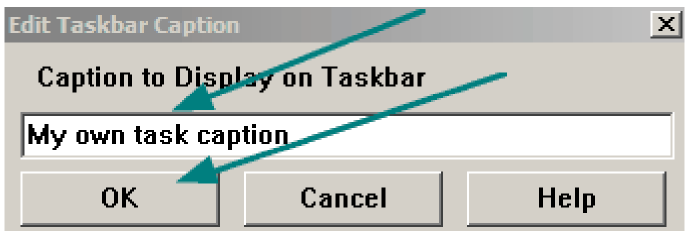
If two runs use the same control file name at the same time, then the runs are numbered uniquely:



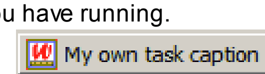
The automatic caption can be replaced by one chosen by you. On the Edit menu, select Edit Taskbar Caption



The following dialog displays:



You can type in your own caption, and then click OK. Your caption displays on the bottom of your screen. This is useful for reminding yourself about a particular analysis you have running.



21.42 Equating and linking tests

Equated or linked tests need to share something. What do your tests share?

1. Items. Both tests have a few of the same items. (Common Item Equating)

2. Persons. Both tests were administered to a few of the same people. (Common Person Equating)

3. Person distribution. Both tests were administered to samples of people with the same ability distribution. (Common Distribution Equating)

4. Item content. Similar items in the two tests can be identified. (Common Item-Content "Virtual" Equating)

Test Equating and linking are usually straightforward with *Winsteps,* but do require clerical care. The more thought is put into test construction and data collection, the easier the equating will be.

Imagine that Test A (the more definitive test, if there is one) has been given to one sample of persons, and Test B to another. It is now desired to put all the items together into one item hierarchy, and to produce one set of measures encompassing all the persons.

Initially, **analyze each test separately.** Go down the "Diagnosis" pull-down menu. If the tests don't make sense separately, they won't make sense together.

There are several equating methods which work well with *Winsteps*. Test equating is discussed in Bond & Fox "Applying the Rasch model", and earlier in Wright & Stone, "Best Test Design".

"WINSTEPS-based Rasch methods that used multiple exam forms' data worked better than Bayesian Markov Chain Monte Carlo methods, as the prior distribution used to estimate the item difficulty parameters biased predicted scores when there were difficulty differences between exam forms." Rasch Versus Classical Equating in the Context of Small Sample Sizes Ben Babcock and Kari J. Hodge. Educational and Psychological Measurement- Volume: 80, Number: 3 (June 2020)

We we want to put Test B onto Test A's scale. This is the same as putting Fahrenheit (Test B) temperatures onto a Celsius (Test A) scale:

New USCALE= for Test B = (Old USCALE= for Test B)*(S.D. of relevant persons or items for Test A)/(S.D. of relevant persons or items for Test B)

New UIMEAN= or UPMEAN= for Test B = (Mean of relevant persons or items for Test A) - ((Mean of relevant persons or items for Test B - Old UIMEAN or UPMEAN for Test B)*(S.D. of relevant persons or items for Test A)/(S.D. of relevant persons or items for Test B))

Rescaled Test B measure = ((Old Test B measure - Old UIMEAN or UPMEAN for Test B)/(Old USCALE for Test B))*(New USCALE for Test B) + (New UIMEAN or UPMEAN for Test B)

Example: suppose we have freezing and boiling points in modified Fahrenheit and modified Celsius.

Test A: Celsius*200 + 50: USCALE=200, UIMEAN=50, freezing: 50, boiling: 20050, range = 20050-50 = 20000, mean = 10050
Test B: Fahrenheit*10+1000: USCALE=10, UIMEAN=1000, freezing: 1320, boiling: 3120, range = 3120-1320=1800, mean = 2220

For convenience, we will substitute the observed range for the S.D. in the equations above:

New Test B modified Fahrenheit USCALE = 10*20000/1800 = 111.1111
Then 1320, 3120 becomes (1320/10)*111.111 = 34666.7, (3120/10)*111.1111 = 14666.7,
so that the rescaled Test B range becomes 34666.7-14666.7 = 20000 = the Test A range

New Test B Fahrenheit UIMEAN = 10050 - (2220-1000)*20000/1800 = -3505.56

Thus, rescaled Test B freezing: 1320 becomes ((1320-1000)/10)*111.1111 - 3505.56 = 50 = Test A freezing
rescaled Test B boiling: 3120 becomes ((3120-1000)/10)*111.1111 - 3505.56 = 20050 = Test A boiling

---

Concurrent or One-step Equating with common items or persons (vertical scaling, etc.)
All the data are entered into one big array. This is convenient but has its hazards. Off-target items can introduce noise and skew the equating process, CUTLO= and CUTHI= may remedy targeting deficiencies. Linking designs forming long chains require much tighter than usual convergence criteria. Always cross-check results with those obtained by one of the other equating methods.

Concurrent equating of two tests, A and B, is usually easier than equating separate analyses. MFORMS= can help set up the data. But always analyze test A and test B separately first. Verify that test A and test B are functioning correctly. Then scatterplot the item difficulties for the common items from the separate analysis of Test A against the item difficulties from a separate analysis of Test B. Verify that they are on an approximately straight line approximately parallel to the identity line. Then do the concurrent analysis. You can also do a DIF analysis on the common items.

Example 1: 6 10-item Tests with some common persons between pairs of tests to form a chain linking all Tests. Groups of persons have also responded to each Test.
a) Use the content of the items, not the item statistics, to pair up a few items in each Test with their equivalents in one or more other Tests. Code this pairing into the item labels. These labels will act as indicators that the equating is working properly when we later list all 60 items in difficulty order. This is known as "virtual equating" - www.rasch.org/rmt/rmt193a.htm - We are not doing this to equate, but to validate the common-person equating, especially of Test 3.

b) Combine all the data into one Winsteps data file: 1,000 or so persons by 60 items. Put the Test number in the item labels, and the Group number in the person labels. Each student will have data for they tests they took and missing data for the tests they didn't take. The Winsteps MFORMS= instruction may help with this.

c) Run one analysis of everyone - "Concurrent equating".
Everything is in the same frame-of-reference
Every student has an ability measure, every Group has subtotals: Winsteps Table 28
Every item has a difficulty measure. Scan the list of 60 items in Measure order to check on (a). Any paired items that have conspicuously different difficulty measures deserve investigation. Every Test has subtotals, Winsteps Table 27.
DPF analysis of the common persons persons by Test indicates how stable person measures are across Tests: Winsteps Table 31.

This approach avoids having to make awkward (and error-prone) equating adjustments.

Example 2:
You have 88 different items in three test forms, O, A, B. An item can be in one, two or all three forms (common items).
1. Put a code in each item label to indicate which form(s) the item belongs to:
O = O, A=A, B=B, C=O+A, D=O+B, E=A+B, F=O+A+B

2. Put a code in each person label to indicate which form was answered

3. Construct one data file with all the items and all the persons.
Each unique item has the same column for all the forms.
NI=88
There is missing data where a person was not administered an item.
The Winsteps command MFORMS= may help you with this.

4. Analyze all the data together. All the persons and items will be on the same measurement scale.

5. If you need score-to-measure tables for each form, then in the Winsteps Specification menu box:
ISELECT={OCDF} ;item codes for first form: O
Table 20
ISELECT=* ; to reset
ISELECT={ACEF} ; item codes for second form: A
Table 20
ISELECT=* ; to reset
ISELECT={BDEF} ; item codes for third form: B
Table 20
ISELECT=* ; to reset

Common Item Equating
This is the best and easiest equating method. The two tests share items in common, preferably at least 5 spread out across the difficulty continuum. There is no specific minimum number of comon items. We usually want as many common items as possible, but are constrained by test design considerations. For instance, https://www.rasch.org/rmt/rmt51h.htm recommends 20 common items in each test. Great for tests of 200+ items, but what if the test only has 20 items in total? How low can we go? Only one common item is obviously too fragile. We can probably get away with 3 common items, spread across the ability range, but what if one or two of those items malfunction? So that leads us to 5 common items as a practical minimum. In a 20-item test (common in classroom tests), 5 items is one-quarter of the test. We would probably not want to go higher than one-quarter in order to limit item exposure and increase test security.

In the Winsteps analysis, indicate the common items with a special code in column 1 of the item labels.

Example: there are 6 items. Items 1 and 2 are common to the two tests. Items 3 and 4 are only in Test A. Items 5 and 6 are only in Test B
....
&END
C Item 1
C Item 2
A Item 3

A Item 4
B Item 5
B Item 6
END LABELS

Step 1. From the separate analyses,
obtain the mean and standard deviation of the common items:
use the "Specification" pull-down menu: ISUBTOT=1
Then produce Table 27 item summary statistics - this will give the mean and standard deviation of the common items.
Crossplot the difficulties of the common items, with Test B on the y-axis and Test A on the x-axis. The slope of the best fit is:
slope = (S.D. of Test B common items) / (S.D. of Test A common items) i.e., the line through the point at the means of the common items and through the (mean + 1 S.D.). This should have a slope value near 1.0. If it does, then the first approximation: for Test B measures in the Test A frame of reference:
Measure (B) - Mean(B common items) + Mean(A common items) => Measure (A)

Step 2. Examine the scatterplot. Points far away from the best fit line indicate items that have behaved differently on the two occasions. You may wish to consider these to be no longer common items. Drop the items from the plot and redraw the best fit line. Items may be off the diagonal, or exhibiting large misfit because they are off-target to the current sample. This is a hazard of vertical equating. CUTLO= and CUTHI= may remedy targeting deficiencies.

Step 3a. If the best-fit slope remains far from 1.0, then there is something systematically different about Test A and Test B. You must do "Celsius - Fahrenheit" equating. Test A remains as it stands.
Include in the Test B control file:
USCALE = S.D. (A common items) / S.D.(B common items)
UMEAN = Mean(A common items) - Mean(B common items)
and reanalyze Test B. Test B is now in the Test A frame of reference, and the person measures from Test A and Test B can be reported together.

Note: This is computation is based on an approximate trend line through points measured with error ("error-in-variables").

Step 3b. The best-fit slope is near to 1.0. Suppose that Test A is the "benchmark" test. Then we do not want responses to Test B to change the results of Test A.
From a Test A analysis produce IFILE= and SFILE= (if there are rating or partial credit scales).
Edit the IFILE= and SFILE= to match Test B item numbers and rating (or partial credit) scale.
Use them as an IAFILE= and SAFILE= in a Test B analysis.
Test B is now in the same frame of reference as Test A, so the person measures and item difficulties can be reported together

Step 3c. The best-fit slope is near to 1.0. Test A and Test B have equal priority, and you want to use both to define the common items.
Use the MFORMS= command to combine the data files for Test A and Test B into one analysis. The results of that analysis will have Test A and Test B items and persons reported together.

```
    Items
------------
||||||||||||
||||||||||||             Test A Persons
||||||||||||
||||||||||||
||||||||||||
||||||||||||
------------
 -   -   -  ------------
 |   |   |  ||||||||||||
 |   |   |  ||||||||||||    Test B Persons
 |   |   |  ||||||||||||
 |   |   |  ||||||||||||
 |   |   |  ||||||||||||
 |   |   |  ||||||||||||
 -   -   -  ------------
```

Partial Credit items
"Partial credit" values are much less stable than dichotomies. Rather than trying to equate across the whole partial credit structure, one usually needs to assert that, for each item, a particular "threshold" or "step" is the critical one for equating purposes. Then use the difficulties of those thresholds for equating. This relevant threshold for an item is usually the transition point between the two most frequently observed categories - the Rasch-Andrich threshold - and so the most stable point in the partial credit structure.

Stocking and Lord iterative procedure
The Stocking and Lord (1983) present an iterative common-item procedure in which items exhibiting DIF across tests are dropped from the link until no items exhibiting inter-test DIF remain. A known hazard is that if the DIF distribution is skewed, the procedure trims the longer tail and the equating will be biased. To implement the Stocking and Lord procedure in Winsteps, code each person (in the person id label) according to which test form was taken. Then request a DIF analysis of item x person-test-code (Table 30). Drop items exhibiting DIF from the link, by coding them as different items in different tests.

Stocking and Lord (1983) Developing a common metric in item response theory. Applied Psychological Measurement 7:201-210.

Fuzzy Common-Item Equating
Two instruments measure the same trait, but with no items or persons in common.
1. Identify roughly similar pairs of items on the two instruments, and cross-plot their measures. We expect the plot to be fuzzy but it should indicate an equating line.

2. Virtual equating or pseudo-common-item equating (see below): Print the two item hierarchy maps and slide them up-and-down relative to each other until the overall item hierarchy makes the most sense. The relative placement of the local origins (zero points) of the two maps is the equating constant.

Choosing Common Items
1. Cross-plot the item difficulties of the pairs of possible common items from your original analyses.
2. In the scatterplot, there should be a diagonal line of items parallel to the identity line. These will be the best common items.

Common-item equating. Using Excel to construct a bank of item numbers for use with MFORMS=. Two test forms, 97Up and 97Down have some items in common. The item labels are in two Winsteps data files.

1. Copy the item labels from the Winsteps data files into this worksheet: Columns B and F
2. Put in sequence numbers in column A using =(cell above+1)
3. Copy Column A and paste special (values) into Columns C and G
4. In Column D, VLOOKUP Column F in Columns B, C. If #N/A then make it 9999
    =IF(ISNA(VLOOKUP(F17,$B$17:$C$1747,2,FALSE)),9999,VLOOKUP(F17,$B$17:$C$1747,2,FALSE))
5. Copy column D and paste special (values) into Column E
6. Copy columns E F G into I J K
7. Sort IJK on columns I and K
8. Copy K into L
9. Go down column I to first 9999 (the first item in 97Down not in 97Up)
10. Place the first number after the last number in column A into column I
11. Sequence up from that number to the end of the items
12. The MFORMS= item-bank numbers for the first test are in column 1. They are the same as the original entry numbers.
13. The MFORMS= entry numbers for the second test are in column K. The bank numbers are in column I

	A	B	C	D	E	F	G	H	I	J	K
16	Seque	97UP	Entry/Banked	Combined	Combined value	97Down	Entry		Banked	97Down	Entry
17	1	497850414F	1	1670	1670	497600156F	1		1	4978504	776
18	2	497850438F	2	938	938	497232351M	2		3	4978502	789
19	3	497850294F	3	9999	9999	497750169M	3		4	4978503	792
20	4	497850309F	4	1320	1320	497712090M	4		5	4978501	778
21	5	497850127F	5	1612	1612	497220413M	5		6	4978502	787
22	6	497850282M	6	1371	1371	497750066M	6		7	4978502	793

16	Sequence	97UP	Entr	Combined	Comb	97Down	Entr		Banke	97Down	Entry
17	1	497850414F	1	=IF(ISNA(VLOOKUP(F17,$B$17:$C$1747,2,FALSE)),9999,VLOOKUP(F17,$B$17:$C$1747,2,FALSE))	1670	497600156F	1		1	497850414F	776
18	=(A17+1)	497850438F	2	=IF(ISNA(VLOOKUP(F18,$B$17:$C$1747,2,FALSE)),9999,VLOOKUP(F18,$B$17:$C$1747,2,FALSE))	938	497232351M	2		3	497850294F	789
19	=(A18+1)	497850294F	3	=IF(ISNA(VLOOKUP(F19,$B$17:$C$1747,2,FALSE)),9999,VLOOKUP(F19,$B$17:$C$1747,2,FALSE))	9999	497750169M	3		4	497850309F	792
20	=(A19+1)	497850309F	4	=IF(ISNA(VLOOKUP(F20,$B$17:$C$1747,2,FALSE)),9999,VLOOKUP(F20,$B$17:$C$1747,2,FALSE))	1320	497712090M	4		5	497850127F	778
21	=(A20+1)	497850127F	5	=IF(ISNA(VLOOKUP(F21,$B$17:$C$1747,2,FALSE)),9999,VLOOKUP(F21,$B$17:$C$1747,2,FALSE))	1612	497220413M	5		6	497850282M	787

Common Person Equating

Some persons have taken both tests, preferably at least 5 spread out across the ability continuum.

Step 1. From the separate analyses, crossplot the abilities of the common persons, with Test B on the y-axis and Test A on the x-axis. The slope of the best-fit line i.e., the line through the point at the means of the common persons and through the (mean + 1 S.D.) point should have slope near 1.0. If it does, then the intercept of the line with the x-axis is the equating constant.

First approximation: Test B measures in the Test A frame of reference = Test B measure + x-axis intercept.

Step 2. Examine the scatterplot. Points far away from the joint-best-fit trend-line indicate persons that have behaved differently on the two occasions. You may wish to consider these to be no longer common persons. Drop the persons from the plot and redraw the joint-best-fit trend-line.

Step 3a. If the best-fit slope remains far from 1.0, then there is something systematically different about Test A and Test B. You must do "Celsius - Fahrenheit" equating. Test A remains as it stands.
The slope of the best fit is: slope = (S.D. of Test B common persons) / (S.D. of Test A common persons)
Include in the Test B control file:
USCALE = the value of 1/slope
UMEAN = the value of the x-intercept
and reanalyze Test B. Test B is now in the Test A frame of reference, and the person measures from Test A and Test B can be reported together.

Step 3b. The best-fit slope is near to 1.0. Suppose that Test A is the "benchmark" test. Then we do not want responses to Test B to change the results of Test A.
From a Test A analysis produce PFILE=
Edit the PFILE= to match Test B person numbers
Use it as a PAFILE= in a Test B analysis.
Test B is now in the same frame of reference as Test A, so the person measures and person difficulties can be reported together

Step 3c. The best-fit slope is near to 1.0. Test A and Test B have equal priority, and you want to use both to define the common persons.
Use your text editor or word processor to append the common persons' Test B responses after their Test A ones, as in the design below. Then put the rest of the Test B responses after the Test A responses, but aligned in columns with the common persons's Test B responses. Perform an analysis of the combined data set. The results of that analysis will have Test A and Test B persons and persons reported together.

```
        Test A items                 Test B items
|-----------------------------|
|-----------------------------|
|-----------------------------|
|-----------------------------||-----------------------------| Common Person
|-----------------------------|
|-----------------------------||-----------------------------| Common Person
```

```
|-----------------------------|
|-----------------------------|
|-----------------------------||-----------------------------| Common Person
|-----------------------------|
|-----------------------------|
|-----------------------------||-----------------------------| Common Person
|-----------------------------|
                               |-----------------------------|
                               |-----------------------------|
                               |-----------------------------|
                               |-----------------------------|
                               |-----------------------------|
                               |-----------------------------|
                               |-----------------------------|
                               |-----------------------------|
                               |-----------------------------|
                               |-----------------------------|
```

Common-person equating. Using Excel to construct a data file for use with Excel input. Two test forms, 97Up and 97Down have some person in common. The person labels are data are in Excel worksheets.

In a new worksheet
1. Copy test 1 responses and person labels to, say, columns B to AZ. The person labels are in AZ
2. Copy test 2 responses and person labels to, say, columns BC to DA. The person labels are in DA
3. Put in sequence numbers in column A using =(cell above+1)
4. Copy "values" column A to columns BA, DB
5. In column BB, VLOOKUP column AZ in column DA. If found BA, If not, 9999
=IF(ISNA(VLOOKUP(AZ15,$DA$15:$DB$1736,2,FALSE)),9999,BA15)
6. In column DC, VLOOKUP column DA in column AZ. If found the look-up value, If not, 9999
=IF(ISNA(VLOOKUP(DA15,$AZ$15:$BA$1736,2,FALSE)),9999,VLOOKUP(DA15,$AZ$15:$BA$1736,2,FALSE))
7. Sort B-BB on column BB, BA
8. Sort BC-DC on column DC, DB
9. Copy and paste the 9999 rows for Test 2 below the last row for Test 1
10. Use Winsteps Excel input to create a Winsteps control and data file for the combined data

Steps 1-6.

	A	B	AY	AZ	BA	BB	BC	CZ	DA	DB	DC
14	Sequence			97Up	Entry	Match			97Down	Entry	Match
15	1	1	4	497850414F	1	1	1	4	497600156F	1	1670
16	2	1	2	497850438F	2	9999	1	4	497232351M	2	938
17	3	1	1	497850294F	3	3	3	4	497750169M	3	9999
18	4	1	2	497850309F	4	4	3	3	497712090M	4	1320

Steps 7-10.

14	Sequence			97Up	Entry	Match			97Down	Entry	Match
15	1	1	4	497850414F	1	1	1	4	497850414F	776	1
16	2	1	1	497850294F	3	3	1	4	497850294F	789	3
17	3	1	2	497850309F	4	4	1	4	497850309F	792	4

Common Person Equating (or Subtests) with different Polytomies: An Example

400 persons have responded to Scale A (10 items) and Scale B (20 items). Scale A and Scale B have different rating scales.
I want a score-to-measure table for each Scale on the same measurement scale.

(1) Construct a data file with 400 rows (persons) and 30 columns (items)
10 items of scale A and 20 items of scale B

(2) define 2 rating scales, for the10 items of Scale A and the 20 items of Scale B.
ISGROUPS=*
1-10 A
11-30 B
*

(3) analyze all the data together with Winsteps

(4) Winsteps specification menu:
IDELETE=+1-10 ; notice the "+"
keeps Scale A items

(5) Output Table 20 for Scale A

(6) Winsteps specification menu:
IDELETE=
reinstates all items
IDELETE=1-10
deletes items for Scale A

(7) Output Table 20 for Scale B

Virtual Equating of Test Forms

The two tests share no items or persons in common, but the items cover similar material.

Step 1. Identify pairs of items of similar content and difficulty in the two tests. Be generous about interpreting "similar" at this stage. These are the pseudo-common items.

Steps 2-4: simple: The two item hierarchies (Table 1 using short clear item labels) are printed and compared, equivalent items are identified. The sheets of paper are moved vertically relative to each other until the overall hierarchy makes the most sense. The value on Test A corresponding to the zero on Test B is the UMEAN= value to use for Test B. If the item spacing on one test appear expanded or compressed relative to the other test, use USCALE= to compensate.

Or:

Step 2. From the separate analyses, crossplot the difficulties of the pairs of items, with Test B on the y-axis and Test A on the x-axis. The slope of the best-fit line i.e., the line through the point at the means of the common items and through the (mean + 1 S.D.) point should have slope near 1.0. If it does, then the intercept of the line with the x-axis is the equating constant.

First approximation: Test B measures in the Test A frame of reference = Test B measure + x-axis intercept.

Step 3. Examine the scatterplot. Points far away from the joint-best-fit trend-line indicate items that are not good pairs. You may wish to consider these to be no longer paired. Drop the items from the plot and redraw the trend line.

Step 4. The slope of the best fit is: slope = (S.D. of Test B common items) / (S.D. of Test A common items)
= Standard deviation of the item difficulties of the common items on Test B divided by Standard deviation of the item difficulties of the common items on Test A

Include in the Test B control file:
USCALE = the value of 1/slope

UMEAN = the value of the x-intercept
and reanalyze Test B. Test B is now in the Test A frame of reference, and the person and item measures from Test A and Test B can be reported together.

Random Equivalence Equating
The samples of persons who took both tests are believed to be randomly equivalent. Or, less commonly, the samples of items in the tests are believed to be randomly equivalent.

Step 1. From the separate analyses of Test A and Test B, obtain the means and sample standard deviation of the Rasch person-ability measures for two person samples (including extreme scores).

Step 2. To bring Test B into the frame of reference of Test A, adjust by the difference between the means of the Rasch person-ability measures for the person samples and user-rescale by the ratio of their sample standard deviations.

Include in the Test B control file:
USCALE = value of (sample S.D. person sample for Test A) / (sample S.D. person sample for Test B)
UMEAN = value of (mean for Test A) - (mean for Test B * USCALE)
and reanalyze Test B.

Check: Test B should now report the same sample mean and sample standard deviation as Test A for the Rasch person-ability measures.

Test B is now in the Test A frame of reference, and the person measures from Test A and Test B can be reported together.

In short::
1. Rasch-analyze each group separately.
2. Choose one group as the reference group. This is usually the largest group. Note down its group mean and S.D.
3. Adjust all the means and S.D. of the other groups so that they have the reference mean and S.D. - you can do this with UIMEAN= and USCALE=
4. Combine all the person files PFILE= and item files IFILE=. Excel files are convenient for this. Excel can sort etc.

Paired Item Equating - Parallel Items - Pseudo-Common Items

When constructing tests with overlapping content.

Step 1. From your list of items (or your two tests), choose 20 pairs of items. In your opinion, the difficulties of the two items in each pair should be approximately the same.

Step 2. One item of each pair is in the first test, and the other item is in the second test. Be sure to put codes in the item labels to remind yourself which items are paired.

Step 3. Collect your data.

Step 4. Analyze each test administration separately.

Step 5. Subtotal the difficulties of the paired items for each test administration (Table 27). The difference between the pair subtotals is the equating constant. Is this a reasonable value? You can use this value in UIMEAN= of one test to align the two tests.

Step 6. Cross-plot the difficulties of the pairs of items (with confidence bands computed from the standard errors of the pairs of item estimates). The plot will confirm (hopefully) your opinion about the pairs of item difficulties. If not, you will learn a lot about your items!!

Linking Tests with Common Items
Here is an example:
A. The first test (50 items, 1,000 students)
B. The second test (60 items, 1,000 students)

C. A linking test (20 items from the first test, 25 from the second test, 250 students)

Here is a typical Rasch approach. It is equivalent to applying the "common item" linking method twice.

(a) Rasch analyze each test separately to verify that all is correct.

(b) Cross-plot the item difficulties for the 20 common items between the first test and the linking test. Verify that the link items are on a statistical trend line parallel to the identity line. Omit from the list of linking items, any items that have clearly changed relative difficulty. If the slope of the trend line is not parallel to the identity line (45 degrees), then the test discrimination has changed. The test linking will use a "best fit to trend line" conversion:
Corrected measure on test 2 in test 1 frame-of-reference =
((observed measure on test 2 - mean measure of test 2 link items)*(SD of test 1 link items)/(SD of test 1 link items))
+ mean measure of test 1 link items

(c) Cross-plot the item difficulties for the 25 common items between the second test and the linking test. Repeat (b).

(d1) If both trend lines are approximately parallel to the identity line, than all three tests are equally discriminating, and the simplest equating is "concurrent". Put all 3 tests in one analysis. You can use the MFORMS= command to put all items into one analysis. You can also selectively delete items using the Specification pull-down menu in order to construct measure-to-raw score conversion tables for each test, if necessary.
Or you can use a direct arithmetical adjustment to the measures based on the mean differences of the common items: *www.rasch.org/memo42.htm* "Linking tests".

(d2) If best-fit trend lines are not parallel to the identity line, then tests have different discriminations. Equate the first test to the linking test, and then the linking test to the second test, using the "best fit to trend line" conversion, shown in (b) above. You can also apply the "best fit to trend" conversion to Table 20 to convert every possible raw score.

21.43 Estimation bias correction - warnings

Winsteps uses JMLE (= Joint Maximum-Likelihood Estimation), implemented with iterative-curve fitting, rather than Newton-Raphson estimation, because iterative curve-fitting is more robust against awkward data patterns.

Every estimation method has strengths and weaknesses. The primary weakness of JMLE is that estimates have statistical bias. This is most obvious in a test of two dichotomous items (Andersen, 1973). In such a test, the difference between the item difficulties of the two items will be estimated to be twice its true value. In practical situations, the statistical bias is usually less than the standard errors of the estimates . However, the advantages of JMLE far outweigh its disadvantages. JMLE is estimable under almost all conditions including arbitrary and accidental patterns of missing data, arbitrary anchoring (fixing) of parameter estimates, unobserved intermediate categories in rating scales, and multiple different Rasch models in the same analysis.

Andersen, E. B. Conditional inference for multiple-choice questionnaires. British Journal of Mathematical and Statistical Psychology, 1973, 26, 31-44.

In the psychometric literature, the terms "bias" and "inconsistency" are usually used in the context of the estimation of the difficulties of dichotomous items in a fixed length test administered to a sample of persons. Each measure-parameter is imagined to have a true value, and it is the purpose of the estimation procedure is to estimate that value from the available data. We can never be sure that we have exactly estimated the true value.

If the sample size is infinite, and the resulting item estimates are their true values, then the estimates are consistent.
If the sample size is finite, and the expectations of the possible item estimates are their true values, then the estimates are unbiased.

Winsteps implements JMLE. JMLE estimates are inconsistent and biased. They are less central than the true values. For instance, if the test consists of two dichotomous items, then, with an infinite sample, the JMLE estimate of the difference between the two item difficulties will be twice the true value. In this situation, an immediate solution is PAIRED=Yes.

Ben Wright and Graham Douglas discovered that the multiplier (L-1)/L is an approximate correction for JMLE item bias, where L is the test length. For a two-item test this correction would be (2-1)/2 = 0.5 . It is implemented in Winsteps with STBIAS=YES.

Winsteps uses the raw scores as sufficient statistics for its estimates. The parameter estimates reported by Winsteps are the values for which "the observed raw score = the model-expected raw score".

"Statistical Consistency" (as usually conceptualized in the psychometric literature) relates to an infinite sample size with a finite test length. Under these conditions, Winsteps estimates are statistically inconsistent (i.e., are not the "true" parameter values even with an infinite amount of data) because inestimable extreme scores are included in the estimation space. "Conditional" estimation methods, CMLE, remove ("condition out") extreme scores from the estimation space,

The practical concern is "estimation bias", "departure of estimates from their true values with a finite amount of data". Winsteps estimates do have estimation bias. The Winsteps estimates are less central than they should be. But, as the likelihood of observing extreme scores reduces, the bias in the Winsteps estimates also reduces. Published studies indicate that when the test length is longer than 20 dichotomous items and the sample size is greater than 20 cases, then the Winsteps estimation bias is inconsequentially small. Estimation bias is usually only of concern if exact probabilistic inferences are to be made from logit measures obtained from small samples or short tests. But such inferences are imprecise irrespective of the size of the estimation bias.

There are techniques which correct for estimation bias under specific conditions. One such condition is when the data correspond to pairwise observations (such as a basketball league or chess competition). Winsteps has the PAIRED=YES option for this situation.

At least two sources of estimation error are reported in the literature.

An "estimation bias" error. This is usually negligibly small after the administration of 10 dichotomous items (and fewer rating scale items). Its size depends on the probability of observing extreme score vectors. For a two item test, the item measure differences are twice their theoretical values, reducing as test length increases. This can be corrected. STBIAS= does this approximately, but is only required if exact probability inferences are to be made from logit measure differences.

A "statistical inflation" error. Since error variance always adds to observed variance, individual measures are always reported to be further apart (on average) than they really are. This cannot be corrected, in general, at an individual- measure level, because, for any particular measurement it cannot be known to what extent that measurement is biased by measurement error. However, if it is hypothesized that the persons, for instance, follow a normal distribution of known mean and standard deviation, this can be imposed on the estimates (as in MMLE) and the global effects of the estimate dispersion inflation removed. This is done in some other Rasch estimation software.

Estimation Bias

All Rasch estimation methods have some amount of estimation bias (which has no relationship with demographic bias). The estimation algorithm used by Winsteps, JMLE, has a slight bias in measures estimated from most datasets. The effect of the bias is to spread out the measures more widely than the data indicate. In practice, a test of more than 20 dichotomous items administered to a reasonably large sample will produce measures with inconsequential estimation bias. Estimation bias is only of concern when exact probabilistic inferences are to be made from short tests or small samples. Ben Wright opted for JMLE in the late 1960's because users were rarely concerned about such exact inferences, but they were concerned to obtain speedy, robust, verifiable results from messy data sets with unknown latent parameter distributions. Both of the identifiable sources of error are reduced by giving longer tests to bigger samples. With short tests, or small samples, other threats to validity tend to be of greater concern than the inflationary ones.

If estimation bias would be observed even with an infinitely large sample (which it would be with JMLE), then the estimation method is labeled "statistically inconsistent" (even though the estimates are predictable and logical). This sounds alarming but the inconsistency is usually inconsequential, or can be easily corrected in the unlikely event that it does have substantive consequences.

The JMLE joint likelihood estimation algorithm produces estimates that have a usually small statistical bias. This bias increases the spread of measures and calibrations, but usually less than the standard error of measurement. The bias quickly becomes insignificantly small as the number of persons and items increases. The reason that JMLE is statistically inconsistent under some conditions, and noticeably biased for short tests or small samples, is that it includes the possibility of extreme scores in the estimation space, but cannot actually estimate them. Inconsistency doesn't really matter, because it asks "if we have infinite data, will the estimation method produce the correct answer?" Estimation bias, also called statistical bias, is more important because it asks "How near to correct are the estimates with finite data?" In practice, JMLE bias is smaller than the other sources of noise in the data. See Ben Wright's comments at www.rasch.org/memo45.htm

For paired comparisons and very short tests, estimation can double the apparent spread of the measures, artificially inflating test reliability. This can be eliminated by specifying PAIRED=YES.

Correcting for bias may be helpful when it is desired to draw exact probabilistic inferences for small, complete datasets without anchoring.

Correcting for bias may be misleading, or may be suppressed by Winsteps, in the presence of missing data or anchored persons or items.

Bias correction can produce apparently inconsistent measures if bias-corrected measures, estimated from an unanchored analysis, are then used to anchor that same dataset.

Estimation correction methods:

STBIAS=YES implements a variant of the simple bias correction proposed in Wright, B.D. and Douglas, G.A. (1977). Best procedures for sample-free item analysis. Applied Psychological Measurement, 1, 281-294. With large samples, a useful correction for bias is to multiply the estimated measures by (L-1)/L, where L is the smaller of the average person or item response count, so, for paired comparisons, multiply by 0.5. This is done automatically when PAIRED=YES.

Other Rasch programs may or may not attempt to correct for estimation bias. When comparing results from other programs, try both STBIAS=Y and STBIAS=N to find the closest match.

Estimation methods with less estimation bias under some circumstances include CMLE and MMLE, but these have other limitations or restrictions which are deemed to outweigh their benefits for most uses.

Technical information:

Statistical estimation bias correction with JMLE is relevant when you wish to make exact probabilistic statements about differences between measures for short tests or small samples. The (L-1)/L correction applies to items on short dichotomous tests with large samples, where L is the number of non-extreme items on a test. For long dichotomous tests with small samples, the correction to person measures would be (N-1)/N. Consequently Winsteps uses a bias correction on dichotomous tests for items of (L-1)/L and for persons of (N-1)/N

The reason for this correction is because the sample space does not match the estimation space. The difference is extreme score vectors. Estimation bias manifests itself as estimated measures which are more dispersed than the unbiased measures. The less likely an extreme score vector, the smaller the correction to eliminate bias. Extreme score vectors are less likely with polytomies than with dichotomies so the bias correction is smaller. For example, if an instrument uses a rating scale with m categories, then Winsteps corrects the item measures by (m-1)(L-1)/((m-1)(L-1)+1) and person measures by (m-1)(N-1)/((m-1)(N-1)+1) - but these are rough approximations.

With most Rasch software using CMLE, PMLE or MMLE bias correction of item measures is not done because the estimation bias in the item difficulties is generally very small. Bias correction of person abilities is not done though estimation bias exists.

Interaction terms are computed in an artificial situation in which the abilities and difficulties estimates are treated as known. Estimation bias is a minor effect in the interaction estimates. It would tend to increase very slightly the probability that differences between interaction estimates are reported as significant. So this is another reason to interpret DIF tests conservatively. If the number of relevant observations for an interaction term is big enough for the DIF effect to be regarded as real, and not a sampling accident, then the estimation bias will be very small. In the worst case, the multiplier would be of the order of (C-1)/C where C is the number of relevant observations.

Comparing Estimates

Bigsteps and Winsteps should produce the same estimates when

(a) they are run with very tight convergence criteria, e.g.,
RCONV=.00001
LCONV=.00001
MJMLE=0

(b) they have the same statistical bias adjustment
STBIAS=YES ; estimates will be wider spread
or
STBIAS=NO ; estimates will be narrower

(c) they have the same extreme score adjustment
EXTRSC=0.5

The item estimates in BTD were produced with statistical bias adjustment, but with convergence criteria that would be considered loose today. Tighter convergence produces a wider logit spread. So the BTD item estimates are slightly more central than Winsteps or Bigsteps.

Winsteps and Bigsteps are designed to be symmetric. Transpose persons and items, and the only change is the sign of the estimates and an adjustment for local origin. The output reported in BTD (and by most modern Rasch programs) is not symmetric. So the person measure estimates in BTD are somewhat different.

Do-it-yourself estimation-bias correction

Correcting for estimation-bias in Winsteps estimates has both advantages and disadvantages. Corrected estimates are usually slightly more central than uncorrected estimates. The only conspicuous advantage of bias correction is for making inferences based on the exact logit distance between the Rasch estimates. Since, with small data sets, the bias correction is usually less than the standard error of the Rasch estimates, bias correction may be of doubtful statistical utility.

STBIAS= will not correct for bias accurately with missing data, IWEIGHT= or PWEIGHT=. It may over- or under- correct for estimation bias.

If you do need estimation-bias correction that is as accurate as possible with your data set, you will need to discover the amount of bias in the estimates, and then use USCALE= to perform your own estimation-bias correction.

Here is a procedure using simulated data sets:

1. In your control file, STBIAS=No and USCALE=1
2. Obtain the Winsteps estimates for your data
3. Simulate many datasets using those estimates. (SIFILE= on the Winsteps Output Files menu).
4. Obtain the Winsteps estimates from the simulated data sets
5. Regress the simulated estimates on your initial estimates. These will give a slope near 1.0.
6. Obtain the Winsteps estimates for your data with USCALE = 1/slope

The set of estimates in 6 is effectively unbiased.

21.44 Estimation methods: JMLE, PROX, WMLE, CMLE, PMLE, AMLE

The Joint Maximum Likelihood Estimation (JMLE) equations in Winsteps are similar to www.rasch.org/rmt/rmt122q.htm for dichotomies, and www.rasch.org/rmt/rmt102t.htm for polytomies, enhanced to allow estimation of both person abilities and item difficulties simultaneously.

The dichotomous estimation equations are implemented in the Excel spreadsheet at www.rasch.org/moulton.htm and the polytomous estimation equations are implemented in the Excel spreadsheet at www.rasch.org/poly.xls

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Comparison of Estimation Methods: Linacre (2022) compares the item estimates produced by R Statistics packages (including eRm, TAM, ltm, pairwise, sirt), Winsteps and Facets using three datasets. In this comparison, there estimation methods include CMLE, JMLE, MMLE and PMLE. Each set of item estimates has its own logit scaling due to estimation method, convergence criteria, niceties of implementation and local constraints. After standardizing the logit scales, the estimates for CMLE, JMLE and MMLE coincide. Consequently for any application in which logit scales are transformed into user-friendly scales, all these estimation methods are equivalent for the items (and probably the persons). After standardizing, PMLE estimates were generally close to the other estimates but noticeably different for some items. Upon further inspection, it was seen that the uneven use of the observations by PMLE can produce effective item p-values that differ from the raw-score p-values used by all the other estimation methods. This can bias the PMLE item estimates relative to all the other estimation methods.

Linacre J.M. (2022) R Statistics: survey and review of packages for the estimation of Rasch models, Int J Med Educ. 2022; 13:171-175; Published 24/06/2022

Winsteps implements two methods of estimating Rasch parameters from ordered qualitative observations: JMLE and PROX. Estimates of the Rasch measures are obtained by iterating through the data. Initially all unanchored parameter estimates (measures) are set to zero. Then the PROX method is employed to obtain rough estimates. Each iteration through the data improves the PROX estimates until they are usefully good. Then those PROX estimates are the initial estimates for JMLE which fine-tunes them, again by iterating through the data, in order to obtain the final JMLE estimates. The iterative process ceases when the convergence criteria are met. These are set by MJMLE=, CONVERGE=, LCONV= and RCONV=. Depending on the data design, this process can take hundreds of iterations (Convergence: Statistics or Substance?). When only rough estimates are needed, force convergence by pressing Ctrl+F or by selecting "Finish iterating" on the File pull-down menu.

Extreme scores: (perfect, maximum possible scores, and zero, minimum possible scores) are dropped from the main estimation procedure. Their measures are estimated separately using EXTRSC=.

Missing data: most Rasch estimation methods do not require that missing data be imputed, or that there be case-wise or list-wise omission of data records with missing data. For datasets that accord with the Rasch model, missing data lower the precision of the measures and lessen the sensitivity of the fit statistics, but do not bias the measure estimates.

Likelihood: Using the current parameter estimates (Rasch measures), the probability of observing each data point is computed, assuming the data fit the model. The probabilities of all the data points are multiplied together to obtain the likelihood of the entire data set. The parameter estimates are then improved (in accordance with the estimation method) and a new likelihood for the data is obtained. The values of the parameters for which the likelihood of the data has its maximum are the "maximum likelihood estimates" (Ronald A. Fisher, 1922).

JMLE "Joint Maximum Likelihood Estimation" is also called UCON, "Unconditional maximum likelihood estimation". It was devised by Wright & Panchapakesan, www.rasch.org/memo46.htm. In this formulation, the estimate of the Rasch parameter (for which the observed data are most likely, assuming those data fit the Rasch model) occurs when the observed raw score for the parameter matches the expected raw score. "Joint" means that the estimates for the persons (rows) and items (columns) and rating scale structures (if any) of the data matrix are obtained simultaneously. The iterative estimation process is described at Iteration.

Advantages - these are implementation dependent, and are implemented in Winsteps:
(1) independence from specific person and item distributional forms.
(2) flexibility with missing data
(3) the ability to analyze test lengths and sample sizes of any size
(4) symmetrical analysis of person and item parameters so that transposing rows and columns does not change the estimates
(5) flexibility with person, item and rating scale structure anchor values
(6) flexibility to include different variants of the Rasch model in the same analysis (dichotomous, rating scale, partial credit, etc.)
(7) unobserved intermediate categories of rating scales can be maintained in the estimation with exact probabilities.
(8) all non-extreme score estimable (after elimination of extreme scores and rarely-observed Guttman subsets)
(9) all persons with the same total raw scores on the same items have the same measures; all items with the same raw scores across the same persons have the same measures.

Disadvantages:

(11) measures for extreme (zero, perfect) scores for persons or items require post-hoc estimation.
(12) estimates are statistically inconsistent. Infinite data produces usually only slightly statistically-incorrect estimates. This is seen as estimation bias for finite samples..
(13) estimation bias, particularly with small samples or short tests, inflates the logit distance between estimates. The estimation bias is minescule for large datasets, and almost always less that the standard error of the estimates. The measure-order of the estimates is correct. Estimation bias is easy to correct when required. STBIAS=.
(14) chi-squares reported for fit tests (particularly global fit tests) may be somewhat inflated, exaggerating misfit to the Rasch model to a very small degree.

Comment on (8): An on-going debate is whether measures should be adjusted up or down based on the misfit in response patterns. With conventional test scoring and Rasch JMLE, a lucky guess counts as a correct answer exactly like any other correct answer. Unexpected responses can be identified by fit statistics. With the three-parameter-logistic item-response-theory (3-PL IRT) model, the score value of an unexpected correct answer is diminished whether it is a lucky guess or due to special knowledge. In Winsteps, responses to off-target items (the locations of lucky guesses and careless mistakes) can be trimmed with CUTLO= and CUTHI=, or be diminished using TARGET=Yes.

Comment on (13): JMLE exhibits some estimation bias in small data sets, but this rarely exceeds the precision (model standard error of measurement, SEM) of the measures. Estimation bias is only of concern when exact probabilistic inferences are to be made from short tests or small samples. Estimation bias can be exactly corrected for paired-comparison data with PAIRED=Yes. For other data, It can be approximately corrected with STBIAS=Yes, but, in practice, this is not necessary (and sometimes not advisable).

JMLE estimation details:
Newton-Raphson is an all-purpose estimation procedure and relatively easy to implement, so Winsteps once used this method. However, Newton-Raphson works best when there is a clear maximum in the likelihood function. This usually happens with complete data with dichotomies, but the story is different for long rating scales, partial credit, and incomplete data. Then we can get several local maxima, and Newton-Raphson has difficulty choosing between them. This situation became more common as Winsteps was applied to datasets that were not originally envisioned. For instance, it was analysis of DNA strings that motivated the increase in items in Winsteps to 60,000.

Rasch does have a useful feature. The underlying functions are all monotonic logistic curves. We can take advantage of this to refine the estimation process. So, in Winsteps, the estimation process for each parameter is like this:

step 1.
current value of the parameter estimate -> compute expected score
current value of the parameter estimate + a little bit -> compute expected score
compute the logistic ogive between the two current values and the two expected scores
from the logistic ogive, predict the parameter value that matches the observed score. This is the new current value for this parameter. Do this once.

step 2. Then do the same thing for the next parameter and all the other parameters.

step 3. return to step 1 while the biggest change in any parameter value is big, or the biggest difference between any observed and expected score is big. "Big" is defined by the convergence criteria.

step 4. the estimates have converged. We have the best values of the parameters. Rejoice!

PROX is the Normal Approximation Algorithm devised by Cohen (1979). This algorithm capitalizes on the similar shapes of the logistic and normal ogives. It models both the persons and the items to be normally distributed. The variant of PROX implemented in Winsteps allows missing data. The form of the estimation equations is:
Ability of person = Mean difficulty of items encountered +
log ((observed score - minimum possible score on items encountered) /
(maximum possible score on items encountered - observed score))
* square-root (1 + (variance of difficulty of items encountered) / 2.9)

In Winsteps, PROX iterations cease when the variance of the items encountered does not increase substantially from one iteration to the next.

Advantages - these are implementation dependent, and are implemented in Winsteps:

(2)-(9) of JMLE
Computationally the fastest estimation method.

Disadvantages
(1) Person and item measures assumed to be normally distributed.
(11)-(14) of JMLE

AMLE is Anchored Maximum Likelihood Estimation. It is also called MLE, Maximum Likelihood Estimatin. The items or persons, along with the Andrich thresholds for polytomies, are anchored at pre-set, fixed, measures, then the person or item measures are estimated. It is described at https://www.rasch.org/rmt/rmt122q.htm

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Other estimation methods in common use (but not implemented in Winsteps):

Gaussian least-squares finds the Rasch parameter values which minimize the overall difference between the observations and their expectations, Sum((Xni - Eni)²) where the sum is overall all observations, Xni is the observation when person encounters item i, and Eni is the expected value of the observation according to the current Rasch parameter estimates. For Effectively, off-target observations are down-weighted, similar to TARGET=Yes in Winsteps.

Minimum chi-square finds the Rasch parameter values which minimize the overall statistical misfit of the data to the model, Sum((Xni - Eni)² / Vni) where Vni is the modeled binomial or multinomial variance of the observation around its expectation. Effectively off-target observations are up-weighted to make them less improbable.

Gaussian least-squares and Minimum chi-square:
Advantages - these are implementation dependent:
(1)-(8) All those of JMLE.

Disadvantages:
(9) persons with the same total raw scores on the same items generally have different measures; items with the same raw scores across the same persons generally have different measures.
(11)-(13) of JMLE
(14) global fit tests uncertain.

CMLE. Conditional maximum likelihood estimation. Item difficulties are structural parameters. Person abilities are incidental parameters, conditioned out for item difficulty estimation by means of their raw scores. The item difficulty estimates are those that maximize the likelihood of the data given the person raw scores and assuming the data fit the model. The item difficulties are then used for person ability estimation using a JMLE approach.

Advantages - these are implementation dependent:
(1), (6)-(9) of JMLE
(3) the ability to analyze person sample sizes of any size
(5) flexibility with item and rating scale structure anchor values
(12) statistically-consistent item estimates
(13) minimally estimation-biased item estimates
(14) exact global fit statistics

Disadvantages:
(2) limited flexibility with missing data
(3) test length severely limited by mathematical precision of the computer
(4) asymmetric analysis of person and item parameters so that transposing rows and columns changes the estimates
(5) no person anchor values
(11) of JMLE
(13) estimation-biases of person estimates small but uncertain

Here is how CMLE works. Let's assume dichotomous data, no missing data and no weighting ...

1) start with any set of item difficulties and all person abilities are zero logits
2) count the number of people with each observed raw score (drop extreme scores)

3) compute the probability of success and failure on each item according to the Rasch model
4) for each raw score, compute the likelihood (product of probabilities) of every way of making that raw score. For instance, if there are K items, then there are K ways of making a raw score of 1. each has K-1 failures and 1 success.
5) the expected score in each item-score cell = sum of Likelihoods of response strings with success on the item for the raw score / sum of all the Likelihoods for the raw score. This computation eliminates the person ability ("conditions out" the ability).
5) after computing the expected score in every cell of the item-score matrix, sum the expected scores on each item for each raw score (multiplied by number of persons with that raw score).
6) the summed expected scores are the current expected item raw score.
7) for each item compare the current expected item raw score with the observed item raw score, and adjust the item difficulty accordingly (using, for instance, Newton-Raphson).
8) repeat from 3) until all expected item scores approximate observed item scores.
9) with the item difficulties, compute the person abilities using AMLE.

QCMLE. Quasi-Conditional Maximum Likelihood Estimation. This estimates the CMLE values from the JMLE probability matrix. The marginal totals of the CMLE and JMLE probability matrices are the same, and the cell values are similar. QCMLE gives a useful indication of the difference between JMLE and CMLE estimates, and so the size of the estimation bias in JMLE estimates. This is usually small to negligible.

EAP. Expected A Posteriori estimation derives from Bayesian statistical principles. This requires assumptions about the expected parameter distribution. An assumption is usually normality, so EAP estimates are usually more normally distributed than Winsteps estimates (which are as parameter-distribution-free as possible). EAP is not implemented in Winsteps.

MMLE. Marginal maximum likelihood estimation. Item difficulties are structural parameters. Person abilities are incidental parameters, integrated out for item difficulty estimation by imputing a person measure distribution. The item difficulties are then used for person ability estimation using a JMLE approach.

Advantages - these are implementation dependent:
(3), (6)-(9) of JMLE
(1) independence from specific item distributional forms.
(2) flexibility with missing data extends to minimal length person response strings
(5) flexibility with item and rating scale structure anchor values
(11) extreme (zero, perfect) scores for persons are used for item estimation.
(12) statistically-consistent item estimates
(13) minimally estimation-biased item estimates
(14) exact global fit statistics

Disadvantages:
(1) specific person distribution required
(4) asymmetric analysis of person and item parameters so that transposing rows and columns changes the estimates
(5) no person anchor values
(11) measures for extreme (zero, perfect) scores for specific persons or items require post-hoc estimation.
(13) estimation-biased of person estimates small but uncertain

PMLE. Pairwise maximum likelihood estimation. Person abilities are incidental parameters, conditioned out for item difficulty estimation by means of pairing equivalent person observations. The item difficulties are then used for person ability estimation using a JMLE approach.

Advantages - these are implementation dependent:
(1), (3), (6), (7) of JMLE
(5) flexibility with item and rating scale structure anchor values
(8) all persons with the same total raw scores on the same items have the same measure
(12) statistically-consistent item estimates

Disadvantages:
(11) of JMLE
(2) reduced flexibility with missing data
(4) asymmetric analysis of person and item parameters so that transposing rows and columns changes the estimates
(5) no person anchor values

(8) items with the same total raw scores across the same persons generally have different measures.
(13) estimation-bias of item and person estimates small but uncertain
(14) global fit tests uncertain.
(15) uneven use of data in estimation renders standard errors and estimates less secure

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Thomas Warm's (1989) Weighted Maximum Likelihood Estimation WMLE, WLE

WMLE (or WLE) estimates, reported in IFILE= and PFILE=, are usually slightly more central than Winsteps estimates. Standard MLE estimates of any type are the maximum values of the likelihood function and so statistical modes. Thomas Warm shows that the likelihood function is skewed, leading to an additional source of estimation bias. Warm's weighted maximum likelihood estimate is less biased then the standard maximum likelihood estimate (MLE). Warm suggests an unbiasing correction that can be applied, in principle, to any MLE method, but there are computational constraints. Even when feasible, this fine tuning appears to be less than the relevant standard errors and have little practical benefit. The WMLE procedure can over-correct for the estimation bias in measures estimated from almost-extreme scores or very few observations.

The algebra is shown in Shudong Wang and Tianyou Wang.(1999) Precision of Warm's Weighted Likelihood Estimation of Ability for a Polytomous Model in CAT. There is an example at Example at WMLE.
Lord's bias corrected estimate = MLE + (J / (2 * I^2)). which is reported for items.
Warm's bias corrected estimate, WLE when (raw score - J / (2 * I)) = Expected score, which is reported for persons.

Suggestion to produce a WMLE TCC:
1. In your control file: WMLE=YES
2. Output the PFILE= to excel: PFILE=pfile.xlsx
3. In the Excel worksheet: scatterplot the WMLE person measures against the JMLE person MEASURE
4. Add a trendline: polynomial order 4 and show equation: save the equation
5. Output TCCFILE= to Excel
6. In a new column, "WMLE": multiply MEASURE by the equation. The WMLE values should be slightly more central than the MEASURE values.
7. Plot SCORE against WMLE for the WMLE TCC

Cohen Leslie. (1979) Approximate Expressions for Parameter Estimates in the Rasch Model, The British Journal of Mathematical and Statistical Psychology, 32, 113-120

Fisher R.A. On the mathematical foundations of theoretical statistics. Proc. Roy. Soc. 1922 Vol. CCXXII p. 309-368

Warm T.A. (1989). Weighted likelihood estimation of ability in item response theory. Psychometrika, 54, 427-450

21.45 Exact Match: OBS% and EXP%

```
+---------------------------------------------------------------------------------------------------+
|ENTRY    RAW                   MODEL|   INFIT  |  OUTFIT  |PTMEA|EXACT MATCH|                      |
|NUMBER  SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.| OBS%  EXP%| KID                  |
|------------------------------------+----------+----------+-----+-----------+----------------------|
|    72     14     25    -1.32    .37|2.02   2.9|5.16   5.7|A .04| 60.0  65.8| JACKSON, SOLOMON     |
```

Suppose your dataset consists of observations, {Xni}, of person n on item i. Based on the Rasch parameters (measures), there is an expected value Eni corresponding to each observation Xni. Eni is obtained by a calculation from the Rasch model.

When the absolute value of (Xni-Eni) is less than 0.5 then the observed data point is within 0.5 score points of its expected value, so the match is the closest possible. Thus, across all observations of item i,
Count (|Xni-Eni| <0.5) = A - these observations are of the closest categories to their expectations
Count (|Xni-Eni| =0.5) = B - these observations are on the borderline of matching their expectations
Count (|Xni-Eni| >0.5) = C - these observations are at least one category away from their expectations

So that A+B+C = Count (Xni)

OBS% = Observed % = 100 * (A + B/2) / (A+B+C)

B/2: consider the situation when person ability = item difficulty with dichotomous observations. Then every observation is 1 or 0, and every expectation is 0.5, so B = 100%. Under these conditions, it would be reasonable to say that 50% (B/2) of the observations matched their expectations.

Each possible value of Xni has a probability according to the Rasch model. Based on these, the expected value of OBS% can be computed, this is the EXP%. So, if the possible values of Xni are j=0,1,2,...,m, with probabilities Pnij, then
| j-Eni |<0.5 is either 1 when the condition is true, or zero when it is false, so
A = sum ((| j-Eni | < 0.5)*Pnij) - this is the sum of all the Pnij for which the absolute value j-Eni is less than 0.5
B = sum ((| j-Eni | = 0.5)*Pnij) - this is the sum of all the Pnij for which the absolute value j-Eni equals 0.5
C = sum ((| j-Eni | > 0.5)*Pnij) - this is the sum of all the Pnij for which the absolute value j-Eni is greater than 0.5

So that A+B+C = Count (Xni)

EXP% = Expected % = 100 * (A + B/2) / (A+B+C)

If OBS%<EXP% then the local data are more random than the model predicts.
If OBS%>EXP% then the local data are more predictable than the model predicts.

21.46 Excel plotting

First try the "Plots" pull-down menu.

Plotting: This is conveniently and flexibly done with Excel:

(A) Check that your copy of Excel works.

(B) Download the free Chart-Labeler add-in from www.appspro.com/Utilities/ChartLabeler.htm

(C) Run XYChartLabeler.exe
The Excel add-in "XY Chart Labels" is added to the Excel Tools pull-down menu.

(D) To plot
Write PFILE= or IFILE= from two analyses, or copy rows from Output Tables.

Copy and paste each of these into Excel:
Use "Data" "Text to Columns" to put values in columns

Put the columns to be plotted next to each other:
x-axis values to left of y-axis values.
Highlight numbers to be cross-plotted.

To make a plot:
Click on "Chart Wizard" or "Insert" ribbon
Click on "XY Scatter"
"Next"
"Next"
Fill in "Chart Title" and "Value" names
"Next"
Click "A new sheet"
"Finish"

On the plot:
Click "Series 1"
"Clear"
Right click a data point
Click "Format data"
Click "Marker none" (the data points will soon disappear!! - Don't worry!)
Click "OK"
Right click a grid-line

"Clear"

Add point labels:
Click on "Chart" tab
Click "Tools"
Click "XY Chart labels"
Click "XY Add"
Click "Centered"
Click "Select label _"
Click "Sheet 1" tab
Highlight point labels
Click red marker
Click "OK"
Point-labeled XY plot appears.

Use the plot to communicate:
Click on plot
Use handles to make the plot square
If drawing toolbar is not active:
 Right click a toolbar
 Click on Drawing
Click on "line" tool
Draw in a useful line.

21.47 Excel-formatted output Tables

Exporting Winsteps Tables to Excel is easy.

Winsteps control file, Extra specifications, or Specification menu: BOXSHOW=No

Winsteps control file or Output Tables menu: the Table you want, such as Table 6.1, misfitting persons.

Output Table in NotePad (or your text editor:
"Select" with the mouse the part you want (Usually column heading lines to the bottom of the Table)
then right-click "Copy"

Launch Excel

Paste into Excel - top left cell. The Winsteps Table will go into the first column.

Excel: "Data", "Text to columns"

Excel: Delimited with spaces, or Fixed Width

Excel usually gets everything exactly right, so that each Winsteps table column is in a separate Excel column.

Done!

You can now use Excel to sort and select the Table columns.
Then paste the Excel table into Word (or wherever).

21.48 Extra Specifications prompt

Winsteps expects to find the control variables in your control file. You may, however, specify one or more control variables on the "Extra specifications" line. These variables supersede instructions in the control file. This is useful for making temporary changes to the control variables. There are special rules for blanks (see Example 3). You can turn off the Extra Specifications prompt from the Edit Initial Settings menu.

Example 0: You want to verify that your data is correctly formatted, so you only want to do one JMLE iteration this time, i.e., you want to set MJMLE=1 for this run only:

Please enter name of Winsteps control file: SF.TXT(Enter)
Please enter name of report output file: SFO.TXT(Enter)
 Extra specifications (if any). Press Enter to analyze:
 MJMLE=1(Enter)

Note:
Extra specifications? (e.g., MJMLE=1), or press Enter:
 MJMLE = 1(Enter)
  is invalid because there are blanks in MJMLE = 1.

Example 1: Use commas , instead of blanks as separators within a command:
 Extra specifications (if any). Press Enter to analyze:
idelete=10,13,14-17 pdelete=14,6-18,+13

Example 2: You want to produce the fit plot in Table 4 with specially chosen ranges on the axes:
 Please enter name of Winsteps control file: SF.TXT(Enter)
 Please enter name of report output file: SFO.TXT(Enter)
 Extra specifications? (e.g., MJMLE=1), or press Enter:
  TABLES=0001 MRANGE=3 FRANGE=4(Enter)

Example 3: To put blanks in an Extra Specification. Put the whole specification within " " (double quotes). Put the argument within ' ' (single quotes). E.g., You want the title TITLE= to be: Analysis B, and UMEAN=50.
 Please enter name of Winsteps control file: SF.TXT(Enter)
 Please enter name of report output file: SFO.TXT(Enter)
 Extra specifications? (e.g., MJMLE=1), or press Enter:
  "Title = 'Analysis B' " UMEAN=50

Example 4: Sub-lists.
In the Control file:
ISGROUPS=*
1-32 A
33-64 B
65-98 C
99-110 D
*

At the Extra specifications prompt: Use a comma , instead of a blank for the internal separator. Use a blank for the end-of-line separator.
ISGROUPS=* 1-32,A 33-64,B 65-98,C 99-110,D *

21.49 Extreme scores: what happens

Estimation:
Extreme scores are the lowest and highest possible scores for persons on items, or for items by persons. They include zero and perfect scores. They are shown in the Tables as MINIMUM ESTIMATE MEASURE and MAXIMUM ESTIMATE MEASURE.

Mathematically, they correspond to infinite or indefinite measures on the latent variable and so are not directly estimable. Accordingly persons or items with extreme scores are dropped for the duration of the measurement estimation process. The extreme persons are dropped casewise. The extreme items are dropped listwise.

Sometimes the effect of dropping extreme items and persons is to make other items and persons extreme. If so, these are also dropped. If the data have a Guttman pattern, ultimately all items and persons are dropped and the measures for that data set are reported as inestimable.

After the measures of all non-extreme items and persons have been estimated, then the extreme scores are reinstated. Reasonable extreme measures are imputed for them (using a Bayesian approach), so that all persons and items have measures. This is done by making small score adjustments using EXTREMESCORE=.

With TARGET=, CUTLO=, CUTHI= or ISGROUPS=, it may not be possible to estimate a measure for an extreme score. There are reported as INESTIMABLE.

Fit computation:
Item Infit and Outfit: In the IFILE=, these are reported for each item and summarize fit across all scored responses excluding responses in extreme person scores.
In the DISFILE=, these are reported for each scored response and summarize fit excluding responses in extreme person scores.

Let's set PDROPEXTREME=YES, so that extreme scores for persons are not counted. Then, here is an example:
```
IFILE:   Infit and Outfit mean-squares for 16237 responses scored 1 or 0 = 1.0873 and 1.1317
DISFILE: Infit and Outfit mean-squares for 10537 responses scored 1      = 1.0733 and 1.0916
         Infit and Outfit mean-squares for  5700 responses scored 0 have different values for
each incorrect response code.
```

Responses in extreme person scores always have perfect fit (infit and outfit mean-squares = 0), so they are excluded from fit computations everywhere.

Extreme person scores do have estimated measures, so they are included in the item and item-option response counts, average measures, and correlations.

Example 1: We want statistics that exclude responses in all person and item extreme scores.
PDROPEXTREME= Yes
IDROPEXTREME= Yes

21.50 Faster analysis: How long will an analysis take?

Most analyses have reached convergence within 30 iterations. A tentative guideline is:
length of analysis in minutes = (number of persons)*(length of test)/1,000,000

An analysis of 7000 persons on 2700 items using a 2.5GHz PC with 2GB RAM required 10 minutes.

For a faster analysis,
1. at least 2GB of RAM memory. 4GB is better, see Memory.
2. PRCOMP=NO if you don't want to produce ICORFILE=, PCORFILE=, Table 23 or Table 24
3. DISTR=NO if you don't want distractor/option sub-tables: Table 14.3 etc., DISFILE=
4. SUBSETS=NO if you don't need to check for disjoint subsets in the data
5. PTBIS=SKIP if you don't need point-correlations in Table 13, 18, IFILE=, etc.
6. larger values for the convergence criteria: CONVERGE=, LCONV=, RCONV=, or reduce the maximum number of iterations MJMLE=
7. MPROX=1 if the data are sparse
8. CMATRIX=NO if you do not need the category confusion matrix in Table 3.2, etc.
9. put the input files and the work files on different disk drives, see Edit Initial Settings.
10. put the Windows Temporary Folder on a RAM-type disk (faster access).

21.51 Fit diagnosis: infit outfit mean-square standardized

"Every single time, also start with the small data — it's eyeballing anomalies that have led me to some of my best findings." *Katelyn Gleason, CEO and Founder. Eligible Healthtech, September 2021, twittering about data analysis in general.*

Remember that our purpose is to measure the persons, not to optimize the items and raters. A good approach is to compute the person measures based on all the different item selections that you think are reasonable. Start with all the items, and then reduce to smaller sets of items. Cross-plot the person measures. If the person measures are collinear, use the larger set of items. If the person measures are not collinear, use the set of items which produces the more meaningful set of person measures.

A recent critique, M. Müller, "Item fit statistics for Rasch analysis: can we trust them?", Journal of Statistical Distributions and Applications (2020) 7:5, points out that CMLE response residuals are more exact than JMLE ones. Also, infit and outfit statistics are not ideal. But interestingly, the paper is concerned with Type 1 errors being too high, i.e., that using infit and outfit, especially in a JMLE context, the Rasch model is rejected as false when it should not be! The paper does not discuss Type 2 errors. So, based on this paper, we can say that JMLE infit and outfit report the situation as worse than it really is. So if JMLE infit and outfit are acceptable for practical purposes, then they definitely are!

What do Infit Mean-square, Outfit Mean-square, Infit Zstd (z-standardized), Outfit Zstd (z-standardized) mean?

Every observation contributes to both infit and outfit. But the weighting of the observations differs. On-target observations contribute less to outfit than to infit.

Outfit: outlier-sensitive fit statistic. This is based on the conventional chi-square statistic. This is more sensitive to unexpected observations by persons on items that are relatively very easy or very hard for them (and vice-versa).

Infit: inlier-pattern-sensitive fit statistic. This is based on the chi-square statistic with each observation weighted by its statistical information (model variance). This is more sensitive to unexpected patterns of observations by persons on items that are roughly targeted on them (and vice-versa).

Outfit = sum (residual ^{2} / information) / (count of residuals) = average ((standardized residuals)^2) = chi-square/d.f. = mean-square

The standardized residual is also called the *Pearson* residual.

Infit = sum ((residual ^{2} / information) * information) / sum(information) = average ((standardized residuals)^2 * information) = information-weighted mean-square

Mean-square: this is the chi-square statistic divided by its degrees of freedom. Consequently its expected value is close to 1.0. Values greater than 1.0 (underfit) indicate unmodeled noise or other source of variance in the data - these degrade measurement. Values less than 1.0 (overfit) indicate that the model predicts the data too well - causing summary statistics, such as reliability statistics, to report inflated statistics. See further dichotomous and polytomous mean-square statistics. The mean-square Outfit statistic is also called the *Reduced* chi-square statistic. For computations, see

If the mean-squares average much below 1.0, then the data may have an almost-Guttman pattern. Please use much tighter convergence criteria.

Z-Standardized: these report the statistical significance (probability) of the chi-square (mean-square) statistics occurring by chance when the data fit the Rasch model. "Standardized" means "transformed to conform to a unit-normal distribution". The values reported are unit-normal deviates, in which .05% 2-sided significance corresponds to 1.96. Overfit is reported with negative values. These are also called t-statistics reported with infinite degrees of freedom.

ZSTD probabilities: two-sided unit-normal deviates	
1.00	p= .317
1.96	.050
2.00	.045
2.58	.01
3.00	.0027
4.00	.00006
5.00	.0000006

Infit was an innovation of Ben Wright's (G. Rasch, 1980, Afterword). Ben noticed that the standard statistical fit statistic (that we now call Outfit) was highly influenced by a few outliers (very unexpected observations). Ben need a fit statistic that was more sensitive to the overall pattern of responses, so he devised Infit. Infit weights the observations by their statistical information (model variance) which is higher in the center of the test and lower at the extremes. The effect is to make Infit less influenced by outliers, and more sensitive to patterns of inlying observations.

Ben Wright's Infit and Outfit statistics (e.g., RSA, p. 100, www.rasch.org/rmt/rmt34e.htm) are initially computed as mean-square statistics (i.e., chi-square statistics divided by their degrees of freedom). For Outfit the d.f. is the count of observations. For Infit the d.f. is the sum of the information in the observations = 1 / item or person logit S.E.**2. Their likelihood (significance) is then computed. This could be done directly from chi-square tables, but the convention is to report them as unit normal deviates (i.e., t-statistics corrected for their degrees for freedom). I prefer to call them z-statistics, but the Rasch literature has come to call them t-statistics, so now I do to. It is confusing because they are not strictly Student t-statistics (for which one needs to know the degrees of freedom) but are random normal deviates.

$$Infit_i = \frac{\sum_{n=1}^{N}((X_{ni} - E(X_{ni}))^2)}{\sum_{n=1}^{N}\sum_{j=0}^{m}(P(j)(j - E(X_{ni}))^2)}$$

$$Outfit_i = \frac{\sum_{n=1}^{N}\frac{(X_{ni} - E(X_{ni}))^2}{\sum_{j=0}^{m}(P(j)(j - E(X_{ni}))^2)}}{N}$$

where i is item i, n=1 to N are the persons, Xni is the observation of category j of the rating scale.j=0,m. E(Xni) is the expected value of Xni. There is a similar computation for each person n, where i=1 to L are the items.

General guidelines:
First, investigate **negative point-measure or point-biserial correlations**. Look at the Distractor Tables, e.g., 10.3. Remedy miskeys, data entry errors, etc.

Then, the general principle is:

> **Investigate outfit before infit,**
> **mean-square before t standardized,**
> **high values before low or negative values.**

There is an asymmetry in the implications of out-of-range high and low mean-squares (or positive and negative t-statistics). High mean-squares (or positive t-statistics) are a much greater threat to validity than low mean-squares (or negative fit statistics).

Poor fit does not mean that the Rasch measures (parameter estimates) aren't additive. The Rasch model forces its estimates to be additive. Misfit means that the reported estimates, though effectively additive, provide a distorted picture of the data.

The fit analysis is a report of how well the data accord with those additive measures. So a MnSq >1.5 suggests a deviation from unidimensionality in the data, not in the measures. So the unidimensional, additive measures present a distorted picture of the data.

High outfit mean-squares may be the result of **a few random responses** by low performers. If so, drop with PDFILE= these performers when doing item analysis, or use EDFILE= to change those response to missing.

High infit mean-squares indicate that the items are mis-performing for the people on whom the items are targeted. This is a bigger threat to validity, but more difficult to diagnose than high outfit.

Mean-squares show the size of the randomness, i.e., the amount of distortion of the measurement system. 1.0 are their expected values. Values less than 1.0 indicate observations are too predictable (redundancy, model overfit). Values greater than 1.0 indicate unpredictability (unmodeled noise, model underfit). Mean-squares usually average to 1.0, so if there are high values, there must also be low ones. Examine the high ones first, and temporarily remove them from the analysis if necessary, before investigating the low ones.

Zstd are t-tests of the hypotheses "do the data fit the model (perfectly)?" ZSTD (standardized as a z-score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic value has been adjusted to a unit normal value. They show the improbability (significance). 0.0 are their expected values. Less than 0.0 indicate too predictable. More than 0.0 indicates lack of predictability. If mean-squares are acceptable, then Zstd can be ignored. They are truncated towards 0, so that 1.00 to 1.99 is reported as 1. So a value of 2 means 2.00 to 2.99, i.e., at least 2. For exact values, see Output Files. If the test involves less than 30 observations, it is probably too insensitive, i.e., "everything fits". If there are more than 300 observations, it is probably too sensitive, i.e., "everything misfits".

Interpretation of parameter-level mean-square fit statistics:	
>2.0	Distorts or degrades the measurement system.
1.5 - 2.0	Unproductive for construction of measurement, but not degrading.
0.5 - 1.5	Productive for measurement.

<0.5	Less productive for measurement, but not degrading. May produce misleadingly good reliabilities and separations.

In general, mean-squares near 1.0 indicate little distortion of the measurement system, regardless of the Zstd value. Evaluate high mean-squares before low ones, because the average mean-square is usually forced to be near 1.0. Mean-square fit statistics will average about 1.0, so, if you accept items (or persons) with large mean-squares (low discrimination), then you must also accept the counter-balancing items (or persons) with low mean-squares (high discrimination).

Outfit mean-squares: influenced by outliers. Usually easy to diagnose and remedy. Less threat to measurement.
Infit mean-squares: influenced by response patterns. Usually hard to diagnose and remedy. Greater threat to measurement.

Extreme scores always fit the Rasch model exactly, so they are omitted from the computation of fit statistics. If an extreme score has an anchored measure, then that measure is included in the fit statistic computations.

Anchored runs: Anchor values may not exactly accord with the current data. To the extent that they don't, the fit statistics may be misleading. Anchor values that are too central for the current data tend to make the data appear to fit too well. Anchor values that are too extreme for the current data tend to make the data appear noisy.

Question: Are you contradicting the usual statistical advice about model-data fit?
Statisticians are usually concerned with "how likely are these data to be observed, assuming they accord with the model?" If it is too unlikely (i.e., significant misfit), then the verdict is "these data don't accord with the model." The practical concern is: "In the imperfect empirical world, data never exactly accord with the Rasch model, but do these data deviate seriously enough for the Rasch measures to be problematic?" The builder of my house followed the same approach (regarding Pythagoras theorem) when building my bathroom. It looked like the walls were square enough for his practical purposes. Some years later, I installed a full-length rectangular mirror - then I discovered that the walls were not quite square enough for my purposes (so I had to make some adjustments) - so there is always a judgment call. The table of mean-squares is my judgment call as a "builder of Rasch measures".

Question: My data contains misfitting items and persons, what should I do?

Let us clarify the objectives here.

A. www.rasch.org/rmt/rmt234g.htm is aimed at the usual situation where someone has administered a test from somewhere to a sample of people, and we, the analysts, are trying to rescue as much of that data as is meaningful. We conservatively remove misfitting items and persons until the data makes reasonable sense. We then anchor those persons and items to their good measures. After reinstating whatever misfitting items and persons we must report, we do the final analysis.

B. A pilot study is wonderfully different. We want to optimize the subset of items. The person sample and the data can be tailored to optimize item selection. Accordingly,

First, even before data analysis, we need to arrange the items into their approximately intended order along the latent variable. With 89 items, item can be conceptually grouped into clusters located at 5 or more levels of the latent variable, probably more than 5. This defines what we want to measure. If we don't know this order, then we will not know whether we have succeeded in measuring what we intended to measure. We may accidentally construct a test that measures a related variable. This happened in one edition of the MMPI where the test constructors intended to measure depression, but produced a scale that measured "depression+lethargy".

Second, we analyze the data and inspect the item hierarchy. Omit any items that are locating in the wrong place on the latent variable. By "omit", I mean give a weight of zero with IWEIGHT=. Then the item stays in the analysis, but does not influence other numbers. This way we can easily reinstate items, if necessary, knowing where they would go if they had been given the usual weight of 1.

Third, reanalyze the data with the pruned item hierarchy. Omit all persons who severely underfit the items, these are contradicting the latent variable. Again, "omit" means PWEIGHT= 0. Also omit persons whose "cooperation" is because they have an overfitting response set, such as the middle category of every item.

Fourth, analyze again. The data should be coherent. Items in the correct order. Persons cooperating. So apply all the other selection criteria, such as content balancing, DIF detection, to this coherent dataset.

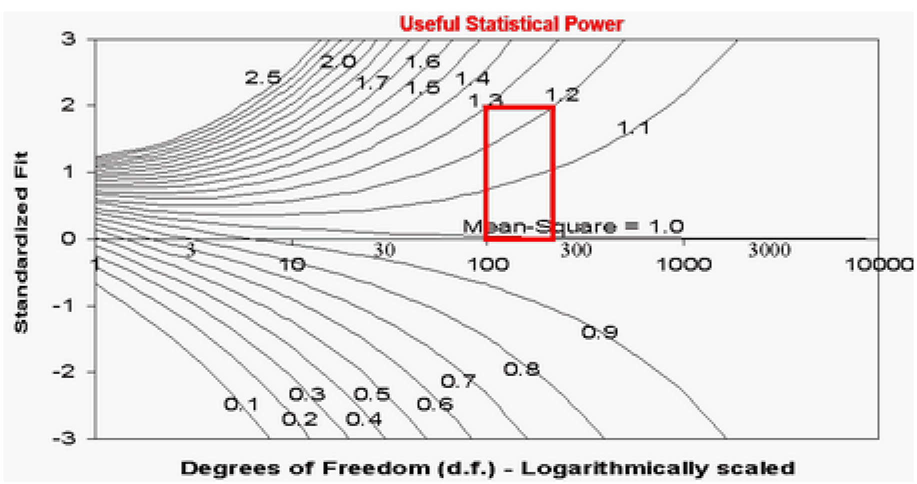
Question: Should I report Outfit or Infit?
A chi-square statistic is the sum of squares of standard normal variables. Outfit is a chi-square statistic. It is the sum of squared standardized residuals (which are modeled to be standard normal variables). So it is a conventional chi-square, familiar to most statisticians. Chi-squares (including outfit) are sensitive to outliers. For ease of interpretation, this chi-square is divided by its degrees of freedom to have a mean-square form and reported as "Outfit". Consequently I recommend that the Outfit be reported unless there is a strong reason for reporting infit.

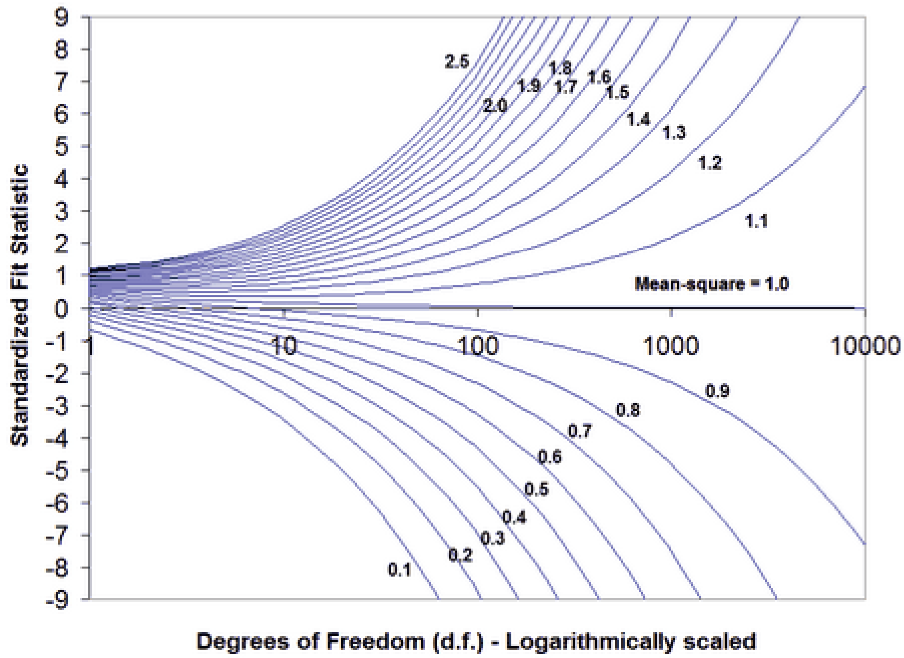
In the Rasch context, outliers are often lucky guesses and careless mistakes, so these outlying characteristics of respondent behavior can make a "good" item look "bad". Consequently, Infit was devised as a statistic that down-weights outliers and focuses more on the response string close to the item difficulty (or person ability). Infit is the sum of (squares of standard normal variables multiplied by their statistical information). For ease of interpretation, Infit is reported in mean-square form by dividing the weighted chi-square by the sum of the weights. This formulation is unfamiliar to most statisticians, so I recommend against reporting Infit unless the data are heavily contaminated with irrelevant outliers.

Question: Are mean-square values, >2 etc, sample-size dependent?
The mean-squares are corrected for sample size: they are the chi-squares divided by their degrees of freedom, i.e., sample size. The mean-squares answer "how big is the impact of the misfit". The t-statistics answer "how likely are data like these to be observed when the data fit the model (exactly)." In general, the bigger the sample the less likely, so that t-statistics are highly sample-size dependent. We eagerly await the theoretician who devises a statistical test for the hypothesis "the data fit the Rasch model usefully" (as opposed to the current tests for perfectly).

The relationship between mean-square and z-standardized t-statistics is shown in this plot. Basically, the standardized statistics are insensitive to misfit with less than 30 observations and overly sensitive to misfit when there are more than 300 observations.

Winsteps cuts off mean-square values at 9.90 because values higher than 9.90 have the same meaning as those of 9.90: the data really, really do not fit the Rasch model.





Question: For my sample of 2400 people, the mean-square fit statistics are close to 1.0, but the Z-values associated with the INFIT/OUTFIT values are huge (over 4 to 9.9). What could be causing such high values?

Your results make sense. Here is what has happened. You have a sample of 2,400 people. This gives huge statistically power to your test of the null hypothesis: "These data fit the Rasch model (exactly)." In the nomographs above, a sample size of 2,400 (on the right-hand-side of the plot) indicates that even a mean-square of 1.2 (and perhaps 1.1) would be reported as misfitting highly significantly. So your mean-squares tell us: "these data fit the Rasch model usefully", and the Z-values tell us: "but not exactly". This situation is often encountered in situations where we know, in advance, that the null hypothesis will be rejected. The Rasch model is a theoretical ideal. Empirical observations never fit the ideal of the Rasch model if we have enough of them. You have more than enough observations, so the null hypothesis of exact model-fit is rejected. It is the same situation with Pythagoras theorem. No empirical right-angled-triangle fits Pythagoras theorem if we measure it precisely enough. So we would reject the null hypothesis "this is a right-angled-triangle" for all triangles that have actually been drawn. But obviously billions of triangle are usefully right-angled.

Hagell and Westergren (Journal of Applied Measurement, 2016) recommend using a sample size between 250 and 500. You can use the Winsteps FORMAT= command to obtain this from a larger sample.

Example of computation:
Imagine an item with categories j=0 to m. According to the Rasch model, every category has a probability of being observed, Pj.
Then the expected value of the observation is E = sum (j * Pj)
The model variance (sum of squares) of the probable observations around the expectation is V = sum (Pj * (j - E) **2).
This is also the statistical information in the observation.
For dichotomies, these simplify to E = P1 and V = P1 * P0 = P1*(1-P1).

For each observation, there is an expectation and a model variance of the observation around that expectation.
residual = observation - expectation
Outfit mean-square = sum (residual**2 / model variance) / (count of observations)
Infit mean-square = sum (residual**2) / sum (modeled variance)

Thus the outfit mean-square is the accumulation of squared-standardized-residuals divided by their count (their expectation). The infit mean-square is the accumulation of squared residuals divided by their expectation.

Outlying observations have smaller information (model variance) and so have less information than on-target observations. If all observations have the same amount of information, the information cancels out. Then Infit mean-square = Outfit mean-square.

For dichotomous data. Two observations: Model p=0.5, observed=1. Model p=0.25, observed =1.
Outfit mean-square = sum ((obs-exp)**2 / model variance) / (count of observations) = ((1-0.5)**2/(0.5*0.5) + (1-0.25)**2/(0.25*0.75))/2 = (1 + 3)/2 = 2
Infit mean-square = sum ((obs-exp)**2) / sum(model variance) = ((1-0.5)**2 + (1-0.25)**2) /((0.5*0.5) + (0.25*0.75)) = (0.25 + 0.56)/(0.25 +0.19) = 1.84. The off-target observation has less influence.

The Wilson-Hilferty cube root transformation converts the mean-square statistics to the normally-distributed z-standardized ones. For more information, please see Patel's "Handbook of the Normal Distribution" or www.rasch.org/rmt/rmt162g.htm.

Diagnosing Misfit: Noisy = Underfit. Muted = Overfit

Classification	INFIT	OUTFIT	Explanation	Investigation
	Noisy	Noisy	Lack of convergence Loss of precision Anchoring	Final values in Table 0 large? Many categories? Large logit range? Displacements reported?
Hard Item	Noisy	Noisy	Bad item	Ambiguous or negative wording? Debatable or misleading options?
	Muted	Muted	Only answered by top people	At end of test?
Item	Noisy	Noisy	Qualitatively different item Incompatible anchor value	Different process or content? Anchor value incorrectly applied?
		?	Biased (DIF) item	Stratify residuals by person group?
		Muted	Curriculum interaction	Are there alternative curricula?
	Muted	?	Redundant item	Similar items? One item answers another? Item correlated with other variable?
Rating scale	Noisy	Noisy	Extreme category overuse	Poor category wording? Combine or omit categories? Wrong model for scale?
	Muted	Muted	Middle category overuse	
Person	Noisy	?	Processing error Clerical error Idiosyncratic person	Scanner failure? Form markings misaligned? Qualitatively different person?
High Person	?	Noisy	Careless Sleeping Rushing	Unexpected wrong answers? Unexpected errors at start? Unexpected errors at end?
Low Person	?	Noisy	Guessing Response set "Special" knowledge	Unexpected right answers? Systematic response pattern? Content of unexpected answers?
	Muted	?	Plodding Caution	Did not reach end of test? Only answered easy items?
Person/Judge Rating	Noisy	Noisy	Extreme category overuse	Extremism? Defiance? Misunderstanding the rating scale?
	Muted	Muted	Middle category overuse	Conservatism? Resistance?
Judge Rating			Apparent unanimity	Collusion? Hidden constraints?

INFIT: information-weighted mean-square, sensitive to irregular inlying patterns
OUTFIT: usual unweighted mean-square, sensitive to unexpected rare extremes
Muted: overfit, un-modeled dependence, redundancy, the data are too predictable
Noisy: underfit, unexpected unrelated irregularities, the data are too unpredictable.

Guessing and Carelessness

Both guessing and carelessness can cause high outfit mean-square statistics. Sometimes it is not difficult to identify which is the cause of the problem. Here is a procedure:
1) Analyze all the data: output PFILE=pf.txt IFILE=if.txt SFILE=sf.txt
2) Analyze all the data with anchor values: PAFILE=pf.txt IAFILE=if.txt SAFILE=sf.txt

2A) CUTLO= -2   this eliminates responses to very hard items, so person misfit would be due to unexpected responses to easy items
2B) CUTHI= 2 this eliminates responses to very easy items, so person misfit would be due to unexpected responses to hard items.

What is your primary concern? Statistical fit or productive measurement?

Statistical fit is like "beauty". Productive measurement is like "utility".

Statistical fit is dominated by sample size. It is like looking at the data through a microscope. The more powerful the microscope (= the bigger the sample), the more flaws we can see in each item. For the purposes of beauty, we may well scrutinize our possessions with a microscope. Is that a flaw in the diamond? Is that a crack in the crystal? There is no upper limit to the magnification we might use, so there is no limit to the strictness of the statistical criteria we might employ. The nearer to 1.0 for mean-squares, the more "beautiful" the data.

In practical situations, we don't look at our possessions through a microscope. For the purposes of utility, we are only concerned about cracks, chips and flaws that will impact the usefulness of the items, and these must be reasonably obvious. In terms of mean-squares, the range 0.5 to 1.5 supports productive measurement.

However, life requires compromise between beauty and utility. We want our cups and saucers to be functional, but also to look reasonably nice. So a reasonable compromise for high-stakes data is mean-squares in the range 0.8 to 1.2.

Fit statisticsfor item banks are awkward. They depend on the manner in which the items in the item banks are used, and also the manner in which the item difficulties are to be verified and updated. Initial values for the items often originate in conventional paper-and-pencil tests, but if the item bank is used to support other styles of testing, these initial values will be superseded by more relevant values. Constructing fit statistics for other styles of testing has proved challenging for theoreticians. This has forced the relaxation of the strict rules of conventional statistical analysis. This is probably why you are having difficulty finding appropriate literature.

My person sample size is 2,000. Many items have significant misfit. What shall I do?

Don't despair! Your items may not be as bad as those statistics say.

If the noise in the data is homogeneous, then the noise-level is independent of sample size. The mean-square statistics will also be independent of sample size.

t-statistics are sensitive to the power of the statistical test (sample size). The relationship between mean-squares and *t*-statistics is shown in the Figures above which suggests that, for practical purposes, *t*-statistics are under-powered for sample sizes less than 100 and over-powered for sample sizes greater than 300.

So my recommendation (not accepted by conventional statisticians) is that mean-squares be used in preference to *t*-statistics. In my view, the standard *t*-tests are testing the wrong hypothesis. Wrong hypothesis = "The data fit the model (perfectly)". Right hypothesis = "The data fit the model (usefully)". Unfortunately conventional statisticians are not interested in usefulness and so have not formulated *t*-tests for it.

Alternatively, random-sample 300 from your 2,000 test-takers. Perform your t-tests with this reduced sample. Confirm your findings with another random-sample of 300.

21.52 Global fit statistics

Please use Table 44. This uses simulations to estimate the degrees of freedom.

Here is an earlier computation of degrees of freedom which tended to exaggerate misfit of the data to the Rasch model:

Winsteps reports global fit statistics and approximate global log-likelihood chi-square (or chi-squared) statistic† in Table 44.1. The usual significance levels are p≤.05 and p≤.01.

Example: To compare the fit of "Rating Scale Model" (RSM) and "Partial Credit Model" (PCM, ISGROUPS=0) analyses. The number of categories and items is in the Table heading. The chi-square test is:
(global chi-square for RSM analysis - global chi-square for PCM analysis) with d.f. ((PCM Categories - 2*Items) - (RSM categories - 2)) where the 2 is 1 for the bottom category and 1 for the centering of the rating/PCM thresholds

The variance tables report the relative sizes of explained and unexplained variances.

The chi-square value is approximate. It is based on the current reported estimates which may depart noticeably from the "true" maximum likelihood estimates for these data. The degrees of freedom are the number of datapoints used in the free estimation (i.e., excluding missing data, data in extreme scores, etc.) less the number of free parameters.
For an unanchored analysis, free parameters = non-extreme items + non-extreme persons - 1 + (categories in estimated rating-scale structures - 2 * rating-scale structures).

Thus, for the "Liking for Science" data of 75 children administered 25 items. There are 74 non-extreme children and 25 non-extreme items. The data are complete so there are 74 x 25 = 1850 data points. The free parameters are 74 + 25 - 1 + (3-category rating scale - 2 x 1 rating scale) = 99 parameters. So the degrees of freedom are 1850 - 99 = 1751. The log-likelihood chi-square is 2657.91. So that the significance p=.000, i.e., the data exhibit highly significant misfit to the Rasch model, as is nearly always expected.

If you wish to compute your own global (or any other) fit test, the response-level probabilities, residuals etc. are reported in the XFILE=. For instance, for a global fit test, you could add up all the log-probabilities. Then chi-square estimate = - 2 * log-probability. A different chi-square estimate is the sum of squared-standardized residuals. You can count up the number of free parameters. For complete dichotomous data, it is usually the minimum of (number of different person marginal raw scores, number of different item marginal scores) - 1.

For a more local fit test, the chi-square estimate is -2 * sum of log-probabilities of relevant data or sum of squared-standardized residuals for the relevant data. The degrees of freedom approximate the count of data points less L'/L for each relevant person parameter and N'/N for each relevant item parameter, where L' is the number of responses by the person included in the local test and L is the total number of responses by the person. N' is the number of responses to the item included in the local test and N is the total number of responses to the item.

Deviance statistics are more trustworthy. They are the difference between the chi-squares of two analyses, with d.f. of the difference between the number of free parameters estimated.

The Rasch model is an idealization, never achieved by real data. Accordingly, given enough data, we expect to see statistically significant misfit the model. If the current data do not misfit, we merely have to collect more data, and they will! In essence, the null hypothesis of this significance test is the wrong one! We learn nothing from testing the hypothesis, "Do the data fit the model (perfectly)?" Or, as usually expressed in social science, "Does the model fit the data (perfectly)?" Perfection is never obtained in empirical data. What we really want to test is the hypothesis "Do the data fit the model usefully?" And, if not, where is the misfit, and what is it? Is it big enough in size (not "statistical significance") to cause trouble? This is the approach used in much of industrial quality-control, and also in Winsteps.

The general principle for degrees of freedom is "number of data points used for estimating the parameters - number of free parameters estimated". So, in most Rasch situations, when computing the d.f.:
1. omit extreme scores (persons and items).
2. data points = number of datapoints in non-extreme scores.
3. number of free person parameters = number of persons
4. number of free item parameters = number of items - 1, because the items are usually centered at 0 so one parameter is constrained to be the negative of the sum of the other parameters.
5. number of free parameters for each rating scale structure = number of categories in the structure - 2.
6. So dichotomies have no free parameters
"Rating scale model" = one structure for all the data
"Partial credit model" = one structure per item
Grouped-item model" = one structure per item-group.

However, this formula-based computation tends to exaggerate misfit of the data to the Rasch model. This, is superseded by the simulation method in Table 44.

† Wilks, Samuel S. (1938). "The large-sample distribution of the likelihood ratio for testing composite hypotheses". The Annals of Mathematical Statistics. 9 (1): 60–62. https://projecteuclid.org/download/pdf_1/euclid.aoms/1177732360

21.53 Glossary

Glossary - Dictionary - Lexicon of Rasch Measurement Terminology	
Glosario Español www.rasch.org/rmt/glosario.htm	
Ability	the level of successful performance of the objects of measurement (persons) on the latent variable. Each person's location on the unidimensional variable measured in "additive Rasch units", usually logits.
Additive scale	Scale of measurement in which the units have the properties of simple addition, so that "one more unit = the same amount extra regardless of the amount you already have". Typical measuring devices such as tape measures and thermometers have additive scales. Rasch additive scales are usually delineated in logits.
Agent of Measurement	the tool (items, questions, etc.) used to define a latent variable, and to position objects of measurement (persons etc.) along that variable.
Analytic rating	a rating of a specific aspect of a performance (cf. Holistic rating)
Anchor	the process of using anchor values to insure that different analyses produce directly comparable results.
Anchor Value	a pre-set logit value assigned to a particular object, agent or step to be used as a reference value for determining the measurements or calibrations of other objects, agents or steps.
Anchor Table	the table of Anchor Values used during Rasch analysis of an Input Grid and so included in the Results Table produced. The Anchor Table has the same format as the Results Table.
Anchoring	the process of using anchor values to insure that different analyses produce directly comparable results.
Best Test Design	Wright, B.D. & Stone, M.H., Best Test Design: Rasch Measurement. Chicago: Mesa Press, 1979
Bias	A change in logit values based on the particular agents or objects measured.
BOTTOM	The value shown in the Results Table for an agent on which all objects were successful, (so it was of bottom difficulty), or for an object which had no success on any agent (so it was of bottom ability)
Bottom Category	the response category at which no level of successful performance has been manifested.
Calibration	a difficulty measure in logits used to position the agents of measurement (usually test items) along the latent variable.
CAT Test	Computer-Adaptive Test. A test administered by computer in which the display of the next item depends on the response to the previous item.
Categories CATS	qualitative levels of performance on an observational or response format, e.g., a rating scale.
Cell	Location of data in the spreadsheet, given by a column letter designation and row number designation e.g. B7
Classical Test Theory	Item analysis in which the raw scores are treated as additive numbers.
Common Scale	a scale of measurement on which all agents and objects can be represented.
Column	Vertical line of data in the Spreadsheet data, usually representing in an Input Grid all responses to a particular item, or in a Results Table, all statistics measuring the same attribute of agents or objects.
Comment	A semi-colon ; followed by text. This is ignored by Winsteps and Facets.
Complete data	Data in which every persons responds to every item. It makes a completely-filled rectangular data matrix. There are no missing data.

Computer-Adaptive Test	CAT Test. A test administered by computer in which the display of the next item depends on the response to the previous item.
Construct validity	The correlation between the item difficulties and the latent trait as intended by the test constructor. "Is the test measuring what it is intended to measure?"
Content	the subject area evoked and defined by an agent.
Continuation line	A separate line of text which Winsteps analyses as appended to the end of the previous line. These are shown with "+".
Contrast component	In the principal components analysis of residuals, a principal component (factor) which is interpreted by contrasting the items (or persons) with opposite loadings (correlations) on the component.
Control file	A DOS-text file on your disk drive containing the Winsteps control variables.
Control variable	In Winsteps, "control variable = value", is an instruction for controlling the computer program, e.g., "ITEM1 = 4".
Convergence	the point at which further improvement of the item and person estimates makes no useful difference in the results. Rasch calculation ends at this point.
Correlation	the relationship between two variables
CTT	Classical Test Theory
Data file	Winsteps: file containing the person labels and the responses to the items. It is part of the Control file if DATA= or MFORMS= are not used.
Demographics	Information about the person included the person label, e.g., "F" for female or "M" for male
Deterministic	Exactly predictable without any uncertainty. This contrasts with Probabilistic.
Dichotomous Response	a response format of two categories such as correct-incorrect, yes-no, agree-disagree.
DIF Differential item functioning	Change of item difficulty depending on which person classification-group is responding to the item, also called "item bias"
Difficulty	the level of resistance to successful performance of the agents of measurement on the latent variable. An item with high difficulty has a low marginal score. The Rasch item difficulty is the location on the unidimensional latent variable, measured in additive Rasch units, usually logits. Item difficulty measures are the locations on the latent variable (Rasch dimension) where the highest and lowest categories of the item are equally probable, regardless of the number of categories the item has.
Dimension	a latent variable which is influencing the data values.
Discrepancy	one or more unexpected responses.
Distractor	Incorrect answer to a multiple-choice question, which is intended to distract the examinee away from the correct option. Sometimes all the options, correct and incorrect, are called "distractors".
Disturbance	one or more unexpected responses.
Diverging	the estimated calibrations at the end of an iteration are further from convergence than at the end of the previous iteration.
Easiness	the level of susceptibility to successful performance of the agents of measurement on the latent variable. An item with high easiness has a high marginal score.
Eigenvalue	The value of a characteristic root of a matrix, the numerical "size" of the matrix
Element	Individual in a facet, e.g., a person, an item, a judge, a task, which participates in producing an observation.
Empirical	Based on observation or experiment
Empirical data	data derived from observation or experimentation
END LABELS END NAMES	Winsteps: the end of the list of item identifying labels. This is usually followed by the data.
Entry number	Sequence number of the person or item in the dataset. Person: Entry number 1 is the top row of the response-level data.

	Item: Entry number 1 is the left-hand column of item-response data.
Equating	Putting the measures from two tests in the same frame of reference
Estimate	A value obtained from the data. It is intended to approximate the exactly true, but unknowable value.
EXP Expected value	Value predicted for this situation based on the measures
Expected Response	the predicted response by an object to an agent, according to the Rasch model analysis.
EXP() Exponential	Mathematical function used in estimating the Rasch measures
Exponential form	The Rasch model written in terms of exponentials, the form most convenient for computing response probabilities.
Extreme item	An item with an extreme score. Either everyone in the sample scored in the top category on the item, or everyone scored in the bottom category. An extreme measure is estimated for this item, and it fits the Rasch model perfectly, so it is omitted from fit reports.
Extreme person	A person with an extreme score. This person scored in the top category on the every item, or in the bottom category on every item. An extreme measure is estimated for this person, who fits the Rasch model perfectly, so is omitted from fit reports.
Facet	The components conceptualized to combine to produce the data, e.g., persons, items, judges, tasks.
Fit Statistic	a summary of the discrepancies between what is observed and what we expect to observe.
Focal group	The person classification-group which is the focus of a differential-item-functioning investigation
Frame of reference	The measurement system within which measures are directly comparable
Fundamental Measurement	1. Measurement which is not derived from other measurements. 2. Measurement which is produced by an additive (or equivalent) measurement operation.
Guttman	Louis Guttman (1916-1987) organized data into Scalograms intending that the observed response by any person to any items could be predicted deterministically from its position in the Scalogram.
Guttman pattern	Success on all the easier items. Failure on all the more difficulty items.
Heading	an identifier or title for use on tables, maps and plots.
Holistic rating	One rating which captures all aspects of the performance (cf. Analytic rating)
Hypothesis test	Fit statistics report on a hypothesis test. Usually the null hypothesis to be tested is something like "the data fit the model", "the means are the same", "these is no DIF". The null hypothesis is rejected if the results of the fit test are significant ($p \leq .05$) or highly significant ($p \leq .01$). The opposite of the null hypothesis is the alternate hypothesis.
Imputed data	Data generated by the analyst or assumed by the analytical process instead of being observed.
Independent	Not dependent on which particular agents and objects are included in the analysis. Rasch analysis is independent of agent or object population as long as the measures are used to compare objects or agents which are of a reasonably similar nature.
Infit	an information-weighted or inlier-sensitive fit statistic that focuses on the overall performance of an item or person, i.e., the information-weighted average of the squared standardized deviation of observed performance from expected performance. The statistic plotted and tabled by Rasch is this mean square normalized.
Interval scale	Scale of measurement on which equal intervals represent equal amounts of the variable being measured. Rasch analysis constructs interval scales with additive properties.

Item	agent of measurement (prompt, probe, "rating scale"), not necessarily a test question, e.g., a product rating. The items define the intended latent trait.
Item bank	Database of items including the item text, scoring key, difficulty measure and relevant statistics, used for test construction or CAT tests
Iteration	one run through the data by the Rasch calculation program, done to improve estimates by minimizing residuals.
Knox Cube Test	a tapping pattern test requiring the application of visual attention and short term memory.
Latent Trait	The idea of what we want to measure. A latent trait is defined by the items or agents of measurement used to elicit its manifestations or responses.
Link	Relating the measures derived from one test with those from another test, so that the measures can be directly compared.
LN() Logarithm	Natural or Napierian logarithm. A logarithm to the base e, where e = 2.718... This contrasts with logarithms to the base 10.
Local origin	Zero point we have selected for measurement, such as sea-level for measuring mountains, or freezing-point for Celsius temperature. The zero point is chosen for convenience (similarly to a "setting-out point"). In Rasch measurement, it is often the average difficulty of the items.
Log-odds	The natural logarithm of the ratio of two probabilities (their odds).
Logit	"Log-odds unit": the unit of measure used by Rasch for calibrating items and measuring persons on the latent variable. A logarithmic transformation of the ratio of the probabilities of a correct and incorrect response, or of the probabilities of adjacent categories on a rating scale.
Logistic curve-fitting	an estimation method in which the improved value of an estimate is obtained by incrementing along a logistic ogive from its current value, based on the size of the current raw-score residual.
Logistic ogive	the relationship between additive measures and the probabilities of dichotomous outcomes.
Logit-linear	The Rasch model written in terms of log-odds, so that the measures are seen to form a linear, additive combination
Map	a bar chart showing the frequency and spread of agents and objects along the latent variable.
Matrix	a rectangle of responses with rows (or columns) defined by objects and columns (or rows) defined by agents.
MCQ Multiple-Choice Question.	This is an item format often used in educational testing where the examinee selects the letter corresponding to the answer.
Mean-square MnSq	Also called the relative chi-square and the normed chi-square. A mean-square fit statistic is a chi-square statistic divided by its degrees of freedom (d.f.). Its expectation is 1.0. Values below 1.0 indicate that the data are too predictable = overly predictable = overfit of the data to the model. Values above 1.0 indicate the data too unpredictable = underfit of the data to the model
Measure Measurement	the location (usually in logits) on the latent variable. The Rasch measure for persons is the person ability. The Rasch measure for items is the item difficulty.
Menu bar	This is at the top of a program's window, and shows a list of standard program operations
Misfit	Any difference between the data the model predictions. Misfit usually refers to "underfit". The data are too unpredictable.
Missing data	Data which are not responses to the items. They can be items which the examinees did not answer (usually score as "wrong") or items which were not administered to the examinee (usually ignored in the analysis).
Model	Mathematical conceptualization of a relationship

Muted	Overfit to the Rasch model. The data are too predictable. The opposite is underfit, excessive noise.
Newton-Raphson iteration	A general method for finding the solution of non-linear equations
Noise	1. Randomness in the data predicted by the Rasch model. 2. Underfit: excessive unpredictability in the data, perhaps due to excessive randomness or multidimensionality.
Normal	a random distribution, graphically represented as a "bell" curve which has a mean value of 0 and a standard deviation of 1.
Normalized	1. the transformation of the actual statistics obtained so that they are theoretically part of a unit-normal distribution. "Normalized" means "transformed into a unit-normal distribution". We do this so we can interpret the values as "unit-normal deviates", the x-values of the normal distribution. Important ones are ±1.96, the points on the x-axis for which 5% of the distribution is outside the points, and 95% of the distribution is between the points. 2. linearly adjusting the values so they sum to a predetermined amount. For instance, probabilities always sum to 1.0.
Not administered	an item which the person does not see. For instance, all the items in an item bank which are not part of a computer-adaptive test.
Object of Measurement	person, product, site, to be measured or positioned along the latent variable.
OBS Observed	Value derived from the data
Observation Observed Response	the actual response by an object to an agent.
Odds ratio	Ratio of two probabilities, e.g., "odds against" is the ratio of the probability of losing (or not happening) to the probability of winning (or happening).
Outfit	an outlier-sensitive fit statistic that picks up rare events that have occurred in an unexpected way. It is the average of the squared standardized deviations of the observed performance from the expected performance. Rasch plots and tables use the normalized unweighted mean squares so that the graphs are symmetrically centered on zero.
Outliers	unexpected responses usually produced by agents and objects far from one another in location along the latent variable.
Overfit	The data are too predictable. There is not enough randomness in the data. This may be caused by dependency or other constraints.
Perfect score	Every response "correct" or the maximum possible score. Every observed response in the highest category.
Person	the object of measurement, not necessarily human, e.g., a product.
Plot	an x-y graph used by Rasch to show the fit statistics for agents and objects.
Point Labels	the placing on plots of the identifier for each point next to the point as it is displayed.
Point-measure correlation PT-MEASURE, PTMEA	The correlation between the observations in the data and the measures of the items or persons producing them.
Poisson Counting	a method of scoring tests based on the number of occurrences or non-occurrences of an event, e.g. spelling mistakes in a piece of dictation.
Polarity	The direction of the responses on the latent variable. If higher responses correspond to more of the latent variable, then the polarity is positive. Otherwise the polarity is negative.
Polytomous response	responses in more than two ordered categories, such as Likert rating-scales.
Population	Every person (or every item) with the characteristics we are looking for. A sample of persons or items is usually assumed to be a random sample from the population.
Predictive validity	This is the amount of agreement between results obtained by the evaluated instrument and results obtained from more directly, e.g., the correlation between success level on a test of carpentry skill and success level making furniture for

	customers. "Do the person measures correspond to more and less of what we are looking for?"
Probabilistic	Predictable to some level of probability, not exactly. This contrasts with Deterministic.
Process	the psychological quality, i.e., the ability, skill, attitude, etc., being measured by an item.
PROX	the "Normal Approximation" estimation algorithm (Cohen, 1979). used to obtain initial estimates for the iterative estimation process.
Rack	Placing the responses to two tests in adjacent columns for each person, as though the items were being placed on a rack, c.f., stack.
Rasch, Georg	Danish Mathematician (1906-1980), who first propounded the application of the statistical approach used by Rasch.
Rasch measure	linear, additive value on an additive scale representing the latent variable
Rasch Model	a mathematical formula for the relationship between the probability of success (P) and the difference between an individual's ability (B) and an item's difficulty (D). P=exp(B-D)/(1+exp(B-D)) or log [P/(1-P)] = B - D
Rasch-Andrich Threshold	Step calibration. Location on the latent variable (relative to the center of the rating scale) where adjacent categories are equally probable.
Rating Scale	A format for observing responses wherein the categories increase in the level of the variable they define, and this increase is uniform for all agents of measurement.
Rating Scale Analysis	Wright, B.D. & Masters, G.N., Rating Scale Analysis: Rasch Measurement. Chicago: Mesa Press, 1982.
Raw score	the marginal score; the sum of the scored observations for a person, item or other element.
Reference group	The person classification-group which provides the baseline item difficulty in a differential-item-functioning investigation
Reliability	Reliability (reproducibility) = True Variance / Observed Variance (Spearman, 1904, etc.). It is the ratio of sample or test variance, corrected for estimation error, to the total variance observed.
Residuals	the difference between data observed and values expected.
Response	The value of an observation or data-point indicating the degree of success by an object (person) on an agent (item)
Response set	Choosing the same response on every item, such as always selecting option "C" on a multiple-choice test, or always selecting "Agree" on an attitude survey.
Results Table	a report of Rasch calculations.
Rigidity	when agents, objects and steps are all anchored, this is the logit inconsistency between the anchoring values, and is reported on the Iteration Screen and Results Table. 0 represents no inconsistency.
Row	a horizontal line of data on a Spreadsheet, usually used, in the Input Grid, to represent all responses by a particular object. The top row of each spreadsheet is reserved for Rasch control information.
Rule-of-thumb	A tentative suggestion that is not a requirement nor a scientific formula, but is based on experience and inference from similar situations. Originally, the use of the thumb as a unit of measurement.
Sample	the persons (or items) included in this analysis
Scale	the quantitative representation of a latent variable.
Scalogram	Picture of the data in which the persons (rows) and items (columns) are arranged by marginal raw scores.
Score points	the numerical values assigned to responses when summed to produce a score for an agent or object.
Scoring key	The list of correct responses to multiple-choice (MCQ) items.
Scree plot	Plot showing the fraction of total variance in the data in each variance component.

Separation	the ratio of sample or test standard deviation, corrected for estimation error, to the average estimation error. This is the number of statistically different levels of performance that can be distinguished in a normal distribution with the same "true" S.D. as the current sample. Separation = 2: high measures are statistically different from low measures.
Specification	A Winsteps control-variable and its value, e.g., "Name1=17"
Stack	Analyzing the responses of the same person to multiple administrations of the same test as though they were made by separate persons, by "stacking" the person records in one long data file, c.f., "rack"
Standard Deviation: P.SD, S.SD	The root mean square of the differences between the sample of values and their mean value. In Winsteps, all standard deviations are "population standard deviations" (the sample is the entire population) = P.SD. For the larger "sample standard deviation" (the sample is a random selection from the population) = S.SD, please multiply the Winsteps standard deviation by square-root (sample-size / (sample size - 1)).
Standard Error	An estimated quantity which, when added to and subtracted from a logit measure or calibration, gives the least distance required before a difference becomes meaningful.
Step calibration Step difficulty	Rasch-Andrich threshold. Location on the latent variable (relative to the center of the rating scale) where adjacent categories are equally probable.
Steps	the transitions between adjacent categories as ordered by the definition of the latent variable.
Strata	= (4*Separation+1)/3 This is the number of statistically different levels of performance that can be distinguished in a normal distribution with the same "true" S.D. as the current sample, when the tales of the normal distribution are due to "true" measures, not measurement error. Strata=3: very high, middle, and very low measures can be statistically distinguished.
Sufficient statistic	A statistic (a number) which contains all the information in the data from which to estimate the value of a parameter.
Suffix	The letters added to a file name which specify the file format, e.g., ".txt" means "text file". If you do not see the suffix letters, instruct Windows to display them. See the Lesson 1 Appendix.
Table	Lists of words and numbers, arrange in columns, usually surrounded by "|".
Targeted	when the item difficulty is close to the person ability, so that he probability of success on a dichotomous item is near to 50%, or the expected rating is near to the center of the rating scale.
Targeting	Choosing items with difficulty equal to the person ability.
Task bar	This shows the Windows programs at the bottom of your computer screen
Template	a specially formatted input file.
Test length	The number of items in the test
Test reliability	The reliability (reproducibility) of the measure (or raw score) hierarchy of sample like this sample for this test. The reported reliability is an estimate of (true variance)/(observed variance), as also are Cronbach Alpha and KR-20.
TOP	The value shown in the Results Table for an agent on which no objects were successful, (so it was of top difficulty), or for an object which succeeded on every agent (so it was of top ability)
Top Category	the response category at which maximum performance is manifested.
UCON	the unconditional (or "joint" JMLE) maximum likelihood estimation formula, used by some Rasch programs for the second part of the iteration process.
Underfit	The data are too unpredictable. The data underfit the model. This may be because of excessive guessing, or contradictory dimensions in the data.
UNSURE	Rasch was unable to calibrate this data and treated it as missing.

Unweighted	the situation in which all residuals are given equal significance in fit analysis, regardless of the amount of the information contained in them.
Variable	a quantity or quality which can change its value
Weighted	the adjustment of a residual for fit analysis, according to the amount of information contained in it.
Zero score	Every response "incorrect" or the minimum possible score. Every observed response in the lowest category.
ZSTD	Probability of a mean-square statistic expressed as a z-statistic, i.e., a unit-normal deviate. For p≤.05 (double-sided), ZSTD>|1.96|.
&END	The end of the list of Winsteps control variables
&INST	The beginning of the list of Winsteps control variables. This is not necessary.

21.54 Google Map of Winsteps statistics

Wu et al. (2020) use Google Maps to display Wright maps and other Rasch output. Here is how to do that. We will use GPSVisualizer at www.gpsvisualizer.com. Google Maps has many more capabilities if you want to go further.

In Winsteps, for statistics in the item file:

HLINES=Yes
ROW1HEADING= No
Output files menu: IFILE=
File format dialog box: tab-delimited
check "Labels in quotation marks"
Permanent file
Give the file a name, e.g., mymap.txt

GPSVisualizer expects the input file to have these column headings:
longitude: x-axis in range -180 to + 180 (choose the column for this)
latitude: y-axis in range -90 to +90 (choose the column for this)
longitude 0, latitude 0 is a point off the coast of Africa, so there is almost nothing in the background of the map.
name: the point label
most other column headings are ignored, but GPSVisualizer has many options, see its Tutorials

In GPSVisualizer,
Click "Choose file": mymap.txt - if you change mymap.txt you must "Choose File" again to upload the changes
Click "Map it" - the map should display in Google Maps.

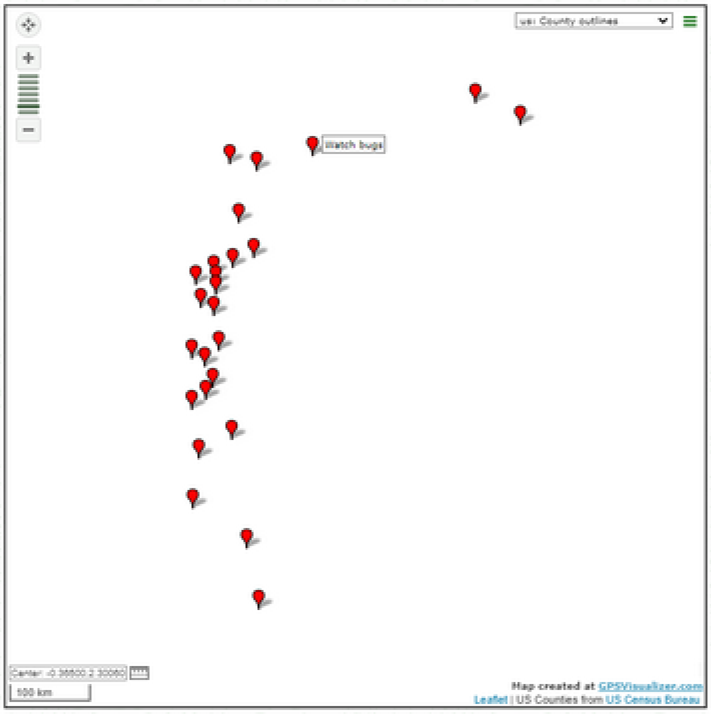
For more control over the map, click "JPEG/PNG/SVG maps"
Background map: None
Title: (your choice)
Advanced options: Border = Yes
File #1: mymap.txt

and many more options. See its "Help", "Tutorials" and try outputting in other formats.

Wu H.-M., Shao Y., Chien T.-W. (2020) Student's Performance Shown on Google Maps Using Online Rasch Analysis. Journal of Applied Measurement, 21, 2, 225-234.

Example: using Example0.txt.
Output IFILE= with all columns tab-separated:
Change "MEASURE" to "Longitude"
Change "OUT.MSQ" to "Latitude"
Follow the instructions above.

When the map displayed, I chose "us: County Outlines" so that topographical features (such as islands near Africa) are not shown.



21.55 Guttman errors, Guttman reversals

Winsteps does not report Guttman reversals. It can be done with the R Statistics package: GetR

The procedure:
1. Install the free software R Statistics

2. Run Winsteps on your data

3. Output Files menu: IPMATRIX=
Field: scored responses
No person details
No item details
Include extreme persons
Include extreme items
Output to R Statistics with a temporary file

4. R Statistics launches with "data" dataset

In your R window, do this once:
install.packages("GetR") # do this once

Then each time afterwards, copy and paste this into your R window:

```
library(GetR)
guttmanErrors(data) # the count of Guttman errors for each person displays
sum(guttmanErrors(data)) # the total number of Guttman errors
sum(guttmanErrors(data))/nrows(data) # the average number of Guttman errors per person
```

21.56 Guttman parameterization of rating scales

Rating scales with many categories often have unobserved categories or categories with very low frequencies. These make the standard estimation of Andrich thresholds (step difficulties), based on the relative frequencies of adjacent categories, subject to accidents in the data. Modeling the relationship between the thresholds with a continuous function smooths out the lumpiness in the data.

Louis Guttman (1941, etc.) proposes that responses to attitude-survey items can be summarized by the scale location and scale intensity. Guttman called these "principal components". Here named "Guttman components". The family of Guttman components was extended by Pender Pedler (1987), also Andrich and Luo (2003) , as a set of orthogonal polynomials summarizing the Andrich thresholds.

The Orthogonal Polynomials

Pedler's (1987) orthogonal-polynomial Guttman components of the rating-scale thresholds are:

SFUNCTION=	Polynomial where x is the observation	Formula: categories numbered 0..m	Minimum Categories / Thresholds	Interpretation
(0)	$T_0(x)$	0	1 / 0	rating-scale exists
1	$T_1(x)$	1	2 / 1	mean: central location of Andrich thresholds
2	$T_2(x)$	2(x - (m+1)/2)	3 / 2	dispersion, variance: linear relationship
3	$T_3(x)$	3(x - (m+1)/2)² - (m² - 1)/4	4 / 3	skewness: quadratic
4	$T_4(x)$	4(x - (m+1)/2)³ - (x - (m+1)/2)(3m² - 7)/5	5 / 4	kurtosis: cubic
(k+1)	higher order: $T_{k+1}(x)$	[(k+1)/k] (x - (m+1)/2) $T_k(x)$ - ([(m² - (k-1)²)(k² - 1)]/[4(2k - 1)(2k-3)]) $T_{k-1}(x)$	k+2 / k+1	higher moments

These are operationalized in Winsteps using SFUNCTION=. For instance, SFUNCTION=3:
Andrich threshold between categories x-1 and x = F(x) = $p_1T_1(x) + p_2T_2(x) + p_3T_3(x)$ where p_1, p_2, p_3 are the data-dependent coefficients.

Estimating the Coefficients of the Polynomials

The initial values of the coefficients, p, are zero. In Winsteps, the central location of the Andrich thresholds of a rating scale is set at zero logits, so p_1 is stays at zero. Initially all the F(x) are also zero, so the thresholds are all at the central location.

The category probabilities are computed by applying the threshold values to the Andrich Rating-Scale Model, Partial Credit Model, etc. This produces:
1. an observed and expected frequency for each category
2. a modeled variance of the probability of each category

The likelihood of the data = Λ = Product (Probability (x_{ni})) where x_{ni} are the observations.
Log-likelihood of the data = $\lambda = \sum (Ln(Px_{ni})) = \sum (x_{ni}(Bn - Di) - \sum_{j=1,x}F_j) - \sum$ (Ln(probability normalizer))
$\partial\lambda / \partial p_k = \sum \sum_{j=1,,x}T_k(j) - \sum P_{ni} (\sum_{j=1,m}T_k(j))$
$\partial^2\lambda / \partial p_k^2 = \sum P_{ni}(\sum_{j=1,m}T_k(j))^2 - (\sum P_{ni}(\sum_{j=1,m}T_k(j)))^2$
then, by Newton-Raphson,

change in Pk = $\partial\lambda / \partial p_k$ / $\partial^2\lambda / \partial p_k^2$

Andrich, D. & Luo, G. (2003). Conditional Pairwise Estimation in the Rasch Model for Ordered Response Categories using Principal Components. *Journal of Applied Measurement, 4(3),* 205-221.
Guttman, L. (1950). The principal components of scale analysis. In S.A. Stouffer, L. Guttman, E.A. Suchman, P.F. Lazarsfeld, S.A. Star and J.A. Clausen (Eds.), *Measurement and Prediction, pp. 312-361*. New York: Wiley.
Pedler, P.J. (1987) Accounting for psychometric dependence with a class of latent trait models. *Ph.D. dissertation.* University of Western Australia.

21.57 Half-rounding

Rounding occurs when a number, such as 5.032 is to be displayed with only two decimal places, e.g., as 5.03.

The general rule followed by Winsteps is to round to the nearest displayable value. Examples:
5.034 rounds to 5.03
5.036 rounds to 5.04
-5.034 rounds to -5.03
-5.036 rounds to -5.04

Rounding errors may arise with 5.035 and -5.035. Winsteps intends to round these away from zero to 5.04 and -5.04.

In practice, the computer arithmetic sometimes loses precision due to hardware limitations, so that 5.035 becomes an internal number like 5.034999997 - a number which is the same computationally as 5.035. But this value half-rounds to 5.03. This behavior is impossible to predict, because most displayed numbers are the result of a long chain of internal computations, .

Increasing the value of UDECIM= may display more decimal places, and so better display the numerical results.

In recent versions, Winsteps adds .0000005 to positive numbers, and subtracts that amount from negative numbers, in order that .005 will almost always round to .01.

21.58 Inestimable measures

Winsteps may not be able to provide an estimate of a measure. INESTIMABLE is reported if all observations are eliminated as forming part of extreme response strings. To make such measures estimable, further data (real or artificial) or Winsteps specifications are required.

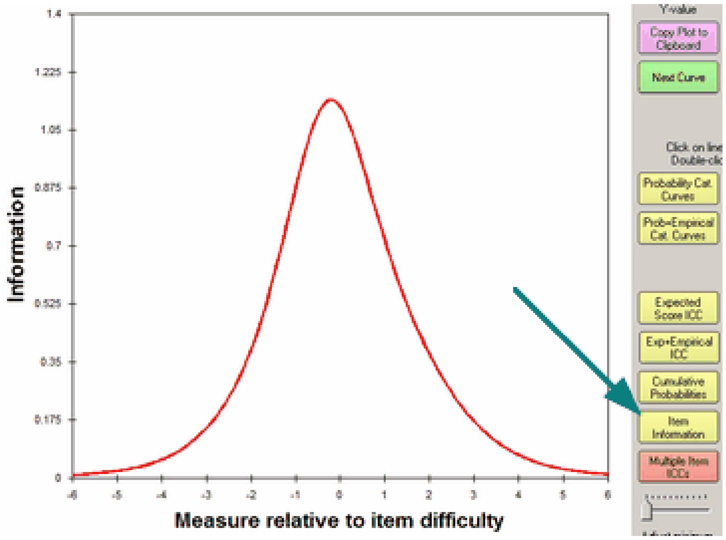
Example: ISGROUPS=0 is specified (partial credit model) but all responses are in the same category. Winsteps cannot construct a rating scale structure. If possible, include this item in the same ISGROUPS= grouping as an estimable item.

See also https://link.springer.com/article/10.1007/BF02293919 Fischer, G.H. On the existence and uniqueness of maximum-likelihood estimates in the Rasch model. Psychometrika 46, 59–77 (1981)

21.59 Information - item and test

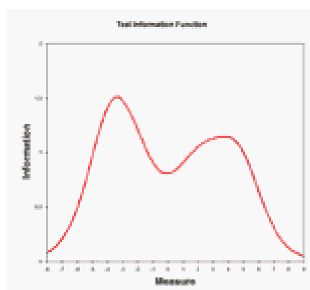
Fisher information is the amount of information data provide about a parameter. For item information, this is the amount of information the response to an item provides about a person parameter. For test information, this is the amount of information all of the items encountered by a person provide about a person parameter.

All dichotomous items have the same Rasch-derive item information. For a response of probability p, the item information is the binomial variance of the probability, p(1-p). This function is:



For polytomous items, the information function depends on the rating scale structure. The better targeted the item is on the person the more Fisher information the item provides about the person parameter. This motivates some item selection techniques for computer-adaptive testing. An algorithm for the Fisher item information function for polytomous items is given at www.rasch.org/rmt/rmt191a.htm.

The test information function is the sum of the item information functions. The standard error of a measure is the inverse square-root of the test information at the location of the maximum-likelihood parameter estimate (or higher). Here is the test information function for the Knox Cube Test in Example 1.



.

Test (sample) reliability is a summary of the interaction between the sample distribution and the test information function.

21.60 Installation fails - anti-virus

My apologies for this difficulty.

0. Is your anti-virus software reporting a problem with installing Winsteps?

1. Which anti-virus software is installed on your computer?

2. Please launch https://www.virustotal.com/gui/home/url - this is the free VirusTotal scan website.
Click on "FILE", then choose your downloaded file Winstepspasswordinstall,,,.exe

3. Does virustotal report any problems?

4. If no problems, then your anti-virus program is giving a false positive.
a) disconnect your computer from the Internet
b) disable your antivirus software
c) launch Winstepspasswordinstall....5.exe
d) install Winsteps
e) delete Winstepspasswordinstall......exe

f) restart your antivirus software
g) reconnect to the internet
h) scan your computer for viruses

5. If problems, please email mike@winsteps.com.

21.61 Installing multiple versions of Winsteps

If you need to install several versions of Winsteps on the same computer, install them in different folders. This is enough for them to work independently.

21.62 IRT to Rasch conversion

The 3-PL b values are roughly equivalent to the Rasch difficulties. The b difficulties are probably in probits, which could be converted to logits by multiplying them by 1.702. However, empirically, the conversion factor differs.

Do you have any of the 3-PL data? If so, use the 3-PL parameters to estimate the 3-PL thetas for those data. Then analyze the same data with Rasch and obtain the Rasch person measures (Rasch thetas). Cross-plot the two sets of thetas. The slope of the best-fit line gives the conversion between the empirical 3-PL scaling and the Rasch logit scaling.

3-PL IRT or the Rasch Model?

Guessing and item discrimination alter the data. The Rasch measures are based on the data, and so guessing and discrimination alter the Rasch measures.

We do fit analysis to discover the extent to which aberrations in the data are altering the Rasch measures. In particular, Outfit is sensitive to guessing and infit is sensitive to item discrimination. Lucky guesses increase raw scores and so increase Rasch measures. High item discrimination increases logit differences and so increases test reliability. In the extreme, this is called the "attenuation paradox".

So, why do we use Rasch measures, instead of the 3-PL IRT model which parameterizes guessing and item discrimination?

If anyone actually applied the 3-PL IRT model rigorously, then every different person response string would produce a different person estimate ("pattern scoring"). This is impractical because it is too difficult to explain to non-specialists that the same raw score on the same items produces different thetas (ability estimates) for persons with different response strings. Accordingly even 3-PL advocates use the Rasch principle that the same raw score on the same items always produces the same person estimates!

Parameterizing item discriminations also has practical drawbacks. When item discriminations differ, then the perceived item difficulty hierarchy is different for persons of different abilities (because the item ICCs/IRFs cross). Again this is too difficult to explain to non-specialists. How can Addition be easier for low performers than Subtraction, but Addition can be more difficult than Subtraction for high performers? Accordingly a compromise item difficulty hierarchy (beta or delta) is presented as though it is the same for everyone. Again this is the Rasch principle that the item difficulties are the same for everyone!

So, though it is useful to know about guessing and item discrimination, in practice they are ignored when results are presented to non-specialists!

For a more thorough discussion of Rasch vs 3-PL, see https://www.rasch.org/rmt/rmt61a.htm

How about this as a summary?
"The Rasch model computes item difficulties and person abilities on a strictly linear scale based on item and person raw scores without requirements such as complete data and normal distributions. The effect is to limit the impact of guessing and item discrimination. This makes the Rasch model more convenient in terms of utility, inference and explanation to non-technical audiences compared to other IRT models."

21.63 Item difficulties from score-to-measure table

```
' This is Visual Basic Code


' This is Visual Basic Code

Option Explicit
Public Sub main()

' solving non-linear equations by targeted trial-and-error

' Example using Knox Cube Test data
' in this example, arrays start at 0

Dim maxi&, maxn&
maxi& = 14  ' 14 items
maxn& = 14 ' scores are in range 0 to 14

ReDim r#(maxn&)  ' scores
ReDim b#(maxn&) ' measures for scores
ReDim d#(maxi&) ' target items

' list of scores
r(0) = 0.25  ' this was the extreme score adjustment
r(1) = 1
r(2) = 2
r(3) = 3
r(4) = 4
r(5) = 5
r(6) = 6
r(7) = 7
r(8) = 8
r(9) = 9
r(10) = 10
r(11) = 11
r(12) = 12
r(13) = 13
r(14) = 13.75

' list of measures
b(0) = -6.66
b(1) = -5.3
b(2) = -4.35
b(3) = -3.64
b(4) = -2.97
b(5) = -2.26
b(6) = -1.39
b(7) = -0.26
b(8) = 0.94
b(9) = 1.96
b(10) = 2.88
b(11) = 3.76
b(12) = 4.65
b(13) = 5.73
b(14) = 7.15

' size of estimation adjustment
Dim diff#
diff# = 0.1  ' too big or too small and this process fails
              ' tweaking this value may give slightly better, or hugely worse, results

ReDim scoren#(maxn) ' expected scores based on current set of item difficulties
```

```
Dim oldsqrdiff#  ' sum of squared differences from previous iteration
Dim newsqrdiff#  ' sum of squared differences for this iteration

Dim sumn#(2)  ' 0,1,2 = 3 squared differences for tweaking current item
Dim dhold# ' holding current item

Dim i&, n&, k&, j& ' indexes into arrays

oldsqrdiff# = 9999  ' big starting value
newsqrdiff = 9998   ' big, but slightly smaller starting value

While newsqrdiff < oldsqrdiff ' continue iterating while squared difference reduces
  oldsqrdiff = newsqrdiff ' save current difference
  newsqrdiff = 0  ' reset new difference
  For i = 1 To maxi& ' loop down the items
     dhold = d(i) ' hold the current item
     For k = 0 To 2 ' try 3 different item values
        d(i) = dhold + (k - 1) * diff#
        sumn(k) = 0 ' squared difference for this target item value
        For n = 0 To maxn& ' loop through all the scores
           scoren(n) = 0 ' expected score
           For j = 1 To maxi ' loop through all the items
             scoren(n) = scoren(n) + 1# / (1# + Exp(d(j) - b(n))) ' sum the expected scores
           Next j
           sumn(k) = sumn(k) + (scoren(n) - r(n)) ^ 2 ' accumulate squared differences between
                                                    ' expected and observed scores
        Next n  ' next score
   Next k  ' next target item value
   If sumn(0) < sumn(1) And sumn(0) < sumn(2) Then ' is target value k=0 the lowest?
       d(i) = dhold - diff# ' yes: revise target item value
       newsqrdiff = sumn(0) ' save differences in case this is the last score
   ElseIf sumn(2) < sumn(1) And sumn(2) < sumn(0) Then ' is target value k=2 the lowest?
       d(i) = dhold + diff#
       newsqrdiff = sumn(2)
   Else ' no change  - k=1, the original d(i) is good
       d(i) = dhold
       newsqrdiff = sumn(1)
   End If
  Next i ' next target item
  Debug.Print oldsqrdiff, newsqrdiff ' display squared differences for confirmation
Wend


For n = 0 To maxn
   Debug.Print n, r(n), scoren(n), r(n) - scoren(n) ' list of scores and differences
Next n

For i = 1 To maxi
  Debug.Print i, d(i) ' list of item difficulties
Next i

Stop

End Sub

Iteration report for KCT data:

Previous iteration   This iteration
 9998                        83.3772167769053
 83.3772167769053            82.8586294323071
.......
 7.18316390024933E-03        7.08576670997411E-03
 7.08576670997411E-03        7.08576670997411E-03
```

```
 List of observed scores, expected scores, differences
0    0.25      0.29  -0.04
1    1  0.99   0.01
2    2  2.00   0.00
3    3  3.02  -0.02
4    4  4.03  -0.03
5    5  5.00   0.00
6    6  5.97   0.03
7    7  6.99   0.01
8    8  8.01  -0.01
9    9  8.99   0.01
10  10  9.98   0.02
11  11 10.99   0.01
12  12 11.98   0.02
13  13 12.99   0.01
14  13.75     13.69   0.06

 List of item difficulties (item order does not matter)
            Estimate  Actual
 10             5.0     4.80
 12             4.9     4.80
 14             4.5     4.80
 8              3.0     3.37
 6              2.9     2.24
 4              1.7     1.95
 2              0.6      .79
 9             -1.1    -1.57
 3             -2.9    -2.35
 7             -3.1    -3.38
 13            -3.5    -3.38
 1             -3.8    -3.83
 5             -4.1    -3.83
 11            -4.1    -4.40
```

21.64 Item difficulty: definition

As modeled in Winsteps, the difficulty (challenge, easiness, etc.) of an item (task, prompt, etc.) is the point on the latent variable (unidimensional continuum) at which the highest and lowest categories have equal probability of being observed. This is usually near the center of the middle category of an odd number of categories, or close to the transition between adjacent central categories of an even number of categories.

For a dichotomous item, this is the point at which each category has a 50% probability of being observed.

For a Rasch-Andrich rating-scale item, this definition implies that the sum of the rating-scale-structure measures sum to zero relative to the item difficulty, i.e., the sum of the Rasch-Andrich thresholds is zero, i.e., sum(Fj) = 0.

For a Masters partial-credit item, this definition implies that the item difficulty is the average of the difficulties of the Rasch-Masters thresholds for the item, i.e., Di = average of the delta (Dij) values, so that re parameterizing, Dij = Di + Fj, then sum(Fij) = 0 for each item i.

21.65 Item discrimination or slope estimation

In Winsteps, item discrimination is not a parameter. It is merely a descriptive statistic.

Thoughts about item discrimination: Item discrimination and Rasch fit statistics are asymmetric. Noisy, unpredictable misfit (high mean-squares, large positive t-values, very low discrimination) degrade measurement. But too predictable overfit (low mean-squares, large negative, t-statistics, very high discrimination) do not degrade measurement. They merely cause standard errors to be estimated too low and reliabilities to be estimated too high - this is equivalent to the well-known "attenuation paradox" of CTT. So the useful range of discrimination is something like the range 0.5 to 2 or it could be 0.5 to infinity!! But when discrimination becomes very high (mean-squares very low), that usually means the items are malfunctioning in some way. Here is an informative paper on the topic of high item discrimination:

Journal of Educational Measurement, 25, 1, 15, 1988. "Item Discrimination: When More Is Worse" by Geofferey N. Masters.
High item discrimination can be a symptom of a special kind of measurement disturbance introduced by an item that gives persons of high ability a special advantage over and above their higher abilities. This type of disturbance, which can be interpreted as a form o f item "bias," can be encouraged by methods that routinely interpret highly discriminating items as the "best" items on a test and may be compounded by procedures that weight items by their discrimination. The type of measurement disturbance described and illustrated in this paper occurs when an item is sensitive to individual differences on a second, undesired dimension that is positively correlated with the variable intended to be measured. Possible secondary influences of this type include opportunity to learn, opportunity to answer, and test-wiseness.

The Rasch model specifies that item discrimination, also called the item slope, be uniform across items. This supports additivity and construct stability. Winsteps estimates what the item discrimination parameter would have been if it had been parameterized. The Rasch slope is the average discrimination of all the items. It is not the mean of the individual slopes because discrimination parameters are non-linear. Mathematically, the average slope is set at 1.0 when the Rasch model is formulated in logits, or 1.70 when it is formulated in probits (as 2-PL and 3-PL usually are). 0.59 is the conversion from logits to probits.

The empirical discrimination is computed after first computing and anchoring the Rasch measures. In a post-hoc analysis, a discrimination parameter, ai, is estimated for each item. The estimation model is of the form:

$$\log\left(\frac{Pnij}{Pni(j-1)}\right) \equiv a_i\left(\hat{B}_n - \hat{D}_i - \hat{F}_j\right)$$

This has the appearance of a 2-PL IRT or "Generalized Partial Credit" model, but differs because the discrimination or slope parameter is not used in the estimation of the other parameters. The reported values of item discrimination, DISCR, are a first approximation to the precise value of *ai* obtained from the Newton-Raphson estimation equation:

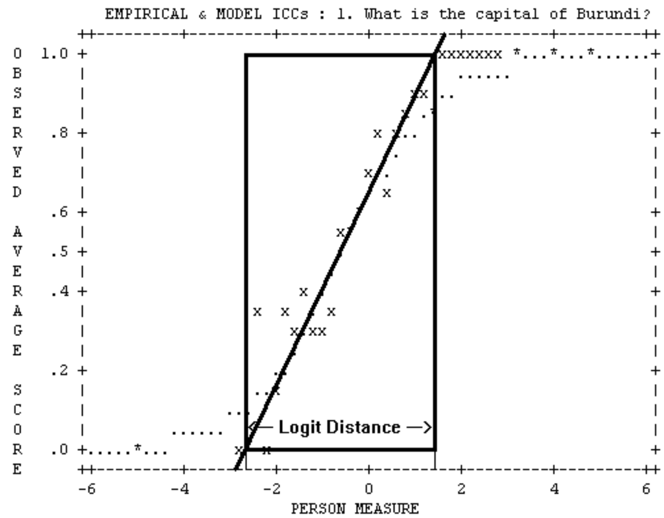
$$\hat{a}_i = 1 + \left[\frac{\sum_n (X_{ni} - P_{ni})(\theta_n - b_i)}{\sum_n P_{ni}(1 - P_{ni})(\theta_n - b_i)^2}\right]$$

The possible range of *ai* is -∞ to +∞, where +∞ corresponds to a Guttman data pattern (perfect discrimination) and -∞ to a reversed Guttman pattern. Rasch estimation usually forces the average item discrimination to be near 1.0. Consequently an estimated discrimination of 1.0 accords with Rasch model expectations. Values greater than 1.0 indicate over-discrimination, and values less than 1.0 indicate under-discrimination. Over-discrimination is thought to be beneficial in many raw-score and IRT item analyses. High discrimination usually corresponds to low MNSQ values, and low discrimination with high MNSQ values.

From an informal simulation study, Edward Wolfe reports Winsteps discrimination to have a .88 correlation with the generating slope parameters for a 2-PL dataset. BILOG has a .95 correlation.

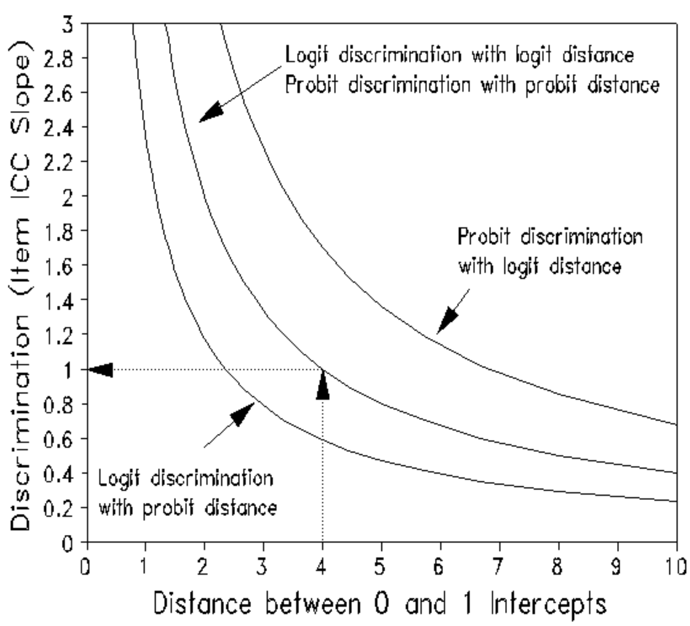
Table 29.1 allows you to estimate the empirical item discrimination, at least as well as a 2-PL IRT computer program. This is because 2-PL discrimination estimation is degraded by the imputation of a person distribution and constraints on discrimination values. It is also skewed by accidental outliers which your eye can disregard. When Discrimination=Yes. exact computation is done in the measure tables.

In Table 29.1 draw in the line that, to your eye, matches the central slope of the empirical item characteristic curve (ICC).



Estimate the logit distance from where the line intercepts the .0 score value to where it intercepts the 1.0 score value (for dichotomies). The logit distance here is about 4.0 logits.

Use the central logit measure to logit discrimination line in this nomogram to estimate discrimination. In this nomogram, a logit distance of 4.0 logits, corresponds to a logit discrimination of 1.0, in accordance with model prediction. Steeper slopes, i.e., higher discriminations, correspond to shorter distances.



21.66 Item map in Excel or Word

See Wright map

21.67 Item Maps - Combining

Procedure for Combining Item maps

1. Run the separate analyses. You may need to adjust UPMEAN= to include extreme person measures.

2. Output an IAFILE= from each analysis to Excel.

3. Copy all the separate IAFILE= into one Excel worksheet with all the measures in the same column

4. Number the items sequentially in column A. The item measures are in column B

5. In a new text file

```
TITLE = Combined item map
ITEM1 = 1
NI = (total number of items)
NAME1=1 (it will not be used)
NAMELENGTH=1
CODES=01
IAFILE=*
(paste column A and B from the combined Excel worksheet)
*
&END
(list of all the item labels from the combined Excel worksheet)
END LABELS
1010101010 ... (for NI= columns)
0101010101 ... (for NI= columns)
```

6. Analyze this dummy data file and produce Table 12

21.68 Iterations - PROX & JMLE

The Rasch model formulates a non-linear relationship between non-linear raw scores and additive measures. So, estimating measures from scores requires a non-linear process. This is performed by means of iteration. Two estimation methods are used, PROX and JMLE.

The fundamental transformation in linearizing raw scores is:
log ((observed raw score - minimum possible raw score) / (maximum possible raw score - observed raw score))

In Winsteps, initially every person is estimated to have the same ability measure at the origin of the measurement scale. Each item is estimated to have the same difficulty measure, also at the origin of the measurement scale. Each rating scale structure parameter, Rasch-Andrich threshold, is also estimated to be 0.

In Winsteps, the first phase of estimation uses the PROX (normal approximation) estimation algorithm. This takes the initial set of estimates and produces revised estimates:

$$B_n = \mu_n + \sqrt{1+\sigma_n^2/2.9}\,\log_e(R_n/(N_n-R_n))$$

where Bn is the revised ability estimate for person n, mn is the mean difficulty of the items encountered by person n, and sn is the standard deviation of those item difficulties. Rn is the observed raw score for person n and Nn is a perfect, maximum possible score on those same items. Similarly, for the items,

$$D_i = \mu_i - \sqrt{1+\sigma_i^2/2.9}\,\log_e(R_i/(N_i-R_i))$$

where Di is the revised difficulty estimate for item i, mi is the mean ability of the persons encountering by item i, and si is the standard deviation of those person abilities. Ri is the observed raw score on item i and Ni is a perfect score by those same persons.

To update these PROX estimates, Winsteps traverses the data computing the values of all the terms on the right-side of the estimation equations. This traversal is called an "iteration". When the increase in the range of the person or item measures is smaller than 0.5 logits, or when MPROX= is reached, iteration ceases.

Initial estimates of the Rasch-Andrich threshold between category k and category k-1 are obtained from log (observed frequency of category k-1 / observed frequency of category k) normalized to sum to zero across the thresholds of a rating scale.

The PROX estimates become the starting values for JMLE (Joint Maximum Likelihood Estimation). Using these person, item and rating scale structure estimates, Winsteps computes the expected value, according to the Rasch model, corresponding to each observation in term. After iterating through the entire data set, the marginal sums of these expected values, the person expected raw scores and the item expected raw scores, are compared with their observed (empirical) values. If a person's expected raw score is less than that person's observed raw score, then the ability estimate raised. If the person's expected raw score is greater than the observed score, then the ability estimate is lowered. For items, if the expected raw score is less than the observed score, then the difficulty estimate is lowered. If the item's expected raw score is greater than the observed score, then the difficulty estimate is raised.

The estimation equations for JMLE are derived in RSA, where Newton-Raphson iteration is employed.

y' = y + (observed score - Rasch expected score based on current estimates)/(modeled variance)

where y = a current estimated person measure and y' is the improved estimate.

To see this process in an Excel spreadsheet, go to www.rasch.org/moulton.htm

Newton-Raphson estimation has proved unstable with sparse data sets and also with rating scales which have alternating very high and very low frequency categories. Accordingly, Winsteps implements a more robust proportional-curve-fitting algorithm to produce JMLE estimates. The relationship between raw scores and measures is always monotonic, so the characteristic curve for each person or item parameter approximates a logistic ogive:

In the plot below, x is the Rasch measure for the person Bn or item Di currently being estimated. y is the corresponding raw score.
Assume we are estimating the person ability of person n. Applying the dichotomous or polytomous Rasch model, for person n, x' = Bn, the current ability estimate, we have a set of Rasch item scores across all the items, summed to give an expected raw score y' for person n.
Let us also calculate a set of Rasch item scores for measure x" = x'+d, summed to give an expected raw score y", where d=1 or other convenient value.

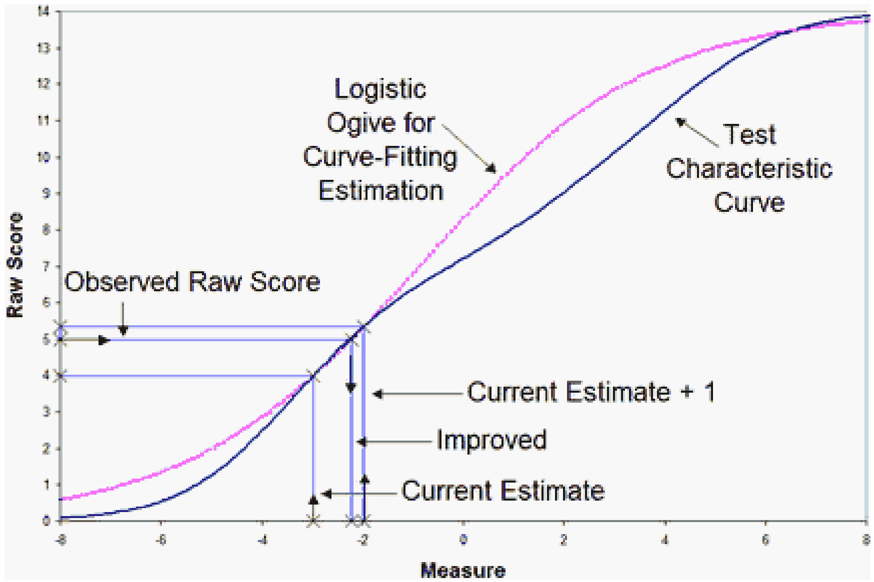
Here is a relationship equation to fit these values to a logistic ogive:
(y-l) / (h-y) = exp[(x-c) / a]
or
x = a * log((y-l)/(h-y)) + c
where x = an estimated measure, a = inverse slope of the ogive, y = a raw score, l = the known minimum possible raw score for the parameter being estimated, h = the known maximum possible raw score for the parameter being estimated, c = the central location of the ogive.

Using x',y' and x",y", we can apply the relationship equation as two simultaneous equations in x and y and solve for a and c. We can then apply the relationship equation with a and c now known, and also y as the observed raw score for person n, obtaining x"' a better estimate of Bn, so that x"'-x is the change in Bn to produce the better estimate of Bn.

We can do the same thing for every person and item.

In summary, values of x are obtained from the current estimated measure y and a nearby measure (y + d). From these, a and c are estimated. The revised measure x"' is obtained by evaluating the equation using the observed raw score as the value of y.

In the plot below for Example 1, the current estimate, x, is -3 logits, a nearby estimate, x+d, is -2 logits. These both estimate raw scores on the currently-estimated test characteristic curve (TCC, the remainder of which is not yet known). The violet line is the logistic ogive going through these two known points. It is close to the putative TCC. The observed score of "5" is then found on the logistic ogive and an improved estimate is obtained. After all the person and item estimates are improved, the estimated TCC changes and this estimation process is repeated by performing another iteration through the data. Winsteps sets d equal to the biggest logit change in any item or person estimate in the previous iteration. This rapidly becomes much less than 1.0.



For the rating scale structure, the estimate, xk, for Rasch-Andrich threshold k is improved by
xk' = xk - log (observed count category k / observed count category k-1)
+ log (estimated count category k / estimated count category k-1)

When the various convergence criteria are satisfied, iteration ceases and the final estimates are obtained. These are used in computing fit statistics.

Example: Here is the iteration Table for example0.txt:

CONVERGENCE TABLE

PROX ITERATION	ACTIVE COUNT KIDS	ACTS	CATS	EXTREME 5 RANGE KIDS	ACTS	MAX LOGIT CHANGE MEASURES	STRUCTURE
1	75	25	3	3.78	3.20	3.8918	.0740
2	74	25	3	4.59	3.71	.8258	-.6158
3	74	25	3	4.83	3.92	.2511	-.1074

JMLE ITERATION	MAX SCORE RESIDUAL*	MAX LOGIT CHANGE	LEAST CONVERGED KID	ACT	CAT	CATEGORY RESIDUAL	STRUCTURE CHANGE
1	2.84	-.1955	60	22*	2	21.44	.0076
2	.71	-.0335	53	15*	0	-5.89	.0144
3	-.43	.0293	53	5*	1	3.48	.0101
4	.32	.0235	18	11*	1	2.71	.0079
5	.24	.0184	18	11*	0	-2.09	.0060
6	.19	.0141	18	11*	0	-1.63	.0045
7	.14	.0108	18	11*	0	-1.25	.0035
8	.11	.0082	18	11*	0	-.96	.0026
9	.08	.0062	18	11*	0	-.73	.0020
10	.06	.0048	18	11*	0	-.56	.0015

In the top section of the Convergence Table are reported the number of active persons, items and categories. The range of item and person measures at the end of each PROX iteration is shown, also the biggest change in any person or item, and in any Rasch-Andrich threshold. PROX iteration ceases with iteration 3 because the "KIDS" (persons) and "ACTS" (items) range has increased by less than 0.5 logits.

In the lower section, for each JMLE iteration, the maximum score residual, the biggest difference between any observed and expected marginal score is shown. Also the biggest change in any measure. Iteration ceases when the values, in iteration 10, are less than the convergence criteria.

Newton-Raphson (quadratic estimation)	$x_{k+1} = x_k - \frac{f(x_k)}{f'(x_k)}$
Generalized Newton-Raphson (cubic estimation)	$x_{k+1} = x_k - \frac{f'(x_k) - \sqrt{f'^2(x_k) - 2f(x_k)f''(x_k)}}{f''(x_k)}$
HouseHölder's method (cubic estimation)	$x_{k+1} = x_k - \frac{f(x_k)}{f'(x_k)} - \frac{f^2(x_k)f''(x_k)}{2f'^3(x_k)}$

W. Nazeer et al. (2016) "Generalized Newton Raphson's method free from second derivative." J. Nonlinear Sci. Appl. 9 (2016), 2823–2831.

21.69 jMetrik Rasch analysis software and Winsteps - useful features

jMetrik is freeware for performing Rasch, Classical and other analyses. Its results and features are compatible with the JMLE-option of Winsteps.

To use jMetrik, download it (with Java JRE, if not already installed on your computer). Then read the Quick-Start Guide or watch an instructional video.

Starting with Winsteps:
Perform a Winsteps analysis
Output Files menu: Mtrix File IPMATRIX=,
3. Response value after scoring
Persons are rows, items are columns
include extreme persons
include extreme items
Person Entry Number
Person Label
Person Labelf field: @GENDER - for DIF analysis
Item Entry Number
OK

Output File Specifications:
Text Editor
Text tab-delimited fields
Labels in quotation marks
Permanent File
OK

File Name:
c:\responses.txt - your choice

File displays - check it is what you want

Launch jMetrik
Manage menu
New Database: Responses
Create

Open Database: Responses
Import Data
Table Name: Responses
Browse
File Name:: c:\Responses.txt
Delimiter: Tab
OK
Import
Left-hand panel: Double-click on RESPONSES
Responses load into right-hand panel
Analyze menu
Frequencies
>> (all variables)
Run (summary statistics for every variable)
and so on ....

Later runs:
Manage menu
New Database: Responses
Open Database: Responses
Analyze menu
Rasch Models (JMLE)
Item Tab - Save Item Estimates - "Items"
>> select all items
click on RUN
Graph menu
Item Map
Item Parameter Table - Select - ITEMS
> item label
RUN
and so on ...

21.70 JMLE is inconsistent!

Reviewers may reject Winsteps and its estimation method, JMLE, because they are "inconsistent", quoting perhaps Christensen (2012) "“Estimation of the item parameters using the joint likelihood function leads to inconsistent item parameter estimates because the number of parameters increases with the number of persons”, and recommending CMLE or MMLE

Response: It is true that JMLE (UMLE, UCON) is statistically inconsistent for infinite data. For finite data this is seen as "estimation bias". During many discussions/arguments in the 1970s and 1980s it was discovered that the JMLE estimation bias is inconsequential for most datasets and can easily be corrected where it is consequential . See, for instance, www.rasch.org/memo45.htm which appeared in Applied Psychological Measurement 12 (3) pp. 315-318, September 1988. and, more recently, "Overall, the differences between the results produced with the three estimation methods [CMLE, JMLE, MMLE] were negligible, and the discrepancies observed between datasets were attributable to the software choice as opposed to the estimation method." in Nicklin C., Vitta J.P. (2022) Assessing Rasch measurement estimation methods across R packages with yes/no vocabulary test data. *Language Testing.*

Of course, MMLE is estimation-biased if the person distribution mismatches the assumed person theta distribution (which it always does, empirical data never matches a theoretical distribution, - as the reviewer implicitly admits). CMLE, as usually implemented, is estimation-biased for the person measures (thetas) - see my note in Rasch Measurement Transactions - www.rasch.org/rmt/rmt331.pdf "CMLE – a Problem, its Solution and a Useful Approximation". Further depending on the nature of your data and analysis, CMLE and MMLE may be impossible to implement.

In my experience over 40 years JMLE estimation bias is only consequential for pairwise data, so Winsteps has a special command for this unique situation: "PAIREDdata=Yes". In other situations, I recommend against bias correction, STBIAScorrection=Yes in Winsteps, because of its side-effects. For instance, only for uncorrected JMLE can we complete this loop: *raw person and item scores with original data -> item estimates and person estimates -> original person and item raw scores.* This is important if we intend to predict person raw scores and item p-values for future data from the current estimates.

Every estimation method has advantages and disadvantages. A somewhat obscure disadvantage, and almost irrelevant for practical purposes, is the lack of "statistical consistency" of JMLE estimates. Here is the idea. Suppose we had an infinite amount of data, and used JMLE to estimate the parameter values from it. Would those parameter values be the "true" values of the parameters? The answer is no! The worst case is a test of only two dichotomous items. If the true difference between the difficulties of the two items is one logit. JMLE would report two logits difference! This indicates that JMLE is "statistical inconsistent". However, this two-to-one "estimation bias" is easy to correct. We simply divide all the estimates by two! In Winsteps, this is done automatically with the instruction "PAIRED=Yes". With longer tests, the correction is (number of items-1)/(number of items), corrected by STBIAS=YES. For longer tests, this correction quickly becomes meaninglessly small.

In fact, even for short tests, the correction for estimation bias is unnecessary unless we need to make very exact inferences about small logit differences. However, we discover that the correction is smaller than the standard errors of the estimates. We are in the situation that Quality-Control guru, W. E. Deming, pointed out is over-correction when applied to industrial machinery. We are trying to adjust the estimation process within its area of uncertainty. The result, Deming demonstrated, is that the outcome of the process becomes worse, not better!

Estimation bias, the practical consequence of statistical inconsistency, does not change the hierarchy of item difficulties and person abilities. So, if you are applying a user-friendly rescaling (USCALE=) to the logit values, the estimation bias is entirely inconsequential.

On the other hand, estimation methods that are statically consistent (with infinite data), such as CMLE, MMLE, PMLE, can also have estimation bias (with finite data) depending on the characteristics of those data. For instance, MMLE imposes a theoretical distribution of person abilities on the person parameters. This may or may not be a good match to the actual distribution of those parameters. PMLE uses the data in an uneven way during the estimation process resulting in estimation bias. CMLE, MMLE and PMLE are all asymmetric in the way they estimate the item and person parameters. This is fine if we think of a fixed set of items and a potentially infinite sample of persons, but in other applications of Rasch measurement, both the "items" and "persons" are fixed, or both the "items" and "persons" are potentially infinite. JMLE is symmetric in its estimates. Transpose the data matrix, and the absolute differences between the estimates for specific items and/or specific persons do not change. For those other estimation methods, those differences do change.

21.71 Local Dependence

In some data designs, data are collected from the same persons more than once, or observations are collected on equivalent items. Consequently there is reason to suspect that local dependence exists in the data. What is its impact on the Rasch measures?

In practical terms, a correlation of r=0.40 is low dependency. The two items only have 0.4*0.4=0.16 of their variance in common. Correlations need to be around 0.7 before we are really concerned about dependency.

Local dependence usually squeezes or stretches the logit measures, but does not usually change cut-points much when they are expressed in raw-score terms.

Procedure A. If a subset of items may have strong local dependence, then rescore the subset as one partial-credit item.
1) Analyze all the data with subset of items as separate items. Output the person measures to Excel. PFILE=
2) Combine the scores on the subset of items into one partial credit item. All the other items remain unchanged. Analyze all the data. Output the person measures to Excel. PFILE=
3) In Excel, cross-plot the person measures from (1) and (2). The curvature of the plot shows the influence of the local dependence on linearity.
4) Is the curvature big enough to be important to your audience? If yes, use the person measures from (3). If no, use the person measures from (2). My guess is usually "No".

Procedure B. To avoid local dependence in measuring change from pre-test to post-test:
1. Create a random, "stacked" dataset, in which each patient only appears once, either at pre-test or post-test. For instance, see FORMAT= example 7.
2. Run an initial Winsteps analysis and create item and step anchor files: IFILE=if.txt, SFILE=sf.txt
3. Run Winsteps on the full pre-test data set using the IAFILE=if.txt and SAFILE=sf.txt from step #2
4. Run Winsteps on the full post-test data set using the IAFILE-if.txt and SAFILE=sf.txt from step #2

5. You can determine the effect of local dependence by cross-plotting the person measures from 3) and 4) against the measures from an unanchored stacked analysis of all the data.

Marais I. Response dependence and the measurement of change. J Appl Meas. 2009;10(1):17-29

Procedure C. Here is an experiment to determine whether local dependence is a problem. Assuming that data from the same persons may be a problem, select from your cases one of each different response string. This will make the data as heterogeneous as possible. Perform an analysis of this data set and see if that changes your conclusions markedly. If it does, then local dependence may be a concern. If it doesn't then local dependence is having no substantive impact.

Using Excel, a method of obtaining only one of each different response string:

0. Import the data into excel as a "character" column
1. from the Excel data pull down menu choose -> filter -> advanced filter
2. under "action" choose "copy to another location"
3. click "list range" and highlight the range of element numbers - if you want the whole column click on the letter at the top of the column
4. click "copy to" and choose an empty column, e.g., column J.
5. click "unique records only"
6. click "OK"
7. look at column J. The data are unique.

21.72 Logit and probit

When USCALE=1 (or USCALE= is omitted), measures are reported in logits. When USCALE=0.59, measures are reported in approximated probits.

Logit: A logit (log-odds unit, pronounced "low-jit") is a unit of additive measurement which is well-defined within the context of a single homogeneous test. When logit measures are compared between tests, their probabilistic meaning is maintained but their substantive meanings may differ. This is often the case when two tests of the same construct contain items of different types. Consequently, logit measures underlying different tests must be equated before the measures can be meaningfully compared. This situation is parallel to that in Physics when some temperatures are measured in degrees Fahrenheit, some in Celsius, and others in Kelvin.

As a first step in the equating process, plot the pairs of measures obtained for the same elements (e.g., persons) from the two tests. You can use this plot to make a quick estimate of the nature of the relationship between the two logit measurement frameworks. If the relationship is not close to linear, the two tests may not be measuring the same thing.

Logarithms: In Rasch measurement all logarithms, "log", are "natural" or "Napierian", sometime abbreviated elsewhere as "ln". "Logarithms to the base 10" are written log10. Logits to the base 10 are called "lods". 1 Lod = 0.4343 * 1 Logit. 1 Logit = 2.3026 * 1 Lod.

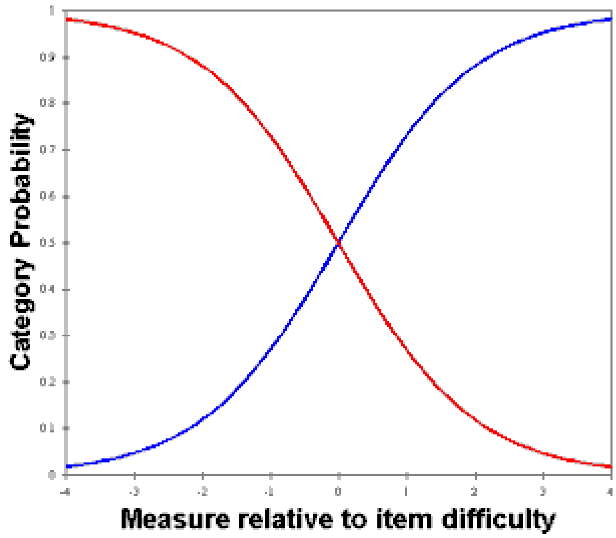
Logit-to-Probability Conversion Table

Logit difference between ability measure and item calibration and corresponding probability of success on a dichotomous item is shown in the table. A rough approximation between -2 and +2 logits is:

Probability% = (logit ability - logit difficulty) * 20 + 50

Logit Difference	Probability of Success	Probit Difference		Logit Difference	Probability of Success	Probit Difference
5.0	99%	2.48		-5.0	1%	-2.48
4.6	99%	2.33		-4.6	1%	-2.33
4.0	98%	2.10		-4.0	2%	-2.10
3.0	95%	1.67		-3.0	5%	-1.67
2.2	90%	1.28		-2.2	10%	-1.28
2.0	88%	1.18		-2.0	12%	-1.18
1.4	80%	0.85		-1.4	20%	-0.85
1.1	75%	0.67		-1.1	25%	-0.67
1.0	73%	0.62		-1.0	27%	-0.62
0.8	70%	0.50		-0.8	30%	-0.50
0.69	67%	0.43		-0.69	33%	-0.43
0.5	62%	0.31		-0.5	38%	-0.31

0.4 0.2 0.1 0.0	60% 55% 52% 50%	0.25 0.13 0.06 0.00		-0.4 -0.2 -0.1 -0.0	40% 45% 48% 50%	-0.25 -0.13 -0.06 -0.00



Example with dichotomous data:
In Table 1, it is the distance between each person and each item which determines the probability.

```
                            MEASURE   | MEASURE
<more> ------------------ PERSONS -+- ITEMS -------------------- <rare>
 5.0                                 +                              5.0
                                     |
                                     |
                                     | XXX (items difficult for persons) <- 4.5 logits
                                     |
                                     |
 4.0                                 +                              4.0
                                     |
                                  XX | <- 3.7 logits
                                     |
                                     |
                                     |
 3.0                                 +                              3.0
```

The two persons are at 3.7 logits. The three items are at 4.5 logits. The difference is 3.7 - 4.5 = -0.8 logits. From the logit table above, this is predicted as 30% probability of success for persons like these on items like these. 30% probability of success on a 0-1 item means that the expected score on the item is 30%/100% score-points = 0.3 score-points.

Inference with Logits
Logit distances such as 1.4 logits are applicable to individual dichotomous items. 1.4 logits is the distance between 50% success and 80% success on a dichotomous items.

Logit distances also describe the relative performance on adjacent categories of a rating scale, e.g, if in a Likert Scale, "Agree" and "Strongly Agree" are equally likely to be observed at a point on the latent variable, then 1.4 logits higher, "Strongly Agree" is likely to be observed 8 times, for every 2 times that "Agree" is observed.

For sets of dichotomous items, or performance on a rating scale item considered as a whole, the direct interpretation of logits no longer applies. The mathematics of a probabilistic interpretation under these circumstances is complex and rarely worth the effort to perform. Under these conditions, logits are usually only of mathematical value for the computation of fit statistics - if you wish to compute your own.

Different tests usually have different probabilistic structures, so that interpretation of logits across tests are not the same as interpretation of logits within tests. This is why test equating is necessary.

Logits and Probits

Logits are the "natural" unit for the logistic ogive. Probits are the "natural" units for the unit normal cumulative distribution function, the "normal" ogive. Many statisticians are more familiar with the normal ogive, and prefer to work in probits. The normal ogive and the logistic ogive are similar, and a conversion of 1.7 approximately aligns them.

When the measurement units are probits, the dichotomous Rasch model is written:
log (P / (1-P)) = 1.7 * (B -D)

To have the measures reported in probits, set USCALE = 0.59 = 1/1.7 = 0.588

But if the desired probit-unit is based on the empirical standard deviation, then set USCALE = 1 / (logit S.D.)

Some History

Around 1940, researchers focused on the "normal ogive model". This was an IRT model, computed on the basis that the person sample has a unit normal distribution N(0,1).

The "normal ogive" model is: Probit (P) = theta - Di
where theta is a distribution, not an individual person.

But the normal ogive is difficult to compute. So they approximated the normal ogive (in probit units) with the much simpler-to-compute logistic ogive (in logit units). The approximate relationship is: logit = 1.7 probit.

IRT philosophy is still based on the N(0,1) sample distribution, and so a 1-PL IRT model is:

log(P/(1-P)) = 1.7 (theta - Di)

where theta represents a sample distribution. Di is the "one parameter".

The Rasch model takes a different approach. It does not assume any particular sample or item distribution. It uses the logistic ogive because of its mathematical properties, not because of its similarity to the cumulative normal ogive.

The Rasch model parameterizes each person individually, Bn. As a reference point it does not use the person mean (norm referencing). Instead it conventionally uses the item mean (criterion referencing). In the Rasch model there is no imputation of a normal distribution to the sample, so probits are not considered.

The Rasch model is: log(P/(1-P)) = Bn - Di

Much IRT literature asserts that "1-PL model = Rasch model". This is misleading. The mathematical equations can look similar, but their motivation is entirely different.

If you want to approximate the "normal ogive IRT model" with Rasch software, then
(a) adjust the person measures so the person mean = 0: UPMEAN=0
(b) adjust the user-scaling: probits = logits/1.7: USCALE=0.59

After this, the sample may come close to having an N(0,1) sample distribution - but not usually! So you can force S.D. = 1 unit, by setting USCALE = 1 / person S.D.

21.73 Mantel and Mantel-Haenszel DIF statistics

Mantel-Haenszel is the industry-standard DIF statistic, but it expects complete data because it stratifies the data by raw scores. Please Google "Mantel-Haenszel". The Winsteps implementation is slightly different because it stratifies by person measure (same as raw scores for complete data), so it is robust against missing data.

If the data are incomplete (missing data), then there are alternative methods, such as the Rasch-Welch method. There is no industry-standard method in this situation. Most methods require deletion of persons with incomplete response strings, see epm.sagepub.com/content/69/1/18.short- Rasch-Welch uses all available data.

Differential item functioning (DIF) an be investigated using log-odds estimators, Mantel-Haenszel (1959) for dichotomies or Mantel (1963) for polytomies. The sample is divided into difference classification groups (also called reference groups and focal groups) which are shown in Table 30 and specified with DIF=. And then sliced into strata by ability measure (equivalent to raw score for complete data).

The usual M-H computation stratifies the sample by raw scores, so it works with case-wise deletion of cases with missing data. Winsteps stratifies cases by measure, so cases with missing data are stratified at their estimated measure. For complete data and thin-slicing, the conventional M-H computation and the Winsteps M-H computation produce the same numbers. With missing date or thick-slicing, the conventional M-H computations and the Winsteps M-H computations may differ.

M-H and the t-tests in Winsteps should produce the same results, because they are based on the same logit-linear theory. But, in practice, M-H will be more accurate if the data are complete and there are large numbers of subjects at every score level, so called "thin" matching. Under other circumstances, M-H may not be estimable, or must use grouped-score "thick" matching, in which case the t-test method will probably be more accurate. Similar conclusions can also be inferred from https://www.eric.ed.gov/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED334230&ERICExtSearch_SearchType_0=no&accno=ED334230

MHSLICE= controls the width of each slice, thin or thick. MHSLICE= specifies the width of the slice (in logits) of the latent variable be included in each cross-tab. The lower end of the lowest slice is always the lowest observed person measure.

MHSLICE = 0 bypasses Mantel-Haenszel or Mantel computation.

MHSLICE = .1 logits and smaller. The latent variable is stratified into thin slices. This corresponds to the slicing by raw scores with complete data

MHSLICE = 1 logit and larger. The latent variable is stratified into thick slices.

For each slice, a cross-tabulation is constructed for each pair of person classifications against each scored response level. An odds-ratio is computed from the cross-tab. Zero and infinite ratios are ignored. A homogeneity chi-square is also computed when possible.

Thin slices are more sensitive to small changes in item difficulty across person classifications, but more persons are ignored in inestimable cross-tabs. Thick slices are more robust because fewer persons are ignored. Use the Specification pull-down menu to set different values of MHSLICE= and then produce the corresponding Table 30.

In principle, when the data fit the Rasch model, the Mantel and Mantel-Haenszel estimators should concur with the Rasch DIF contrast measures. The Rasch DIF contrast weights each person equally. Mantel weights each cross-tabulation equally. Thus when the DIF estimates disagree, it indicates that the DIF in the data is non-uniform with ability level.

Computation:
Person classification groups are A, B, ... They are compared pairwise. Starting from the lowest person measure, each slice is MHSLICE= logits wide. There are K slices up through the highest person measure. For the target item, in the kth slice and comparing classification groups A and B, with categories renumbered from 0 to simplify the computation,

Person Classification Groups, g = 1, 2, by j = 0, J categories by k = 1, K ability strata (slices)								
		Rating-Scale Category						
		j = 0	1	2	3	j	J	Total:
Classification Group		Score = Y0	Y1	Y2	Y3	Yj	YJ	
Reference	g = 1	nk10	nk11	nk12	nk13	nk1j	nk1J	Nk1
Focal	2	nk20	nk21	nk22	nk23	nk2j	nk2J	Nk2
Total:		Mk0	Mk1	Mk2	Mk3	Mkj	MkJ	Tk

Then the Mantel (1963) or Mantel-Haenszel (1959) DIF chi-square for the target item is:

$$\chi_1^2 = \frac{\left[\left| \sum_{k=1}^{K} \sum_{j=0}^{J} \left(nk1jYj - Nk1MkjYj / Tk \right) \right| - continuity \right]^2}{\sum_{k=1}^{K} \frac{Nk1Nk2}{Tk^2 (Tk-1)} \left[Tk \sum_{j=0}^{J} MkjYj^2 - \left(\sum_{j=0}^{J} MkjYj \right)^2 \right]}$$

where continuity = 0.5 for dichotomies and = 0 for polytomies.

The Mantel-Haenszel (1959) log-odds estimator for dichotomies and the Liu-Agresti (1996) cumulative log-odds estimator (CUMLOR) for polytomies are:

$$Snkgj = \sum_{h=0}^{j-1} nkgh$$

$$LOR = \frac{\sum_{k=1}^{K} \sum_{j=1}^{J} \left(Snk1j(Nk2 - Snk2j) / Tk \right)}{\sum_{k=1}^{K} \sum_{j=1}^{J} \left(Snk2j(Nk1 - Snk1j) / Tk \right)}$$

Liu, I-M, & Agresti, A. (1996). Mantel-Haenszel-type inference for cumulative odds ratios with a stratified ordinal response. Biometrics, 52, 1223-1234.

Mantel N. (1963) Chi-square tests with one degree of freedom: extensions of the Mantel-Haenszel procedure. J Amer Stat Assoc 58, 690-700.

Mantel, N. and Haenszel, W. (1959) Statistical aspects of the analysis of data from retrospective studies of disease. J Natl Cancer Inst 22, 719-748.

<table>
<tr><th>ETS DIF Category</th><th colspan="2">with DIF Contrast and DIF Statistical Significance</th></tr>
<tr><td>C = moderate to large</td><td>|DIF| ≥ 0.64 logits</td><td>prob(|DIF| ≤ 0.43 logits) ≤ .05 (2-sided)
approximately: |DIF| > 0.43 logits + 2 * DIF S.E.</td></tr>
<tr><td>B = slight to moderate</td><td>|DIF| ≥ 0.43 logits</td><td>prob(|DIF| = 0 logits) ≤ .05 (2-sided)
approximately: |DIF| > 2 * DIF S.E</td></tr>
<tr><td>A = negligible</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">C-, B- = DIF against focal group; C+, B+ = DIF against reference group</td></tr>
<tr><td colspan="3">ETS (Educational Testing Service) use Delta δ units.
1 logit = 2.35 Delta δ units. 1 Delta δ unit = 0.426 logits.</td></tr>
<tr><td colspan="3">Zwick, R., Thayer, D.T., Lewis, C. (1999) An Empirical Bayes Approach to Mantel-Haenszel DIF Analysis. . Journal of Educational Measurement, 36, 1, 1-28
More explanation at www.ets.org/Media/Research/pdf/RR-12-08.pdf pp. 3,4</td></tr>
</table>

Example:

```
----------------------------------------------------------------------------------------------------------------
| PERSON   DIF    DIF   PERSON   DIF    DIF      DIF    JOINT      Welch       Mantel-Haenszel Size ITEM        |
| CLASS  MEASURE S.E.  CLASS  MEASURE S.E.  CONTRAST S.E.    t  d.f. Prob.  Chi-squ Prob. CUMLOR Number  Name   |
|---------------------------------------------------------------------------------------------------------------|
| A        1.47   .28  P        2.75   .33     -1.28    .43 -2.96 102 .0038   7.198 .0073  -1.20       1 Response|
|---------------------------------------------------------------------------------------------------------------|
Size of Mantel-Haenszel slice = .100 logits
```

```
title="MH computation"
; d.f.=1 chi=7.198 p=0.073
; log-odds = -1.20
codes=01
clfile=*
1 Better
0 Same
*
item1=1
name1=1
NI=1
pweight=$s9w2 ; weighting substitutes for entering multiple records
PAFILE=$S6W1 ; anchoring forces stratification
DIF = $4W1 ; cross-tab by Gender, F or M
&end
Response
;234567890
END LABELS
1 FA 1  16
0 FA 1  11
1 FP 1   5
0 FP 1  20
1 MA 2  12
0 MA 2  16
1 MP 2   7
0 MP 2  19
```

21.74 Misfit diagnosis: infit outfit mean-square standardized

"Every single time, also start with the small data — it’s eyeballing anomalies that have led me to some of my best findings." *Katelyn Gleason, CEO and Founder. Eligible Healthtech, September 2021, twittering about data analysis in general.*

Remember that our purpose is to measure the persons, not to optimize the items and raters. A good approach is to compute the person measures based on all the different item selections that you think are reasonable. Start with all the items, and then reduce to smaller sets of items. Cross-plot the person measures. If the person measures are collinear, use the larger set of items. If the person measures are not collinear, use the set of items which produces the more meaningful set of person measures.

A recent critique, M. Müller, "Item fit statistics for Rasch analysis: can we trust them?", Journal of Statistical Distributions and Applications (2020) 7:5, points out that CMLE response residuals are more exact than JMLE ones. Also, infit and outfit statistics are not ideal. But interestingly, the paper is concerned with Type 1 errors being too high, i.e., that using infit and outfit, especially in a JMLE context, the Rasch model is rejected as false when it should not be! The paper does not discuss Type 2 errors. So, based on this paper, we can say that JMLE infit and outfit report the situation as worse than it really is. So if JMLE infit and outfit are acceptable for practical purposes, then they definitely are!

What do Infit Mean-square, Outfit Mean-square, Infit Zstd (z-standardized), Outfit Zstd (z-standardized) mean?

Every observation contributes to both infit and outfit. But the weighting of the observations differs. On-target observations contribute less to outfit than to infit.

Outfit: outlier-sensitive fit statistic. This is based on the conventional chi-square statistic. This is more sensitive to unexpected observations by persons on items that are relatively very easy or very hard for them (and vice-versa).

Infit: inlier-pattern-sensitive fit statistic. This is based on the chi-square statistic with each observation weighted by its statistical information (model variance). This is more sensitive to unexpected patterns of observations by persons on items that are roughly targeted on them (and vice-versa).

Outfit = sum (residual ² / information) / (count of residuals) = average ((standardized residuals)²) = chi-square/d.f. = mean-square

The standardized residual is also called the *Pearson* residual.

Infit = sum ((residual ² / information) * information) / sum(information) = average ((standardized residuals)² * information) = information-weighted mean-square

Mean-square: this is the chi-square statistic divided by its degrees of freedom. Consequently its expected value is close to 1.0. Values greater than 1.0 (underfit) indicate unmodeled noise or other source of variance in the data - these degrade measurement. Values less than 1.0 (overfit) indicate that the model predicts the data too well - causing summary statistics, such as reliability statistics, to report inflated statistics. See further dichotomous and polytomous mean-square statistics. The mean-square Outfit statistic is also called the *Reduced* chi-square statistic. For computations, see

If the mean-squares average much below 1.0, then the data may have an almost-Guttman pattern. Please use much tighter convergence criteria.

Z-Standardized: these report the statistical significance (probability) of the chi-square (mean-square) statistics occurring by chance when the data fit the Rasch model. "Standardized" means "transformed to conform to a unit-normal distribution". The values reported are unit-normal deviates, in which .05% 2-sided significance corresponds to 1.96. Overfit is reported with negative values. These are also called t-statistics reported with infinite degrees of freedom.

ZSTD probabilities: two-sided unit-normal deviates	
1.00	p= .317
1.96	.050
2.00	.045
2.58	.01
3.00	.0027
4.00	.00006
5.00	.0000006

Infit was an innovation of Ben Wright's (G. Rasch, 1980, Afterword). Ben noticed that the standard statistical fit statistic (that we now call Outfit) was highly influenced by a few outliers (very unexpected observations). Ben need a fit statistic that was more sensitive to the overall pattern of responses, so he devised Infit. Infit weights the observations by their statistical information (model variance) which is higher in the center of the test and lower at the extremes. The effect is to make Infit less influenced by outliers, and more sensitive to patterns of inlying observations.

Ben Wright's Infit and Outfit statistics (e.g., RSA, p. 100, www.rasch.org/rmt/rmt34e.htm) are initially computed as mean-square statistics (i.e., chi-square statistics divided by their degrees of freedom). For Outfit the d.f. is the count of observations. For Infit the d.f. is the sum of the information in the observations = 1 / item or person logit S.E.**2. Their likelihood (significance) is then computed. This could be done directly from chi-square tables, but the convention is to report them as unit normal deviates (i.e., t-statistics corrected for their degrees for freedom). I prefer to call them z-statistics, but the Rasch literature has come to call them t-statistics, so now I do to. It is confusing because they are not strictly Student t-statistics (for which one needs to know the degrees of freedom) but are random normal deviates.

$$Infit_i = \frac{\sum_{n=1}^{N}((X_{ni} - E(X_{ni}))^2)}{\sum_{n=1}^{N}\sum_{j=0}^{m}(P(j)(j - E(X_{ni}))^2)}$$

$$Outfit_i = \frac{\sum_{n=1}^{N}\frac{(X_{ni} - E(X_{ni}))^2}{\sum_{j=0}^{m}(P(j)(j - E(X_{ni}))^2)}}{N}$$

where i is item i, n=1 to N are the persons, Xni is the observation of category j of the rating scale.j=0,m. E(Xni) is the expected value of Xni. There is a similar computation for each person n, where i=1 to L are the items.

General guidelines:
First, investigate **negative point-measure or point-biserial correlations**. Look at the Distractor Tables, e.g., 10.3. Remedy miskeys, data entry errors, etc.

Then, the general principle is:

Investigate outfit before infit,
mean-square before t standardized,
high values before low or negative values.

There is an asymmetry in the implications of out-of-range high and low mean-squares (or positive and negative t-statistics). High mean-squares (or positive t-statistics) are a much greater threat to validity than low mean-squares (or negative fit statistics).

Poor fit does not mean that the Rasch measures (parameter estimates) aren't additive. The Rasch model forces its estimates to be additive. Misfit means that the reported estimates, though effectively additive, provide a distorted picture of the data.

The fit analysis is a report of how well the data accord with those additive measures. So a MnSq >1.5 suggests a deviation from unidimensionality in the data, not in the measures. So the unidimensional, additive measures present a distorted picture of the data.

High outfit mean-squares may be the result of **a few random responses** by low performers. If so, drop with PDFILE= these performers when doing item analysis, or use EDFILE= to change those response to missing.

High infit mean-squares indicate that the items are mis-performing for the people on whom the items are targeted. This is a bigger threat to validity, but more difficult to diagnose than high outfit.

Mean-squares show the size of the randomness, i.e., the amount of distortion of the measurement system. 1.0 are their expected values. Values less than 1.0 indicate observations are too predictable (redundancy, model overfit). Values greater than 1.0 indicate unpredictability (unmodeled noise, model underfit). Mean-squares usually average to 1.0, so if there are high values, there must also be low ones. Examine the high ones first, and temporarily remove them from the analysis if necessary, before investigating the low ones.

Zstd are t-tests of the hypotheses "do the data fit the model (perfectly)?" ZSTD (standardized as a z-score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic value has been adjusted to a unit normal value. They show the improbability (significance). 0.0 are their expected values. Less than 0.0 indicate too predictable. More than 0.0 indicates lack of predictability. If mean-squares are acceptable, then Zstd can be ignored. They are truncated towards 0, so that 1.00 to 1.99 is reported as 1. So a value of 2 means 2.00 to 2.99, i.e., at least 2. For exact values, see Output Files. If the test involves less than 30 observations, it is probably too insensitive, i.e., "everything fits". If there are more than 300 observations, it is probably too sensitive, i.e., "everything misfits".

Interpretation of parameter-level mean-square fit statistics:	
>2.0	Distorts or degrades the measurement system.
1.5 - 2.0	Unproductive for construction of measurement, but not degrading.
0.5 - 1.5	Productive for measurement.

<0.5	Less productive for measurement, but not degrading. May produce misleadingly good reliabilities and separations.

In general, mean-squares near 1.0 indicate little distortion of the measurement system, regardless of the Zstd value. Evaluate high mean-squares before low ones, because the average mean-square is usually forced to be near 1.0. Mean-square fit statistics will average about 1.0, so, if you accept items (or persons) with large mean-squares (low discrimination), then you must also accept the counter-balancing items (or persons) with low mean-squares (high discrimination).

Outfit mean-squares: influenced by outliers. Usually easy to diagnose and remedy. Less threat to measurement.
Infit mean-squares: influenced by response patterns. Usually hard to diagnose and remedy. Greater threat to measurement.

Extreme scores always fit the Rasch model exactly, so they are omitted from the computation of fit statistics. If an extreme score has an anchored measure, then that measure is included in the fit statistic computations.

Anchored runs: Anchor values may not exactly accord with the current data. To the extent that they don't, the fit statistics may be misleading. Anchor values that are too central for the current data tend to make the data appear to fit too well. Anchor values that are too extreme for the current data tend to make the data appear noisy.

Question: Are you contradicting the usual statistical advice about model-data fit?
Statisticians are usually concerned with "how likely are these data to be observed, assuming they accord with the model?" If it is too unlikely (i.e., significant misfit), then the verdict is "these data don't accord with the model." The practical concern is: "In the imperfect empirical world, data never exactly accord with the Rasch model, but do these data deviate seriously enough for the Rasch measures to be problematic?" The builder of my house followed the same approach (regarding Pythagoras theorem) when building my bathroom. It looked like the walls were square enough for his practical purposes. Some years later, I installed a full-length rectangular mirror - then I discovered that the walls were not quite square enough for my purposes (so I had to make some adjustments) - so there is always a judgment call. The table of mean-squares is my judgment call as a "builder of Rasch measures".

Question: My data contains misfitting items and persons, what should I do?

Let us clarify the objectives here.

A. www.rasch.org/rmt/rmt234g.htm is aimed at the usual situation where someone has administered a test from somewhere to a sample of people, and we, the analysts, are trying to rescue as much of that data as is meaningful. We conservatively remove misfitting items and persons until the data makes reasonable sense. We then anchor those persons and items to their good measures. After reinstating whatever misfitting items and persons we must report, we do the final analysis.

B. A pilot study is wonderfully different. We want to optimize the subset of items. The person sample and the data can be tailored to optimize item selection. Accordingly,

First, even before data analysis, we need to arrange the items into their approximately intended order along the latent variable. With 89 items, item can be conceptually grouped into clusters located at 5 or more levels of the latent variable, probably more than 5. This defines what we want to measure. If we don't know this order, then we will not know whether we have succeeded in measuring what we intended to measure. We may accidentally construct a test that measures a related variable. This happened in one edition of the MMPI where the test constructors intended to measure depression, but produced a scale that measured "depression+lethargy".

Second, we analyze the data and inspect the item hierarchy. Omit any items that are locating in the wrong place on the latent variable. By "omit", I mean give a weight of zero with IWEIGHT=. Then the item stays in the analysis, but does not influence other numbers. This way we can easily reinstate items, if necessary, knowing where they would go if they had been given the usual weight of 1.

Third, reanalyze the data with the pruned item hierarchy. Omit all persons who severely underfit the items, these are contradicting the latent variable. Again, "omit" means PWEIGHT= 0. Also omit persons whose "cooperation" is because they have an overfitting response set, such as the middle category of every item.

Fourth, analyze again. The data should be coherent. Items in the correct order. Persons cooperating. So apply all the other selection criteria, such as content balancing, DIF detection, to this coherent dataset.

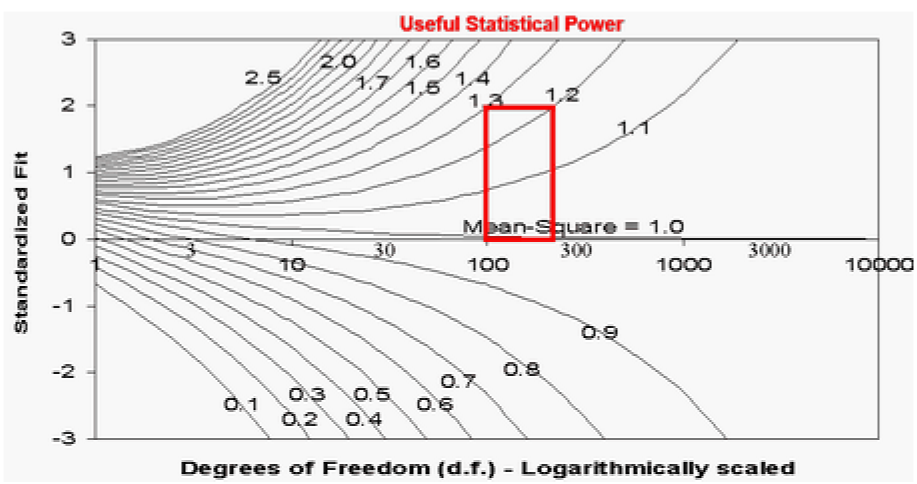
Question: Should I report Outfit or Infit?
A chi-square statistic is the sum of squares of standard normal variables. Outfit is a chi-square statistic. It is the sum of squared standardized residuals (which are modeled to be standard normal variables). So it is a conventional chi-square, familiar to most statisticians. Chi-squares (including outfit) are sensitive to outliers. For ease of interpretation, this chi-square is divided by its degrees of freedom to have a mean-square form and reported as "Outfit". Consequently I recommend that the Outfit be reported unless there is a strong reason for reporting infit.

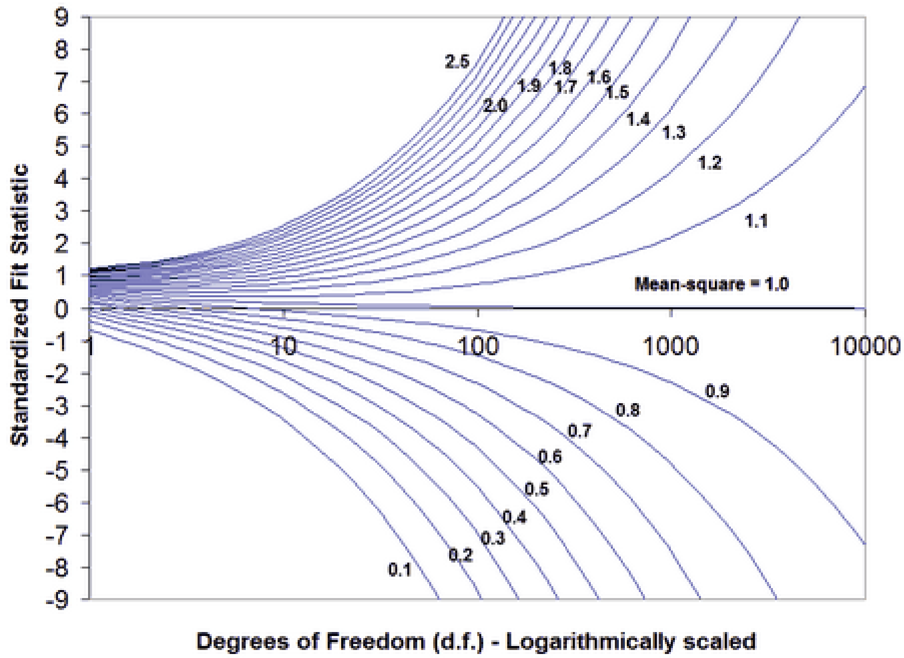
In the Rasch context, outliers are often lucky guesses and careless mistakes, so these outlying characteristics of respondent behavior can make a "good" item look "bad". Consequently, Infit was devised as a statistic that down-weights outliers and focuses more on the response string close to the item difficulty (or person ability). Infit is the sum of (squares of standard normal variables multiplied by their statistical information). For ease of interpretation, Infit is reported in mean-square form by dividing the weighted chi-square by the sum of the weights. This formulation is unfamiliar to most statisticians, so I recommend against reporting Infit unless the data are heavily contaminated with irrelevant outliers.

Question: Are mean-square values, >2 etc, sample-size dependent?
The mean-squares are corrected for sample size: they are the chi-squares divided by their degrees of freedom, i.e., sample size. The mean-squares answer "how big is the impact of the misfit". The t-statistics answer "how likely are data like these to be observed when the data fit the model (exactly)." In general, the bigger the sample the less likely, so that t-statistics are highly sample-size dependent. We eagerly await the theoretician who devises a statistical test for the hypothesis "the data fit the Rasch model usefully" (as opposed to the current tests for perfectly).

The relationship between mean-square and z-standardized t-statistics is shown in this plot. Basically, the standardized statistics are insensitive to misfit with less than 30 observations and overly sensitive to misfit when there are more than 300 observations.

Winsteps cuts off mean-square values at 9.90 because values higher than 9.90 have the same meaning as those of 9.90: the data really, really do not fit the Rasch model.





Question: For my sample of 2400 people, the mean-square fit statistics are close to 1.0, but the Z-values associated with the INFIT/OUTFIT values are huge (over 4 to 9.9). What could be causing such high values?

Your results make sense. Here is what has happened. You have a sample of 2,400 people. This gives huge statistically power to your test of the null hypothesis: "These data fit the Rasch model (exactly)." In the nomographs above, a sample size of 2,400 (on the right-hand-side of the plot) indicates that even a mean-square of 1.2 (and perhaps 1.1) would be reported as misfitting highly significantly. So your mean-squares tell us: "these data fit the Rasch model usefully", and the Z-values tell us: "but not exactly". This situation is often encountered in situations where we know, in advance, that the null hypothesis will be rejected. The Rasch model is a theoretical ideal. Empirical observations never fit the ideal of the Rasch model if we have enough of them. You have more than enough observations, so the null hypothesis of exact model-fit is rejected. It is the same situation with Pythagoras theorem. No empirical right-angled-triangle fits Pythagoras theorem if we measure it precisely enough. So we would reject the null hypothesis "this is a right-angled-triangle" for all triangles that have actually been drawn. But obviously billions of triangle are usefully right-angled.

Hagell and Westergren (Journal of Applied Measurement, 2016) recommend using a sample size between 250 and 500. You can use the Winsteps FORMAT= command to obtain this from a larger sample.

Example of computation:
Imagine an item with categories j=0 to m. According to the Rasch model, every category has a probability of being observed, Pj.
Then the expected value of the observation is E = sum (j * Pj)
The model variance (sum of squares) of the probable observations around the expectation is V = sum (Pj * (j - E) **2).
This is also the statistical information in the observation.
For dichotomies, these simplify to E = P1 and V = P1 * P0 = P1*(1-P1).

For each observation, there is an expectation and a model variance of the observation around that expectation.
residual = observation - expectation
Outfit mean-square = sum (residual**2 / model variance) / (count of observations)
Infit mean-square = sum (residual**2) / sum (modeled variance)

Thus the outfit mean-square is the accumulation of squared-standardized-residuals divided by their count (their expectation). The infit mean-square is the accumulation of squared residuals divided by their expectation.

Outlying observations have smaller information (model variance) and so have less information than on-target observations. If all observations have the same amount of information, the information cancels out. Then Infit mean-square = Outfit mean-square.

For dichotomous data. Two observations: Model p=0.5, observed=1. Model p=0.25, observed =1.
Outfit mean-square = sum ((obs-exp)**2 / model variance) / (count of observations) = ((1-0.5)**2/(0.5*0.5) + (1-0.25)**2/(0.25*0.75))/2 = (1 + 3)/2 = 2
Infit mean-square = sum ((obs-exp)**2) / sum(model variance) = ((1-0.5)**2 + (1-0.25)**2) /((0.5*0.5) + (0.25*0.75)) = (0.25 + 0.56)/(0.25 +0.19) = 1.84. The off-target observation has less influence.

The Wilson-Hilferty cube root transformation converts the mean-square statistics to the normally-distributed z-standardized ones. For more information, please see Patel's "Handbook of the Normal Distribution" or www.rasch.org/rmt/rmt162g.htm.

Diagnosing Misfit: Noisy = Underfit. Muted = Overfit

Classification	INFIT	OUTFIT	Explanation	Investigation
	Noisy	Noisy	Lack of convergence Loss of precision Anchoring	Final values in Table 0 large? Many categories? Large logit range? Displacements reported?
Hard Item	Noisy	Noisy	Bad item	Ambiguous or negative wording? Debatable or misleading options?
	Muted	Muted	Only answered by top people	At end of test?
Item	Noisy	Noisy	Qualitatively different item Incompatible anchor value	Different process or content? Anchor value incorrectly applied?
		?	Biased (DIF) item	Stratify residuals by person group?
		Muted	Curriculum interaction	Are there alternative curricula?
	Muted	?	Redundant item	Similar items? One item answers another? Item correlated with other variable?
Rating scale	Noisy	Noisy	Extreme category overuse	Poor category wording? Combine or omit categories? Wrong model for scale?
	Muted	Muted	Middle category overuse	
Person	Noisy	?	Processing error Clerical error Idiosyncratic person	Scanner failure? Form markings misaligned? Qualitatively different person?
High Person	?	Noisy	Careless Sleeping Rushing	Unexpected wrong answers? Unexpected errors at start? Unexpected errors at end?
Low Person	?	Noisy	Guessing Response set "Special" knowledge	Unexpected right answers? Systematic response pattern? Content of unexpected answers?
	Muted	?	Plodding Caution	Did not reach end of test? Only answered easy items?
Person/Judge Rating	Noisy	Noisy	Extreme category overuse	Extremism? Defiance? Misunderstanding the rating scale?
	Muted	Muted	Middle category overuse	Conservatism? Resistance?
Judge Rating			Apparent unanimity	Collusion? Hidden constraints?

INFIT: information-weighted mean-square, sensitive to irregular inlying patterns
OUTFIT: usual unweighted mean-square, sensitive to unexpected rare extremes
Muted: overfit, un-modeled dependence, redundancy, the data are too predictable
Noisy: underfit, unexpected unrelated irregularities, the data are too unpredictable.

Guessing and Carelessness

Both guessing and carelessness can cause high outfit mean-square statistics. Sometimes it is not difficult to identify which is the cause of the problem. Here is a procedure:
1) Analyze all the data: output PFILE=pf.txt IFILE=if.txt SFILE=sf.txt
2) Analyze all the data with anchor values: PAFILE=pf.txt IAFILE=if.txt SAFILE=sf.txt

2A) CUTLO= -2   this eliminates responses to very hard items, so person misfit would be due to unexpected responses to easy items
2B) CUTHI= 2 this eliminates responses to very easy items, so person misfit would be due to unexpected responses to hard items.

What is your primary concern? Statistical fit or productive measurement?

Statistical fit is like "beauty". Productive measurement is like "utility".

Statistical fit is dominated by sample size. It is like looking at the data through a microscope. The more powerful the microscope (= the bigger the sample), the more flaws we can see in each item. For the purposes of beauty, we may well scrutinize our possessions with a microscope. Is that a flaw in the diamond? Is that a crack in the crystal? There is no upper limit to the magnification we might use, so there is no limit to the strictness of the statistical criteria we might employ. The nearer to 1.0 for mean-squares, the more "beautiful" the data.

In practical situations, we don't look at our possessions through a microscope. For the purposes of utility, we are only concerned about cracks, chips and flaws that will impact the usefulness of the items, and these must be reasonably obvious. In terms of mean-squares, the range 0.5 to 1.5 supports productive measurement.

However, life requires compromise between beauty and utility. We want our cups and saucers to be functional, but also to look reasonably nice. So a reasonable compromise for high-stakes data is mean-squares in the range 0.8 to 1.2.

Fit statisticsfor item banks are awkward. They depend on the manner in which the items in the item banks are used, and also the manner in which the item difficulties are to be verified and updated. Initial values for the items often originate in conventional paper-and-pencil tests, but if the item bank is used to support other styles of testing, these initial values will be superseded by more relevant values. Constructing fit statistics for other styles of testing has proved challenging for theoreticians. This has forced the relaxation of the strict rules of conventional statistical analysis. This is probably why you are having difficulty finding appropriate literature.

My person sample size is 2,000. Many items have significant misfit. What shall I do?

Don't despair! Your items may not be as bad as those statistics say.

If the noise in the data is homogeneous, then the noise-level is independent of sample size. The mean-square statistics will also be independent of sample size.

t-statistics are sensitive to the power of the statistical test (sample size). The relationship between mean-squares and *t*-statistics is shown in the Figures above which suggests that, for practical purposes, *t*-statistics are under-powered for sample sizes less than 100 and over-powered for sample sizes greater than 300.

So my recommendation (not accepted by conventional statisticians) is that mean-squares be used in preference to *t*-statistics. In my view, the standard *t*-tests are testing the wrong hypothesis. Wrong hypothesis = "The data fit the model (perfectly)". Right hypothesis = "The data fit the model (usefully)". Unfortunately conventional statisticians are not interested in usefulness and so have not formulated *t*-tests for it.

Alternatively, random-sample 300 from your 2,000 test-takers. Perform your t-tests with this reduced sample. Confirm your findings with another random-sample of 300.

21.75 Missing data

One of Ben Wright's requirements for valid measurement, derived from the work of L.L. Thurstone, is that "Missing data must not matter." Of course, missing data always matters in the sense that it lessens the amount of statistical information available for the construction and quality-control of measures. Further, if the missing data, intentionally or unintentionally, skew the measures (e.g., incorrect answers are coded as "missing responses"), then missing data definitely do matter. But generally, missing data are missing essentially at random (by design or accident) or in some way that will have minimal impact on the estimated measures (e.g., adaptive tests).

Winsteps does not require complete data in order to make estimates. One reason that Winsteps uses JMLE is that it is very flexible as regards estimable data structures. For each parameter (person, item or Rasch-Andrich threshold) there are sufficient statistics: the marginal raw scores and counts of the non-missing observations. During Winsteps estimation, the observed marginal counts and the observed and expected marginal scores are computed from the same set of non-missing observations. Missing data are skipped over in these additions. When required, Winsteps can compute an expected value for every observation (present or missing) for which the item and person estimates are known.

The basic estimation algorithm used by Winsteps is:
Improved parameter estimate = current parameter estimate
+ (observed marginal score - expected marginal score) / (modeled variance of the expected marginal score)

The observed and expected marginal scores are obtained by summing across the non-missing data. The expected score and its variance are obtained by Rasch estimation using the current set of parameter estimates, see *RSA.*

If data are missing, or observations are made, in such a way that measures cannot be constructed unambiguously in one frame of reference, then the message

WARNING: DATA MAY BE AMBIGUOUSLY CONNECTED INTO nnn SUBSETS

is displayed on the Iteration screen to warn of ambiguous connection.

Missing data in Tables 23, 24: Principal Components Analysis.

For raw observations, missing data are treated as missing. Pairwise deletion is used during the correlation computations. For residuals, missing data are treated as 0, their expected values. This attenuates the contrasts, but makes them estimable.
You can try different methods for missing data by writing an IPMATRIX= of the raw data to a file, and then using your own statistical software to analyze.

Example 1: **Missing observations are scored "1"**

```
ni=4
codes=01
name1=1
item1=1
codes = 01A
ptbis=YES
misscore=1
&end
END LABELS
0110
1001
A001   ; A is in Codes= but scored "missing"
B101   ; B is not in Codes= but is scored 1 by MISSCORE=1
```

```
----------------------------------------------------------------------
|ENTRY   DATA  SCORE |     DATA    | AVERAGE  S.E.  OUTF PTBSE|      |
|NUMBER  CODE  VALUE |  COUNT    % | MEASURE  MEAN  MNSQ CORR.| ITEM | Correlation:
|--------------------+-------------+--------------------------+------|     Code with Score
|    1   A       *** |      1  25*|    -.70              -.50 |I0001 | A {0,0,1,-}{2,1,1,2}
|        0         0 |      1  33 |    -.01          .7  1.00 |      | 0 {1,0,-,-}{2,1,1,2}
|        1         1 |      1  33 |    -.01*       1.4 -1.00 |      | 1 {0,1,-,-}{2.1,1,2}
|        MISSING   1 |      1  33 |    1.26          .4   .50 |      | B {0,0,-,1}{2,1,1,2}
```

Example 2: **Missing data: two types: "skipped" and "not reached"**

Much more at www.rasch.org/rmt/rmt142h.htm

Missing responses in a dataset do not all have the same meaning. For instance, in a timed multiple-choice test. Missing responses between observed responses may mean "skipped" - the respondent decided this question was too hard. Missing responses at the end of the test can mean "not reached", because time ran out before the respondent could respond to these items.

Solution: enter two different missing data codes in the data file, for instance, "S" for skipped and "R" for not reached. Then,

when calibrating the items, we want to ignore "not reached" responses, but score skipped responses as wrong:
CODES=01S
NEWSCORE=010 ; S is scored 0
MISSING-SCORED= -1 ; data code R is not in CODES= so it will be scored -1 = "ignore", "not administered"
IFILE= item-calibrations.txt

when we measure the persons, skipped and not reached responses are wrong:
IAFILE= item-calibrations.txt ; anchor the item difficulties at their good calibrations
CODES=01SR
NEWSCORE=0100 ; S and R are scored 0

Example 3: **Missing categories in a rating scale**

This is a different type of missing data.

Unobserved intermediate categories:
Keep them in the rating scale: STKEEP=yes
Recount the rating scale categories without them: STKEEP=No

Unobserved extreme (top or bottom) categories:

The bottom category has not been observed for one of your items, so Winsteps has omitted it. For Winsteps to include it, we need to tell Winsteps about it. Let's say the errant item is item 6, and the rating scale categories are 1,2,3,4,5. Here are two simple methods:

1. You may be using the Partial Credit Model, PCM, in which each item is modeled to have its own rating scale. If so, put the errant item and another item(s) like it in the same item group:
Now: ISGROUPS=0
Becomes: ISGROUPS=000001100000000
So all items are PCM except the two (items 6 and 7) that share the same rating scale

If the Likert rating scales are similar for many the items, consider grouping similar items together. This will simplify the analysis, and make communicating your findings to your audience easier.

2. Add a dummy person to the dataset who is observed in the bottom category of item 6 and a non-bottom category of another item. You can give this person a small weight if you don't want the person to change things.

Let's put the dummy person as the first person in the data file:
Dummy person xxxxx12xxxxxxxx ; x is missing data

and in your control file
PWEIGHT=*
1 .001 ; person 1 given a small weight
*

There are other options, but they are more complicated.

21.76 Mixed or Mixture Models and Saltus models

Rasch models are grounded in the concept of the unidimensional latent variable, i.e., the items defining the latent variable operate in the same way for all members of the target population. Of course, this is a fiction. But reality can often be made to cooperate.

But there are occasions when a population is comprised of different classes of persons with the items comprising a different latent variable for each class. The classes are called "Latent Classes".

Standard Rasch "latent trait" models can be extended to allow for latent classes. These are called "Mixture Models" (Rost, 1990). The Saltus model (Mark Wilson, 1989) is a mixed model in which segments of items are modeled to shift their difficulties together, and by the same amount, for different latent classes. In these models, the different latent variables are defined by item difficulties, but individual respondents are not assigned to a particular class, but rather the probability that each respondent belongs to each class is reported.

In a finite mixture model, the number of classes is decided in advance. For an infinite model, the number of classes is infinite. The actual number of active classes depends on the data. Observed classes have their probability distributions inferred from the data. Unobserved classes keep their Bayesian distributions.

Winsteps does not do a mixture or Saltus analysis directly, but it can provide much of the same information, and also can indicate whether a more rigorous latent class analysis is likely to be productive.

Here is an approach:

Step 1. Identify meaningful potential respondent classes, e.g., male/female, high/low performers. The Winsteps PCA analysis (e.g., Table 24) may help identify potential person classes. and Table 23 may help to identify item classes.

Step 2. Mark in the person label the class codes. The Microsoft Word "rectangle copy" function may be useful. High and low performers do not need to be flagged, instead the MA2 function can be used.

Step 3. Perform DIF analysis based on the class codes. Items displaying strong DIF may be exhibiting class-related behavior.

Step 4. Flag the items by class in the item identification.

Step 5. Look for item-classification by person-classification interactions (differential classification-grouped functioning, DGF, Table 33). These would approximate the Saltus findings.

Rost, Jürgen. (1990) Rasch Models in Latent Classes: An Integration of Two Approaches to Item Analysis, Applied Psychological Measurement, 14, 271-282

Wilson, M. (1989). Saltus: A psychometric model for discontinuity in cognitive development. Psychological Bulletin, 105, 276-289.

21.77 Müller's continuous rating scale model CRSM

Müller (1987) suggests that continuous-looking data can be modeled with a conceptually infinite number of categories in a fixed interval. The infinite number of Andrich thresholds between the thresholds is modeled with a linear function. Linacre (2001) remarks that the linear function can be generalized to any convenient function and suggests other functions.

An approximate implementation of these continuous models in Winsteps can be obtained by using a high number of categories and a convenient polynomial function.This is done using SFUNCTION= to define the polynomial, and ISRANGE= to define the range of the categories. Müller's continuous rating scale model, CRSM, is approximately equivalent to SFUNCTION=2.

Linacre, J. M. (2001). Percentages with continuous Rasch models. Rasch Measurement Transactions, 14, 771-774.

Müller, H. (1987). A Rasch model for continuous ratings. Psychometrika, 52, 165-181.

21.78 Multidimensional Model - Multidimensionality

Winsteps estimates unidimensional Rasch models, but many of the benefits of multidimensional modeling can be obtained through a Winsteps analysis. The Winsteps results are often easier to understand an use than those of a multidimensional analysis.

Identifying dimensions among the items. This can be done by inspecting the content of the items or through Table 23.

1. Do a standard unidimensional Rasch analysis
2. Use Winsteps Table 23.1 and other information to identify each item's "dimension"
3. Enter a code for the item's dimension into column 1 of the item label
4. Do the standard Rasch analysis
5. Winsteps Table 31, Differential Person Functioning, will give a measure for each person on each "dimension", all in the same frame-of-reference.

Example 1: I always have a problem in unidimensionality. How can I solve this problem in this data and others? Unexplned variance in 1st contrast = 4.6 so that the eigenvalue of first contrast is noticeably greater than 2.0

Reply:
(1) is it truly a problem? There are many reasons for dependency in the data. For instance, if your items are groups using ISGROUPS=, then items in the same group (and so with the same rating scale) are slightly more dependent with each other than with other items.

(2) Look at Table 23.1.
Look at the content (wording) of the items at the top of the plot, and compare them with the items at the bottom of the plot. What is in the top items that contrasts with what is in the bottom item? Are they on different dimensions (for instance, geography and history) or is the difference only superficial (for instance, response format or position on page)?

(3) Please look at the disattenuated correlations of the person measures at the bottom of Table 23.1:

```
Approximate relationships between the KID measures
 PCA      ACT       Pearson       Disattenuated Pearson+Extr  Disattenuated+Extr
Contrast  Clusters  Correlation   Correlation   Correlation   Correlation
 1        1 - 3      0.1404        0.2175        0.1951        0.2923  < far from 1.0
```

If the correlations are near 1.0, then the person measures for the different "dimensions" are statistically the same. No action is needed.

(4) If the items really are on different dimensions and the person measures have a low correlation, then split the items into two subsets .

Please also see:
Dimensionality: contrasts & variances
Dimensionality investigation - an example
Dimensionality: when is a test multidimensional?

Item principal components/contrasts in Table 23 Identifies structure and dimensionality in response residuals
Table 23.0 Variance components scree plot for items
Table 23.1, 23.11 Principal components plots of item loadings
Table 23.2, 23.12 Item Principal components analysis/contrast of residuals
Table 23.3, 23.13 Item contrast by persons
Table 23.4, 23.14 Item contrast loadings sorted by measure
Table 23.5, 23.15 Item contrast loadings sorted by entry number
Table 23.6, 23.16 Person measures for item clusters in contrast. Cluster Measure Plot for Table 23.6.
Table 23.99 Largest residual correlations for items
Youtube video explaining Table 23

Example 2: I want to do a multi-dimensional Rasch analysis with Winsteps.

Multi-dimensional Rasch analysis is implemented directly in ConQuest. In Winsteps, the data for all the domains could be in one control file. Item weighting would be assigned to each item for each domain in separate IWEIGHT= files, one for each domain. Each domain would be analyzed separately with its own IWEIGHT= file, and person measures produced. Finally, the set of person measures (one for each person for each domain) would be summarized into one measure for each person by using a summarizing analysis, e.g., Q-mode analysis.

21.79 Multiple copy-and-paste or other repetitive actions

Sometimes you want to do the same action repeatedly, such as copying and pasting item curves for all the items into a document. Winsteps users report that a Windows keyboard macro can do this successfully. Autohotkey is a free Windows keyboard macro generator. Other tools are listed at www.zerodollartips.com/free-macro-recorder-windows-10/

21.80 Multiple Response items - MR questions

Multiple Response MR questions look like multiple-choice questions, but there is more than one correct option. Respondents must select all the correct options, and none of the incorrect options, to succeed on the item.

Example: Which prepositions are grammatically correct in this sentence?

"I am fighting .... you."

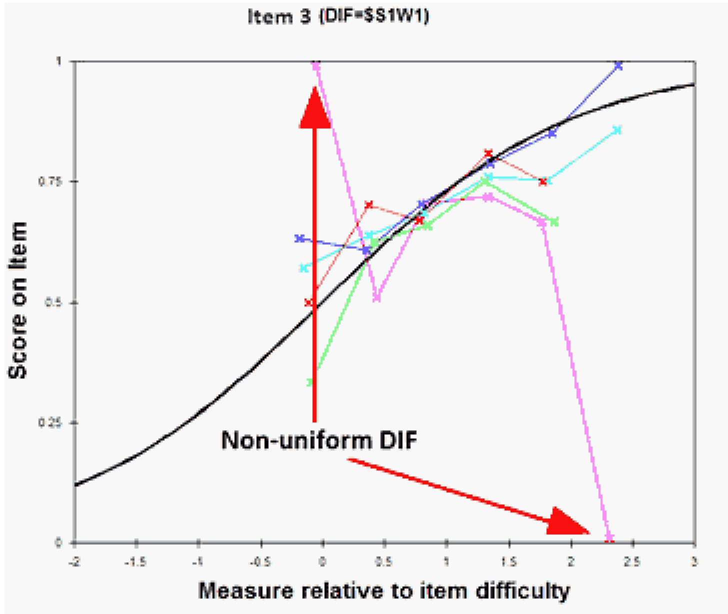
Options: a. against   b. at   c. for   d. from   e. to   f. with
Correct responses: a., c., f.
Incorrect responses: b., d., e.

Winsteps cannot analyze these data directly. Please score each MR item into correct./incorrect (1-0) or correct/partially correct/incorrect (2-1-0). Then enter the scored responses into a standard rectangular data file. Winsteps can analyze this file. Alternatively, code each MR option as a separate 1-0 item.

21.81 Non-uniform DIF tables

When items exhibit different difficulties for different person groups this is called "item bias" or "differential item functioning", DIF. When the DIF is the same for all ability levels of the two groups this is termed Uniform DIF. Table 30 reports this. When DIF differs with ability levels, this is termed Non-Uniform DIF, NUDIF. This is discussed here. Non-uniform DIF is also called Differential Score Functioning or Differential Step Functioning (DSF).

Non-uniform DIF is difficult to interpret. Please start by looking at
Graphs Menu. Non-uniform DIF ICCs.
This will show you which items have an interaction between item difficulty, group membership and ability.



If you see an item for which the item difficulty is noticeably different for high and low performers in a group, then Table 30.1 will report the statistical significance of the difference.

```
DIF class specification is: DIF=$S1W1+MA2
```

Examinee CLASS	Obs-Exp Average	DIF MEASURE	DIF S.E.	Examinee CLASS	Obs-Exp Average	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	Welch d.f.	Prob.	Mantel-Haenszel Chi-squ	Prob.	Size CUMLOR	Item Number	Name
21	.00	-.1950	.1151	22	-.13	.5092	.1836	-.7042	.2166	-3.25	300	.0013	.0000	1.000		3	1

Conceptually, all DIF is non-uniform. "Uniform DIF" = "Average non-uniform DIF". For instance, in the Mantel-Haenszel DIF computation, every raw-score stratification reports a different DIF estimate. The Mantel-Haenszel statistic averages these estimates. Winsteps reports uniform DIF as a summary of a non-uniform DIF distribution in the same way that the mean is a summary of a sample distribution.

1) Look at the empirical ICC (Graphs menu, Non-uniform DIF). Is the empirical ICC clearly flatter or steeper than the model ICC for a classification group? Suppose that is group F

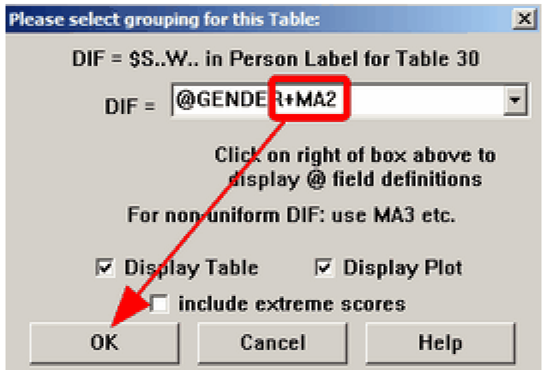
2) In the Winsteps DIF table 30.1, we expect F1 vs. F2 to be both a large DIF contrast (>1.0 logits) and to be statistically significant ($p \leq .05$).

3) There should be a substantive reason for deciding that the NUDIF is not merely a statistical accident.

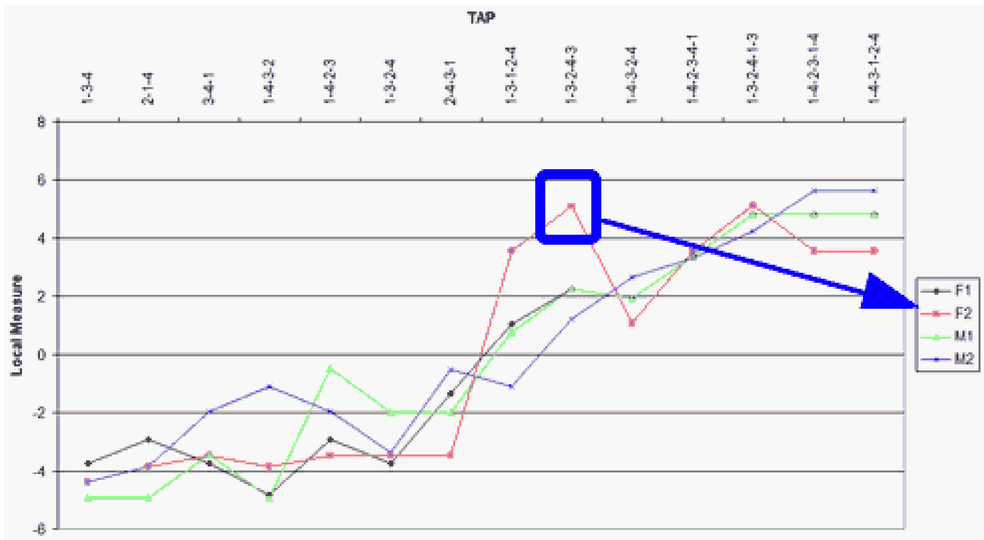
Example, the division sign, ÷, is very difficult for those students who have not learned its meaning, and easy for those who have. So it exhibits NUDIF across grade-levels.

In detail:

1. Simple NUDIF reporting. In Table 30, specify both a person class column with DIF= and the number of ability strata to be reported, e.g., $MA2, which reports 2 levels of ability, the top and bottom half of the ability range. Here is the dialog box:



Here is the plot:



The blue box flags an example of non-uniform DIF. It is "F2" where "F" (@GENDER) is the females, and "2" (MA2) the upper ability group. "F1" is "F' ability group "1", the lower ability group. The non-uniform DIF numbers are shown in Table 30.2:

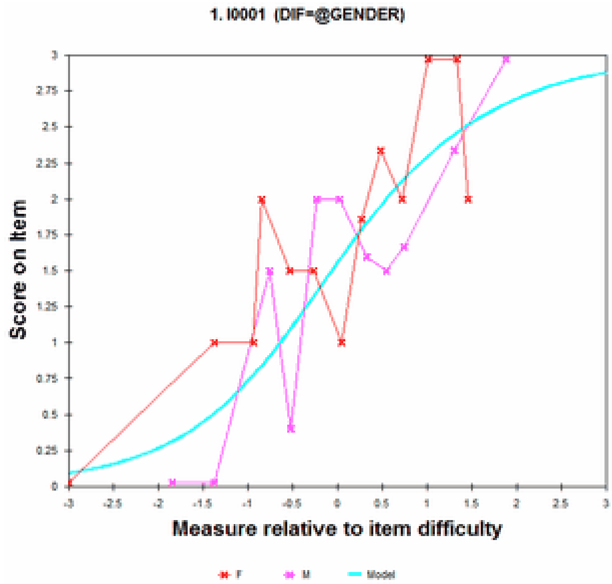
```
TABLE 30.2 KNOX CUBE TEST                         ZOU608WS.TXT Aug 21  6:04 2007
INPUT: 35 KIDS  18 TAPS  MEASURED: 35 KIDS  18 TAPS  2 CATS        WINSTEPS 3.64.0
--------------------------------------------------------------------------------

DIF class specification is: DIF=@GENDER+MA2
```

KID CLASS	OBSERVATIONS COUNT	OBSERVATIONS AVERAGE	BASELINE EXPECT	BASELINE MEASURE	DIF SCORE	DIF MEASURE	DIF SIZE	DIF S.E.	DIF t	TAP Number	Name
F1	7	.00	.01	2.24	-.01	2.24	.00<	3.23	.00	12	1-3-2-4-3
F2	11	.00	.20	2.24	-.20	5.10	2.86<	1.94	1.47	12	1-3-2-4-3
M1	3	.00	.01	2.24	-.01	2.24	.00<	6.68	.00	12	1-3-2-4-3
M2	13	.46	.29	2.24	.17	1.21	-1.02	.65	-1.57	12	1-3-2-4-3

Some person classes have extreme scores. These are shown in the green boxes, and are indicated by "<" for minimum extreme scores and ">" for maximum extreme scores. The plotted DIF measures are shown in the blue box, with the DIF size relative to the overall item difficulty level in the adjacent column.

Table 30.1 reports if there is pairwise DIF between CLASSES/GROUPS.

2. For more insights, plot the non-uniform DIF ICCs.



Example: I would like to study each item for any differences of skewness of responses between male and female respondents. How do I do that in Winsteps?

Try the approaches above, you can also try this:
a) analyze your data together. Output person measures: PFILE=pf.txt
b) transpose the data: TRPOFILE=
the persons are now the columns and the items are the rows.
c) in the transposed control file:
ISGROUPS=* (or in a separate file)
1 M (gender of person 1)
2 F (gender of person 2)
3 ...
....
*
d) anchor the persons at their PFILE measures, as items:
IAFILE= pf.txt
USCALE=-1 (convert person ability to item difficulty)
e) analyze the transposed data one item at a time: IDELETE=+23 (number of the target item)
f) the output will have two rating scales, one for each gender, in Table 3.2 and the Graphs window.
g) you can display the two ICCS simultaneously: Multiple Item ICCs
try with both "relative x-axis" and "absolute x-axis" to see which draws the clearest picture.

21.82 Null or unobserved categories: structural and incidental zeroes

There are two types of unobserved or null categories: structural zeroes and incidental/sampling zeroes.

Structural null categories occur when rating scale categories are number 10, 20, 30,... instead of 1,2,3. To force Winsteps to eliminate non-existent categories 11, 12, 13, either rescore the data IVALUE= or specify STKEEP=NO.

For intermediate incidental null zeroes, imagine this scenario: The Wright & Masters "Liking for Science" data are rescored from 0,1,2 to 0,1,3 with a null category at 2. the categories now mean "disagree, neutral, agree-ish, agree". We can imagine that no child in this sample selected the half-smile of agree-ish.
The category frequencies of categories 0,1,2,3 are 378, 620, 0, 852
The three Rasch-Andrich threshold parameters are -.89, +infinity, -infinity.
The +infinity is because the second parameter is of the order log(620/0). The -infinity is because the third parameter is of the order log(0/852).

Mark Wilson's 1991 insight was that the leap from the 2nd to the 4th category is of the order log(620/852). This is all that is needed for immediate item and person estimation. But it is not satisfactory for anchoring rating scales. In practice however, a large value substitutes satisfactorily for infinity. So, a large value such as 40 logits is used for anchoring purposes. Thus the approximated parameters become -.89, 40.89, -40.00 for SFILE= and SAFILE=. With these anchored threshold values, the expected category frequencies become: 378.8, 619.4, .0, 851.8. None of these are more than 1 score point away from their observed values, and each represents a discrepancy of .2% or less of its category count.

Extreme incidental null categories (unobserved top or bottom categories) are essentially out of range of the sample and so the sample provides no direct information about their estimates. To estimate those estimates requires us to make an assertion about the form of the rating scale structure. The Rasch "Poisson" scale is a good example. All its infinitude of thresholds are estimable because they are asserted to have a specific form. But see Example 12 for a different approach to this situation.

Our recommendation is that structural zeroes be rescored out of the data. If categories **may be** observed next time, then it is better to **include a dummy data record** in your data file which includes an observation of the missing category and reasonable values for all the other item responses that accord with that missing category. This one data record will have minimal impact on the rest of the analysis, especially if you give it a very small weight with PWEIGHT=.

See also Unobserved and dropped categories

Another approach is to model the categories with a polynomial function: SFUNCTION=.

Wilson, M. (1991) Rasch Estimation with Unobserved or Null Categories. www.rasch.org/rmt/rmt51b.htm

21.83 One item test - One observation per respondent

One item test:
A dummy second item is needed. This can be given a very small weight, and its dummy data would be the reverse of the active item. Then every person will have a non-extreme score. If everybody is in the top (or bottom) category, then add a dummy person with a very small person and the opposite category response:

<table>
<tr><td>Example: Live data is:

NI=1
CODES=01
&END
Item 1
END LABELS
1 Person 1
1 Person 2
1 Person 3
1 Person 4</td><td>Live data with Dummy data:

NI=2
CODES=01
IWEIGHT=*
2 .01 ; Adjust weighting up to make measures more central, down to make more extreme.
*
PWEIGHT=*
5 .01
*
&END
Item 1
Item 2 dummy
END LABELS
10 Person 1
10 Person 2
10 Person 3
10 Person 4
01 Person 5 dummy</td></tr>
</table>

Some people (or items) have only one response:
An observation in an extreme category is treated the same as any other extreme score. An equivalent finite measure is reported. Intermediate categories generate finite measures. The measure will have very large standard errors (low precision).

This is like the first item of an adaptive test, or the first observation on a diagnostic instrument. It gives a rough idea of the measure. However, if we only have one observation, there is no opportunity for quality-control fit analysis. That is why carpenter's are encouraged to "measure twice!".

Every person (or item) has only one response:

Question: I'm trying to analyze a dataset where there are four test forms, and on each test form there is only one 4-point polytomous item. That is, each student took one and only one test question. Can this type of dataset be calibrated using Winsteps?

Reply: If there is only one response per person, there is not enough information to construct measures, but only enough to order the people by the raw score of that one response. But .....

If the people taking each of the 4 forms are supposed to be randomly equivalent, then we can equate the forms, and discover how a "3" on one form relates to a "3" on another form. To do this:

Enter the 4 forms as 4 items in Winsteps.
For each "item" enter the column of responses.
Anchor the rows at 0.
Set ISGROUPS=0
Run the analysis.

The measure corresponding to each score on each item is given in Table 3.2, "Score at Cat", and shown in Table 2.2. Use the measures in the "At Cat." column to correspond to the polytomous observations in summary analyses.

Example: The responses to the 4 forms, A, B, C, D, were:

```
A 1 3 2 4
B 2 4 3 1 1 3
C 3 2 2 3 1 4 1
D 4 4 3 2 1
```

Note that the order of the persons within form doesn't matter, and the number of respondents per form doesn't matter. Here is the *Winsteps* control file:

```
Title = "Measurement with 4 forms"
NI=4
Item1=1
Name1=1    ; there aren't any row names.
Codes=1234
ISGROUPS=0   ; allow each form its own rating (or partial credit) scale
Item=Form  ; rename to remind ourselves
Person=Row ; Rows are anchored at zero, and so are all equivalent.
Pafile=*
1-7 0         ; anchor all rows at "0". 7 is the largest number of students who took any form.
*
CONVERGE=L  ; only logit change is used for convergence
LCONV=0.005  ; logit change too small to appear on any report.
&end
A  ; the 4 items are the 4 forms
B
C
D
END LABELS
1234 ; responses per form entered as columns with students in any order.
3424
2323
4132
.111
.34.
.1..
```

Resulting Table 2.2:

```
EXPECTED SCORE: MEAN  (":" INDICATES HALF-POINT THRESHOLD)
-3       -2        -1         0         1         2         3
|---------+---------+---------+---------+---------+---------|  NUM   FORM
1                  1    :    2   :   3     :     4         4    2  B
|                                                           |
|                                                           |
1             1     :     2   :   3     :     4            4    1  A
1        1      :       2     :     3       :      4       4    3  C
|                                                           |
1             1    :    2   :  3     :   4                 4    4  D
|---------+---------+---------+---------+---------+---------|  NUM   FORM
-3       -2        -1         0         1         2         3
```

```
                    7                                ROWS
                    M
```

Table 3.2:

```
SUMMARY OF CATEGORY STRUCTURE. Model="R"
FOR GROUPING "0" FORM NUMBER: 1  A

FORM ITEM DIFFICULTY MEASURE OF .00 ADDED TO MEASURES
+-------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------+
|  1   1       1  14|   .00   .00|  1.00  1.00||  NONE   |( -1.59)| 1
|  2   2       1  14|   .00*  .00|  1.00  1.00||     .00 |   -.42 | 2
|  3   3       1  14|   .00*  .00|  1.00  1.00||     .00 |    .42 | 3
|  4   4       1  14|   .00*  .00|  1.00  1.00||     .00 |(  1.59)| 4
|-------------------+------------+------------++---------+--------+
|MISSING       3  43|   .00      |            ||         |        |
+-------------------------------------------------------------------
AVERAGE MEASURE is mean of measures in category.

+---------------------------------------------------------------------+
|CATEGORY    STRUCTURE   |  SCORE-TO-MEASURE   | 50% CUM.| COHERENCE|
| LABEL    MEASURE  S.E. | AT CAT. ----ZONE----|PROBABLTY| M->C C->M|
|------------------------+---------------------+---------+----------|
|   1      NONE          |( -1.59) -INF   -1.01|         |   0%   0%| 1
|   2          .00   1.15 |   -.42  -1.01    .00|    -.61 |  50% 100%| 2
|   3          .00   1.00 |    .42    .00   1.01|     .00 |  50% 100%| 3
|   4          .00   1.15 |(  1.59)  1.01  +INF |     .61 |   0%   0%| 4
+---------------------------------------------------------------------+
```

Form B:

```
+---------------------------------------------------------------------+
|CATEGORY    STRUCTURE   |  SCORE-TO-MEASURE   | 50% CUM.| COHERENCE|
| LABEL    MEASURE  S.E. | AT CAT. ----ZONE----|PROBABLTY| M->C C->M|
|------------------------+---------------------+---------+----------|
|   1      NONE          |( -1.09) -INF    -.63|         |   0%   0%| 1
|   2         1.10    .76 |   -.11   -.63    .28|    -.14 |  14% 100%| 2
|   3         -.69    .76 |    .70    .28   1.34|     .14 |   0%   0%| 3
|   4          .70   1.08 |(  2.02)  1.34  +INF |    1.02 |   0%   0%| 4
+---------------------------------------------------------------------+
```

21.84 Order of elements in Control file

Element	Function	Status
&INST		optional, for backwards compatibility only
TITLE=	title of analysis	recommended
ITEM1=	starting column of items	Required
NI=	number of items	Required
ISGROUPS=	grouping information	optional, with GRPFRM=N (the standard)
MODELS=	model information	optional, with MODFRM=N (the standard)
RESCORE=	rescore information	optional, with RESFRM=N (the standard)
KEY1=	key information	optional, if KEYFRM= omitted (the standard)
KEY2= ..	(n=1 to 99, number of largest key)	optional, if KEYFRM= omitted (the standard)
KEYn= ..		optional, if KEYFRM= omitted (the standard)
other control variables		optional
; comments		optional
&END		Required
ISGROUPS=	(in data file format)	required if GRPFRM=Y
MODELS=	(in data file format)	required if MODFRM=Y

RESCORE=	(in data file format)	required if RESFRM=Y
KEY1=	(in data file format)	required if KEYFRM=1 or more
KEY2= ..	(in data file format)	required if KEYFRM=2 or more, and so on up to
KEYn=	(in data file format)	required if KEYFRM=n
Item Names	(expects NI= names)	expected if INUMB=N (the standard)
END NAMES		required if INUMB=N (the standard)
data records		required if DATA=" " (the standard)

21.85 Partial Credit model

The "Partial Credit" Rasch model was devised for multiple-choice questions in which credit is given for almost-correct distractors. But there is no reason to believe that the almost-correctness of distractors to different questions is the same. Consequently, each item is modeled to have its own response structure.

This model was extended to any questionnaire using ordered polytomies in which the response structure is modeled to be unique to each item.

Winsteps estimates response structures by item groupings, using ISGROUPS=. From this perspective, the Andrich Rating Scale Model includes all items in one grouping. The Masters Partial Credit Model allocates each item to its own grouping.

The conventional representation of the Partial Credit model is

log (Pnij / Pni(j-1)) = Bn - Dij = theta - delta

Winsteps parameterizes Dij as Di + Fij where sum(Fij) = 0. And Di is the average (Dij).

log (Pnij / Pni(j-1)) = Bn - Di - Fij

Algebraically these two representations are identical.

Thus every item has a mean difficulty, Di. This simplifies communication, because the results of a Partial Credit analysis now have the same form as any other polytomous analysis supported by Winsteps.

Evaluating a PCM analysis

In Winsteps, most of this is in Table 3.2

1. Do the average measures increase with the categories?
2. Do the observations fit the categories?
3. Do the Andrich thresholds advance with the categories?

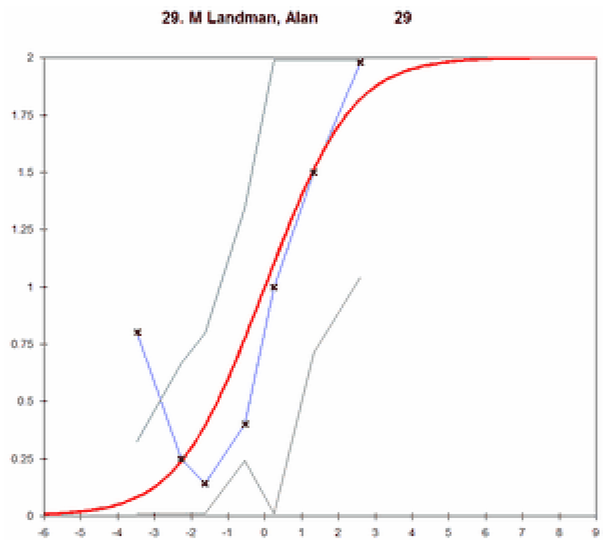
   The alternative could be the Rating Scale Model, if so:
4. Are the item ICC/IRFs different enough to require the added burden on your audience to understand the PCM structures, and also the loss of generalization across current and future items?
5. Is the PCM person "test" reliability noticeably higher than the RSM reliability?

21.86 Person Response Functions (PRF)

To produce Person Response Functions (PRF) or Person Characteristic Curves using Winsteps,

1. Transpose the scored data matrix: Winsteps Output File menu. Transpose. So that the persons become the items.
2. ISGROUPS=0 in the transposed file if you want to model each person to have a unique rating scale.
3. Analyze the transposed file.
4. The Graphs menu now produces person curves, not item curves, but with a reversed x-axis.
5. To smooth the PRF, which is called Hanning, adjust the Smoothing slider

Here is an example from Example0.txt



21.87 Person-free and Item-free measurement

A strength of Rasch methodology is that the estimates of Rasch measures ("Rasch scores", thetas and deltas) are person-free and item-free.

Person-free: as much as is statistically possible, the item-difficulty estimates are independent of the particularly sample of persons from a homogeneous population that are used in the estimation. The actual distribution of the items and persons is irrelevant.

Item-free: as much as is statistically possible, the person-ability estimates are independent of the particularly sample of items from a homogeneous population that are used in the estimation. The actual distribution of the items and persons is irrelevant.

Since each analysis has its own zero-point (frame-of-reference), we need to equate or link the tests to put all the analyses in the same frame-of-reference.

Ben Wright's (1967) demonstration of person-free and item-free estimation:

Item-free person-ability estimates:
1. Analyze a large dataset.
2. Split the items into easy items (low difficulties) and hard items (high difficulties)
3. Analyze each set of items separately.
4. Identify items and persons with extreme (zero, perfect) scores and remove from the analyses. Remove persons with extreme scores in one analysis also from the other analysis.
5. Reanalyze both sets of items.
6. Cross-plot the person estimates. They should form a fuzzy diagonal line. The Winsteps scatterplot includes confidence bands to show the statistical similarity of the two sets of person ability estimates.

Person-free item-difficulty estimates:
1. Analyze a large dataset.
2. Split the persons into high-ability persons and low-ability persons.
3. Analyze each set of persons separately.
4. Identify items and persons with extreme (zero, perfect) scores and remove from the analyses. Remove items with extreme scores in one analysis also from the other analysis.
5. Reanalyze both sets of persons.
6. Cross-plot the item estimates. They should form a fuzzy diagonal line. The Winsteps scatterplot includes confidence bands to show the statistical similarity of the two sets of item difficulty estimates.

Wright, B. D. (1967). Sample-Free Test Calibration and Person Measurement. In
B. S. Bloom (Chair), Invitational Conference on Testing Problems (pp.
84-101). Princeton, NJ: Educational Testing Service. Available at
www.rasch.org/memo1.htm.

21.88 Pivot anchoring

There is usually no problem defining the item difficulty of a standard dichotomous (right/wrong) item. It is the location on the latent variable where there is a 50% chance of success on the item.

Combining dichotomous items makes a polytomous super-item. But how do we define the difficulty of a super-item? Since the difficulty of a dichotomous item is the location on the latent variable where the top and bottom categories are equally probably (= 0.5), we apply the same logic to the super-item. Its difficulty is the location on the latent variable where the top and bottom categories are equally probably (= ?). But this definition does not make sense in every situation. So we may need to choose another definition.

For instance, if a super-item is a combination of 3 dichotomous items (so that its possible scores = 0,1,2,3) , we might define its difficulty as the location on the latent variable where the expected score on the super-item is 1.5. Or the location on the latent variable where scores of 1 and 2 are equally probable. Or the location on the latent variable where the expected score is 1.0 or maybe 2.0. Or .....

For these alternative definitions, we need to compute the distance of the chosen location from the standard location and then apply that distance to the item difficulty using "pivot anchoring" implemented in Winsteps with SAFILE=. We can usually discover the distance we want by looking at the GRFILE= output.

The procedure is:
(1) Analyze the data without pivot-anchoring
(2) Output SFILE=sf.txt which contains the standard Andrich thresholds
(3) Output GRFILE=gr.txt which contains the values connected with all the scores and probabilities on the item
(4) Identify the logit value corresponding to the desired location on the latent variable = M
(5) Subtract M from all the values for the super-item in SFILE=sf.txt
(6) The adjusted SFILE= is now specified as SAFILE=sf.txt, the pivot-anchor file
(7) Analyze the data with pivot-anchoring
(The difficulty of the super-item should now have changed by the specified value, M

Pivots are the locations in the dichotomy, rating (or partial credit) scale at which the categories would be dichotomized, i.e., the place that indicates the transition from "bad" to "good", "unhealthy" to "healthy". Ordinarily the pivot is placed at the point where the highest and lowest categories of the response structure are equally probable. Pivot anchoring redefines the item measures. The effect of pivot anchoring is to move the reported difficulty of an item relative to its rating scale structure. It makes no change to the fit of the data to the model or to the expected observation corresponding to each actual observation.

Dr. Rita Bode's procedure works well. The idea is to align the item difficulties so that the cut-point for each item (equivalent to the dichotomous item difficulty) is located at the reported item difficulty on the latent variable. So, we do an arithmetic sleight of hand. In the original analysis, we look at a Table such as Table 2.2 and see where along the line (row) for each item is the substantive cut-point (pass-fail point, benchmark, etc.) We note down its measure value on the latent variable (x-axis of Table 2.2).

Then, for each item, we compare the measure value new item difficulty with its reported item difficulty. The difference is the amount we need to shift the Andrich thresholds for that item. Here is the computation:

New average thresholds (excluding bottom "0") = Old item difficulty + Old average thresholds (excluding bottom "0") - Provisional New item difficulty

If the analysis is unanchored, Winsteps will maintain the average difficulty of the items:

New item difficulty = Provisional New item difficulty - Average(Provisional New item difficulty) + Average(Old item difficulty)

Person measures with complete response strings will usually have very small or no changes.

Since this can become confusing. It is usually easiest to :

1) output the SFILE= from the original analysis to Excel.
2) add (item difficulty - cut-point) to the threshold values for each item. Example: we want to subtract 1 logit from the item difficulty to move the item difficulty to the cut-point on the latent variable. We add 1 logit to all the thresholds for an item, then Winsteps will subtract 1 logit from the item's difficulty.
3) Copy-and-paste the Excel SFILE= values into the Winsteps control file between SAFILE=* and *
4) Since each item now has different threshold values: ISGROUPS=0
5) This procedure should make no change to the person measures.

In Rita Bode's approach, we have a target item difficulty ordering. Usually most items are already in that order, but a few items are out of order. These out-of-order item need to be pivot-anchored to place them correctly in the item hierarchy.
i) Output Table 13, the original ordering of the items.
ii) Move the item rows up and down to give the desired ordering.
iii) For items that are already in order (usually more than half the items), there is no change to SFILE= in the SAFILE=.
iv) For the other items, change the SFILE= values enough to locate those items in the correct position. Example, to increase the item difficulty by one logit, decrease the thresholds from the SAFILE= to the SAFILE= by one logit.

See also SAFILE=. PIVOT= was an earlier, unsuccessful attempt to automate this procedure.

For polytomies:

1) from your original analysis, with your GROUPS= (if any) and no SAFILE=, output an SFILE=

2) build an SAFILE=

a) for each item, use the SFILE= value for its group

b) add the pivot anchor value to the SFILE= value

c) include the new set of values for the item in the SAFILE=. There must be entries in SAFILE= for every item. Use the SFILE= values directly if there is no change

Example 1: SFILE= for the group with item 1:
1 0 .00
1 1 -.85
1 2 .85

We want to add one logit for item 1, two logits for item 2, no change for item 3

SAFILE=*
1 0 1.00 ; this is a placeholder, but is convenient to remind us of the pivot value
1 1 0.15
1 2 1.85
2 0 2.00
2 1 2.15
2 2 2.85
3 0 0.00
3 1 -.85
3 2 0.85
*

3) do the analysis again with ISGROUPS=0 and SAFILE=* ... *

4) The person measures will shift by the average of the pivot values.

Example 2: We can plot the IRF/ICC ogives for every PCM item on a graph. This gives a complete story of expected responses on all the items for each person on the x-axis, but it does not gives us a useful depiction of the latent variable. When explaining the latent variable in terms of an item hierarchy, we need to take a horizontal slice across all the PCM ICCs/IRFs somewhere around the middle of the rating scale. Pivot anchoring lets us do this.

For instance, the rating scale may be a Likert scale from 1 to 5 with 4=Agree. We may decide that the "pivot" point on the IRF of each item is where the expected score = 4 (which is also the point where category 4=Agree has the highest probability of being observed). So we need to redefine the item difficulty of each PCM item away from its default value (the location where the highest and lowest categories are equal probable) to the location where the expected score on the item = 4. We do this using pivot-anchoring. Here is the procedure:

1. Do a standard PCM analysis (ISGROUPS=0). For each item, Table 3.2, etc., reports the item difficulty + Andrich threshoolds: Di + {Fij}
2. Output IFILE= the item difficulty for each item = Di.   Example: D=2.5 logits
3. Output ISFILE= the location on the latent variable where the expected score on the item is 4 = Ei. Example Ei = 3.0 logits
4. Compute the desired shift of location for each item = Ei - Di = 3.0-2.5 = 0.5 logits
5. Output SFILE= the Andrich thresholds (relative to the item difficulties) for each item = {Fij}. Example: -2, -1, 0, 3
6. Subtract the shift from the Andrich thresholds {Sij} = {Fij- (Ei - Di)}. Example: {Sij} = -2.5, -1.5, -0.5, -2.5
7. Anchor (fix) the Andrich thresholds SAFILE= for each item at their {Sij} values.
8. Rerun the analysis. Item difficulties, D'i, are now located at the points where the expected scores on the items are 4.
Example: Di + Fij = D'i + Sij for each threshold of each item. In our example:
D'i = Di + Fij - Sij = 2.5 + {-2, -1, 0, 3} - {-2.5, -1.5, -0.5, -2.5} = 2.5 + {0.5, 0.5, 0.5, 0.5} = 3.0, the desired location.

21.89 Plausible values

Plausible values are estimates intended to represent the distribution of measures that could produce the observed scores. They were developed for large-scale educational assessments from which group-level measures are to be obtained, but with data too thin to support individual-level measurement.

Winsteps is designed for individual measurement. When this is possible, then group-level reporting can be done, e.g., with PSUBTOT=. The Winsteps estimate approximates the mean of the plausible-value distribution.

Plausible values are values from the error distribution of the estimate. Winsteps reports each person's estimate (measure) and its standard error. Plausible values are values selected at random from a normal distribution with its mean at the estimated measure and with standard deviation equal to the standard error. You can generate these with Excel or other statistical software.

Varma Kay asked:
1) Is it possible to apply sample weights in rasch analysis using Winsteps?

2) Is it possible to generate plausible values including information from both the test data as well as data from background questionnaires?

Your 1) Sample weights in Winsteps - yes, use PWEIGHT=

Your 2a) Plausible values.
Following www.rasch.org/rmt/rmt182c.htm - we can see that plausible values are used to obtain unbiased theta estimates. The problem is that MLE estimates are inflated and EAP values are deflated, so usually a complex estimation procedure is employed. Here is a simple alternative:
0. the true values from the original data: we discover these values at step 5.
1. estimate theta and delta from the original data using any analysis method
2. simulate a dataset using the step 1 theta and delta values
3. estimate theta and delta from the data simulated in step 2.
4. the change in theta mean and S.D. from step 1 to step 2 will tell us how much the estimates inflate or deflate from the original "true" values in step 0 to step 1.
5. compute the "true" values by rolling back the values from step 1 to plausible values from step 0.
[Interestingly, this technique is being used with photography software to defuzz photographs!]

Data from background questionnaires?
yes, this is incorporated in the analysis as weighted polytomous items
1. take a background variable, e.g., age or grade level.
2. formulate it as a polytomy

3. add it to the dataset as an extra item: give it zero weight: IWEIGHT=
4. analyze the data with the extra item using ISGROUPS=
5. look at Table 14.3 for the polytomous item. Adjust the polytomous categories and their scoring until the average measures advance with category.
6. repeat 1.-5. for all the other background variables.
7. all the background are now correlating with the known latent variable
8. adjust IWEIGHT= for each background variable depending on the influence you want it to have on the plausible values.

21.90 Poisson counts

Conceptually, the Poisson Counts model has an infinite number of categories, 0, 1, 2, onwards. In practice, due to time limits and other constraints, there is a finite maximum possible. If that maximum is much higher than the highest observed category, then the Poisson model continues to apply from a practical perspective. If the observed highest is close to the absolute maximum, then use a constrained rating scale. In Winsteps, do this with
ISRANGE=
to set the 0 to absolute maximum range of categories, and
SFUNCTION=
to set the function controlling the Andrich thresholds
SFUNCTION=2 is a good starting value.

The Winsteps program can analyze Poisson count data, with a little work. Poisson counts are a very long rating (or partial credit) scale with pre-set structure. The Andrich Thresholds are $\log_e(n)$, n=1 upwards. You can define a structure anchor file in this way:

```
XWIDE=2
 STKEEP=YES
 CODES = 00010203040506070809101112131415161718192021222324252627282930313233343536373839+
  +40414243444546474849505152535455565758596061626364656667686970717273747576777879+
  +8081828384858687888990919293949596979899
SAFILE=*
0 0      ; placeholder for the bottom count
1 0      ; the value corresponding to log(1) - the pivot point for the item measure
2 .693   ; the value corresponding to loge(2)
3 1.099  ; the value corresponding to loge(3)
```

4 1.386	28 3.332	52 3.951	76 4.331
5 1.609	29 3.367	53 3.970	77 4.344
6 1.792	30 3.401	54 3.989	78 4.357
7 1.946	31 3.434	55 4.007	79 4.369
8 2.079	32 3.466	56 4.025	80 4.382
9 2.197	33 3.497	57 4.043	81 4.394
10 2.303	34 3.526	58 4.060	82 4.407
11 2.398	35 3.555	59 4.078	83 4.419
12 2.485	36 3.584	60 4.094	84 4.431
13 2.565	37 3.611	61 4.111	85 4.443
14 2.639	38 3.638	62 4.127	86 4.454
15 2.708	39 3.664	63 4.143	87 4.466
16 2.773	40 3.689	64 4.159	88 4.477
17 2.833	41 3.714	65 4.174	89 4.489
18 2.890	42 3.738	66 4.190	90 4.500
19 2.944	43 3.761	67 4.205	91 4.511
20 2.996	44 3.784	68 4.220	92 4.522
21 3.045	45 3.807	69 4.234	93 4.533
22 3.091	46 3.829	70 4.248	94 4.543
23 3.135	47 3.850	71 4.263	95 4.554
24 3.178	48 3.871	72 4.277	96 4.564
25 3.219	49 3.892	73 4.290	97 4.575
26 3.258	50 3.912	74 4.304	98 4.585
27 3.296	51 3.932	75 4.317	99 4.595
			*

Arrange that the observations have an upper limit much less than 99, or extend the range of CODES= and SAFILE= to be considerably wider than the observations. Winsteps can go up to category 32767.

Use UASCALE= to multiply all Poisson Andrich Thresholds by a constant to adjust the "natural" form of the Poisson counts to the actual discrimination of your empirical Poisson process, or do the multiplication yourself, which can be different for different items. You need to adjust the constant so that the average overall mean-square of the analysis is about 1.0. See RMT 14:2 about using mean-squares to adjust logit user-scaling. (The *Facets* program does this automatically, if so instructed.)

*But my experience with running Poisson counts in the **Facets** program (which supports them directly) is that most "Poisson count" data do not match the Poisson process well, and are more usefully parameterized as a rating (or partial credit) scale. There is nearly always some other aspect of the situation that perturbs the pure Poisson process, especially by placing a ceiling value on the observations.*

Theory: See Wikipedia . The Poisson model is P(k events in an interval) = e-λ λk /k! so that P(k)/P(k-1) = λ/k, which is implemented in Winsteps as ln(P(k)/P(k-1)) = B - D - ln(k)/UASCALE where B is the person ability, D is the item difficulty, and 1/UASCALE is the Poisson-scale discrimination parameter.

Binomial trials: same as above, with loge(n(m-n+1)) where m is a fixed number of trials and n is the number of successes for n=0 to m, so that there a m thresholds. We can use UASCALE= to adjust for scale discrimination as above.

Negative (inverse) binomial trials: same as above where m is the number of trials and n is a fixed number of successes. For convenience, enter the data as x = (m-n) = number of failures, which will go from 0 to a large number (similar to Poisson counts above). Again we can pre-compute the Andrich thresholds for every observation = log (probability of observing x failures / probability of observing x-1 failures) when we are targeting n successes. If the number of successes is constant for each item, then we can use Winsteps. If it varies across observations within an item, we must use *Facets.* We can use UASCALE= to adjust for scale discrimination as above.

21.91 Polytomous mean-square fit statistics

For a general introduction, see Diagnosing Misfit, also Dichotomous mean-square fit statistics.

Response String **Easy............Hard**	INFIT Mean-square	OUTFIT Mean-square	Point-measure correlation	Diagnosis
I. modeled:				
33333132210000001011	0.98	0.99	0.78	Stochastically
31332332321220000000	0.98	1.04	0.81	monotonic in form
33333331122300000000	1.06	0.97	0.87	strictly monotonic
33333331110010200001	1.03	1	0.81	in meaning
II. overfitting (muted):				
33222222221111111100	0.18	0.22	0.92	Guttman pattern
33333222221111100000	0.31	0.35	0.97	high discrimination
32222222221111111110	0.21	0.26	0.89	low discrimination
32323232121212101010	0.52	0.54	0.82	tight progression
III. limited categories:				
33333333332222222222	0.24	0.24	0.87	high (low) categories
22222222221111111111	0.24	0.34	0.87	central categories
33333322222222211111	0.16	0.2	0.93	only 3 categories
IV. informative-noisy:				
32222222201111111130	0.94	1.22	0.55	noisy outliers
33233332212333000000	1.25	1.09	0.77	erratic transitions
33133330232300101000	1.49	1.4	0.72	noisy progression
33333333330000000000	1.37	1.2	0.87	extreme categories
V. non-informative:				

22222222222222222222	0.85	1.21	0	one category
12121212121212121212	1.5	1.96	-0.09	central flip-flop
01230123012301230123	3.62	4.61	-0.19	rotate categories
03030303030303030303	5.14	6.07	-0.09	extreme flip-flop
03202002101113311002	2.99	3.59	-0.01	random responses
VI. contradictory:				
11111122233222111111	1.75	2.02	0	folded pattern *
11111111112222222222	2.56	3.2	-0.87	central reversal
22222222223333333333	2.11	4.13	-0.87	high reversal
00111111112222222233	4	5.58	-0.92	Guttman reversal
00000000003333333333	8.3	9.79	-0.87	extreme reversal

from Smith R.M. (1996) Rasch Measurement Transactions 10:3 p. 516

The z-score standardized statistics report, as unit normal deviates, how likely it is to observe the reported mean-square values, when the data fit the model. The term z-score is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic value has been adjusted to a unit normal value.

* "folded data" can often be rescued by imposing a theory of "not reached" and "already passed" on to the observations. For instance, in archaeological analysis, the absence of bronze implements can mean a "stone age" or an "iron age" society. A useful recoding would be "1" = "stone age", "2" = "early bronze", "3" = "bronze", "2=>4" = "late bronze", "1=>5" = "iron age". This can be done iteratively to obtain the most self-consistent set of 4's and 5's. (Folding is discussed in Clive Coombes' "A Theory of Data".)

Example: Identify persons who respond in the same category to every item:
Anchoring all the items at the same difficulty and using the Rating Scale Model. Then the distribution of the mean-square fit statistics will indicate the extent to which all items are rated the same. We expect strings like 3333333333333333 to have zero mean-square fit statistics. Set NAME1= and NAMLEN= so that the response strings are also the person labels.

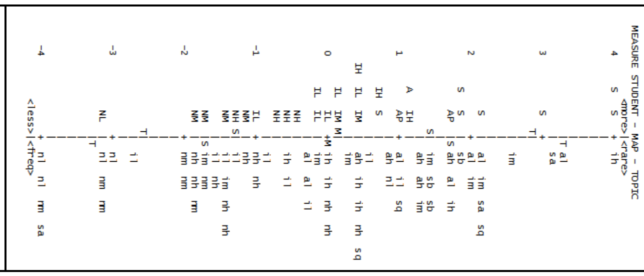
If the responses start in column 1 and there are 9 items:
NAME1 = 1
NAMLEN = 9
ISGROUPS=
IAFILE=*
1-9 0
*
FITP=0 ; show everyone in Table 6.

Output PFILE= to Excel, then you can draw a histogram of the mean-square fit statistics.
For instance: www.ablebits.com/office-addins-blog/2016/05/11/make-histogram-excel/

21.92 Printing pretty tables and graphs

Please see ASCII= to print Tables in different format. See Graph window-bottom right for graphs.

Example 4. A horizontal Wright map.
1) Output Table 1.0
2) Copy-and-Paste into a Word document
3) Document "New Section" before and after map
4) Highlight the map:
5) Fixed space font: Consolas, Lucida Console
6) Small font size
7) Alt-F11 to launch VBA



8) in Immediate Window: Selection.Orientation = wdTextOrientationVerticalFarEast 9) Press Enter Text is rotated!	

21.93 Prior distributions

Question: We pre-tested some polytomous items under one timing condition and have now collected a very small sample of that same data under another timing condition. I would like to be able to use the item/step difficulties from the first condition as priors to estimate item/step difficulties for the second condition.

Answer: Winsteps does not accept prior distributions, so we need to simulate them as additional data.

For instance, we could use the pre-test dataset, down-weight it using PWEIGHT=, and analyze it again together with the new data.

When we have a suitable set of item/step difficulties, then export them with IFILE=if.txt, SFILE=sf.txt

Then analyze only the new data with anchored items and steps IAFILE=if.txt, SAFILE=sf.txt to get a report on only the new data.

21.94 Probabilities from measures

Request: I'm trying to obtain the probabilities by working backwards from the parameters Winsteps estimated, to see if probabilities I calculate correspond to those used to estimate the expected value for each person-item encounter.

Reply:
Yes, if you have the reported person ability, item difficulty, and the Rasch-Andrich threshold values (rating scale structure), then you can calculate exactly the same probabilities as Winsteps.

For dichotomous responses,
Probability of 0 = 1 / (1 + exp(ability-difficulty))
Probability of 1 = 1 / (1 + exp(difficulty-ability))
These probabilities always sum to 1.

An easy way to do this for polytomous (rating-scale, partial-credit) responses is:

Value of bottom category v0 = 1
Value of next category v1 = v0 * exp (ability - difficulty - threshold1)
Value of next category v2 = v1 * exp (ability - difficulty - threshold2)
....
Value of top category vm = v(m-1) * exp (ability - difficulty - threshold m)

then
Probability of category 0 = p0 = v0/ sum(v0+v1+...+vm)
Probability of category 1 = p1 =v1 / sum(v0+v1+...+vm)
....
Probability of category m = pm = vm/sum(v0+v1+...+vm).

These probabilities always sum to 1.

Please compare your probabilities with the graphed values.

21.95 Quality-control misfit selection criteria

Rasch measurement does not make any presumptions about the underlying distribution of the parameters. Maximum likelihood estimation expects "errors" in the observations to be more or less normally distributed around their expected values. Since all observations are integral values, this expectation can be met only asymptotically as the number of persons and items becomes infinite. The information-weighted fit statistic, "infit", and the outlier-sensitive fit statistic, "outfit", are described in BTD and RSA. Possible values, and hence interpretation, of these statistics is influenced by the observed distribution the person and item statistics. This is particularly true of their t standardized values which are designed to follow standard normal (0,1) distributions. The local significance of these statistics is best interpreted in terms of their means and standard deviations reported in Table 3.1. Start investigating the misfit causing the most extreme values of these statistics, and stop your investigation when the observed responses become coherent with your intentions.

The fit statistics reported will not exactly match those printed in BTD or RSA, or those produced by another program. This is because the reported values of these statistics are the result of a continuing process of development in statistical theory and practice. Neither "correct" fit statistics nor "correct" values exist, but see the Appendices for guidance.

Report measure in Tables 6 (FITP=) and Table 10 (FITI=) if any of:

Statistic	Less than	Greater than
t standardized INFIT	-(FITP or FITI)	FITP or FITI
t standardized OUTFIT	-(FITP or FITI)	FITP or FITI
mean-square INFIT	1 - (FITP or FITI)/10	1 + (FITP or FITI)/10
mean-square OUTFIT	1 - (FITP or FITI)/10	1 + (FITP or FITI)/10
point-biserial correlation	negative	

To include every person, specify FITP=0. For every item, FITI=0.

For Table 7, the diagnosis of misfitting persons, persons with a t standardized fit greater than FITP= are reported. Selection is based on the OUTFIT statistic, unless you set OUTFIT=N in which case the INFIT statistic is used.

For Table 11, the diagnosis of misfitting items, items with a t standardized fit greater than FITI= are reported. Selection is based on the OUTFIT statistic, unless you set OUTFIT=N in which case the INFIT statistic is used.

21.96 R Statistics Rasch analysis software and Winsteps

Winsteps can import and export files compatible with the R Statistics package. Many of the R procedures below can be actioned directly from Winsteps menus by one click, not requiring any knowledge of how to operate R.

The freeware R statistics package can be downloaded from www.r-project.org. Paul Murrell has posted useful instructional material online: https://www.stat.auckland.ac.nz/~paul/ - especially good for graphing.

Launching Winsteps from R Statistics

Data Cornering suggests this R command:
1. > system("cmd.exe", input = paste('C:\\This\\Is\\Path\\Your.bat'))
2. *Your.bat* file is a Winsteps Batch= file
3. In the Winsteps control file in *your.bat* file, include TFILE= to output .txt and .rdata files for processing by R. Winsteps control and data files should be .txt files.

Winsteps calls to R statistics fail:

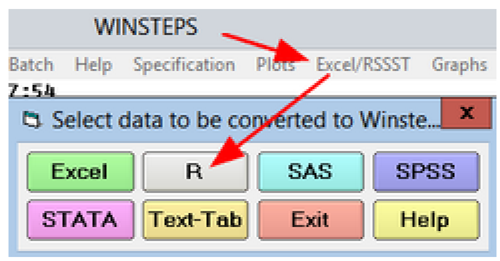
1. Check that file winsteps-zero.dat is in your c:\Winsteps folder along with Winsteps.exe
2. Close all open programs (apps). Go to your %temp% folder and delete all files that Windows will let you delete.
3. Launch R from its shortcut (not through Winsteps) and check that R operates correctly.
4. Launch R through Winsteps. Look at your %temp% folder. It should contain files winsteps-zero.rdata and .Rprofile
5. Check that file extension .rdata is registered in Windows to R Statistics:
https://superuser.com/questions/1456106/windows-10-how-to-set-program-path-in-file-associations

R command	R's response	Meaning
ls()	[1] "IFILE"	list of loaded datasets

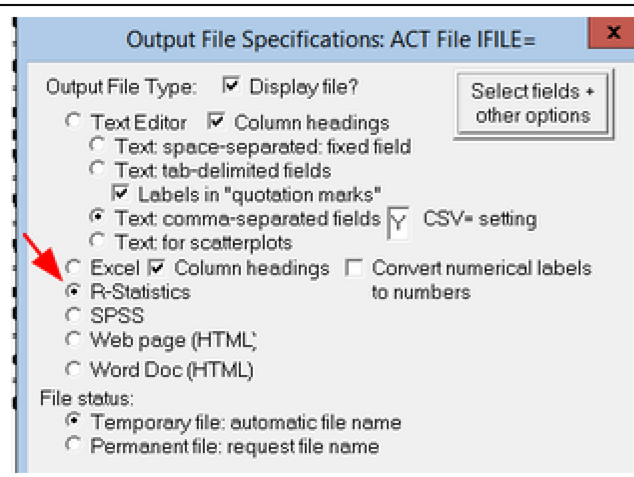
help(ls)	Help windows opens	help for "ls" command
names(IFILE)	[1] "ENTRY" "NAME"	names of variables in the dataset "IFILE"
IFILE	(contents of IFILE)	displays the data in the IFILE dataset
attach(IFILE)	-	IFILE variables active without $ reference
plot (x, y)	scatterplot displays	variable y is plotted against variable x
q()	(R terminates)	quit (exit from) R Statistics
Maximize your R Console window: edit your "Rconsole" file in "C:\Program Files\R\R-...\etc" from "# MDIsize = 0*0+0+0" to "MDIsize = 0*0+0+0"		

An R package to interface with Winsteps is also available from CRAN: Rwinsteps (Albano and Babcock) - cran.r-project.org/web/packages/Rwinsteps/index.html

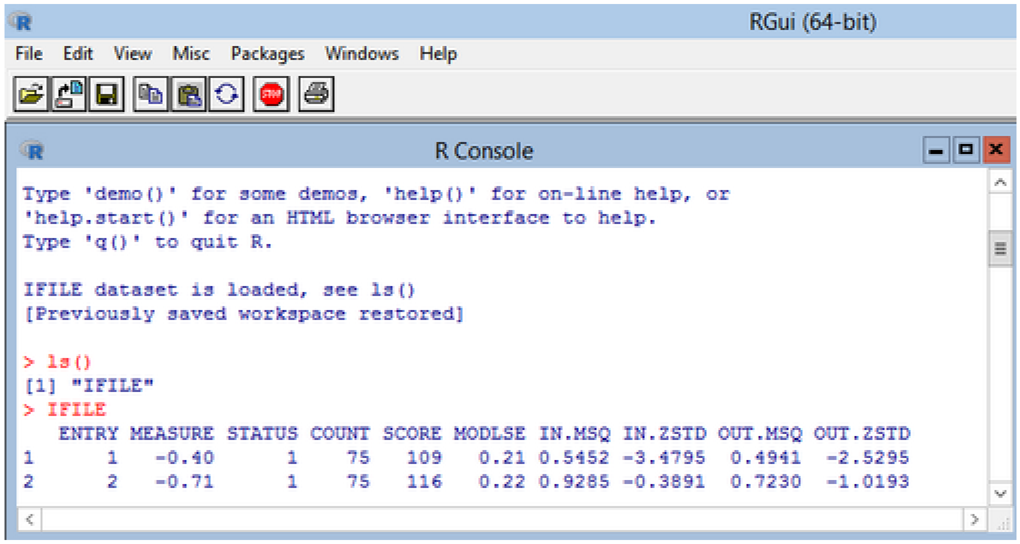
<table>
<tr><th>Action:</th><th>Screen:</th></tr>
<tr><td>Import R statistics data in a .rdata or .rda file.

Now follow the procedure at Excel/RSSST menu.</td><td>
</td></tr>
<tr><td>Export Winsteps output files as R statistics files: .rdata or ,rda

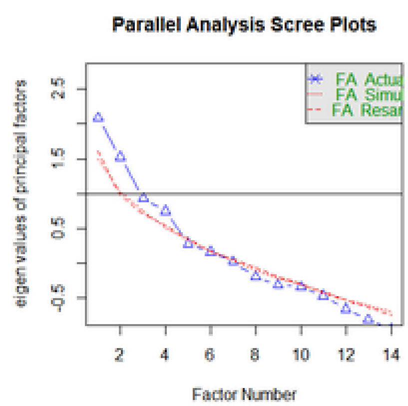
from the Output Files menu
IFILE=
PFILE=
IPMATRIX=

Code for missing data: NA is usually applied automatically</td><td>
</td></tr>
</table>

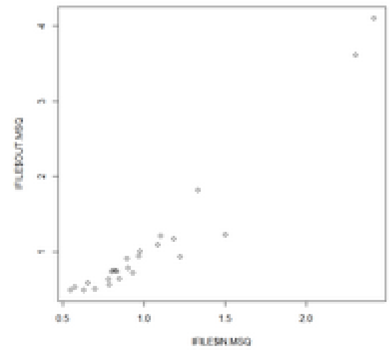
<table>
<tr><td>R Statistics screen

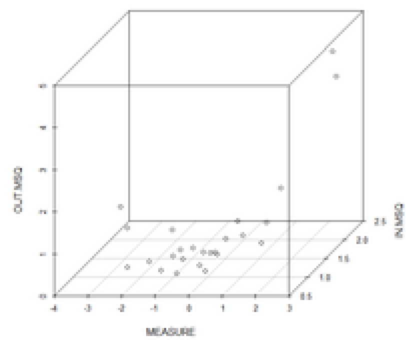
ls() at any time to see list of available objects, etc.</td><td colspan="2">
</td></tr>
<tr><td>R functions</td><td colspan="2">data[data=="."] <- NA # Convert missing data to NA (R Statistics missing data code)</td></tr>
<tr><td>Descriptive statistics</td><td colspan="2">> install.packages('psych")
> library (psych)
> des <- describe(data)
> print (des, digits=3)
vars n mean sd median trimmed mad min max range skew
kurtosis se Q0.25 Q0.75
ZSCORE 476 -0.009 0.827 -0.01 0.006 0.304 -5.969 6.141 12.11 -0.985
21.018 0.038 -0.163 0.21</td></tr>
<tr><td>Principal Components Analysis and Factor analysis of standardized residuals or other numbers</td><td>> install.packages('psych',"FactoMineR')
> library (psych)
> library (FactoMineR)
> result <- fa.parallel (data)
a Scree Plot displays of PCA and FA eigenvalues.
R Console window: "Parallel analysis suggests that the number of factors = 3"
Put 3 (or whatever) in the R "factors" instruction

Principal Components Analysis:
> pca <- PCA(data, graph=FALSE)
> pca$eig
> pcavarcoord
> head(pcaindcoord)

Factor analysis:
> factors <- fa(data, 3)
> print (factors)
the factor loadings are in columns MR1, MR2, ...
> plot(factors)</td><td>
</td></tr>
</table>

<table>
<tr><td>Simple plot with R</td><td>Winsteps Output Files menu: IFILE=, PFILE=. Output to R Statistics. In R Statistics:

res -> attach(IFILE)
res -> plot (IN.MSQ, OUT.MSQ)</td><td></td></tr>
<tr><td>3-D scatter plot</td><td>Use Winsteps Plots menu

Winsteps Output Files menu: IFILE=, PFILE=: Select any 3 variables, e.g. Measure, Infit MnSq, Outfit MnSQ. Output to R Statistics
In R Statistics:
> install.packages("scatterplot3d")
> library (scatterplot3d)
> res <- scatterplot3d(IFILE)</td><td></td></tr>
<tr><td>Mokken scaling:
Loevinger H Coefficient</td><td colspan="2">Output files menu: IPMATRIX=
scored responses, no extreme scores. no person entry numbers, missing data = NA
OK
then when R displays:
install.packages("mokken")
library(mokken)
coefH(data)</td></tr>
<tr><td>Exploratory Factor Analysis (PCA) Functions for Assessing Dimensionality</td><td colspan="2">Output files menu: IPMATRIX=
standardized residuals, no extreme scores, no person entry numbers, missing data = 0
install.packages("remotes")
remotes::install_github("bpoconnor/paramap")
library(paramap)
MAP(data)</td></tr>
<tr><td>CMLE Conditional Maximum Likelihood Estimation: Dichotomous</td><td colspan="2">Output files menu: IPMATRIX=
scored responses, no extreme scores. no person entry numbers, missing data = NA
> install.packages("eRm")
> library(eRm)
activate eRm
> res <- RM(data) # CMLE estimation of item easinesses for dichotomies
RSM() and PCM() for polytomies
> coef(res) # or summary(res) # report the items
> pres <- person.parameter(res) # AMLE estimation of person abilities (thetas)
> coef(pres) # or summary(pres) # report the person estimates
> LRtest(res, splitcr = "median", se = TRUE) # Andersen's Likelihood Ratio Test (LRT)
also
> install.packages("RM.weights")
> library (RM.weights)
> res <- RM.w(data, .w = NULL, .d=NULL, country=NULL, se.control = TRUE, quantile.seq = NULL, write.file = FALSE, max.it=100) # dichotomies
res <- PC.w(data, wt=NULL, extr=NULL, maxiter=100,minconv=.00001,country=NULL, write.file=FALSE, recode = 0, write.iteration=FALSE) # partial credit</td></tr>
</table>

ERMA (Everyone's Rasch Measurement Analyzer)	> install.packages("shiny") > library(shiny) > runGitHub("ShinyERMA", "RaschModel") *Jue Wang (University of Miami) and George Engelhard Jr. (University of Georgia)*
JMLE Joint Maximum Likelihood Estimation: TAM	Output files menu: IPMATRIX= scored responses start from zero, no extreme item scores. no person entry numbers, missing data = NA > install.packages("TAM") > library(TAM) # activate ltm > res <- tam.jml(data) > summary(res) # report the items
MMLE Marginal Maximum Likelihood Estimation: Dichotomous	Output files menu: IPMATRIX= scored responses, no extreme item scores. no person entry numbers, missing data = NA > install.packages("ltm") > library(ltm) # activate ltm > res <- rasch(data =data, constraint = cbind(ncol(data) + 1, 1)) > coef(res) # or summary(res) # report the items Generalized Partial Credit Model: > res <- gpcm(data, constraint = c("gpcm", "1PL", "rasch"), IRT.param = TRUE, start.val = NULL, na.action = NULL, control = list())
MMLE Marginal Maximum Likelihood Estimation: Dichotomous Polytomous, Rating Scale	Output files menu: IPMATRIX= scored responses start from zero, no extreme item scores. no person entry numbers, missing data = NA > install.packages("TAM") > library(TAM) # activate TAM > res <- TAM::tam.mml(data, irtmodel="1PL") # dichotomous > res <- TAM::tam.mml(data, irtmodel="RSM") >summary(res) # report the items and thresholds >pers <- tam.mml.wle(res, score.resp=NULL, WLE=FALSE, adj=.3) # compute AMLE person thetas pers$theta # list the thetas
PMLE Pair-wise Maximum Likelihood Estimation: dichotomous	Output files menu: IPMATRIX= scored responses, no extreme scores. no person entry numbers, missing data = NA > install.packages("pairwise") > library(pairwise) # activate pairwise > res <- pair(data) > summary(res) and > install.packages("sirt") > library("sirt") > res <- rasch.pairwise(data) > summary(res)
other Rasch packages	> install.packages("mixRasch") > install.packages("pcIRT") >install.packages('mirt') > res <- mirt (data, 1, 'Rasch') # for dichotomous and partial credit analysis
Wright Map	Use Winsteps Plots menu

Receiver Operating Curve
Area Under the Curve
ROC AUC
	install.packages("PRROC")
	`library(PRROC)`
	`res <- roc.curve(scores.class0 = XFILE$EXPECTATION,`
	`weights.class0=XFILE$ORDERED,curve=TRUE)`
	`plot(res)`

R Graphics	Use Winsteps Graph window or

<table>
<tr><td>ggplot2</td><td>> install.packages("ggplot2")
> library(ggplot2)
if this fails, then
> remove.packages("ggplot2")
then try again
> data (diamonds)
? ggplot(diamonds, aes(x=carat, y=price))</td></tr>
<tr><td>Cluster Analysis with complete data</td><td>install.packages ("pvclust")
library(pvclust)
data <- scale(data)
fit <- pvclust(data, method.hclust="ward.D2",   method.dist="euclidean")
plot(fit) # dendogram with p values
pvrect(fit, alpha=.95) # red boxes around significantly different clusters</td></tr>
<tr><td>Generalizability Theory</td><td>> remove.packages("Matrix")
> install.packages("Matrix")
> install.packages("gtheory")
> library(Matrix)
> library(gtheory)

#A univariate D study.
#Compare to results on page 116 of Brennan (2001).
data(Brennan.3.2)
formula.Brennan.3.2 <- "Score ~ (1 | Person) + (1 | Task) + (1 | Rater:Task) +
(1 | Person:Task)"
gstudy.out <- gstudy(data = Brennan.3.2, formula = formula.Brennan.3.2)
dstudy(gstudy.out, colname.objects = "Person", data = Brennan.3.2, colname.scores = "Score")
#A multivariate D study.
#Compare to results on pages 270-272 of Brennan (2001).
data(Rajaratnam.2)
formula.Rajaratnam.2 <- "Score ~ (1 | Person) + (1 | Item)"
gstudy.out <- gstudy(data = Rajaratnam.2, formula = formula.Rajaratnam.2,
colname.strata = "Subtest", colname.objects = "Person")
dstudy(gstudy.out, colname.objects = "Person", data = Rajaratnam.2, colname.scores =
"Score",
colname.strata = "Subtest", weights = c(0.25, 0.5, 0.25))</td></tr>
<tr><td>Reading SAS file</td><td>> install.packages("haven")
> library(haven)
> read_sas("c:/winsteps/examples/sastest.sas7bdat")</td></tr>
<tr><td>Reading Excel file</td><td>install.packages("readxl")
# Loading
library("readxl")
# xls files
my_data <- read_excel("my_file.xls")
write.table(my_data, file = "c:/filename.txt", sep = "\t", quote = FALSE)</td></tr>
<tr><td>Mokken scaling
Loevinger H Coefficient</td><td>install.packages("mokken")
library(mokken)

# no missing values: rating scales allowed
# Partition the scale into mokken scales
aisp(data)

# Investigate the assumption of monotonicity
monotonicity.list <- check.monotonicity(data)
summary(monotonicity.list)</td></tr>
</table>

	# plot(monotonicity.list)
	# Investigate the assumption of non-intersecting ISRFs using method restscore
	restscore.list <- check.restscore(data)
	summary(restscore.list)
	# plot(restscore.list)
	# Investigate the assumption of non-intersecting ISRFs using method pmatrix
	# pmatrix.list <- check.pmatrix(data)
	# summary(pmatrix.list)
	# plot(pmatrix.list)
	# Investigate the assumption of IIO using method MIIO
	iio.list <- check.iio(data)
	summary(iio.list)
	# plot(iio.list)
	# Compute the reliability of the scale
	check.reliability(data)

DIF / DPF analysis	> install.packages("difR") > library(difR) DIF: start with mantelhaenszel DPF: transpose your data: t() then mantelhaenszel

Nonparametric Rasch Model Tests	install.packages("eRm")
	library(eRm)
	
	# no missing values: must be binary
	rmat <- as.matrix(data)
	
	# T1: Checks for local dependence via increased inter-item correlations. For all item pairs, cases are counted with equal responses on both items.
	t1 <- NPtest(rmat, n = 100, method = "T1")
	print(t1, alpha = 0.01)
	print(t1, alpha = 0.05)
	
	# T1m: Checks for multidimensionality via decreased inter-item correlations. For all item pairs, cases are counted with equal responses on both items.
	t1m <- NPtest(rmat, n = 100, method = "T1m")
	print(t1m, alpha = 0.01)
	print(t1m, alpha = 0.05)
	
	# T10: Global test for subgroup-invariance. Checks for different item difficulties in two subgroups
	t101 <- NPtest(rmat, method = "T10") # default split criterion is "median"
	t101
	t102 <- NPtest(rmat, method = "T10", splitcr = "mean")
	t102
	
	# T11: Global test for local dependence. The statistic calculates the sum of absolute deviations between the observed inter-item correlations and the expected correlations
	t11 <- NPtest(rmat, method = "T11")
	t11

Fit Analysis "Aberrance"	install.packages("aberrance")) library(aberrance)
Latent Class Analysis LCA	install.packages("poLCA") library(poLCA) # observations must start at 1

	data <- data+1 f <- cbind(X1,X2)~1 p <- loPCA(f, data, nclass=2) # results difficult to interpret at the variable (item) level
Latent Profile Analysis LPA	library(tidyLPA) library(dplyr) data %>% estimate_profiles(n_profiles = 1:2, models = 1:2) %>% plot_profiles() Note: AIC, BIC - the lower the better.
difR: Collection of Methods to Detect Dichotomous Differential Item Functioning (DIF)	install.packages("difR") library(difR)

21.97 Random number generator

For generating pseudo-random numbers, used in simulating data, Winsteps implements a FORTRAN 77 adaptation of this "Mersenne Twister" code:

```
c  A C-program for MT19937, with initialization improved 2002/1/26.
c  Coded by Takuji Nishimura and Makoto Matsumoto.
c  Copyright (C) 1997 - 2002, Makoto Matsumoto and Takuji Nishimura,
c  All rights reserved.
c  Copyright (C) 2005, Mutsuo Saito,
c  All rights reserved.
```

Their website is www.math.sci.hiroshima-u.ac.jp/~m-mat/MT/emt.html

The generator is seeded with the system time or a value chosen by the analyst.

Simulated data observations.

Winsteps simulates data using the estimated values of person ability, item difficulty and rating-scale thresholds. Winsteps implements www.rasch.org/rmt/rmt213a.htm for dichotomous and polytomous data.

If you use these simulated data to estimate the parameter values, then the estimated values will be somewhat wider than the generators. This is due to JMLE bias. It can usually be corrected with STBIAS=YES.

21.98 Rank order data

Rankings and partial rankings, with or without ties, can be conveniently analyzed using ISGROUPS=0 and STKEEP=No

Each **row** is an element or object to be ranked.

Each **column** is a set of rankings by a respondent. In the item label, place any interesting demographics about the respondent doing the ranking.

ISGROUPS=0 - Each respondent (column) has their own "ranking scale". This is equivalent to the Partial Credit model.

STKEEP=No - tied ranks are OK, but if the ranking goes: 1, 2, 2, 4, 5, ... in the data then, from a Rasch perspective this should be: 1, 2, 2, 3, 4, ... which is what STKEEP=NO does for us.

The elements (rows) will have measures and fit statistics indicating respondent preference. The fit statistics for the respondents (columns) will indicate the extent of agreement of each respondent with the consensus. The measures for the respondents are usually meaningless (or the same) and can be ignored.

Fit statistics, DIF and DPF analysis, and contrast analysis of residuals are all highly informative.

Elements rated by only one respondent will be correctly measured (with large standard errors), except if that element is ranked top or bottom by that respondent. When that happens, construct a dummy ranking column in which the extreme elements are not-extreme. Give that ranking a low weight with IWEIGHT=.

If every ranking set includes every element, and ties are not allowed, then the elements can be columns and the respondents can be rows. ISGROUPS=0 is not required.

Example:
In the data, as collect, the ranked objects are columns, the respondents are rows, and the rankings as numbers.

Set up a standard rating-scale analysis of these data.

Run an analysis in Winsteps. Ignore the results except to verify that the data have been input correctly.

Now we want the respondents as columns and the objects as columns:

Winsteps "output files", "transpose". TRPOFILE=

Edit the transposed control file with ISGROUPS=0 and STKEEP=NO

Now run the Winsteps analysis. The results should make sense. The objects (rows) should have measures and fit statistics indicating respondent preference. The fit statistics for the respondents (columns) will indicate the extent of agreement of each respondent with the consensus.

21.99 Rasch - Why use Rasch methodology?

William Boone discusses "Rasch Analysis for Instrument Development: Why, When, and How?" in a Journal article: www.ncbi.nlm.nih.gov/pmc/articles/PMC5132390/

In general, Rasch analysis constructs a unidimensional latent variable from the data. It verifies that each person and item can be placed on it, reporting the persons and items locations by means of linear (additive, interval) measures - the type of measures taken for granted in most scientific and day-to-day activities. Rasch identifies departures in the data for persons, items and even data points from the ideal of unidimensionality. These are reported with fit statistics that guide the improvement of the instrument and point out possible flaws in the data. Rasch also has techniques for identifying multi-dimensionality in the data (PCA of residuals).

Raw scores? Rasch confirms that raw scores mean what we think they mean. For instance, that a higher score indicates more of the latent variable than a lower score. Raw scores are non-linear. They have strong ceiling and floor effects, so Rasch also tells us how much more of the latent variable 1 more score-point indicates at different places along the latent variable. This can have important consequences when change-scores influence decision-making. A 10-point gain near the ends of the raw score range can be 4 times more change along the latent variable than a 10-point gain near the center of the raw score range - www.rasch.org/memo62.htm

Factor analysis? Factor analysis is a useful technique, but is not as exact as Rasch for our data. Our intention is to construct a unidimensional latent variable from the data, not to describe the data with all its variety and intricacies. We need to identify specific areas in the data that do not aid in this construction. Then remedy them, eliminate them or decide that flaws in the data are inconsequential. For instance, in an arithmetic test, factor analysis may point out that "addition" and "subtraction" items are different factors, but provides little help in the decision as to whether "arithmetic" can be treated as one construct. Factor analysis also tends to assign items in different difficulty strata (nodes) to different factors. This has produced misleading findings, see www.rasch.org/rmt/rmt81p.htm - When we have a clear picture of the data and the latent variable, factor analytic techniques, such as PCA of residuals, can be helpful to identify subtle departures in the data from the ideal. Factor analysis may assist in identifying clusters of items which threaten the invariance of the measurement system, but this is indirect and inexact compared with Rasch-based identification of anomalies in the data.

Reliability? This applies equally to Rasch or Classical analysis: With 53 dichotomous items and a reasonably range of person abilities, we would hope the reliability is around 0.9. This gives us about 4 statistically-different measurement strata - www.rasch.org/rmt/rmt63i.htm - So, if this set of items is to be used for decision-making, and this person sample is representative, how many levels of performance need to be identified? If 4 levels, then around 53 items. If only high-low, then 25 items are probably enough.

Invariance? Rasch is rigorous in applying the ordinary definition of invariance: "The property of remaining unchanged regardless of changes in the conditions of measurement." (Dictionary.com). Rasch examines every observation to discover the extent to which it is independent of which particular person and which particular item participates, apart from the person's ability and the item's difficulty. In general, Rasch measures are independent of which items and which persons participate in the measurement process. This is the expected situation for invariant measurement in the physical sciences. In principle, it does not matter which thermometer is used to measure heat, or what the source of the heat is. Rasch applies this to social science data, operationalizing L.L. Thurstone's ideals that (1) "A measuring instrument must not be seriously affected in its measuring function by the object of measurement." (Thurstone, 1928, p.547) and "It should be possible to omit several test questions at different levels of the scale without affecting the individual score (measure)." (Thurstone, 1926, p.446) - cited in .rasch.org/memo62.htm

21.100 Rasch Model

The Rasch Model is a mathematical formula for converting raw scores (test scores, ratings) into linear, additive, interval measures on a line (unidimensional latent variable). Items and persons are positioned on the same line (conjoint measurement). The Rasch model was invented by Georg Rasch (1900-1980), a Danish mathematician around 1950.

21.101 Rasch Software

There are many software packages available for estimating the parameters of Rasch Models. Winsteps and Facets are two packages, each has thousands of users. Winsteps (and its predecessors) and Facets have both been in use for over 30 years and are under constant development.

21.102 Rating scale conceptualization: Andrich, Thurstonian, half-point thresholds

(See Table 1, Table 3.2, Table 12, Table 21, Graphs)

There are several ways of conceptualizing a rating scale item. They all contain exactly the same measurement information, but communicated in different ways. Usually, one of these alternatives will be most meaningful for your audience.
The plots corresponding to these approaches are shown in Table 21, and also on the Graphs screen.

```
-------------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|| ANDRICH |CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||THRESHOLD| MEASURE|
|-------------------+------------+------------++---------+--------          |
|  0   0      378  20|  -.87 -1.03|  1.08  1.19||  NONE   |( -2.07)| 0 Dislike
|  1   1      620  34|   .13   .33|   .85   .69||    -.86 |    .00 | 1 Neutral
|  2   2      852  46|  2.24  2.16|  1.00  1.47||     .86 |(  2.07)| 2 Like
-------------------------------------------------------------------
```

0. Distribution of frequencies of observation in each category. For a rating-scale for which inferences will be made at the category level, we like to see a uniform process at work. When applied to a sample, this would produce a smooth distribution of category frequencies. Unimodal without sharp peaks or troughs. No statistical test is intended, but merely Berkson's "inter-ocular traumatic test" (= what hits you between the eyes).

1. If you conceptualize the rating scale in terms of the probability of individual categories (Andrich's approach), then the Andrich Thresholds are of interest. The Andrich thresholds are the points at which adjacent categories are equally probable.

```
    CATEGORY PROBABILITIES MODES - Andrich Thresholds at intersections
P       -------------------------------------------------------------
R  1.0  00000000                                             22222222
O               0000000                               2222222
B   .8                 000                         222
A                         000                   222
B   .6                       00               22
I   .5                         00*111111111*22
L   .4                        111|00     22|111
I                          111   |  00 22  |   111
T   .2                 1111      |  22*00  |      1111
Y               1111111        22222     00000        1111111
    .0  ********222222222222222  |         |  000000000000000********
        -------------------------------------------------------------
```

```
             -5    -4    -3    -2    -1     0     1     2     3     4     5
                                  PERSON [MINUS] ITEM  MEASURE
```

2. If you conceptualize the rating scale in terms of average ratings on the model (predicted) item characteristic curve (ICC), then "Category measures" are of interest. The "Category Measures" are the points on the latent variable at which the expected score on the item equals the category number. The Rasch-half-point thresholds define the ends of each category interval. These are shown in Table 12.5.

```
        EXPECTED SCORE OGIVE MEANS
E       ------------------------------------------------------------
X    2                                                  222222222222
P                                                2222222
E  1.5---------------------------------------2222*
C                                         111    *
T                                      111       *
E    1-------------------------------111         *
D                                 111 *          *
                               111    *          *
S   .5--------------------00000       *          *
C                   000000*           *          *
O    0  000000000000      *           *          *
R       -----------------------------------------------------------
E      -5    -4    -3    -2    -1     0     1     2     3     4     5
                            PERSON [MINUS]  ITEM  MEASURE
```

```
-----------------------------------------------------------------------
|CATEGORY    STRUCTURE    |  SCORE-TO-MEASURE    | 50% CUM.| COHERENCE|ESTIM|
| LABEL    MEASURE  S.E.  | AT CAT. ----ZONE----|PROBABLTY| M->C C->M|DISCR|
|-------------------------+---------------------+---------+----------+-----|
|   0      NONE           |( -2.07) -INF   -1.19|         |  62%  42%|     | 0 Dislike
|   1        -.86    .07  |    .00  -1.19   1.19|   -1.00 |  54%  71%|  .73| 1 Neutral
|   2         .86    .06  |(  2.07)  1.19  +INF |    1.00 |  85%  78%| 1.19| 2 Like
-----------------------------------------------------------------------
```

3. If you conceptualize the rating scale in terms of the probability of accumulated categories (Thurstone's approach), then Rasch-Thurstonian thresholds = "50% Cumulative Probabilities" are of interest. 50% Cum Probability is the point at which the probability of being observed in the categories below = the probability of being observed in this category or above. These are shown in Table 12.6.

Thurstonian thresholds are category boundaries on the latent variable, where we define "boundary" to mean "if someone has an ability measure exactly on a category boundary, then that person has a 50% chance of being observed in a category below the boundary (including categories down to the bottom of the rating scale) and a 50% chance of being observed in a category above the boundary (including categories up to the top of the rating scale)". This is the same definition that we apply to the only category boundary for a dichotomous item, between 0 and 1. Someone exactly at the 0-1 boundary (the item difficulty) has this same 50-50 chance.

The Rasch-Thurstonian thresholds also approximate the item difficulties when the rating scales are dichotomized between the categories below the target category and those at and above the target category. This is useful when the probability of "success" on a polytomous item must be computed. www.rasch.org/rmt/rmt233e.htm

```
        MEDIANS - Cumulative probabilities
P       ------------------------------------------------------------
R  1.0  ********222222222222222
O       0       1111111        22222
B   .8  0              111          222
A       0                 111          22
B   .6  0                    11          22
I   .5  0----------------------111---------222-----------------------
L   .4  0                       | 11        | 22
I       0                       |   11      |   222
T   .2  0                       |     111   |      222
Y       0                       |        11111        2222222
    .0  0                       |           | 111111111111111********
        ------------------------------------------------------------
```

```
        -5      -4      -3      -2      -1       0       1       2       3       4       5
                                     PERSON  [MINUS]   ITEM   MEASURE
```

21.103 Ratio scale of measures: twice as much

Question: I want to say that person A has twice the ability of person B. How can I do that with logit (or user-scaled) measures?

To say that "one person is twice as good as another" requires a reference point. Think of the same thing with mountains. Mountain A is twice as high as Mountain B. The reference point is "sea level".

Constructing a reference point: A useful approach is to add to the data a dummy person whose performance is at your hypothesized reference point. Include in the data ratings for this dummy person against real items. Weight the dummy person at 0 with PWEIGHT=

Similarly a dummy item at the item's reference point. Include in the data ratings for this dummy item against real persons. Weight the dummy person at 0 with IWEIGHT=

You can now use the person or item at the reference point as the basis for your "twice as much" statements.

For further convenience, you can anchor the dummy person at 0 with PAFILE= or the dummy item at 0 with IAFILE=, but not both at the same time.

21.104 Raw scores as measures

Raw scores are used to construct Rasch measures, but their relationship is non-linear. But the relationship is often linear enough for practical purposes.

If you want to plot raw scores instead of Rasch measures on the x-axis of a graph or plot, then rescale the Rasch measures to approximate raw scores:

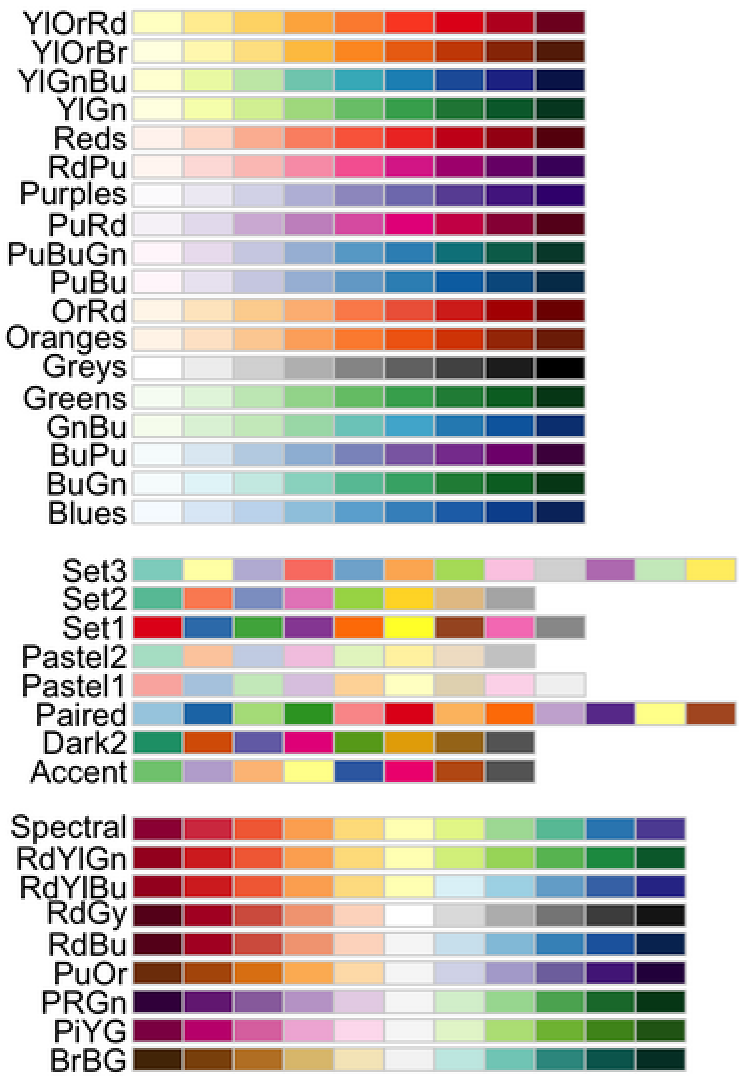
In your Table 20.1, it says something like:
*Predicting Score from Measure: Score = Measure * 8.2680 + 38.9511*

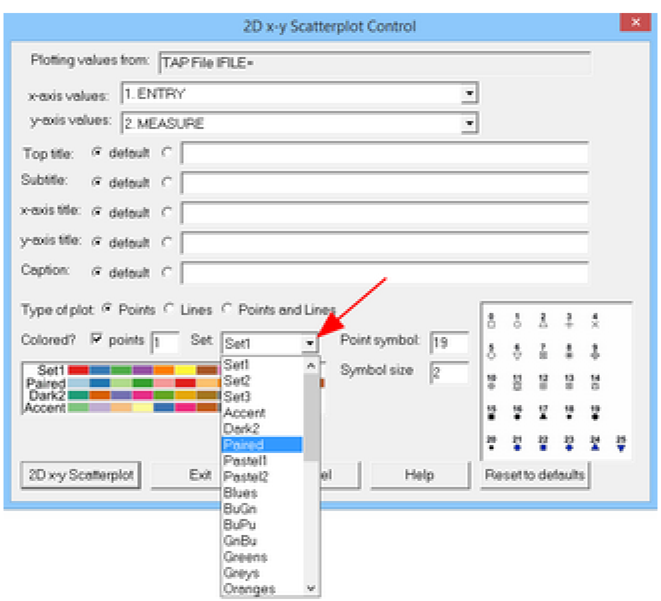
Then try
USCALE= 8.2680   <- use the numbers from your Table 20.1
UIMEAN= 38.9511

Now produce the Graphs with Absolute scaling.

21.105 RColorBrewer palettes

R Statistics color palettes available from Rcolorbrewer. Colors are numbered from 1 onwards in each palette. They are used in 2D scatterplot, 3D scatterplot, Histogram.

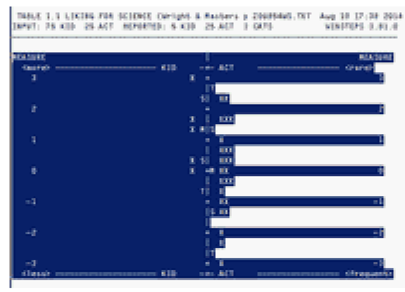
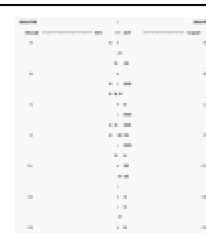
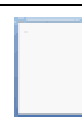
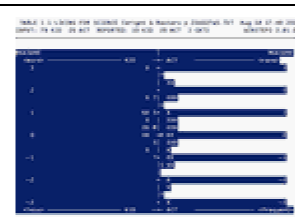

YlOrRd
YlOrBr
YlGnBu
YlGn
Reds
RdPu
Purples
PuRd
PuBuGn
PuBu
OrRd
Oranges
Greys
Greens
GnBu
BuPu
BuGn
Blues
Set3
Set2
Set1
Pastel2
Pastel1
Paired
Dark2
Accent
Spectral
RdYlGn
RdYlBu
RdGy
RdBu
PuOr
PRGn
PiYG
BrBG

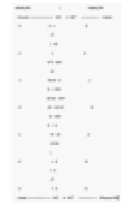
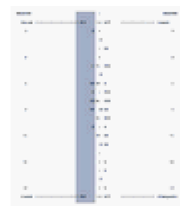

2D x-y Scatterplot Control
Plotting values from:
TAP File IFILE=
x-axis values:
1. ENTRY
y-axis values:
2. MEASURE
Top title:
default
Subtitle:
default
x-axis title:
default
y-axis title:
default
Caption:
default
Type of plot:
Points
Lines
Points and Lines
Colored?
points
Set:
Set1
Point symbol:
19
Symbol size
2
Set1
Paired
Dark2
Accent
Set1
Set2
Set3
Accent
Dark2
Paired
Pastel1
Pastel2
Blues
BuGn
BuPu
GnBu
Greens
Greys
Oranges
2D x-y Scatterplot
Exit
Help
Reset to defaults

21.106 Rectangular copying

Here are three methods of copying a column out of a Winsteps Table:

1. Use Microsoft Word. Do a rectangular copy using alt+mouse
2, Use NotePad++.. Do a rectangular copy using alt+mouse
3. Use Excel. Copy and paste the Table into an Excel worksheet, Do "Data", "Text to Columns"

To copy a rectangle into a map or table with Microsoft Word:		
1.	Open a Word document	
2.	Select and copy the primary Winsteps Table	
3.	Paste into the Word document	
4.	Select all (ctrl+A) Change font to Courier New Font size: 8 (if smaller needed, type in the number)	
5.	Open another Word document	
6.	Select and copy the secondary Winsteps Table	

7.	Paste into the Word document	
8.	Select all (ctrl+A) Change font to Courier New Font size: 8 (if smaller needed, type in the number)	
9.	Rectangular-highlight (alt+mouse drag) the columns to be copied	
10.	Paste into the primary Word document. This may take several attempts to get right. ctrl+z to undo.	
11.	Change column headings Select all: Paragraph format: Single line: No spacing The extra columns should now be correctly inserted into the primary Table.	

To copy a rectangle of numbers:

1. Select the lines of text that include the rectangle of numbers.

2. Copy the lines to the clipboard

3. Paste the lines into a word-processing document or an Excel spreadsheet cell.

4.Set the font of the lines to Courier.

5A. In Word, select rectangles with Alt+Mouse (see below)
5B. In TextPad or NotePad++, select rectangles with Alt+Mouse
5C. In WordPerfect, select "Edit > Select > Rectangle"
5D. In Excel, use "Data > Text to Columns" to select the column of numbers into a column.

You could also display the column of numbers on your computer screen and do a graphical copy. PrintScreen saves the screen to the clipboard, then paste into Paint and do a rectangle selection of what you want. Paste the selection into your document as a Figure.

Rectangular copy-and-paste with Microsoft Word
In Word, ctrl-A the whole document.

Select a "Courier New" font. Now everything lines up neatly in columns.
Click the left mouse button to un-highlight everything.
Move the mouse pointer to the top-left corner of the rectangle you want to copy.
Press and hold down the Alt-Key. Left-click and hold down the mouse. Release the Alt-Key
Drag down to the right-hand corner of what you want. The rectangle should high-light.
Release all keys and mouse-buttons.
Ctrl+C to copy the high-lighted section.
Move the mouse pointer to where you want the rectangle to go.
Ctrl+V to paste.
Add or delete blank spaces to line things up neatly

21.107 Registering .dll or .ocx files

When Winsteps is installed using a downloaded installation file, then all necessary .dll and .ocx files are also installed and registered in the Windows Registry. Sometimes registration fails. Here is a procedure.

You must have Adminstrator privileges for Windows. Let's try to register comdlg32.ocx (replace this with the component you need to register.)

0. Create c:\hold - a temporary folder

1. copy comdlg32.ocx from c:\windows\sysWOW64 or c:\windows\system32\ into c:\hold
Delete comdlg32.ocx from c:\windows\system32 and from c:\windows\sysWOW64

2. Run CCLEANER (free download) - use the **Registry** option
Back up the Registry
Fix all issues (there are probably many)
Fix all issues again (there are probably some)
Fix all issues again and again until there are no issues left

3. copy comdlg32.ocx from c:\hold into c:\windows\sysWOW64

4. In the Windows search or run box:
c:\windows\syswow64\regsvr32.exe c:\windows\syswow64\comdlg32.ocx

5. You should see "dll registry server succeeded"

21.108 Reinstalling Winsteps

The best way to reinstall Winsteps is to run the original installation software, WinstepsPasswordInstall.exe

If this is no longer available:

1. Please download and install www.winsteps.com/ministep.htm

2. Delete ministep.exe and its shortcuts.

3. Copy and replace the folders c\Winsteps from your old computer or from backup to your new computer.

4. On your laptop, right-click on Winsteps.exe. Short-cut to desktop

6. Double click on the short-cut. Winsteps should run correctly.

7. Right-click on the short-cut. Properties. Change the "Start in" folder to your data folder.

21.109 Reliability and separation of measures

Winsteps report reliability and separation statistics treating the sample of measures as the population. If it is not the entire population, then the reliability and separation are slightly higher than the reported values.

Usually person and item reliability and separation have different applications and implications.

Person reliability and separation are used to classify people. Low person separation (< 2, person reliability < 0.8) with a relevant person sample implies that the instrument may not be not sensitive enough to distinguish between high and low performers. More items may be needed.

Item reliability and separation are used to verify the item hierarchy. Low item separation (< 3 = high, medium, low item difficulties, item reliability < 0.9) implies that the person sample is not large enough to confirm the item difficulty hierarchy (= construct validity) of the instrument.

Reliability (separation index) means "reproducibility of relative measure location". It does not report on the quality of the data. So "high reliability" (of persons or items) means that there is a high probability that persons (or items) estimated with high measures actually do have higher measures than persons (or items) estimated with low measures. If you want high reliability, you need a wide sample and/or low measurement error. So, if you want high person (test) reliability, you need a person sample with a large ability (or whatever) range and/or an instrument with many items (or long rating scales). If you want high item reliability, you need a test with a large item difficulty range and/or a large sample of persons. Usually low item reliability is because the person sample size is too small to establish a reproducible item difficulty hierarchy.

Missing data: if some persons have missing observations, these can considerably reduce precision, and so lower reliability estimates. Suggestion: omit person-records with missing data when estimating reliabilities.

Person (sample, test) reliability depends chiefly on
1) Sample ability variance. Wider ability range = higher person reliability.
2) Length of test (and rating scale length). Longer test = higher person reliability
3) Number of categories per item. More categories = higher person reliability
4) Sample-item targeting. Better targeting = higher person reliability
It is independent of sample size. It is largely uninfluenced by model fit.

In general, Test Reliability reported by Classical Test Theory (Cronbach Alpha, KR-20) is higher than Rasch Reliability. Rasch Reliability is higher than 3-PL IRT Reliability.

Rasch Person "Test" Reliability is given by
OV = observed variance of person ability measures
EV = mean of squared standard errors of person ability measures
Person "Test" Reliability = (OV-EV)/OV

Item reliability depends chiefly on
1) Item difficulty variance. Wide difficulty range = high item reliability
2) Person sample size. Large sample = high item reliability
It is independent of test length. It is largely uninfluenced by model fit.

Rasch Item" Reliability is given by
OV = observed variance of item difficulty measures
EV = mean of squared standard errors of item difficulty measures
Item Reliability = (OV-EV)/OV

Note: CTT "item reliability" is the reliability of the person scores based on one item. This is not reported by Winsteps.

Tentative guidelines:
Person reliability: Does your test discriminate the sample into enough levels for your purpose? 0.9 = 3 or 4 levels. 0.8 = 2 or 3 levels. 0.5 = 1 or 2 levels.
Item reliability: Low reliability means that your sample is not big enough to precisely locate the items on the latent variable.
Rater reliability: Low "separation" reliability is better, because we want raters to be reliably the same, not reliably different.

The Winsteps "person reliability" is equivalent to the traditional "test" reliability. Low values indicate a narrow range of person measures, or a small number of items. To increase person reliability, test persons with more extreme abilities (high and low), lengthen the test. Improving the test targeting may help slightly.

The Winsteps "item reliability" has no traditional equivalent. Low values indicate a narrow range of item measures, or a small sample. To increase "item reliability", test more people. In general, low item reliability means that your sample size is too small for stable item estimates based on the current data. If you have anchored values, then it is the item reliability of the source from which the anchor values emanate which is crucial, not the current sample.

The **"model"** person reliability (including measures for extreme scores) is an upper bound to this value, when persons are ordered by measures.

The **"real"** person reliability (including measures for extreme scores) is a lower bound to this value, when persons are ordered by measures

The traditional "test reliability", as defined by Charles Spearman in 1904, etc., is the "true person variance / observed person variance" for this sample on these test items. So it is really a "person sample reliability" rather than a "test reliability", where reliability = reproducibility of person ordering. The "true person variance" cannot be known, but it can be approximated. KR-20 approximates it by summarizing item point-biserials. Cronbach Alpha approximates it with an analysis of variance. Winsteps approximates it using the measure standard errors.

The separation coefficient and reliability computations are computed with and without any elements with extreme measures. Since the measures for extreme scores are imprecise, reliability statistics which include extreme scores are often lower than their non-extreme equivalents. Conventional computation of a reliability coefficient (KR-20, Cronbach Alpha) includes persons with extreme scores. The classical reliability computation includes extreme scores (if any) is the conventional reliability, and usually produces an estimate between the MODEL and REAL values, closer to the MODEL or even above it.

KR-20 value is an estimate of the value when persons are ordered by raw scores. CRONBACH ALPHA (KR-20) KID RAW SCORE RELIABILITY is the conventional "test" reliability index. It reports an approximate test reliability based on the raw scores of this sample. It is only reported for complete data. An apparent paradox is that extreme scores have perfect precision, but extreme measures have perfect imprecision.

Winsteps computes upper and lower boundary values for the True Reliability. The lower boundary is the Real Reliability. The upper boundary is the Model Reliability. The unknowable True Reliability lies somewhere between these two. As contradictory sources of noise are remove from the data, the True Reliability approaches the Model Reliability

Cronbach Alpha and KR-20 Reliability

Here is a check on the computations. Guilford reports 0.81. Winsteps reports 0.82. The difference is probably computational precision and rounding error.

Dichotomous:

```
Title = "Guilford Table 17.2. His Cronbach Alpha = KR-20 = 0.81"
ni=8
item1=1
name1=1
&END
END LABELS
00000000
10000000
10100000
11001000
01010010
11101010
11111100
11111100
11110101
11111111
```

Polytomous (Partial Credit) with missing data:

```
ni=4
codes=01234
groups=0
name1=1
item1=1
&END
END LABELS
1213
2.04
3323
```

4433

This has Cronbach Alpha: (4/3) * (1 - 3.35/10.25) = 0.90

Winsteps uses the population variances (as used by Lee J. Cronbach). SPSS uses the sample variances. For a discussion, see www.pbarrett.net/techpapers/kr20.pdf

Conventionally, only a Person ("Test") Reliability is reported. The relationship between raw-score-based reliability (i.e., KR-20, Cronbach Alpha) and measure-based reliability is complex, see www.rasch.org/rmt/rmt113l.htm - in general, Cronbach Alpha overestimates reliability, Rasch underestimates it. So, when it is likely that the Rasch reliability will be compared with conventional KR-20 or Cronbach Alpha reliabilities (which are always computed assuming the data match their assumptions), then include extreme persons and report the higher Rasch reliability, the "Model" reliability, computed on the assumption that all unexpectedness in the data is in accord with Rasch model predictions.

The big differences between Score and Measure reliabilities occur when
(a) there are extreme scores. These increase score reliability, but decrease measure reliability.
(b) missing data. Missing data always decreases measure reliability. If the missing data are imputed at their expected values (in order to make conventional reliability formulas computable), they increase score reliability. Winsteps attempts to adjust the raw-score reliability for this inflation in the raw-score reliability, but can only do the adjustment in an approximate way.

Winsteps also reports an item reliability, "true item variance / observed item variance". When this value is low, it indicates that the sample size may be too small for stable comparisons between items.

Anchored values are treated as though they are the "true values" of the MLE estimates. Their local standard errors are estimated using the current data in the same way as unanchored MLE standard error estimates. It is the measures (anchored or unanchored) and local standard errors that are used in the reliability computations. If you wish to compute reliabilities using different standard error estimates (e.g., the ones when the anchor values were generated), then please perform a separate reliability computation (using Excel).

You can easily check the Winsteps reliability estimate computation yourself.

Read the Winsteps PFILE= into an Excel spreadsheet.

Compute the STDEVP standard deviation of the person measures. Square it. This is the "Observed variance".

"Model" Reliability: Take the standard ERROR column. Square each entry. Sum the squared entries. Divide that sum by the count of entries. This is the "Model Error variance" estimate. Then,
Model Reliability = True Variance / Observed Variance = (Observed Variance - Model Error Variance) / Observed Variance.

"Real" Reliability: Take the standard ERROR column. Square each entry, SE^2. In another column, put SE^2*Maximum [1.0, INFIT mean-square). Divide that sum by the count of entries. This is the "Real Error variance" estimate. Then,
Real Reliability = True Variance / Observed Variance = (Observed Variance - Real Error Variance) / Observed Variance.

Separation, Strata and Reliability

The crucial elements in the computation of reliability are the "True" variance and the Error variance. These are squared distances and so difficulty to conceptualize directly. It is easier to think of their square-roots, the "True" standard deviation (TSD) and the root-mean-square standard error (RMSE).

SEPARATION coefficient is the ratio of the PERSON (or ITEM) TRUE S.D., the "true" standard deviation, to RMSE, the error standard deviation. It provides a ratio measure of separation in RMSE units, which is easier to interpret than the reliability correlation. This is analogous to the Fisher Discriminant Ratio. SEPARATION coefficient ^{2} is the signal-to-noise ratio, the ratio of "true" variance to error variance.

RELIABILITY (separation index) is a separation reliability. The PERSON (or ITEM) reliability is equivalent to KR-20, Cronbach Alpha, and the Generalizability Coefficient. The relationship between SEPARATION coefficient and RELIABILITY (separation index) is

RELIABILITY = SEPARATION coefficient ²/(1+SEPARATION coefficient ²)
or SEPARATION coefficient = square-root(RELIABILITY/(1-RELIABILITY)).

Separation (if the outlying measures are accidental) or **Strata** (if the outlying measures represent true performances). These numbers are statistical abstractions, but there empirical meaning is indicated by locating the Separation or Strata levels in the observed distribution at (3 * "Observed S.D." / Separation) units apart, centered on the sample mean.

Error RMSE	True SD	True Variance	Observed Variance	Signal-to-Noise Ratio	Separation = True SD / RMSE	Strata = (4*Sep.+1) / 3	Reliability = True Variance / Observed Variance
1	0	0	1	0	0	0	0
1	1	1	2	1	1	1.67	0.5
1	2	4	5	2	2	3	0.8
1	3	9	10	3	3	4.33	0.9
1	4	16	17	4	4	5.67	0.94

There is more at www.rasch.org/rmt/rmt94n.htm and www.rasch.org/rmt/rmt163f.htm

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Spearman-Brown Prediction Formula (Prophecy Formula) for person "Test" reliability with different numbers of items (test lengths)

How many items (or persons) are required to produce the reliability I want with the sample of persons and the same type of items (or this test and the same type of persons)?

T = target number of items, R_T = target person reliability
C = current number of items, R_C = current person reliability

1. Predict number of items = T = C * R_T * (1-R_C) / ((1-R_T) * R_C)

Example: the current test length is C = 10 items, and the current person reliability is R_C = 0.3. We want a person reliability of R_T = 0.8.
Target number of items is T = 10 * 0.8 * (1-0.3) / ((1-0.8)* 0.3) = 94 items.

2. Predicted person "Test" Reliability = R_T = T * R_C / (C * (1-R_C) + T * R_C)

Example: we have a test of C = 11 items of person reliability R_C = 0.5, what is the predicted reliability of a test of T = 17 items?
Predicted person reliability R_T = 17 * 0.5 / (11 * (1-0.5) + 17 * 0.5) = 0.61

Prophecy Formula for person "Test" reliability with different observed standard deviations of the person measures/scores assuming the average error variance is unchanged.

T = target observed standard deviation, R_T = target person reliability
C = current observed standard deviation, R_C = current person reliability

1. Predict person standard deviation = T = C * sqrt ((1-R_C) / (1-R_T))

2, Predict person reliability = R_T = 1 - ((1-R_C)*C² / T²)

Test-Retest Reliability

is the correlation between the person measures obtained from two administrations of the same test to the same persons. The expected value of the test-retest reliability is the person reliability of the first administration.

The "Smallest Detectable Difference" = "Smallest statistically significant difference in a person's measures" when a test is administered twice to a person under normal conditions = 1.96*(person standard deviation)*(test-retest reliability).

Population and Sample Standard Deviation, Reliability, Separation and Strata

Winsteps assumes that the N statistics being summarized are the entire population. It reports the population observed Standard Deviation = P.SD, "True" Standard Deviation = T.P.SD, Reliability = P.Rel, Separation = P.Sep and Strata = P.Strata, average error S.D. = RMSE, where
P.Sep = √ (P.Rel / (P.Rel + 1))
RMSE = P.SD * √ (1 - P.Rel)

If the N statistics are a sample of the entire population, then the summary statistics are the sample observed Standard Deviation = S.SD, "True" Standard Deviation = T.S.SD, Reliability = S.Rel, Separation = S.Sep and Strata = S.Strata, where
S.SD = P.SD * √ (N / (N-1)) - *the sample S.D. is bigger than the population S.D.*
T.S.SD = √ (S.SD**2 - RMSE**2)
S.Sep = T.S.SD / RMSE
S.Strata = (4 * S.Sep + 1) / 3
S.Rel = (1 + (N-1)*P.Rel) / N

Confidence Intervals of a Reliability Coefficient from https://www.psyctc.org/cgi-bin/R.cgi/Feldt1.R

Calculation of Cronbach Alpha

Winsteps uses this formula applied to the original scored observations:

Cronbach Alpha = (item count /(item count - 1)) * (1 - sum (intra-item score population variances) / (inter-person score population variance)))

Example from Journal of the Scientific Society (with population S.D.s to accommodate missing data):

	Q1	Q2	Q3	Q4	Person score
P1	3	3	3	2	11
P2	4	3	4	5	16
P3	3	4	5	4	16
P4	4	3	4	4	15
P5	4	4	5	5	18
P6	5	4	5	5	19
S.D.	0.69	0.5	0.75	1.07	2.54

Population Variances			Item Sum Variances =	3.00	Person Score Variance = 6.47
Item count k = 4	k/(k-1) = 4/3		Cronbach Alpha	k/(k-1)* (1 - item sum/ person variance)	= 0.84 Winsteps = 0.84 Rasch Person Reliability = 0.87

With missing data:

	Q1	Q2	Q3	Q4	Person score
P1	3	3	3	2	11
P2	4	3	4	5	16
P3	3	4	5	4	16
P4	4	3	4	4	15
P5	4	4	5	5	18
P6	5	4	5	Missing	14
S.D.	0.69	0.5	0.75	1.10	2.16
Population Variances			Item Sum Variances =	3.03	Person Score Variance = 4.67
Item count k = 4	k/(k-1) = 4/3		Cronbach Alpha	k/(k-1)* (1 - item sum/ person variance)	= 0.63 Winsteps = 0.63 Rasch Person Reliability = 0.86

21.110 Response-pattern frequency

Here is how to report the frequency of response patterns:

1. In your Winsteps control file,
a) give NAME1= the same value as ITEM1=
b) give NAMELENGTH= the length of the response string = the value of NI= * XWIDE=
c) PSUBTOT=1Wn where n is the same as NAMELENGTH=

2. Analyze the control file

3. Output Table 28 person sub-totals: each response pattern will have a count in the first column.

21.111 Rules for assigning values to control variables (key-words)

Do not worry about these unless Winsteps does not respond to your control file the way you expected. If possible, compare your control file with what is shown in Table 0 of your report output file in order to isolate the problem.

1. Values are assigned to control variables by typing the name of the control variable (or enough of it to disambiguate it), an equal sign, "=", and the value, e.g.
TABLES=11011011100
or
TAB=1101101110   this is enough of TABLES to make clear what you mean.

2. You must use one line for each assignment, but continuation lines are permitted.
To continue a line, put a + at the end of the line. Then put a + at the start of the text in the next line. The two lines will be joined together so that the + signs are squeezed out, e.g.,

```
TITLE = "Analysis of medical+
  + research data"
```

is interpreted as
TITLE = "Analysis of medical research data"

Continuation lines "+" are helpful to make control files fit on your screen.

```
CODES = 01020304+
 +0506+
        +0708
```

is interpreted as
CODES = 0102030405060708

To comment out a continuation line:

```
; CODES = 01020304+
; +05060708
```

3. The control variables may be listed in any order.

4. Character strings must be enclosed in 'single quotes' or "double quotes" when they contain blanks, e.g.,
TITLE="Rasch Analysis of Test Responses"
or
TITLE='Rasch Analysis of Test Responses'
Quotes are not required for single words containing no blanks, e.g. PFILE=kctpf.txt

5. The control variables may be in upper or lower case or mixed,
e.g., Pfile = Person.txt

6. Blanks before or after control variables, and before or after equal signs are ignored, e.g.
TITLE="Test Report"
and
TITLE = "Test Report"
are equally correct.

7. Commas at the end of lines are ignored, so equally correct are:
  NAME1 = 33,
and
  NAME1 = 33

8. Control variables can be made into comments, and so be ignored, by entering a semi-colon in column 1, e.g.
; FITP=3 is ignored

9. When all control variables (required or optional) have been assigned values,
type &END (in upper or lower case) on the next line, e.g.,

```
 Title ="A 30 Item test"
 NI = 30
  ; this is a comment: person names in columns 1-20.
 ITEM1= 21
 &END
```

10. Values may be expressions, with no internal spaces

USCALE = 2*10 ; 20

21.112 RUMM2030+ Rasch analysis software and Winsteps

RUMM, Rasch Unidimensional Measurement Model, Rasch analysis software was launched in 1997 by David Andrich, Barry Sheridan and Guanzhong Luo. RUMM is also an allusion to Georg Rasch's love of alcohol. In 1997, PC software was transitioning from MS-DOS to Windows. RUMM was initially ahead of Winsteps in implementing a graphical-user interface. RUMM analyses are controlled by dialog boxes. Winsteps interactive analyses are controlled by menus. Winsteps also allows non-interactive analyses in "Batch" mode.

RUMM versions implement pair-wise maximum likelihood estimation, PMLE. Winsteps implements JMLE and CMLE. For large datasets, the person and item estimates are effectively the same. An idiosyncrasy in PMLE is that items with the same item raw scores, p-values, for responses by the same persons may have slightly different estimates. This is more noticeable in the implementations of PMLE in some R Statistics packages.

RUMM2030+ and Winsteps have many analytical features in common, but each has unique features. RUMM can import the same rectangular data files as Winsteps. Over the years, RUMM and Winsteps have copied features from each other. If you require a feature that is in RUMM, or elsewhere, which is not yet implemented in Winsteps, please email me, mike@winsteps.com.

21.113 Scoring items with multiple responses

Question: We have 7 items on the test and 3 items are standard 4 option multiple choice items with one correct option as correct. Also there are 3 items that have 5 answer options and have 3 or 4 answer options as correct to achieve one score point. And one item with 6 answer options with 4 options correct to count as 1 correct.

Answer: These creative item types are beyond the standard capability of Winsteps :-(

One solution is to pre-process the responses, for instance with Excel.

Build an Excel worksheet with one row for each person. The standard items are one column each. These can be scored later by Winsteps. For the other items, each item option is one column in the worksheet. So the 5 answer options to one item are 5 columns for each person. In a 6th column, these 5 columns are compared to the scoring key by Excel and the count of right answers shown. In a 7th column, the count in 6th column is compared with the "correct" count and the final 0/1 shown. This is done for all three special items. Then Winsteps converts the Excel file into a Winsteps file (Excel/RSSST menu), selecting only the final score column for each special item.

21.114 Shortcut Keys

Some very frequent operations are quicker to perform using shortcut keystrokes than by menu selection. Here are the shortcut keys implemented in Winsteps:

Alt+ hold down the Alt key and press the letter key.
Ctrl+ hold down the Ctrl key and press the letter key.

Alt+A start **A**nother copy of Winsteps
Alt+E **E**dit the control file
Alt+H display **H**elp file
Alt+R **R**estart Winsteps with this control file
Alt+S **S**pecification entry
Alt+X e**X**it this Winsteps, and restart with this control file

Ctrl+E **E**nd epochs
Ctrl+F **F**inish iterating or **F**inish factoring
Ctrl+O **O**pen a control or output file
Ctrl+Q **Q**uit Winsteps
Ctrl+S **S**ave on-screen activity log
Ctrl+P **P**rint on-screen activity log

Esc **E**scape from action

21.115 Simulating data

See Simulated data file

21.116 Smartphone - running Winsteps on your PC

Winsteps and all windows programs can be run from your smartphone using Google Chrome Remote Desktop. The remote desktop has mouse and keyboard items to access all Winsteps functions. Areas of the smartphone screen can be enlarged by using your smartphone's magnification capabilities so that all Winsteps output can be seen clearly.

21.117 Specifying how data are to be recoded

You will need to choose how this is done.

First, use CODES= to specify the response codes in your data file.

If there is only one type of recoding to be done, use
NEWSCORE=

If this one type of rescoring only applies to some of the items, also use
RESCORE=

If the rescoring is more complex, use
IREFER= and IVALUE=

If the items are multiple-choice, use
KEYn=

If missing values are not to be ignored, i.e., treated as not-administered, you will need
MISSCORE=

If alphabetical codes are used to express two-digit numbers in one column, use
ALPHANUM=

21.118 Speeded tests

Speeded tests are a challenge for measurement. Even Georg Rasch had trouble with them.

If the problem is that people run out of time before completing all the items, then a two-phase approach to Rasch analysis has been used:

In phase 1, item calibration, all not-reached and skipped responses are coded as "not administered". Clearly aberrant responses are ignored (CUTLO=, CUTHI=). This analysis is done to get a good estimate of the true difficulty of the items. Output the item file: IFILE=if.txt

In phase 2, person measurement, all the data are used. Every response is scored right or wrong, including skips and not-reached. The items are anchored IAFILE=if.txt. The person measures are produced.

21.119 Split items - procedure

There are some methods to split an item into two or more columns based on person classification group.

1. From Winsteps, output your data to Excel using Output Files menu, RFILE= or IPMATRIX=
In Excel:
a. Sort the rows (cases) by the target demographic (or whatever) variable
b. Cut the responses to the target items by one demographic group into new columns
c. Label (row 1) the new columns with their item labels and demographic information

d. Save the Excel file under a new name
e. Use the Excel/RSSST menu to convert the new Excel file into a Winsteps control file
f. Analyze the new control file which now has the split items.

2. Use MFORMS=, then EDFILE=

3. Use FORMAT=, then EDFILE=

These examples use FORMAT=. Here are the changes to a control file to split an item:

Example 1: We want to split item 3 "Enjoy cooking", of our 12 item test into two items, based on the Gender (M,F) indicator in column 2 of the person label.

1. Increase number of items:

```
NI= 13 (add one NI=12)
NAME1= (add one if to the right of the items)
```

The new item will be the last item

2. Add coding, grouping for new item 13 in IREFER=, ISGROUPS=, KEY1=

3. Add a new item name before END LABELS for item 13:
Enjoy cooking (male)
Edit the current item name for item 3:
Enjoy cooking (female)

4. Use FORMAT= duplicate the old item into the new item's position, e.g.,

```
FORMAT = (12A,T3,1A,T13,99A)
```

adds the item in column 3 again in column 13. Then follows it with the old column 13 onwards, now starting in column 14..

5. Delete responses in the two versions of the item, based on the person demographics (Gender: M, F) in column 2 of the person label:

```
EDFILE=*
"?M" 3 x ; all Male responses to item 3 are changed to "x" (scored as missing - not administered)
"?{~M}" 13 x ; all not Male responses to item 13 are changed to "x"
*
```

6. The Control file is:

```
Title = "Survey of Personal Preferences"
NI = 13  ; was NI=12
ITEM1 = 1 ; responses start the line
NAME1 = 15 ; was NAME1=14
CODES=12345
FORMAT = (12A,T3,1A,T13,99A) ; repeat column 3 at column 13
EDFILE=*
"?M" 3 x ; all Male responses to item 3 are changed to "x" (scored as missing - not administered)
"?{~M}" 13 x ; all not Male responses to item 13 are changed to "x"
*
RFILE = rfile.txt ; File which shows the reformatted data
&END
Item 1
Item 2
Enjoy cooking (female) ; Item 3
Item 4
....
Item 12
Enjoy cooking (female) ; Item 12
END NAMES
321453324213 PM George ; M is Male in column 2 of person label
532134324522 RF Mary   ; F is Female in column 2 of person label
......

The data become:
32x4533242131 PM George ; M is Male in column 2 of person label
532134324522x RF Mary   ; F is Female in column 2 of person label
```

```
......
```

Example 2: Splitting item 19 in Liking for Science, example0.txt, data by gender, and moving gender to first column of person label:

```
Title= "Liking for Science"
ITEM1= 1 ; Starting column of item responses
NI= 26 ; Number of items  ; one item added to the standard 25
XWIDE = 1 ; this matches the biggest data value observed
CODES= 012 ; matches the data
NAME1 =  28 ; Starting column for person label in formatted data record (gender)
; show column 19 again in column 26, and also column 48 (gender) again in column 28
FORMAT = "(25A1, T19, 1A1, T26, 1A1, T48, 2A1, T27, 50A1)"
EDITFILE=*
"{~F}" 26 m     ; m = deliberately omitted response
"{~M}" 19 m
*
; reformatted file looks like ...
;1234567890123456789012345678901234567890123456789012345678901234
;12111020122220211220210200  M ROSSNER, MARC DANIEL M  1
;101010100111100112 1111102 F  ROSSNER, REBECCA A. F  5
;101121101112101012 101210         ROSSNER, TR CAT    6
&END ; Item labels follow: columns in label
WATBIRDS  ; Item 1
BOOKANIM  ; Item 2
BOOKPLNT  ; Item 3
WATGRASS  ; Item 4
BOTLCANS  ; Item 5
LOOKENCY  ; Item 6
WATAMOVE  ; Item 7
LOOKCRAK  ; Item 8
NAMEWEED  ; Item 9
LISTBIRD  ; Item 10
FINDALIV  ; Item 11
MUSEUM    ; Item 12
GROGARDN  ; Item 13
PIXPLNTS  ; Item 14
ASTORIES  ; Item 15
MAKEMAP   ; Item 16
WATAEAT   ; Item 17
PICNIC    ; Item 18
GOTOZOOM  ; Item 19  - Zoo - Male
WATBUGS   ; Item 20
WATNEST   ; Item 21
WHATEAT   ; Item 22
WATCHRAT  ; Item 23
FLWRSEAT  ; Item 24
TALKPLNT  ; Item 25
GOTOZOOF  ; Item 26 - Zoo - Female
;2345678901234567890123456789012345678901234567890
END NAMES
1211102012222021122021020 ROSSNER, MARC DANIEL M  1
2222222222222222222222222 ROSSNER, LAWRENCE F. M  2
2211011012222122122121111     ROSSNER, TOBY G. M  3
1010010122122111122021111  ROSSNER, MICHAEL T. M  4
1010101001111001122111110  ROSSNER, REBECCA A. F  5
1011211011121010122101210      ROSSNER, TR CAT    6
2220022202222222222222222     WRIGHT, BENJAMIN M  7
2210021022222020122022022 LAMBERT, MD., ROSS W M  8
0110100112122001121120211      SCHULZ, MATTHEW M  9
2100010122221121122011021    HSIEH, DANIEL SEB M 10
2220011102222220222022022     HSIEH, PAUL FRED M 11
0100220101210011021000101    LIEBERMAN, DANIEL M 12
1211000102121121122111000  LIEBERMAN, BENJAMIN M 13
2110020212022100022000120     HWA, NANCY MARIE F 14
1111111111111111112211111  DYSON, STEPHIE NINA F 15
2221121122222222222122022     BUFF, MARGE BABY F 16
2222022222222222222222122      SCHATTNER, GAIL F 17
2222021022222221222122022   ERNST, RICHARD MAX M 18
2221011002222211122020022    FONTANILLA, HAMES M 19
1100010002122212122020022        ANGUIANO, ROB M 20
1111011112122111122021011       EISEN, NORM L. M 21
1211111112222121122121121      HOGAN, KATHLEEN F 22
2211112112222121222122122          VROOM, JEFF M 23
1221012102222110122021022 TOZER, AMY ELIZABETH F 24
2221120222222221222122022         SEILER, KAREN F 25
1111111111111111111111111      NEIMAN, RAYMOND M 26
1110011101122111022120221           DENNY, DON M 27
2211102002122121022012011         ALLEN, PETER M 28
1000101001110000022110200        LANDMAN, ALAN M 29
```

```
1000000002122000022012100  NORDGREN, JAN SWEDE M 30
2211011112221011122121111        SABILE, JACK M 31
1210010011222110121022021       ROSSNER, JACK M 32
2212021212222220222022021       ROSSNER, BESS F 33
2222122222222222222222122        PASTER, RUTH F 34
1110211011122111122011111      RINZLER, JAMES M 35
1110201001122111122011111     AMIRAULT, ZIPPY M 36
1210010012122111122012021      AIREHEAD, JOHN M 37
2211021112222121122222121   MOOSE, BULLWINKLE M 38
2221022112222122222122022   SQURREL, ROCKY J. M 39
2221011022222221222122022      BADENOV, BORIS M 40
2222222222222222222222122     FATALE, NATASHA F 41
2121011112122221122011021    LEADER, FEARLESS M 42
2220112022222121222022021         MAN, SPIDER M 43
1210021012212211022011021       CIANCI, BUDDY M 44
2221022222222222222222022   MCLOUGHLIN, BILLY M 45
2200020002222000222122010        MULLER, JEFF M 46
1110220112212111022010000       VAN DAM, ANDY M 47
2221022222222221222122022    CHAZELLE, BERNIE M 48
1100110101110112111111210      BAUDET, GERARD M 49
2222121222222222222122122        DOEPPNER, TOM M 50
1210021022222221122021022        REISS, STEVE M 51
1111111111111111122111111      STULTZ, NEWELL M 52
0100101010110011021010000       SABOL, ANDREW M 53
1111021121122112122021011       BABBOO, BABOO   54
1010010011122112222111110    DRISKEL, MICHAEL M 55
2221012012222222222122022     EASTWOOD, CLINT M 56
2220022022222222222022022     CLAPP, CHARLIE M 57
1221010122222221222021021       CLAPP, DOCENT   58
2221021122222221222022222            CLAPP, LB   59
1221111122222121122121021    SQUILLY, MICHAEL M 60
2111010022122111122011022     SQUILLY, BAY OF   61
2220000022222220222020000          BEISER, ED M 62
1211010122222122222122010      BECKER, SELWIN M 63
2210022112222121222122011      CORLEONE, VITO M 64
1211211002222012122121200   CORLEONE, MICHAEL M 65
1201010012222120222022021      PINHEAD, ZIPPY   66
1211001001212121222121012     MALAPROP, MRS. F 67
1200010102120120022001010         BOND, JAMES M 68
1210010122222122222021021    BLOFELD, VILLAIN M 69
2222022012222122222022021         KENT, CLARK M 70
2201222001220022220222201       STOLLER, DAVE M 71
1001000100011010021200201    JACKSON, SOLOMON M 72
2012010122210201102202022      SANDBERG, RYNE M 73
2220022002222222222022012      PATRIARCA, RAY M 74
1200110112122221022020010      PAULING, LINUS M 75
```

Example 3: We have non-uniform DIF on an item and want to split the persons high-low.
We need to split the persons on the item by raw score or Rasch measure. To do this conveniently, use RFILE= to output data to Excel. Also output the PFILE= to Excel. Then you can copy the score/measure column from the PFILE to the RFILE. Sort the RFILE by the new score/measure column. then split the desired item column into two columns high/low or whatever.

21.120 Standard errors: model and real

A standard error quantifies the **precision** of a measure or an estimate. It is the standard deviation of an imagined error distribution representing the possible distribution of observed values around their "true" theoretical value. This precision is based on information within the data. The quality-control fit statistics report on **accuracy,** i.e., how closely the measures or estimates correspond to a reference standard outside the data, in this case, the Rasch model.

S.E.s are produced by models of the data and are estimates of precision. For the S.E. of the mean, the model of the data is a normal distribution of the values summarized by the mean. The mean is an estimate, because we never know the true mean of a distribution. The S.E. shows the precision of the mean estimate. For the Rasch "model S.E.", the model is the Rasch model of ordinal data summarized by a parameter estimate. It is an estimate because we never know the true value of the parameter. The S.E. shows the precision of the Rasch estimate.

Standard errors of Rasch estimates reported by Winsteps do not include the imprecision in the estimates of all the other persons or items. When estimating the standard error for a person or item, the other persons and items are treated as though their distributions exactly match their populations and their estimated values are their true values. The imprecision in the estimates due to sampling errors and basing person estimates on item estimates, and *vice-versa,* is usually an order of magnitude less than the reported standard errors.

Note: Survey-style "sample" standard errors and confidence intervals are equivalent to Rasch item-calibration standard errors. So
Survey sample 95% confidence interval on a dichotomous (binary) item reported with a proportion-correct-value as a % = 1.96 * 100% / (**item** logit standard error * sample size)
Example: survey report gives: p = 90%, sample size=100, confidence interval (95%) = 90±6%
Winsteps: logit S.E. of item calibration = 1/sqrt(100*.9*.1) = ±.33 logits.
So survey C.I. % = ±1.96 * 100 /(.33 * 100) = ±6%

Standard Errors of Items

The size of a standard error of an estimate is most strongly influenced by the number of observations used to make the estimate. We need measurement precision (standard error size) adequate for the purpose for which we are using the measures.

Probably the only time we need to be concerned about item standard errors within a test is when we want to say "Item A is definitely more difficult than Item B". For this to be true, their measures need to be more than 3 S.E.s different.

When comparing item difficulties estimated from different datasets, we use the item standard errors to identify when differences between the item difficulties of the same item are probably due to chance, and when they may be due to a substantive change, such as item drift.

Model "Ideal" Standard Error

The highest possible precision for any measure is that obtained when every other measure is known, and the data fit the Rasch model. The model standard error is 1/square root (Fisher information). For well-constructed tests with clean data (as confirmed by the fit statistics), the model standard error is usefully close to, but slightly smaller than, the actual standard error. The "model" standard error is the "best case" error. It is the asymptotic value for JMLE. For dichotomous data this is, summed over items i=1,L for person n, or over person n=1,N for item i:

$$S.E.(B_n, D_i) = 1/\sqrt{\sum \left(P_{ni}\left(1-P_{ni}\right)\right)}$$

For polytomies (rating scales, partial credit, etc.), with categories j=0,m:

$$S.E. = 1/\sqrt{\sum_{n \, or \, i}\left(\sum_{j=0}^{m}\left(jP_{nij} - \sum_{j=0}^{m} jP_{nij}\right)^2\right)}$$

and, for the Rasch-Andrich thresholds,

$$S.E.(F_j) = 1/\sqrt{(}\sum_{n=1}^{N}\sum_{i=1}^{L}\left(\sum_{k=0}^{j} P_{nik} \sum_{k=j+1}^{m} P_{nik}\right))$$

where Pnik is the probability of observing category k for person n on item i.

Misfit-Inflated "Real" Standard Error

Wright and Panchapakesan (1969) *www.rasch.org/memo46.htm* discovered an important result for tests in which each examinee takes more than a handful of items, and each item is taken by more than a handful of examinees: the imprecision introduced into the target measure by using estimated measures for the non-target items and examinees is negligibly small. Consequently, in almost all data sets except those based on very short tests, it is only misfit of the data to the model that increases the standard errors noticeably above their model "ideal" errors. Misfit to the model is quantified by fit statistics. But, according to the model, these fit statistics also have a stochastic component, i.e., some amount of misfit is expected in the data. Discovering "perfect" data immediately raises suspicions! Consequently, to consider that every departure of a fit statistic from its ideal value indicates failure of the data to fit the model is to take a pessimistic position. What it is useful, however, is to estimate "real" standard errors by enlarging the model "ideal" standard errors by the model misfit encountered in the data.

Recent work by Jack Stenner shows that the most useful misfit inflation formula is

Real S.E. of an estimated measure = Model S.E. * Maximum [1.0, sqrt(INFIT mean-square)]

In practice, this "Real" S.E. sets an upper bound on measure imprecision. It is the "worst case" error. The actual S.E. lies between the "model" and "real" values. But since we generally try to minimize or eliminate the most aberrant features of a measurement system, we will probably begin by focusing attention on the "Real" S.E. as we establish that measurement system. Once we become convinced that the departures in the data from the model are primarily due to modeled stochasticity, then we may base our decision-making on the usually only slightly smaller "Model" S.E. values.

What about Infit mean-squares less than 1.0? These indicate overfit of the data to the Rasch model, but do not reduce the standard errors. Instead they flag data that is lacking in randomness, i.e., is too deterministic. Guttman data are like this. Their effect is to push the measures further apart. With perfect Guttman data, the mean-squares are zero, and the measures are infinitely far apart. It would seem that inflating the S.E.s would adjust for this measure expansion, but Jack Stenner's work indicates that this is not so. In practice, some items overfit and some underfit the model, so that the overall impact of low infit on the measurement system is diluted.

Standard Errors with Anchor Values
Anchored measures are shown in the Winsteps output Tables with "A". These are set with IAFILE=, PAFILE= and SAFILE=. Anchor values are exactly precise with zero standard error. But each anchor value is reported with a standard error. This is the standard error that the anchor value would have if it were the freely estimated maximum-likelihood value of the parameter.

Plausible Values
"Plausible values" are random draws from a parameter's posterior distribution. Here the posterior distribution is a normal distribution of N(mean=estimated measure, S.D.=standard error) for each parameter. Plausible values would be random draws from this distribution. The Excel formula to do this is =(Measure + S.E.*NORMSINV(RAND( ))) which can be input into an extra column in a PFILE= or IFILE= written to Excel.

21.121 Standard setting

The Bookmark standard-setting procedure can be implemented using Winsteps. See
scholarworks.umass.edu/pare/vol11/iss1/2/
MacCann, Robert G. & Gordon Stanley (2006). The use of Rasch modeling to improve standard setting. Practical Assessment Research & Evaluation, 11(2).

21.122 Starting Winsteps from the DOS prompt

Winsteps can also be invoked from the DOS prompt in a DOS window.
At the prompt enter
C:>Winsteps(Enter)
Winsteps proceeds with its standard operations.

You can enter control and output files directly on the prompt line.
C:>Winsteps SF.txt SF.OUT(Enter)
Winsteps starts analysis immediately. You will not be prompted for "Extra Specifications"

You can also enter extra specifications here:
C:>Winsteps SF.txt SF.OUT chart=yes distractors=no(Enter)
Leave no spaces within specifications, or place them in quotes, e.g.,
C:>Winsteps SF.txt SF.OUT "chart = yes" "distractors = no"(Enter)

To perform the previous analysis again, with a temporary report output file:
C:>Winsteps @(Enter)
@ is replaced by the top control file on the Files= menu. If no output file is specified, then a temporary one is used.

For Batch file operation, see Batch=

21.123 Subsets and connection ambiguities

You see: **Warning:** Data are ambiguously connected into 6 subsets. Measures may not be comparable across subsets.

Quick (but arbitrary) solution:

Let's assume your data are scored 0 or 1. Then:
a. if subsets of items have the same average difficulty
Add two dummy persons with scored response strings:
10101010....
01010101....

b. if subsets of persons have the same average ability
Add two dummy items (columns) with scored response strings:
01
10
01
10
..

Subsets: are these because different persons were administered non-overlapping subsets of items?
If so, can we assume that each subset of items is equally difficult on average?
If so, we only need 2 dummy persons, because the subsetting is independent of the sample size.
The easiest two dummy persons have response strings for all the items:
101010....
010101...
So the two dummy persons will have about the same ability and about the same success rate on all the subsets of items.
They will tie the subsets together.
The estimation may converge faster if you have more pairs of dummy persons, but then they will start to reduce the spread of the item difficulties in each subset.

More detail: add to the data file two dummy person records so that all persons and items become directly comparable.

Dichotomous data:
`Dummy person 1: responses: 010101010...`
`Dummy person 2: responses: 101010101...`

This says: "the middle level of performance for all subsets of persons is the same."

Rating scale data, where "1" is the lowest category, and "5" is the highest category:
`Dummy person 1: responses: 1212121212...`
`Dummy person 2: responses: 2121212121...`

This says: "the bottom level of performance for all subsets of persons is the same."

If you are concerned the dummy persons or items will skew your statistics, give them very small weights: PWEIGHT= or IWEIGHT=

Explanation: Connectivity (or subsetting) is a concern in any data analysis involving missing data. In general,
nested data are not connected.
fully-crossed data (also called "complete data") are connected.
partially-crossed data may or may not be connected.

Winsteps examines the responses strings for all the persons. It verifies that every non-extreme response string is linked into one network of success and failure on the items. Similarly, the strings of responses to the items are linked into one network of success and failure by the persons.

If person response string A has a success on item 1 and a failure on item 2, and response string B has a failure on item 1 and a success on item 2, then A and B are connected. This examination is repeated for all pairs of response strings and all pairs of items. Gradually all the persons are connected with all the other persons, and all the items are connected with all the other items. But it some persons or some items cannot be connected in this way, then Winsteps reports a "connectivity" problem, and reports which subsets of items and persons are connected.

Mathematics: connectivity is part of Graph Theory. The person/item/judge/... parameters of the Rasch model are the vertices and the observations are the edges. In an undirected graph, we need every vertex to be connected directly or indirectly to every other vertex. A connection is established between two vertices when one vertex is observed to have both a higher observation and a lower observation than another vertex in the same context, or when both both vertices have the same intermediate category of a rating scale in the same context.

Thus there are two situation for failure to connect:
1) there is no direct or indirect link between two vertices, e.g., two different datasets analyzed together with no common parameters. This is detected by the Winsteps/Facets subset routine.

2) the vertices are connected by observations, but the observations do not meet the requirements, e.g., all the person respond to all the items, but half the persons score in the upper half of the rating scale on every item, and the other half of the persons score in the lower half of the rating scale on every item. This is called a "Guttman split" in the data. This is usually obvious in the reported estimates as a big gap on the Wright maps between the two halves of the person distribution.

Example 1: Connection problems and subsets in the data are shown in this dataset. It is **Examsubs.txt.**

```
Title = "Example of subset reporting"
Name1 = 1
Namelength = 24 ;  include response string in person label
Item1 = 13
NI = 12
CODES = 0123 ; x is missing data
ISGROUPS = DDDDDDDDDDRR ; items 1-10 are dichotomies; items 11-12 share a rating scale
MUCON = 3 ; Subsetting can cause very slow convergence
TFILE=*
18.1
14.1
0.4
*
&End
01 Subset 1
02 Subset 1
03 Subset 2
04 Subset 2
05 Subset 7
06 Subset 4
07 Subset 4
08 Subset 5
09 Subset 5
10 Subset 5
11 Subset 6
12 Subset 6
END LABELS
01 Extreme  11111
02 Subset 1 01111
03 Subset 1 10111
04 Subset 2 00101
05 Subset 2 00011
06 Subset 3     011
07 Subset 3     011
08 Subset 4     001
09 Subset 4     010
10 Subset 5        0x1
11 Subset 5        10x
12 Subset 5        x10
13 Subset 6           01
14 Subset 6           10
15 Subset 6           23
16 Subset 6           32
```

The Iteration Screen reports:

```
                              CONVERGENCE TABLE
-Control: \HOLDW95\examples\examsubs.txt Output: \examples\ZOU571WS.TXT
|    PROX         ACTIVE COUNT       EXTREME 5 RANGE      MAX LOGIT CHANGE  |
| ITERATION  PERSON    ITEM  CATS     PERSON    ITEM      MEASURES  STRUCTURE|
>======================================<
|        1       15      12     8       2.00    1.06       -2.0794           |
>======================================<
|        2       15      12     6       2.38    1.84        2.6539   -1.6094 |
>======================================<
```

```
|        3       14       12      6       2.67    1.60        2.7231     .0000 |
>=======================================<
|        4       14       12      6       2.68    2.33       -2.3912     .0000 |
>=======================================<
|        5       14       12      6       2.97    1.77        2.3246           |
>=======================================<
|        6       14       12      6       2.97    2.54       -2.2191           |
>=======================================<
|        7       14       12      6       3.22    2.10        2.0372           |
Probing data connection: to skip out: Ctrl+F - to bypass: subset=no
Processing unanchored persons ...
>=======================================<
Consolidating 9 potential subsets pairwise ...
>==================================
Consolidating 9 potential subsets indirectly pairwise ...
>=======================================<
Consolidating 8 potential subsets pairwise ...
>==================================
Consolidating 7 potential subsets pairwise ...
>==================================
Consolidating 7 potential subsets indirectly pairwise ...
>=======================================<
Warning: Data are ambiguously connected into 7 subsets. Measures may not be comparable
   across subsets.
 Subsets details are in Table 0.4
```

Table 18.1

```
         PERSON STATISTICS:  ENTRY ORDER

---------  ---------------------------
|ENTRY     |                          |
|NUMBER    | PERSON                   |
|--------  +-------------------------|
|     1    | 01 Extreme  11111        | MAXIMUM MEASURE
                                              < Guttman split here >
|     2    | 02 Subset 1 01111        | SUBSET 1
|     3    | 03 Subset 1 10111        | SUBSET 1
                                              < Guttman split here >
|     4    | 04 Subset 2 00101        | SUBSET 2
|     5    | 05 Subset 2 00011        | SUBSET 2
                                              < Guttman split here >
|     6    | 06 Subset 3     011      | SUBSET 3
|     7    | 07 Subset 3     011      | SUBSET 3
                                              < Guttman split here >
|     8    | 07 Subset 4     001      | SUBSET 4
|     9    | 09 Subset 4     010      | SUBSET 4
                                              < Subset split here >
|    10    | 10 Subset 5        0x1   | SUBSET 5
|    11    | 11 Subset 5        10x   | SUBSET 5 < Indirect connection >
|    12    | 12 Subset 5        x10   | SUBSET 5
                                              < Subset split here>
|    13    | 13 Subset 6           01| SUBSET 6
|    14    | 14 Subset 6           10| SUBSET 6
                                              < undetected Guttman split here:
   Winsteps failed! >
|    15    | 15 Subset 6           23| SUBSET 6
|    16    | 16 Subset 6           32| SUBSET 6
|--------  +-------------------------|
```

In Tables and Notes:	***Explanation:***
`< Guttman split here >`	The persons above the split performed an unknowable amount different from the persons below the split. There is no item on which this subset succeeded

	and another subset failed, and also this subset failed and the other subset succeeded. The data are not "well-conditioned" (Fischer G.H., Molenaar, I.W. (eds.) (1995) Rasch models: foundations, recent developments, and applications. New York: Springer-Verlag. p. 41-43).
< Subset split here >	The persons in this subset responded to different items than persons in other subsets. We don't know if these items are easier or harder than items in other subsets.
< Indirect connection >	The persons responded to different items, but they are connected by a loop of successes and failures.
< undetected Guttman split here >	Winsteps subset-detection did ***not*** report than persons 13 and 14 always score lower than persons 15 and 16, causing a Guttman split. We do not know how much better persons 15 and 16 are than persons 14 and 15. Winsteps subset-detection may fail to report subsets. Unreported subsets usually cause big jumps in the reported measures.
Data are ambiguously connected	Measures for persons in different subsets are not comparable. Winsteps always reports measures, but these are only valid within subsets. We do not know how the measures for persons in one subset compare with the measures for persons in another subset. Reliability coefficients are accidental and so is Table 20, the score-to-measure Table. Fit statistics and standard errors are approximately correct.
Measures may not be comparable across subsets	Please always investigate when Winsteps reports subsets, even if you think that all your measures are comparable.
MAXIMUM MEASURE, MINIMUM MEASURE, DROPPED, INESTIMABLE	Persons and items with special features are not included in subsets. Extreme scores (zero, minimum possible and perfect, maximum possible scores) imply measures that are beyond the current frame of reference. Winsteps uses Bayesian logic to provide measures corresponding to those scores.
SUBSET 1, 2, 4	These are directly connected subsets. Within each subset, a person has succeeded on an item and failed on an item, and *vice-versa*. The person performances are directly pairwise comparable within the subset. The persons in this subset have either succeeded on items in other subsets, or failed on items in other subsets, or have missing data on items in other subsets.
SUBSET 3	These two persons have the same responses, so they are in the same subset. No one succeeded on their failed items item, and also failed on their successful item.
SUBSET 5	This is an indirectly connected subset. There is a loop of successes and failures so that the performances of all three persons are connected indirectly pairwise.
SUBSET 6	Persons 13 and 14 are directly comparable using categories 0 and 1 of the rating scale. Persons 15 and 16 are directly comparable using categories 2 and 3 of the rating scale. Winsteps has ***not*** detected that persons 13 and 14 always rate lower than persons 15 and 16, causing a Guttman split.
SUBSET 7 (Table 14.1)	No person is in the same subset as this item. There is no subset in which persons both succeeded and failed on this item.
Connecting SUBSETs	Here are approaches: 1. Collect more data that links items across subsets. Please start Winsteps analysis as soon as you start data collection. Then subset problems can be remedied before data collection ends. 2. Dummy data. Include data for imaginary people in the data file that connects the subsets. 3. Anchor persons or items. Anchor equivalent items (or equivalent persons) in the different subsets to the same values - or juggle the anchor values to make the mean of each subset the same (or whatever)

	4. Analyze each subset of persons and items separately. In Table 0.4, Winsteps reports entry numbers for each person and each item in each subset, so that you can compare their response strings. To analyze only the items and persons in a particular subset, such as subset 4 above, specify the items and persons in the subset: IDELETE= +9-10 PDELETE= +10-11
Memory was not allocatable to probe connectivity	If the data are complete, ignore this message. If the data are sparse, add dummy data records. They will have little influence on connected data, but will connected up data with subsets. See also Memory

Table 14.1

```
---------  -----------------
|ENTRY     |                |
|NUMBER    | ITEM         G |
|--------  +----------------|
|      1   | 01 Subset 1 D | SUBSET 1
|      2   | 02 Subset 1 D | SUBSET 1
                                      < Guttman split here >
|      3   | 03 Subset 2 D | SUBSET 2
|      4   | 04 Subset 2 D | SUBSET 2
                                      < Guttman split here >
|      5   | 05 Subset 7 D | SUBSET 7
                                      < Guttman split here >
|      6   | 06 Subset 4 D | SUBSET 4
|      7   | 07 Subset 4 D | SUBSET 4
                                      < Guttman split here >
|      8   | 08 Subset 5 D | SUBSET 5
|      9   | 09 Subset 5 D | SUBSET 5
|     10   | 10 Subset 5 D | SUBSET 5
                                      < Guttman split here >
|     11   | 11 Subset 6 R | SUBSET 6
|     12   | 12 Subset 6 R | SUBSET 6
|--------  +----------------|
```

Table 0.4 reports

```
SUBSET DETAILS

Subset 1 of 2 ITEM and 2 PERSON
 ITEM: 1-2
 PERSON: 2-3
Subset 2 of 2 ITEM and 2 PERSON
 ITEM: 3-4
 PERSON: 4-5
Subset 3 of 2 PERSON
 PERSON: 6-7
Subset 4 of 2 ITEM and 2 PERSON
 ITEM: 6-7
 PERSON: 8-9
Subset 5 of 3 ITEM and 3 PERSON
 ITEM: 8-10
 PERSON: 10-12
Subset 6 of 2 ITEM and 4 PERSON
 ITEM: 11-12
 PERSON: 13-16
Subset 7 of 1 ITEM
 ITEM: 5
```

Example 2: Analyzing two separate datasets together.
Dataset 1. The Russian students take the Russian items. This is connected. All the data are in one subset.
Dataset 2. The American students take the American items. This is connected. All the data are in one subset.
Dataset 3. Datasets 1 and 2 are put into one analysis. This is not connected. The data form two subsets: the Russian one and the American one. The raw scores or Rasch measures of the Russian students cannot be compared to those of the American students. For instance, if the Russian students score higher than the American students, are the Russian students more able or are the Russian items easier? The data cannot tell us which is true.

Winsteps attempts to estimate an individual measure for each person and item within one frame of reference. Usually this happens. But there are exceptions.

The initial implimentation used the algorithm of David L. Weeks Donald R. Williams Technometrics 6:3 p.319-324 8/1964, but this fails for indirect linking.

21.124 Subtest scoring and weighting

A test or protocol may consist of a series of subtests. You want each person to have a separate measure on each subtest, but in the same frame of reference as the overall test measures.

First, code each item in its item label with what subtest it belongs to.

A. Using DPF.

1. Analyze all the data together.

2. Reporting of subtests.
Reporting subtest items: In an overall analysis, the items of individual subtests can be reported after applying ISELECT= from the Specification pull-down box.

Reporting subtest person measures: a measure for each person on each subtest can be obtained by specifying the subtest identification column in the item label in DPF= and producing Table 31 or the DPF plot.

B. Using separate analyses.

1. Analyze all the data together. Produce an IFILE=if.txt. Produce a PFILE= for global measures.

2. Anchor all items IAFILE=if.txt.
Select one subtest: ISELECT=subtest code
Run Winsteps
Produce IFILE= and PFILE for the subtest.

3. Repeat for the other subtests.

Subtest Weighting

The different subsections have different maximum scores, but you want each subsection to be equally influential in estimating the final measures.

1) Do a standard Rasch analysis to investigate coding problems, misfit, reliability, etc.

2) Weight the items in the different sections so that the overall weights for each section are the same.
Let's suppose that the items are all dichotomies scored 0,1, then

IWEIGHT=*
1-40 1 ; the 40 items in section 1 are given a weight of 1, so weight of section 1 = 40*1 = 40

41-70 1.333 ; the 30 items in section 2 are given a weight of 1.333, so weight of section 2 = 30*1.333 = 39.99
71-120 .8 ; the 50 items in section 3 are given a weight of 0.8, so weight of section 3 = 50*0.8 = 40
*

We want to maintain close to the original overall weight, so that the final reliabilities and standard error have reasonable values.

3) Perform the weighted analysis to report the final person measures.

There are other effective approaches. For instance, perform a separate Rasch analysis for each section, and then combine the subtest measures using www.rasch.org/rmt/rmt83f.htm:

combined measure = sum(section measure/S.E.(section measure))/sum(1/S.E.(section measure))

21.125 Super-items

Do you want to merge item columns to make superitems or testlets?

With Winsteps, output the data to Excel using IPMATRIX= from the Output Files menu
In Excel, sum the item columns for the items that belong in the superitems into new columns
Use the Winsteps Excel/RSSST menu to import the Excel file. Omit items you don't want.

In the Winsteps analysis, specify ISGROUPS=0 for the superitem columns.

For more details, see Testlets

21.126 TAM R Statistics Rasch analysis software and Winsteps

TAM is an R Statistics package with some of the capabilities of Winsteps.

Look at the item estimates in https://cran.r-project.org/web/packages/TAM/TAM.pdf section: tam.jml Example 1.

```
    TAM       TAM    Winsteps
    item      Zero   Zero
1   -2.076 -2.02     -2.04
2   -1.743 -1.69     -1.70
3   -1.217 -1.16     -1.17
4   -0.733 -0.68     -0.68
5   -0.338 -0.28     -0.28
6    0.147  0.20      0.20
7    0.593  0.65      0.65
8    1.158  1.21      1.22
9    1.570  1.62      1.64
10   2.091  2.15      2.17
```

TAM item estimates are not zero-centered. TAM Zero column adjusts the TAM item estimates to be zero centered. These are almost the same as Winsteps item estimates, which are zero-centered. The difference is probably due to slightly different implementation of JMLE and the convergence criteria.

The person "measure" in Winsteps is the TAM theta value. The range of theta estimates in TAM & WINSTEPS are

```
  TAM  original    zero   Winsteps
score 0: -4.404   -4.35  -4.35
score 5: -0.070   -0.02  -0.01
score 10: 4.315    4.37  -4.38
```

The TAM Zero column applies the TAM Zero item adjustment to the TAM thetas. The TAM Zero thetas and Winsteps person measures are essentially the same.

So, TAM and Winsteps estimates differ mainly because:

(1) Estimation bias correction: in Winsteps set
STBIAS=Yes

(2) Winsteps zero-centers the items: to zero-center the person thetas:
UPMEAN=0
UEXTREME=Yes

21.127 Teaching Rasch measurement, Rasch analysis_2

Congratulations! Teaching Rasch methodology can be rewarding, but also has its challenges.

You will probably find that your class is imbued with "Classical" ideas. CTT usually starts with data and statistics. Avoid arguing the wrongs and rights of CTT for as long as possible ....

So avoid CTT pitfalls by starting from Rasch first principles with lots of examples and classroom interactions.

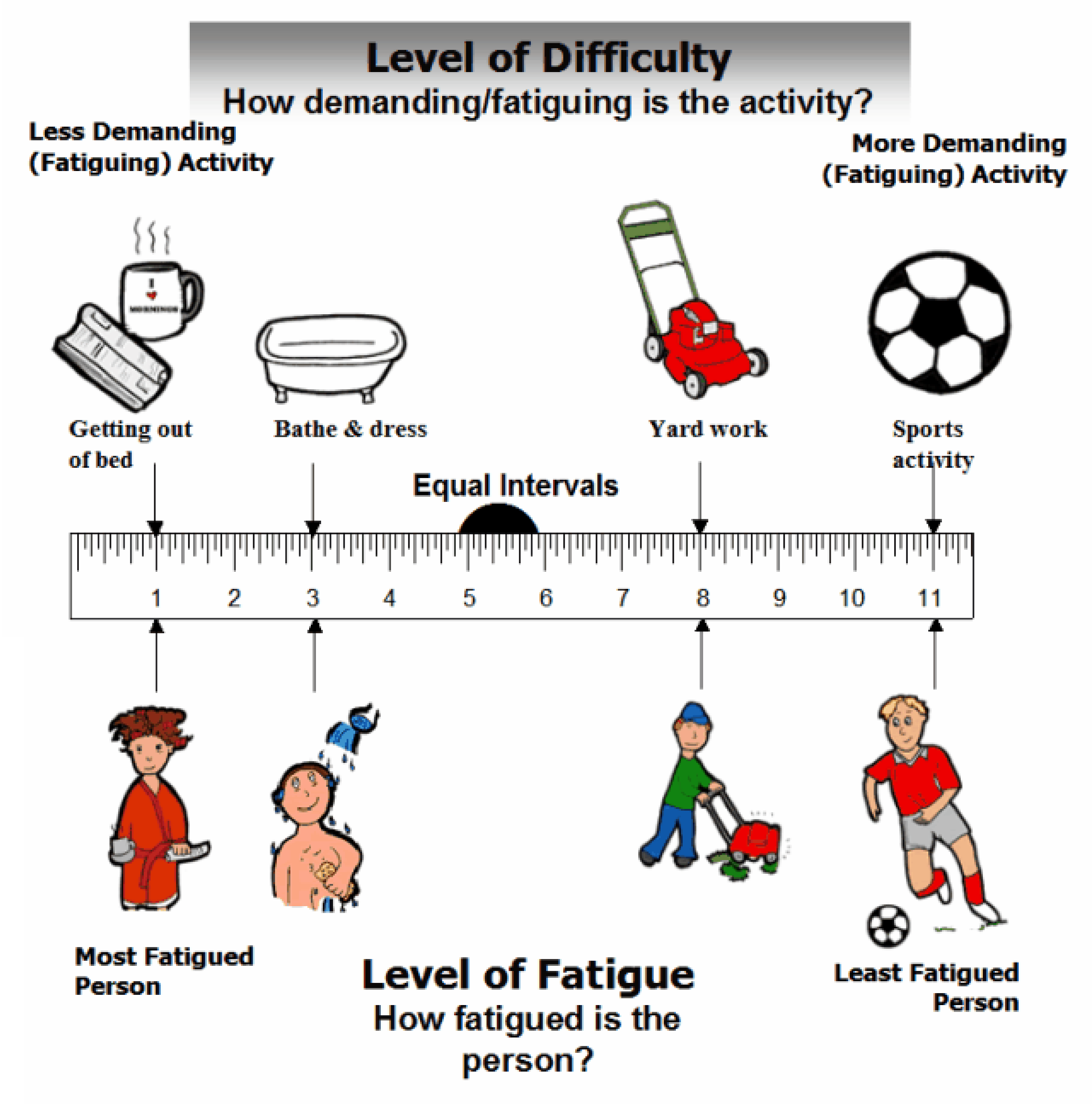


Figure: Measurement map of Fatigue. (Mallinson, 2001)

1. What do we want to measure? Can we express it along a line (latent variable) from less (easy, beginner) to more (hard, expert)?
2. Can we convert this progression into dichotomous items? (relevant items = content validity, item hierarchy = construct validity)
3. How do we expect people of different abilities to respond to these items? (ability ordering = predictive validity)
4. What about people with abilities exactly at, then close to, an item's difficulty? This introduces the idea of probability.
5. We can tell when a person is centered on the dichotomous items when the person's raw score is about 50%
6. Similarly we can tell when an item is close to the mean of the person abilities (thetas) when the frequency (p-value, probability) of success is close to 50%
7. So, based on these probabilities, we can put items and persons on the same "map" of the latent variable based on probabilities: "conjoint measurement". (In my experience, people are amazed at this. They have been taught item analysis and person reporting as separate topics.)
8. Draw a picture of probability (% success) vs. latent variable: logistic ogive -> logits unit of measurement

9. So with these first principles firmly in mind, introduce the Rasch model. Perhaps starting with one of the "Rasch model derived from" in RMT - such as https://www.rasch.org/rmt/rmt62c.htm
10. And now you are off and running ... time to introduce software to do the hard work!
11. If people need to see what is going on "under the hood", there are the Excel worksheets at www.rasch.org/moulton.htm

Mallinson T. (2001) in Linacre J.M. (2005) "Measurement, Meaning and Morality". www.researchgate.net/publication/253231609_Measurement_Meaning_and_Morality

21.128 Testlets

Testlets are groups of locally dependent items, such as the questions about the same topic. Testlets are obvious in theory, but obscure in practice. If the local dependency of all the items is about the same across testlets, then the testlet effect disappears. So, "testlets" are not the problem, the problem is unevenness of local dependency across the testlets. Table 23.99 - inter-item dependency - tends to be too local. It rarely gives us a good picture of dependency within testlets or across testlets.

Suggestion: in each item label, put a testlet code. Then from the individual-item analysis, output Winsteps Table 28 - item subtotals by testlet. Testlets with average item mean-squares much below 1.0 have noticeably greater dependency (of some type) than the other testlets. These testlets would be the obvious candidates to become PCM items. However, there are usually many reasons for local dependency across items within a dataset, so we would want to see the Table 28 findings confirmed by Table 23.1, etc. Each more dependent testlet should also be the dominant feature in a Contrast.

A simple testlet example:
1. Analyze exam1.txt - note down the person measure S.D.
2. choose two items with high local dependency - see Table 23.99
3. create one testlet item (0-1-2) from the two items (0-1)
4. Analyze exam1.txt without the two items and with the testlet item.
The person raw scores must be the same as in 1.
The person measure S.D. must be slightly less than in 1.
The change in person measure S.D. shows the effect of the local dependency on the person measures.

Testlet remediation:
1 combine the testlet's locally dependent items into one polytomous "super" item <- supported by Winsteps
2. the random-effects testlet model i <- not supported by Winsteps

---

How are you conceptualizing the testlets?

A. If the testlets are conceptualized as groups of separate items, then please put a testlet-code in column 1 of the item label. You can then obtain item-level summary statistics in Winsteps using ISUBTOTAL=1 and Table 27. You can also obtain person-by-testlet measures using DPF=1 and Table 31, and person-group-by-testlet using DPF=1, DIF=person group code column and Table 33.

B. If two or more items are highly dependent (so that their residuals are highly correlated in Table 23.99) , then it may be better combine them into one "testlet" item. Testlet Response Theory is technically complex and requires special software, but we can approximate it by combining the dependent items into partial-credit items.

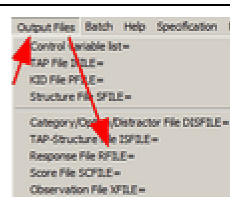
From a Winsteps analysis of the separate items, Output files menu, RFILE= to Excel (with headings). In Excel, sum the separate items into new combined-item columns. Save the Excel file In Winsteps, Excel/RSSST menu, Excel option. Click on the saved Excel file. Select the combined items from the list of Excel columns. Format a Winsteps control and data file. (You can also select the original uncombined items, but will need to weight them zero with

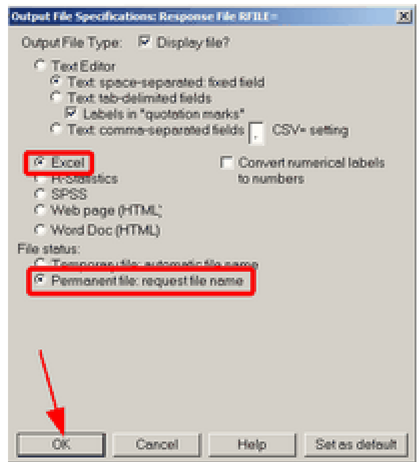
IWEIGHT= in the new analysis.) Analyze the new Winsteps control and data file with ISGROUPS=0 (partial-credit model)

Cross-plot the person measures from the original analysis and the partial credit analysis. Are there any differences? Which analysis produces more meaningful results?

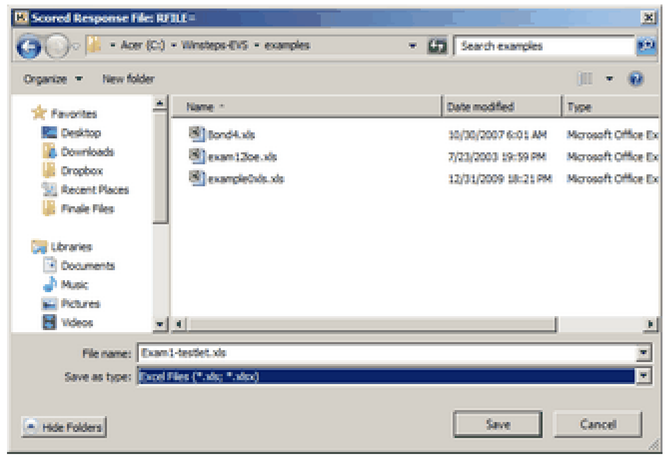
<table>
<tr><th colspan="3">How to combine items into super-items or testlets</th></tr>
<tr><td>1.</td><td>If your data are already in columns in an Excel worksheet, jump to 8.</td><td></td></tr>
<tr><td>2.</td><td>Place your data in a Winsteps control and data file.
Our example is the Knox Cube Test data, exam1.txt</td><td><pre>
; This file is EXAM1.TXT - (";" starts a comment)
 &INST   ; shows this is a control file (optional)
 TITLE='KNOX CUBE TEST' ; Report title
 NAME1=1   ; First column of person label in data file
 ITEM1=11   ; First column of responses in data file
 NI=18   ; Number of items
 CODES=01   ; valid response codes in the data file
 CLFILE=*   ; Labels the observations
 0 wrong   ; 0 in data is "wrong"
 1 Right   ; 1 in data is "right"
 *   ; "*" is the end of a list
 PERSON=KID   ; Person title: KID means "child"
 ITEM=TAP   ; Item title: TAP means "tapping pattern"
 @GENDER=$C9W1   ; Gender indicator in column 9 of data record
 &END   ; Item labels for 18 items follow
1-4   ; tapping pattern of first item: cube 1 then cube 4 are tapped.
2-3
1-2-4
1-3-4
2-1-4
3-4-1
1-4-3-2
1-4-2-3
1-3-2-4
2-4-3-1
1-3-1-2-4
1-3-2-4-3
1-4-3-2-4
1-4-2-3-4-1
1-3-2-4-1-3
1-4-2-3-1-4
1-4-3-1-2-4
4-1-3-4-2-1-4   ; last tapping pattern: 7 actions to remember!
END NAMES   ; END NAMES or END LABELS must come at end of list
Richard M 111111100000000000   ; Here are the 35 person response strings
Tracie F 111111111100000000
Walter M 111111111001000000
</pre></td></tr>
<tr><td>3.</td><td>Launch Winsteps with your control and data file.
Analyze your data
Verify that all is correct</td><td><pre>
 Calculating Fit Statistics
>=======================================<
Standardized Residuals N(0,1) Mean: -.01 S.D.: .85
Time for estimation: 0:0:0.281
 Processing Table 0
KNOX CUBE TEST

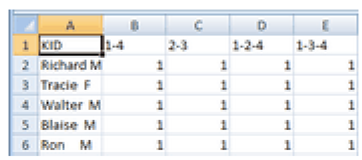
| KID   35 INPUT   35 MEASURED   INFIT   OUTFIT |
| TOTAL   COUNT   MEASURE REALSE   IMNSQ   ZSTD OMNSQ   ZSTD|
| MEAN   9.7   18.0   -.38   1.19   1.02   -.1   .72   -.1|
| S.D.   2.4   .0   2.29   .37   1.00   1.2   1.41   .7|
REAL RMSE   1.24 TRUE SD   1.93 SEPARATION 1.55 KID   RELIABILITY .71
TAP   18 INPUT   18 MEASURED   INFIT   OUTFIT
TOTAL   COUNT   MEASURE REALSE   IMNSQ   ZSTD OMNSQ   ZSTD
MEAN   94.7   175.0   -.95   .67   .99   -.1   .72   -.7
S.D.   69.0   .0   4.92   .63   .29   1.6   .64   1.2
REAL RMSE   .92 TRUE SD   4.83 SEPARATION 5.27 TAP   RELIABILITY .97

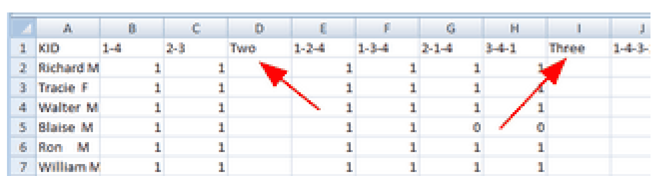
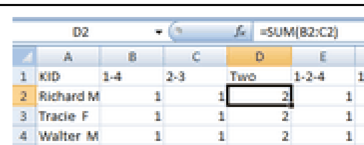
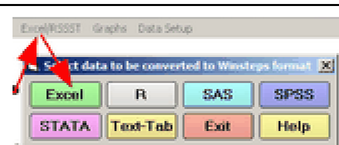
Output written to C:\ANALYSIS\NEW3750\ZOU960WS.TXT
CODES= 01
Measures constructed: use "Diagnosis" and "Output Tables" menus
</pre></td></tr>
<tr><td>4.</td><td>For the scored responses, Output Files menu
RFILE=
or for the original responses, Output Files menu IPMATRIX=</td><td>
</td></tr>
</table>

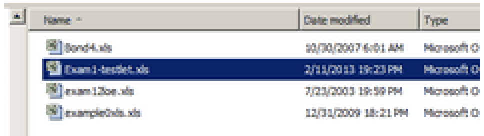
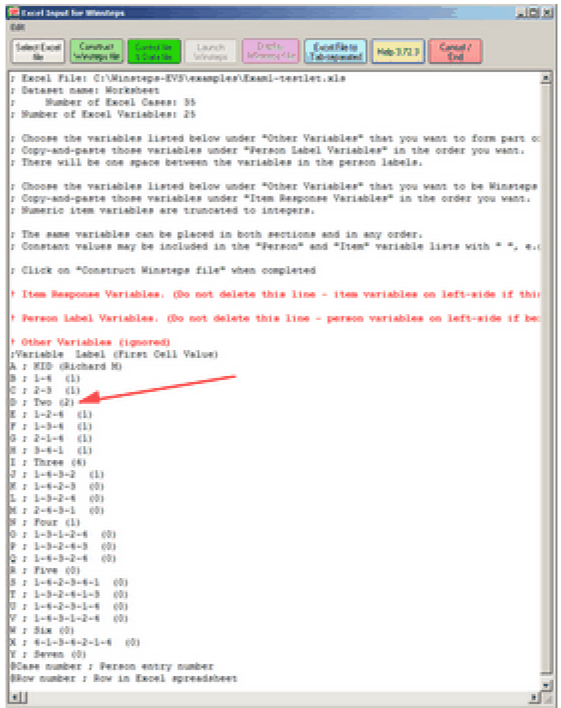
<table>
<tr><td>5.</td><td>Output File dialog box:
Excel
Permanent file
OK</td><td>
</td></tr>
<tr><td>6.</td><td>File name dialog box:
Enter name for testlet Excel file

Our example: Exam1-testlet.xls

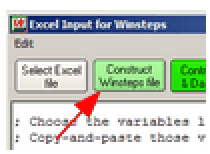
Save</td><td>
</td></tr>
<tr><td>7.</td><td>Excel displays with the data.

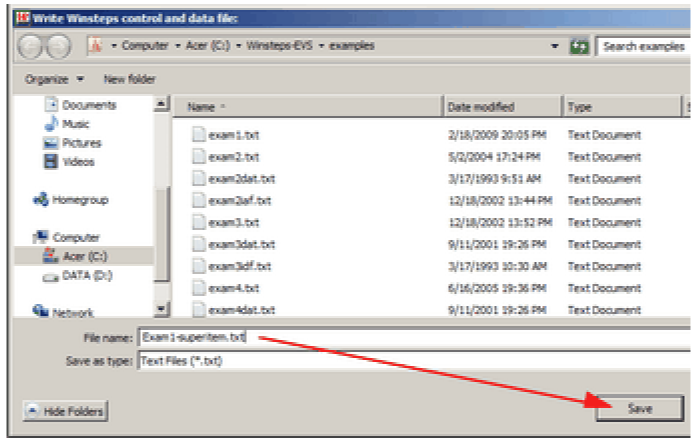
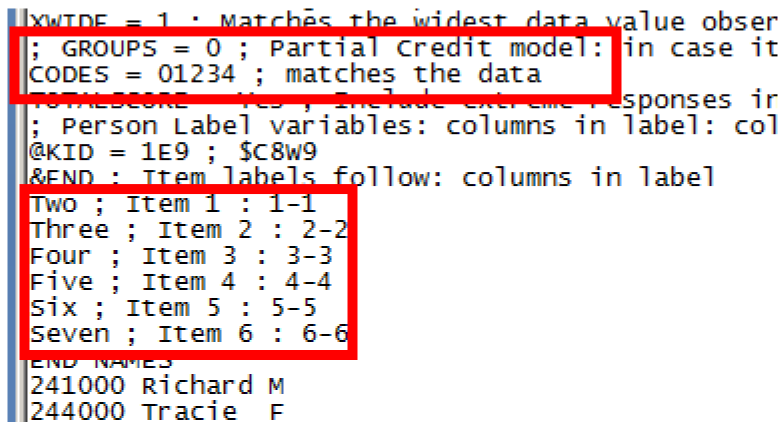
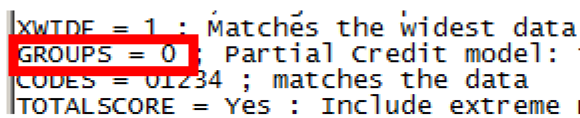
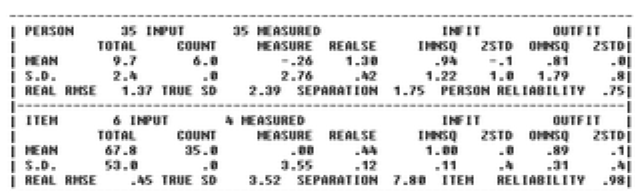
Check that the item labels are in Row 1.</td><td>
</td></tr>
<tr><td>8.</td><td>Insert columns for the testlets, super-items or combined items

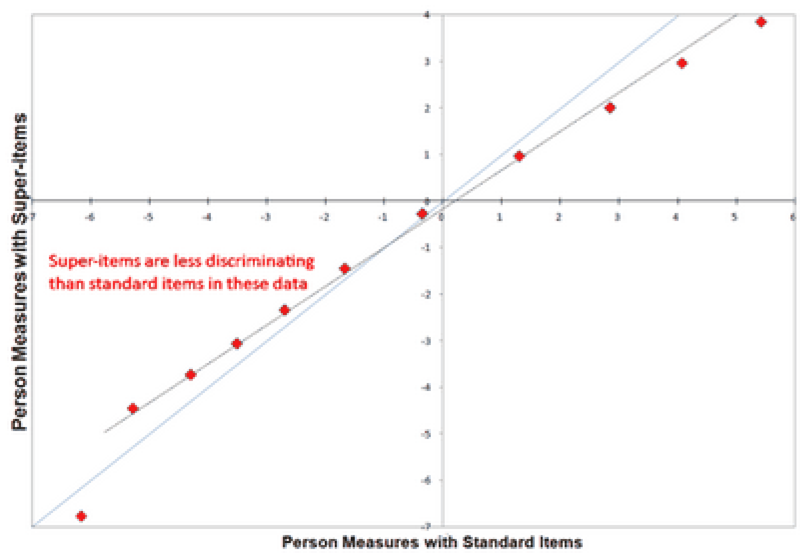
In our example, we will have a super-item item for each length of tapping pattern: Two, Three, ..., Seven</td><td>
</td></tr>
<tr><td>9.</td><td>Sum the responses to the relevant items into the super-item columns</td><td>
</td></tr>
<tr><td>10.</td><td>Save or “Save As” the Excel worksheet</td><td>
</td></tr>
<tr><td>11.</td><td>Winsteps menu bar
Excel/RSSST
Selection box: Excel</td><td>
</td></tr>
</table>

12.	Select the saved Excel worksheet	
13.	The Excel column labels display with the items and super-items	

14.	Copy-and-paste the super-item column labels under “Item Response Variables”
	Other items can be copied, especially if you plan to weight them zero with IWEIGHT=
	Also copy the person column labels under “Person Label Variables”
		`! Item Response Variables.`
		`D ; Two (2)`
		`I ; Three (4)`
		`N ; Four (1)`
		`R ; Five (0)`
		`W ; Six (0)`
		`Y ; Seven (0)`
		`! Person Label Variables.`
		`A ; KID (Richard M)`

15.	Click on “Construct Winsteps File”	

16.	Save the Winsteps control and data file with a suitable name.	
17.	The new Winsteps control and data file displays. It contains the superitems. CODES= contains the scores in the superitems.	
18.	Remove the ; before GROUPS = 0 because we expect each super-item to have its own structure (partial credit model).	
19.	Save the Winsteps control and data file	
20.	Click on “Launch Winsteps”	
21.	The analysis of the super-items is performed	

22.	Appendix: Impact of the super-items on measurement. Output PFILE=pf.txt from the super-item analysis, then in the standard analysis, Scatterplot the person measures against pf.txt In this example, the logit spread of the person measures is less for the super-items than for the standard items. This indicates that there is local dependency among the standard items that comprise each super-item.	
23.	In the plot in 22. all the measures have shifted. The super-items are automatically correctly weighted. However, the mean difficulty of the items changes when separate items are collapsed into super-items. In this situation, either (i) set the mean ability of the persons to be the same in both analyses, UPMEAN=0 ; anchor the mean person ability at 0 logits or (ii) anchor an unchanged item at the same logit difficulty in both analyses, IAFILE=* 1 0 ; anchor item 1 at 0 logits *	

21.129 Theta or B? parameterizing ability

Item Response Theory (IRT) generally uses "theta", θ, to symbolizea person ability distribution. This accords with the prevalent usage of theta in statistics: "In statistics, θ, the lowercase Greek letter 'theta', is the usual name for a (vector of) parameter(s) of some general probability distribution." (Wikipedia).

In principle, Rasch does not parameterize ability as a distribution, but as the property of an individual. The actual distribution of the individual abilities is usually inconsequential. So, in Winsteps documentation, ability is shown as B, usually with an individual's subscript, n, as B_n

21.130 Transferring Winsteps to a new computer

This will probably work for you. Fast and free ...

1. Let's assume Winsteps is installed in folder c:\Winsteps of your old computer. Copy and save this folder and subfolders onto a USB drive.
2. On the new computer: download and install Ministep (free) from https://www.winsteps.com/ministep.htm into c:\Winsteps on your new computer. Check that Ministep runs, then exit from it.
3. Copy c:\Winsteps from the USB drive to c:\Winsteps on your new computer, overwriting any existing files.
4. in c:\Winsteps on your new computer, right-click on Winsteps.exe and create a short-cut on the desktop - also delete Ministep.exe
5. Double-click on the Winsteps desktop short-cut - Winsteps should launch with full functionality.

21.131 t-statistics

Prob. is the two-sided probability of the absolute value of the reported t with the reported d.f., so that a statistically significant finding for a single two-sided t-test is Prob.<.05, and a highly significant finding is Prob.<.01. Please interpret this conservatively, i.e., "barely significant is probably not significant". If you wish to make a Bonferroni multiple-comparison correction, compare this Prob. with your chosen significance level, e.g., $p<.05$, divided by the number of DIF tests in this Table. This is approximate because of dependencies between the statistics underlying the computation.

Many statistical tests are reported as Student's *t* statistics. This table shows the significance-level values for different degrees of freedom (d.f.). Often the reported *t*-statistics have effectively infinite degrees of freedom and so approximate a unit normal distribution. *t*-statistics with infinite degrees of freedom are also called *z*-statistics, paralleling the use of "z" in z-scores.

Table of the two-sided *t* distribution

d.f.	p=.05	p=.01	d.f.	p=.05	p=.01	d.f.	p=.05	p=.01
1	12.71	63.66	11	2.20	3.11	21	2.08	2.83
2	4.30	9.93	12	2.18	3.06	22	2.07	2.82
3	3.18	5.84	13	2.16	3.01	23	2.07	2.81
4	2.78	4.60	14	2.15	2.98	24	2.06	2.80
5	2.57	4.03	15	2.13	2.95	25	2.06	2.79
6	2.45	3.71	16	2.12	2.92	30	2.04	2.75
7	2.37	3.50	17	2.11	2.90	100	1.98	2.63
8	2.31	3.36	18	2.10	2.88	1000	1.96	2.58
9	2.26	3.25	19	2.09	2.86	Infinite	1.96	2.58
10	2.23	3.17	20	2.09	2.85	(z-statistic)		

Quick approximate degrees of freedom for 2-sample t-test: d.f. = size of sample 1 + size of sample 2 - 2

Welch's refinement of Student's *t*-test for possibly unequal variances of two samples:

Two Independent Samples:
For sample 1, M_1 = mean of the sample
SS_1 = sum of squares of observations from the individual sample means
N_1 = sample size (or number of observations)
$SS_1 / (N_1 - 1)$ = sample variance around the mean (or the measure) = S^2_1
Similarly for sample 2.

$t = (M_1 - M_2) / \mathrm{sqrt}\ (S^2_1 + S^2_2)$.
with von Davier (2025) improvement: to Satterthwaite (1946) degrees of freedom:
d.f. = $(S^2_1 + S^2_2)^2 / [\ (1 + 4 / (N_1 + N_2 - 2))\ *\ ((S^2_1)^2 / (N_1+1) + ((S^2_2)^2 / (N_2+1))\ ]$

Two Measures:
Measure 1 = M_1 with standard error SE_1 and N_1 observations. Standard error variance = $EV_1 = SE_1^2$ with N_1-1 d.f.
Measure 2 = M_2 with standard error SE_2 and N_2 observations. Standard error variance = $EV_2 = SE_2^2$ with N_2-1 d.f.

$t = (M_1 - M_2) / \mathrm{sqrt}\ (EV_1 + EV_2) = (M_1 - M_2) / \mathrm{sqrt}\ (SE_1^2 + SE_2^2)$

with von Davier (2025) improvement: to Satterthwaite (1946) degrees of freedom:
d.f. = $(EV_1 + EV_2)^2 / [\ (1 + 4 / (N_1 + N_2 - 2))\ *\ ((EV_1)^2 / (N_1+1) + ((EV_2)^2 / (N_2+1))\ ]$

Satterthwaite, F. E. (1946), "An Approximate Distribution of Estimates of Variance Components.", Biometrics Bulletin 2: 110-114
von Davier, M. (2025). "An Improved Satterthwaite (1941, 1946) Effective df Approximation". Journal of Educational and Behavioral Statistics.- Onliine first.

Welch, B. L. (1947), "The generalization of "Student's" problem when several different population variances are involved.", Biometrika 34: 28-35

Example: Gender subtotals for Example0.txt Table 28:
M_1 = 1.62, M_2 = .76, SE_1 = .38, SE_2 = .16, N_1 = 18, N_2 = 57
Welch: t = 2.09, d.f. = 24, p = .049

21.132 Unidimensionality

See Multidimensionality

21.133 Unobserved and dropped categories

If you have data in which a category is not observed, then you must make an assertion about the unobserved category. There are several options:

For intermediate categories: either
(a) this category will never be observed (this is called a "structural zero"). Generally, these categories are collapsed or recoded out of the rating scale hierarchy. This happens automatically with STKEEP=No.
or (b) this category didn't happen to be observed this time (an "incidental" or "sampling" zero). These categories can be maintained in the rating scale hierarchy (using STKEEP=Yes), but are estimated to be observed with a probability of zero.

1. Dummy data

For extreme categories:
(a) if this category will never be observed, the rating scale is analyzed as a shorter scale. This is the Winsteps standard.
(b) if this category may be observed, then introduce a dummy record into the data set which includes the unobserved extreme category, and also extreme categories for all other items except the easiest (or hardest) item. This forces the rare category into the category hierarchy.
(c) If an extreme (top or bottom) category is only observed for persons with extreme scores, then that category will be dropped from the rating (or partial credit) scales. This can lead to apparently paradoxical or incomplete results. This is particularly noticeable with ISGROUPS=0. Again, dummy data solves this.

In order to account for unobserved extreme categories, a dummy data record needs to be introduced. If there is a dropped bottom category, then append to the data file a person data record which has bottom categories for all items except the easiest, or if the easiest item is in question, except for the second easiest.

If there is a dropped top category, then append to the data file a person data record which has top categories for all items except the most difficult, or if the most difficult item is in question, except for the second most difficult.

This extra person record will have very little impact on the relative measures of the non-extreme persons, , especially if you give it a very small weight with PWEIGHT=, but will make all categories of all items active in the measurement process.

If it is required to produce person statistics omitting the dummy record, then at the Specification Menu use PDELETE= or PSELECT= to omit it, and regenerate Table 3.

See also Null or unobserved categories: structural and incidental zeroes

Example: when the "Liking for Science" data, example0.txt, are analyzed with the Partial Credit Model, ISGROUPS=0, item 18, "Go on a Picnic", does not have the bottom 0 category of the 3-category 0-1-2 rating scale. The next easiest item is item 19, "Go to the zoo", so add a dummy data record looking like, to which you can give a very small influence by using PWEIGHT= with a small value.

```
*****************01***** Dummy data (0 for item 18, 1 for item 19)
```

Example 2: Item 1 has no category 0 in this dataset, but the category should exist.

Title="test"
Codes=012

```
Isgroups=0 ; each item has its own rating-scale
NI=3
Item1=1
Name1=1
Pweight=*
4 0.01  ; small weight for dummy person 4 - adjust this weight if 0 for item 4 is too far away
*
&END
END LABELS
211  Person 1
122  Person 2
100  Person 3
011  Dummy person 4 because there was no 0 for item 1
```

2. Forced category range

Another approach is to specify the unobserved categories with ISRANGE=, and then model all the categories with a polynomial function: SFUNCTION=.

3. Anchored thresholds

Using SAFILE=, reasonable threshold values can be applied to the item so that thresholds for unobserved categories do not need to be estimated.

21.134 User-friendly rescaling: zero point and unit

Winsteps sets the zero point (local origin) at the mean item difficulty (including extreme items if UEXTREME=Yes). The unit of measurement is the logit. Changing the zero point and transforming logits into other units can be done with UIMEAN=, UPMEAN=, USCALE=. These transformed measurements can be more meaningful for particular applications, see Chapter 8 of BTD. Anchor values are treated according to UASCALE=

Table 20.1 suggests values for UIMEAN= and USCALE= which produce a more friendly range of measures.
The USCALE= Calculator in the Help menu can do many of the computations in these examples:

Example 0: we observe the (current mean) and (current S.D.) of a set of measures. We want (desired mean) and (desired S.D.) then
new USCALE = (current USCALE=) *(desired S.D.) / (current S.D.)
new UIMEAN = desired mean - (current mean - current UIMEAN=)*(new USCALE=) / (current USCALE=)

we observe the (current high) and (current low). We want (desired high) and (desired low) then
new USCALE = (current USCALE=) *(desired high-desired low)) / (current high-current low)
new UIMEAN = desired mean - (current mean - current UIMEAN=)*(new USCALE=) / (current USCALE=)

Example 1: CHIPs are a useful transformation, in which 1 logit = 4.55 CHIPs. In this user-scaling system, standard errors tend to be about 1 CHIP in size. The recommended control variable settings are:
USCALE = 4.55
UIMEAN = 50
UDECIM = 1
MRANGE = 50

The probability structure of this relationship is:

```
 Probability of Success
  Difference between Person Ability Measure and Item Difficulty Measure in CHIPs
 .10 -10
 .25 -5
 .50 0
 .75 5
```

.90 10

Example 2: WITs are one tenth the size of CHIPs, enabling the elimination of decimals from your output tables.
USCALE = 45.5
UIMEAN = 500
UDECIM = 0
MRANGE = 500

Example 3: You want the lowest reportable person measure to be 0 and the highest to be 100. Looking at Table 20, you see the extreme values are -4.53 and +5.72. You have not used USCALE= and UIMEAN=, so the current values are USCALE=1, UIMEAN=0.

Therefore,
"wanted low" person measure = 0
"wanted high" person measure = 100
"wanted range" = "wanted high" - "wanted low" = 100 - 0 = 100

"current low" person measure = -4.53
"current high" person measure = 5.72
"current range" = "current high" - "current low" = 5.72 - -4.53 = 10.25

USCALE= (wanted range) / (current range) = 100 / 10.25 = 9.76

UIMEAN= (wanted low) - (current low * USCALE) = 0 - (-4.53 * 9.76) = 44.20

Required values are:
USCALE = 9.76
UIMEAN = 44.20
UDECIM = 0 to show no decimal places in report

Double checking, when previous values are UIMEAN=0, USCALE=1:
low value = (current low)*(USCALE=) + (UIMEAN=) = (-4.53 * 9.76) + 44.20 = -0.01 = 0
high value = (current high)*(USCALE=) + (UIMEAN=) = (5.72 * 9.76) + 44.20 = 100.02 - 100

Example 4: You want the lowest reportable person measure to be 0 and the highest to be 100. Looking at Table 20, you see the extreme values are -4.53 and +5.72. The current values are USCALE=2, UIMEAN=1.5

Therefore,
"wanted low" person measure = 0
"wanted high" person measure = 100
"wanted range" = "wanted high" - "wanted low" = 100 - 0 = 100

"current low" person measure = -4.53
"current high" person measure = 5.72
"current range" = "current high" - "current low" = 5.72 - -4.53 = 10.25

"current UIMEAN" = 1.5
"current USCALE" = 2

USCALE= [(wanted range) / (current range)]/(current USCALE) = [100 / 10.25]/2 = 9.76/2 = 4.88

UIMEAN= (wanted low) - [(current low-current UIMEAN) * USCALE] = 0 - [(-4.53-1.5) * 9.76] = 58.85

Required values are:
USCALE = 4.88
UIMEAN = 58.85
UDECIM = 0 to show no decimal places in report

Double checking is most easily done by looking at the new Table 20.

Example 5: You want the lowest reportable person measure to be 100 and the highest to be 900. Looking at Table 20, you see the extreme values are -4.53 and +5.72. Looking at the second page of output, you see the current values are USCALE=1 and UMEAN=0.

USCALE= (previous USCALE=) * (wanted range: 900 - 100) / (reported range: 5.72 - -4.53) = 1 * 800 / 10.25 = 78.05
UMEAN= (wanted low) - (reported low - previous UMEAN=)*(wanted range)/(reported range) = 100 - (-4.53 - 0)*800/10.25 = 453.56
UDECIM = 0 to show no decimal places in report

Example 6: You want norm-referenced user-scaling, such that the person mean is 0.0, and the person standard deviation is 1.0.

In a standard analysis, set:
UDECIM=4
USCALE=1
UMEAN=0

Look at Table 18

```
+-----------------------------
|ENTRY    RAW
|NUMBER  SCORE  COUNT  MEASURE
|-----------------------------
| MEAN     6.7   14.0   -.3728
| P.SD     2.4     .0   2.2202
+-----------------------------
```

Set (either in a new analysis, or using the "Specification" pull-down menu
USCALE = 1/person S.D. = 1/2.2202 = 0.4504
UMEAN = - person mean/person S.D. = - (-.3728)/2.2202 = 0.1679
Look at Table 18

```
+-----------------------------
|ENTRY    RAW
|NUMBER  SCORE  COUNT  MEASURE
|-----------------------------
| MEAN     6.7   14.0    .0000
| P.SD     2.4     .0   1.0000
+-----------------------------
```

Example 7: You want to give your pass-fail point the value 400 and 100 to the lowest reported measure. Inspecting your output you see that the pass-fail point is at 1.5 logits, and that -3.3 logits is the lowest reported measure.
Then 400-100 new units = 1.5 - (-3.3) logits, so
USCALE = 300 / 4.8 = 62.5
UMEAN = 400 - (1.5) * 62.5 = 306.25
Then: 1.5 logits = 306.25 + 1.5*62.5 = 400
-3.3 logits = 306.25 - 3.3*62.5 = 100

Example 8: Form 1 and Form 2 are obtained from an item bank. We rescale Form 1 and want to apply the same rescaling to Form 2.

Do the Form 1 analysis:
UASCALE= is the scaling of the item bank scale (1 if logits)
IAFILE= is the list of bank item difficulties for Form 1
No UIMEAN=, UPMEAN=, UMEAN= or USCALE= command.

We rescale Form 1 to have its own scale setting UIMEAN= and USCALE= with the scaling calculator.
Note down the values or list them with the Control Variable list from the Output Files menu.

In the Form 2 control file:
UASCALE= is the scaling of the item bank scale (1 if logits)
IAFILE= is the list of bank item difficulties for Form 2

No UIMEAN, UPMEAN or UMEAN command.

In the Form 2 control file, add these commands:
TFILE=*
; these are actioned after the analysis, at the beginning of the reporting
14.1 ; this will report the bank item anchor values as a check
3.1 ; summary statistics
UIMEAN= value from Form 1 ; the values used for the analysis are rescaled
USCALE= value from Form 1
14.1 ; rescaled items
3.1 ; summary statistics
18.1 ; rescaled persons
*

You can add these to an analysis of the Form 1 data to check that it works.

Do the analysis of Form 2.

21.135 Using a word processor or text editor

If you don't like NotePad, then change word processor

a) Input files: all lines in your control and data files follow DOS text conventions. This means that files created with a Word Processor, such as "Word Perfect", must be saved as "DOS-text with line breaks" or "ASCII" files.

1. Lines must not contain tabs or word processor codes.
2. Lines cannot overflow onto the next line, except for data records which are processed using the FORMAT= or MFORMS= control variables.
3. Lines must end with DOS or ASCII Carriage Return and Line Feed codes.

Be particularly careful to instruct your Word Processor to allow more characters within each line than are present in the longest line in your control or data files. Then your Word Processor will not break long data or control lines into two or more text lines with "Soft Return" codes. These cause Winsteps to malfunction. Space for a large number of characters per line is obtained by specifying a very wide paper size and/or a very small type size to your Word Processor.

When using "Word Perfect" to edit control or data files, select the smallest available type size (often 20 cpi or 5 pt). Define and use a very wide (50 inch) page style. It does not matter whether your printer can actually print it. Always save control and data files as "DOS-text with line breaks" or ASCII files.

With WordStar, use "Non-Document" mode to avoid these difficulties.

b) Output files: when importing Winsteps output into a document file, the following options have proved useful:

Base Font - 17 cpi (or more) or 8 point (or smaller) or 132 characters per line (or more)
Left Justify
Page numbering
Margins: top = 1", bottom = 0.5", left = 1", right = 0"

If your plot looks like this, please change the font in your text editor to "fixed width": Courier New, Consolas, Lucida Console

```
  -4   -3   -2   -1    0    1    2    3    4    5
  -+------+------+------+------+------+------+------+------+------+- COUNT  CLUSTER
.8 +                |                         +
  |                |        A B               | 2     1
.7 +                |                         +
  |                |                       |
.6 +                |          C              + 1     1
```

becomes

```
     -4      -3      -2      -1       0       1       2       3       4       5
     -+-------+-------+-------+-------+-------+-------+-------+-------+-------+- COUNT   CLUSTER
  .8 +                                |                                       +
     |                                |             A  B                      | 2       1
```

```
 .7 +                                    |                            +
    |                                    |                            |
 .6 +                                    |              C             + 1      1
```

21.136 UTF-8 Chinese character set

Multibyte UTF-8 codes (Chinese) are allowed in person and item labels..Winsteps control variables are ASCII characters.

Excel/RSSST menu:
Your data in an Excel worksheet:

È	Item 2	Item3	Name
1	1	0	管理和社会发展
1	0	1	中英文均可
0	1	0	及时通过邮箱投递

Copy your data to a text-tab file if Excel fails, then use text-tab on the Excel/RSSST menu.

```
È  Item 2  Item3   Name
1  1   0   管理和社会发展
1  0   1   中英文均可
0  1   0   及时通过邮箱投递
```

In conversion window:

```
! Other Variables (ignored)
;Variable  Label (First Active Cell Value)
1   Ãˆ ; 1
2   Item 2 ; 1
3   Item3 ; 0
4   Name ; ç®¡ç†å’Œç¤¾ä¼šå‘å±•
@Case number ; Person entry number
@Row number ; Row in Text file
```

ignore this

Winsteps control file:

```
&INST
.......
&END ; Item labels follow
Item 1 ; Item 1 : 1-1
Item 2 ; Item 2 : 2-2
Item 3 ; Item 3 : 3-3
END NAMES
110 管理和社会发展
101 中英文均可
010 及时通过邮箱投递
```

Winsteps output table:

```
-------------------------------
|ENTRY   TOTAL|
|NUMBER  SCORE| PERSON
|-------------+----------------
|      1     2| 管理和社会发展
|      2     2| 中英文均可
|      3     1| 及时通过邮箱投递
```

UTF8CODE= substitutes for multibyte characters to maintain the spacing. Here, UTF8CODE= ~

```
-----------------------------------------------
| DATA | ITEM                 | PERSON
|------+----------------------+------------------
|    2 | ~~~~~~~~             | 馬蒔撰
|    0 | Item 1 ~~~           | 馬蒔撰
|    1 | Item 2 ~~~~~~        | 及时通过邮箱投递
```

21.137 Validity investigation

Question: I really want to you to help me in a simple explanation understand how in practice can I go about collecting validity evidences via Rasch Analysis with Winsteps to support use and inference of my test?

Answer: There are many types of validity described in the literature, but they summarize to two main topics:
1. Content validity: does the test measure what it is intended to measure? Content validity is determined by content experts. If a panel of experts is used, then Winsteps can be used to analyze their content-relevance ratings of each item - a more sophisticated approach than Lawshe, Charles H. (1975). "A Quantitative Approach to Content Validity".

2. Construct validity: does the hierarchy of item difficulties accord with the construct theory underlying the items? For instance, are the "division" items harder than the "addition" items in general?

3. Predictive validity: does the test produce measures which correspond to what we know about the persons? Do children in higher grades have higher measures (thetas)?

Investigation of these validities is performed directly by inspection of the results of the analysis (Rasch or Classical or ...), or indirectly through correlations of the Rasch measures (or raw scores, etc.) with other numbers which are thought to be good indicators of what we want.

Question: That is what exactly type of validity questions should I ask and how can I answer them using Rasch analysis?

Answer: 1. Construct validity: we need a "construct theory" (i.e., some idea about our latent variable) - we need to state explicitly, before we do our analysis, what will be a more-difficult item, and what will be a less-difficult item.
Certainly we can all do that with arithmetic items: 2+2=? is easy. 567856+97765=? is hard.
If the Table 1 item map agrees with your statement. Then the test has "construct validity". It is measuring what you intended to measure.
2. Predictive validity: we need to we need to state explicitly, before we do our analysis, what will be a the characteristics of a person with a higher measure, and what will be the characteristics of a person with a lower measure. And preferably code these into the person labels in our Winsteps control file.
For arithmetic, we expect older children, children in higher grades, children with better nutrition, children with fewer developmental or discipline problems, etc. to have higher measures. And the reverse for lower measures.
If the Table 1 person map agrees with your statement. Then the test has "predictive validity". It is "predicting" what we expected it to predict. (In statistics, "predict" doesn't mean "predict the future", "predict" means predict some numbers obtained by other means.

Question: More specifically, in using, for example, DIF analysis via Winsteps what type of validity question I am trying to answer?

Answer: 1. Construct validity: DIF implies that the item difficulty is different for different groups. The meaning of the construct has changed! Perhaps the differences are too small to matter. Perhaps omitting the DIF item will solve the problem. Perhaps making the DIF item into two items will solve the problem.
For instance, questions about "snow" change their difficulty. In polar countries they are easy. In tropical countries they are difficult. When we discover this DIF, we would define this as two different items, and so maintain the integrity of the "weather-knowledge" construct.
2. Predictive validity: DIF implies that the predictions made for one group of persons, based on their measures, differs from the predictions made for another group. Do the differences matter? Do we need separate measurement systems? ...

Question: Similarly, in using Fit statistics, dimensionality, and order of item difficulty what type of validity questions I am attempting to answer via Winsteps?

Answer: They are the same questions every time. Construct Validity and Predictive Validity. Is there a threat to validity? Is it big enough to matter in a practical way? What is the most effective way of lessening or eliminating the threat?

Question: I used the numbers in my Winsteps output to prove the Validity of my instrument, but a reviewer says that is not enough.

Answer: Your Validity seems to be relating only to statistical validity. Generally speaking this is of lower concern than:

1. Construct/Content validity - is the instrument measuring what it is intended to measure: e.g., Are these arithmetic items? Does their difficulty order agree with the construct theory about which arithmetic items are easier (one digit addition) and which are harder (long division)? You may need a content expert to assist with this.
2. Predictive validity - do the measures make sense with our experience of people whom we perceive to have more and less of what we intend to measure? For instance, with increasing elementary-school grade-levels do person (children) measures (thetas) increase on average? We may tie this to the results of another accepted instrument = concurrent validity.
3. If we satisfy (1) and (2), we can then proceed to the type of fine-tuning that you are discussing: Statistical validity
Are there off-dimensional, ambiguous, duplicative, etc., items that should be dropped or rewritten?
Are there items that have DIF, e.g., gender DIF: an arithmetic item that references cooking or carpentry?
Then we need to decide how many levels of competence the instrument is intended to detect. This ties in with the Test (=Person Sample) reliability. If we only need to separate high performers from low performers, then a reliability of 0.8 is enough. High-middle-low we need 0.9. More levels we need to go further toward 1.0.

21.138 Videos and Tutorials

There are Winsteps tutorials at www.winsteps.com/tutorials.htm

Youtube has over 70 Rasch-related videos at www.youtube.com

21.139 Weighting items and persons

There are circumstances in which certain items are to be given more influence in constructing the measures than others. For instance, certain items may be considered critical to the demonstration of competence. Though Winsteps supports several methods, IWEIGHT= is simplest for items, and PWEIGHT= for persons. Another approach is to replicate the data for particular items. This can be done with FORMAT= without changing the data file. Items can also be rescored from say, 0-1 to 0-2, but this makes variable maps difficult to interpret.

Unweighted and Weighted analysis: unweighted data is preferable for calibrating the Rasch items. This is because each observation is modeled to contribute one unit of independent statistical information. The effect of weighting is to distort the distribution of independent statistical information in the data. A practical approach is:

Step 1. Analyze the data without weighting. Investigate misfit, construct validity, etc.

Step 2. Weight the items. Compare the item calibrations with weighted and unweighted data to identify where there are discrepancies.

The true reliability of the measures is from the unweighted analysis. Weighting introduces an arbitrariness into the analysis. One solution is to adjust the weights to maintain the unweighted reliability = Ru. The reliability of the weighted analysis, using an initial set of weights, = Rw. We can then scale the weights using the Spearman-Brown Prophecy Formula: S = Ru * (1-Rw) / ((1-Ru)*Rw)). Multiply the initial set of weights by S. Then the weighted and unweighted reliabilities should be the same.

Standard errors and fit statistics: The weights applied to items or persons are used in computing the measure estimates, standard errors and fit statistics. When using significance tests with weighting, normalize the weights so that the total amount of independent statistical information in the data is not over- or under-inflated, i.e., when using PWEIGHT= with an observed sample size of N, multiply all PWEIGHT= values by N / (sum of all weights).

The standard is weights = 1.

When an item or person is weighted as 2, then the expected score and observed score for the item or person is doubled..

When an item or person is weighted as 0, then that person does not influence the JMLE estimates, standard errors or fit statistics of other persons and items, but does have measure, standard error and fit statistics computed on all observations for itself. This is useful for evaluating pilot or off-dimensional items, or measuring idiosyncratic persons.

Estimation with weighting

Estimation Method	Raw score with weighting	Estimated when

JMLE	Person raw score = observations * IWEIGHT Item raw score = observations * PWEIGHT	Item and Person: Expected score = raw score
CMLE	For item estimation: Person raw score = observations with PWEIGHT= occurrences (IWEIGHT= ignored) † For item estimation: Item raw score = observations*PWEIGHT For person estimation: Person raw score = observations * IWEIGHT	Item: Expected score = raw score Person (AMLE):: Expected score = raw score

† all items are weighted 1 for CMLE item estimation, so that the conditional person scores are convenient integers. 0-weighted items (pilot items) are also weighted 1. But for CMLE-based person estimates (AMLE), item weighting applies, so 0-weighted items are ignored for person estimation.

Observation = Xni
Expected value (computed using the Rasch model) = Eni
Accumulated raw score = Accumulated raw score = Xni * IWEIGHT * PWEIGHT
Accumulated expected score = Accumulated expected score = Eni * IWEIGHT * PWEIGHT
Accumulated marginal count for item = Accumulated marginal count for item + IWEIGHT * PWEIGHT
Accumulated marginal count for person = Accumulated marginal count for person + IWEIGHT * PWEIGHT

Special rules apply when IWEIGHT=0 or PWEIGHT=0.
IWEIGHT=0 the item totals are incremented by PWEIGHT. The person totals are not incremented.
PWEIGHT=0 the person totals are incremented by IWEIGHT. The item totals are not incremented.

JMLE Estimation Accumulated expected score (for each person and each item) = Accumulated raw score (for each person and each item).

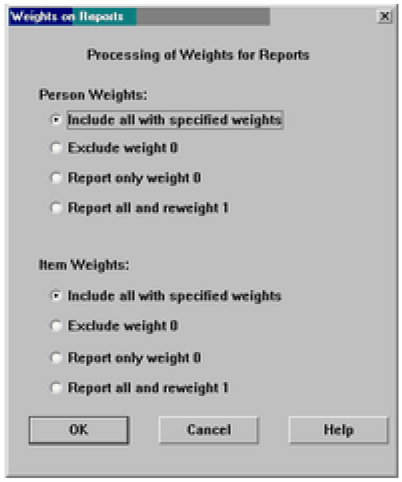
Weight Selection for Tables 23 and 24: On the output tables menu, these are the options for persons and/or items. When IWEIGHT= or PWEIGHT= are used in estimation, reports can be adjusted to reflect those weights or not. Weights of zero are useful for pilot items, variant items or persons with unusual characteristics. These can be reported exclusively or excluded from reports.

(1) all items or persons are reported, with their weights (the standard). Tables 23 and 24 are computed as though all weights are 1.

(2) items or persons with a weight of 0 are excluded from the reporting. Tables 23 and 24 are computed as though all weights are 1, but zero weights are omitted.

(3) only items or persons with a weight of 0 are reported. Tables 23 and 24 are computed only from items or persons with a weight of 0.

(4) all items or persons are reported as though they have a weight of 1.



Example 1: MCQ items are scored 0-1. CR items are scored 0-0.5-1. How can we combine them in one Winsteps analysis.

Approach A (recommended). Double the scores of the CR items to 0-1-2, and then IWEIGHT= them by 0.5.

Approach B (not recommended). Double the scores of the MCQ items to 0-(1)-2, and double the scores of the CR items to 0-1-2. IWEIGHT= them all by 0.5. This gives the MCQ items a rating scale in which the middle category is not observed, making their ICCs steeper.

Example 2: What is the cut-score in a weighted analysis corresponding to a cut-score in an unweighted analysis?

Here is an approach:
1. In the unweighted analysis, identify the logit value of the cut-score. Save the person measures to Excel.
2. In the weighted analysis, save the person measures to Excel.
3. Cross-plot the weighted person measures (y-axis) against the unweighted person measures (x-axis)
4. Use the Excel "trend line" function to obtain a reasonable curve through the person-measure points.
5. Identify the value on the y-axis (weighted cut-score measure) corresponding to the value on the x-axis of the unweighted cut-score measure.

21.140 Winsteps modules

Modules installed with Winsteps / Ministep

Winsteps / Ministep Module	64-bit	32-bit
Installation	WinstepsPasswordInstall...exe MinistepInstall.exe	WinstepsInstall32.exe (included in 64-bit install)
Analysis	Winsteps.exe / Ministep.exe Windows 11, 10, 8, 7, Vista includes features since 4.8.2	Winsteps 4.8.2 available for Windows XP and later
Bar Charts	Winstbar64.exe	Winstbar.exe, Winstbar1.dll, Winstbar2.dll
Check SPSS status	WinSPSScheck64.exe checks for SPSSIO64.dll	WinSPSScheck.exe checks for SPSSIO32.dll
Data setup	windata64.exe	windata.exe
Help support	(built-in)	KeyHH.exe
Input formatter for Excel/RSSST	wininput64.exe uses R Statistics interface	wininput.exe uses Excel, SPSSIO32.dll and SAS Local Provider

Output to Excel plots	winexcel64.exe, winexcel.dat uses Excel	winexcel.exe uses Excel
Output to R Statistics plots and reports	installation of R Statistics required	installation of R Statistics required
Output to SPSS .sav files	winspssg64.exe	winspssg.exe
Probability graphs	Winxojog.exe	winvbexe.exe, winvbebr.exe
Software support	Windows / Xojo .dll, .png	Windows / VB6 .dll, .ocx
SPSS interface	spssio64.hld / spssio64.dll	spssio32.hld / spssio32.dll
Bongo sound	winsteps.mid	
Demonstration files	example files: .txt, .xls. ...	
Fonts	font files: .ttf	
Help file	winsteps.chm	
Javascript for sortable table	winsteps.js	
R Statistics interface	winsteps-zero.dat	

21.141 Winsteps: history and "steps"

What is the origin of Winsteps and to what does "steps" refer?

Winsteps is an outcome of this process of development:

In 1983, Benjamin D. "Ben" Wright of the University of Chicago and John "Mike" Linacre released the first Rasch analysis program for personal computers (IBM PCs). It was also the first Rasch program to allow missing data. It was called Microscale, "Rasch scaling by microcomputer". Since MS-DOS was limited to 8-character program names, the actual execution name was "MSCALE".

1987: Mscale (dichotomies and Andrich rating scales) + Msteps (for partial credit "steps"). Ben implemented the Microscale algorithm on a Unix minicomputer using his own staff, but kept the PC execution name, "Mscale".

1989: Bigscale (back to PCs). Again under MS-DOS but with much larger datasets. Mike takes over software development again.

1991: Bigsteps (the functionality of Msteps was included in Bigscale). Ben interpreted this to mean "big steps forward in social science measurement"

1998: Winsteps (Windows-native Bigsteps). Ben interpreted this to mean "winning steps forward in social science measurement".

1999: The University of Chicago ejected Winsteps from its computers for "encouraging gambling". They seemed to be unaware that probability theory originated in gambling. Winsteps.com was launched as a separate endeavor under the direction of Mike Linacre.

2001: Ben Wright was incapacitated. Winsteps became an independent activity of Mike Linacre.

For developments since 2001, see www.winsteps.com/wingood.htm

When talking about Rasch measurement, Ben Wright used "**step**" to mean:

(a) the category number counting up from 0 at the bottom. The bottom step, for dichotomies or polytomies, was the lowest category, always numbered 0. Ben would talk about going up and down the steps as one moved up and down the latent variable.

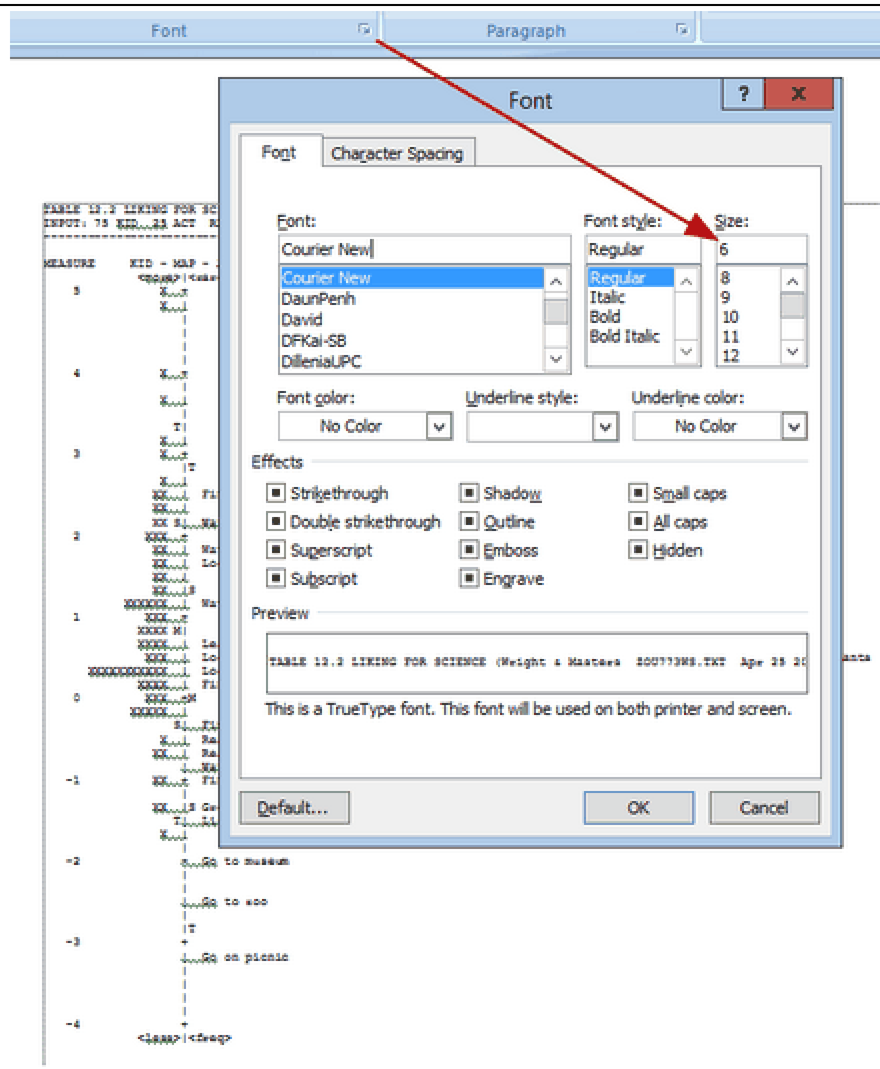
(b) the location of the transition from one category to the next higher category on the latent variable. Now called the Rasch-Andrich threshold for polytomies and the item difficulty for dichotomies.

(c) the process of moving from one category to the next as one's amount of the latent variable changes. A low negative threshold below a category indicates that the category is easy to step into as one moves up the latent variable. A high positive threshold below a category indicates a category that is hard to step into. So "disordered" thresholds around a category (high below, low above) indicate a category that is "hard to step into and easy to step out of" as one moves up the latent variable, i.e., a narrow category. The extreme of this is an infinitely-narrow, i.e., unobserved, category. It is infinitely hard to step into and infinitely easy to step out of.

21.142 Wright maps in Word, Excel, R, Notepad++

WrightMap map in R: see Plots menu.

Transferring the item map to a Microsoft Word document:
As a Word document: Output the item map as a Word document using Winsteps specification ASCII=D.
As text, copied into Word (also works for Notepad++): Adjust the size of the map using Winsteps specifications LINELENGTH=, MRANGE=, MAXPAGE= As text: Copy-and-paste the map into the .doc file. In the .doc file, 1. copy-and-paste from Notepad to Word. 2. Select all (ctrl+a) in Word 3. Change font to **`Courier New`** or another fixed-space font, such as `Consolas`, `Lucida Console`, `Andale Mono`. 4. If the lines wrap, then 4a. change page orientation to "Landscape" 4b. smaller point size (you can type in point-sizes smaller than on the pull-down list): "6" works well.



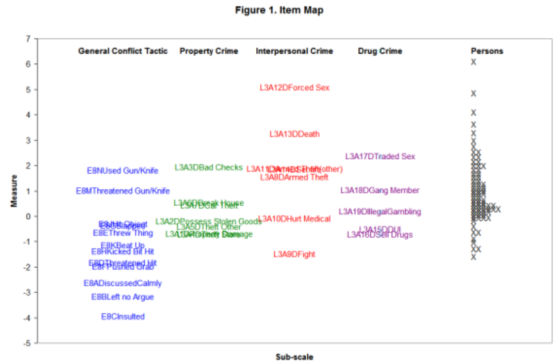
5. Item maps can be combined in Word (or Notepad++) using rectangular-copy, alt+mouse.
6. Item maps can be rotated in Microsoft Word with:
   Alt-F11 to launch VBA
   In VBA Immediate Window:
   Selection.Orientation = wdTextOrientationVerticalFarEast (press Enter key)

As a picture:
Display the .txt file on your screen. Press your PrintScreen key to copy a picture of the .txt file on your screen into the Windows clipboard. Paste into your Word document. Format the picture.

As a webpage:
Output the item map as a webpage using Winsteps specification ASCII=W. Copy-and-paste the item map into your Word document.

Item Map in Excel

1. We want to produce this Excel Chart (or close approximation)



2. from this Excel worksheet.

Constructed with:

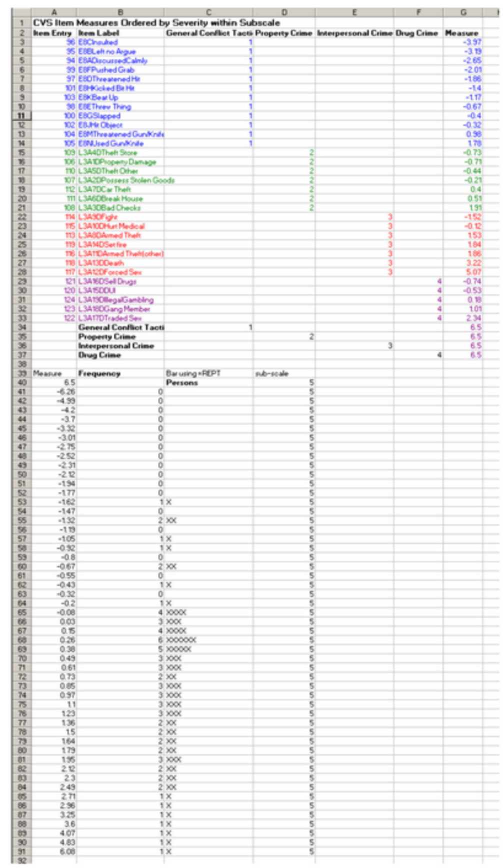
1. x-axis column is the sub-scale number for each item

2 y-axis column is the item measure from IFILE= output to an Excel file.

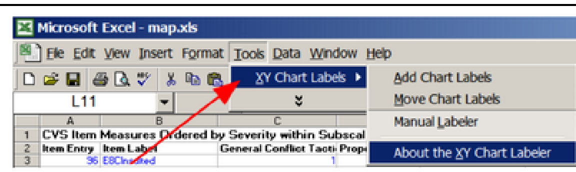
3 put in headings with x and y coordinates to place at the top or bottom of the columns

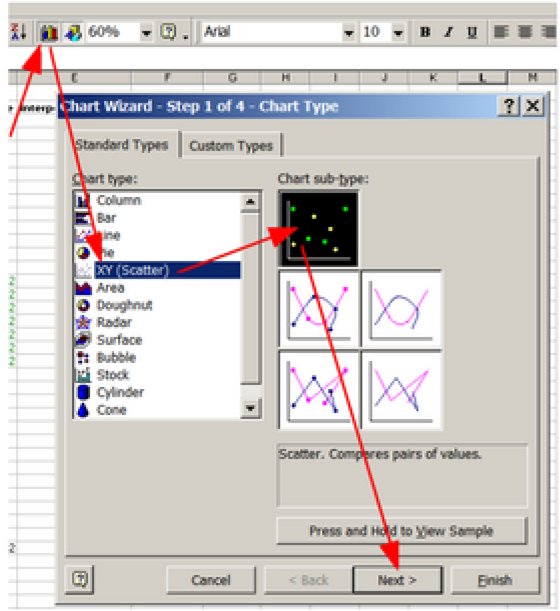
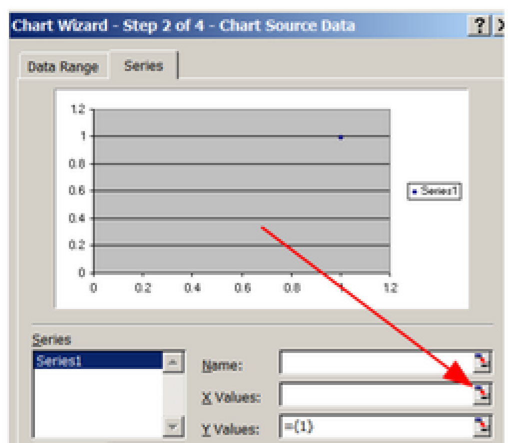
4. for the person measure distribution, Use the Scorefile= from the Output File menu. Write the file to Excel, and then use the "Measure" and "Frequency" columns.
(If you want different "bins", use PFILE= and the Excel =frequency() formula.)

5. Then use the =REPT() Excel function to format a person sample bar

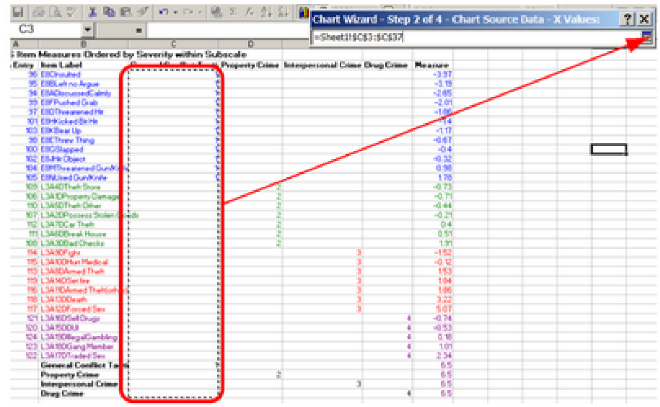


3. On the Excel worksheet toolbar, verify that you have XY Chart Labels. If not, download and install from:
www.appspro.com/Utilities/ChartLabeler.htm

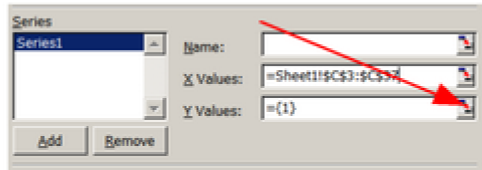


4. On the Excel Worksheet page, Click on Chart icon or "Insert" ribbon Click on XY (Scatter) Click on non-lines sub-type Click on Next	
5. Click on Series	
6. Click on Add	
7. Click on X values	

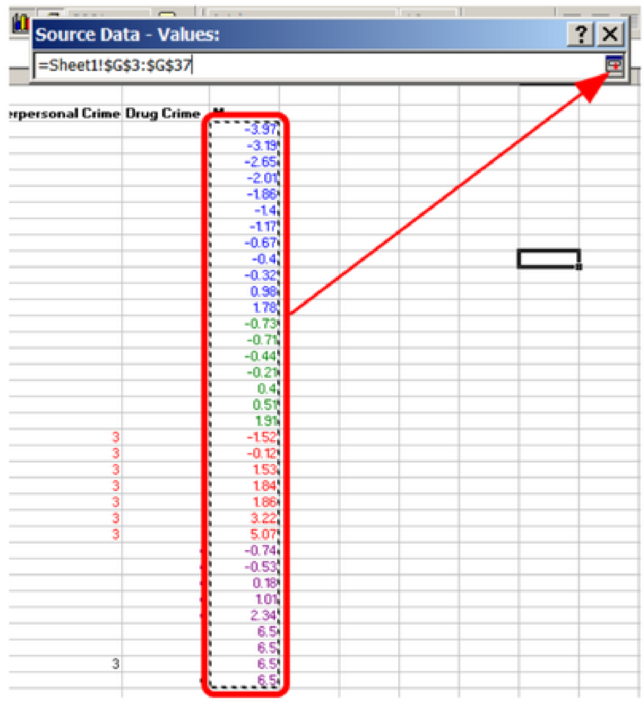
8. On Worksheet, drag mouse to highlight first sub-scale column.
Then click on series-selector icon



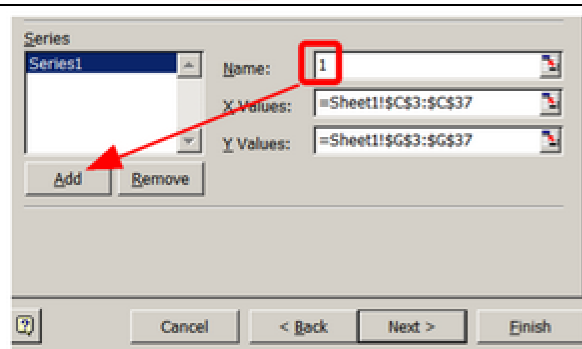
9. In Chart dialog
Click on Y Values selector icon

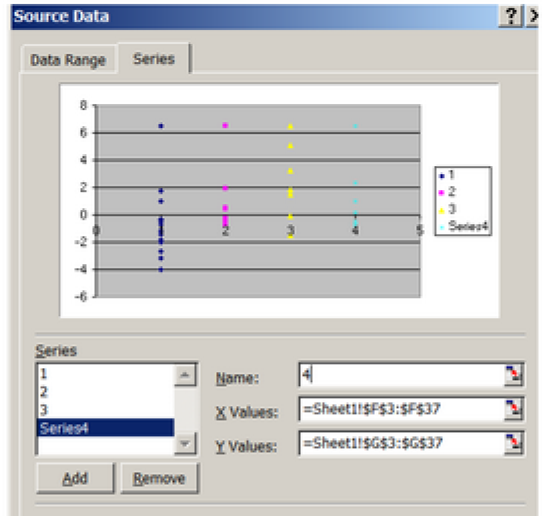
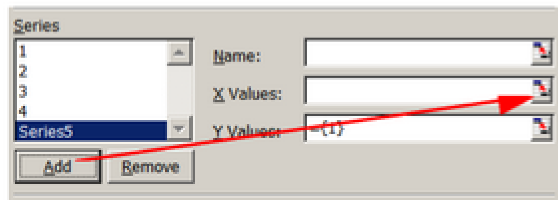


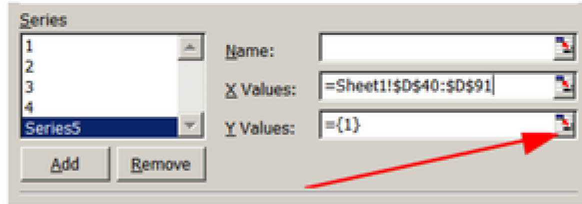
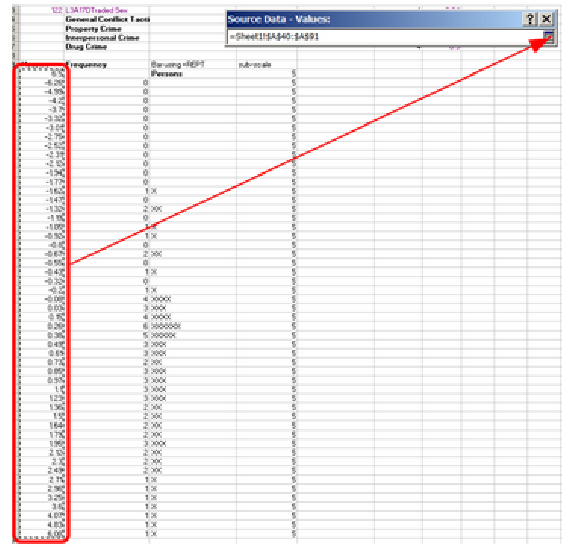
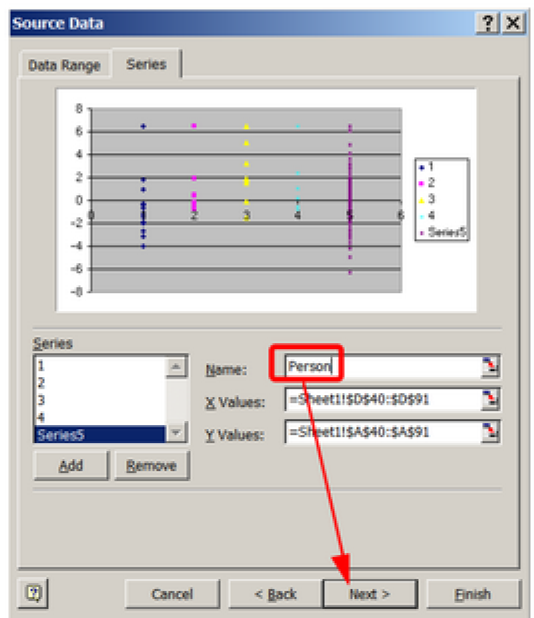
10. On Worksheet, drag mouse to highlight measure column.
Then click on series-selector icon

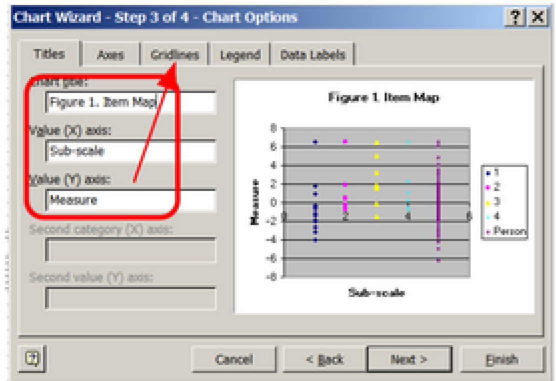
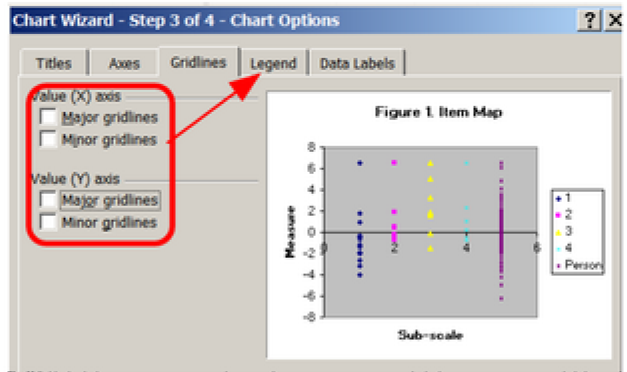
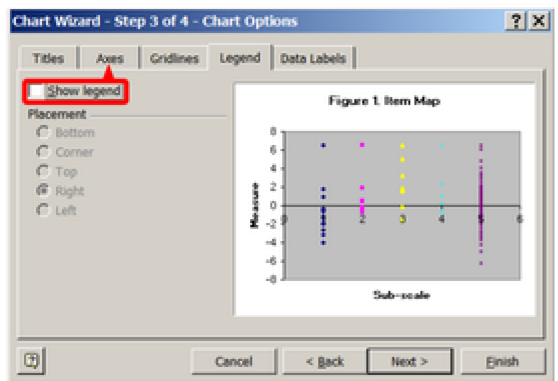
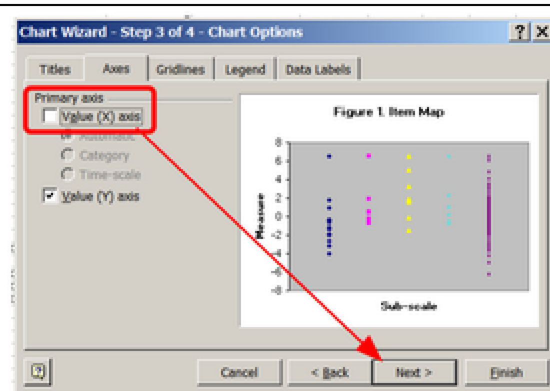


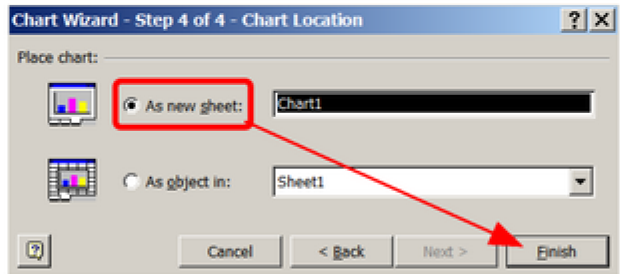
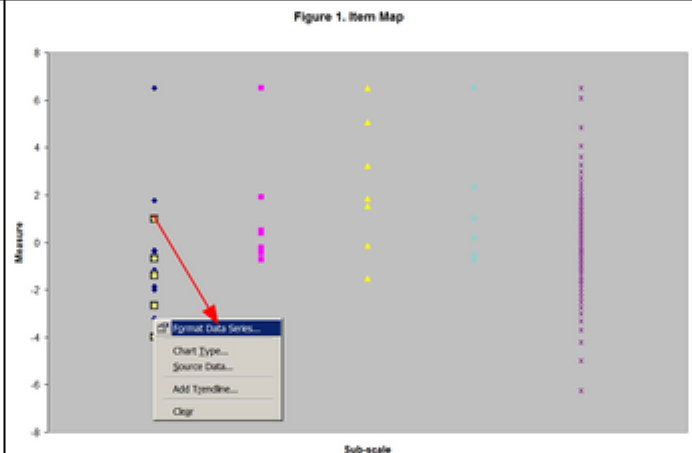
11. Type in the sub-scale number as the Name
For the next sub-scale:
Click Add



<table>
<tr><td>12. Repeat 7 through 11 for the other item sub-scales</td><td></td></tr>
<tr><td>13. Now for the Person distribution
Click Add
Click on X Values icon</td><td></td></tr>
<tr><td>14. On worksheet, drag mouse to highlight the person sub-scale number
Click on range-selector icon</td><td></td></tr>
</table>

<table>
<tr><td>15. In Chart dialog, click on Y-values icon</td><td>
</td></tr>
<tr><td>16. Drag mouse to select person measures
Click on range-selector icon</td><td>
</td></tr>
<tr><td>17. Type int Name: Person
Click Next</td><td>
</td></tr>
</table>

18. In Chart Wizard: On Titles Tab: Type in Chart Title: Figure 1. Item Map Value (X) axis: Sub-scale Value (Y) axis: Measure Click on “Grid lines” Tab	
19. On Grid lines Tab: Uncheck all boxes Click on Legend Tab	
20. On Legend Tab: Uncheck “Show Legend” Box Click on “Axes” Tab	
21. On Axes Tab Uncheck “Value (X) axis” Click on Next	

<table>
<tr>
<td>22. Click on “As new sheet”
Click on Finish</td>
<td>
</td>
</tr>
<tr>
<td>23. Right-click on first sub-scale
Click on “Format Data Series”</td>
<td>
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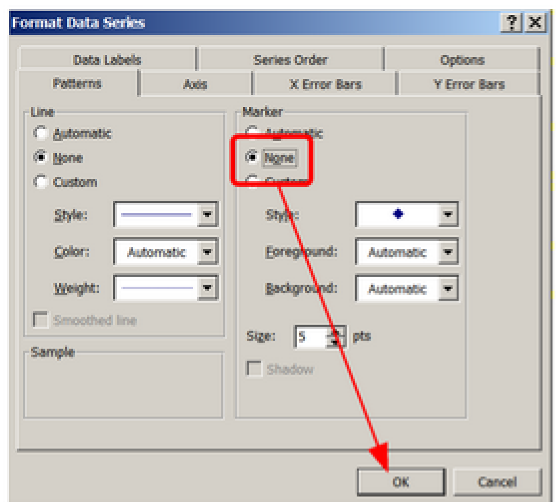
<tr>
<td>24. Click on “Marker: None”
Click on “OK”</td>
<td>
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</tr>
<tr>
<td>25. Same again for the other sub-scales:
Right-click on sub-scale
Click on “Format Data Series”
Click on “Marker: None”
Click on “OK”</td>
<td>
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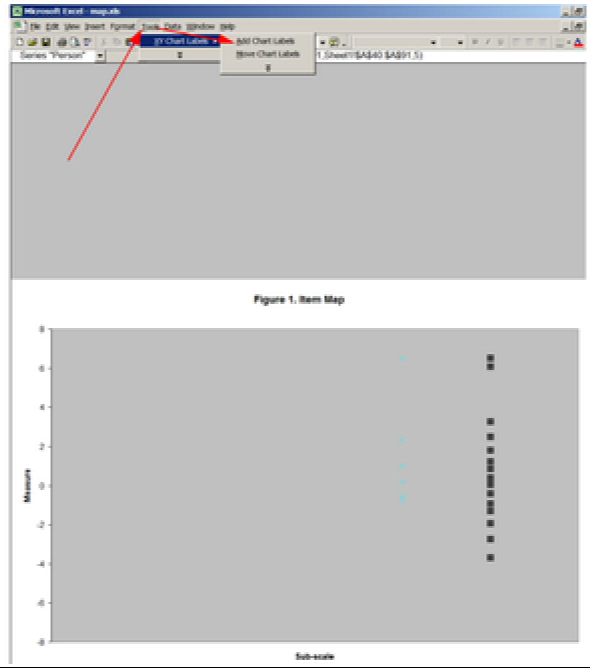
<table>
<tr>
<td>26. Click on “Tools”
Click on “XY Chart Labels”
Click on “Add Chart Labels”</td>
<td>
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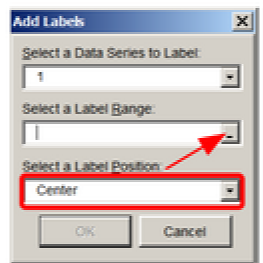
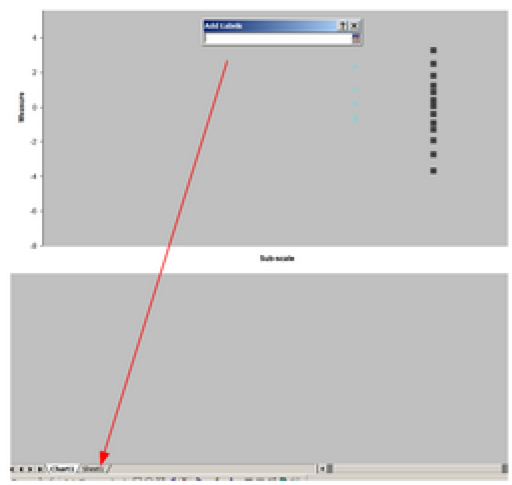
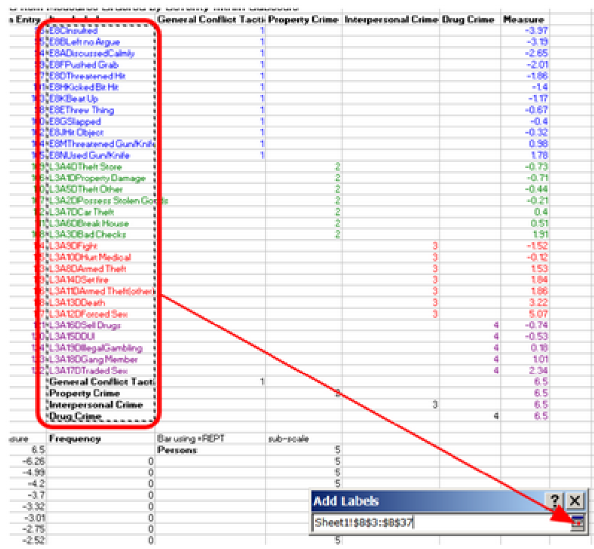
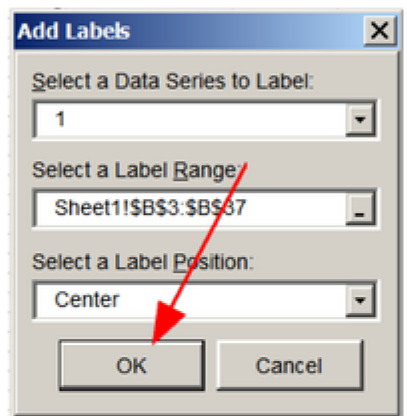
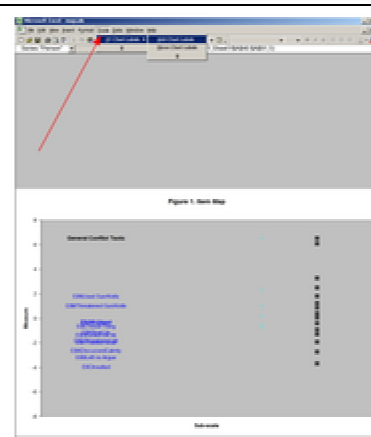
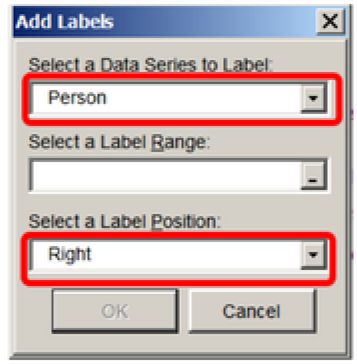
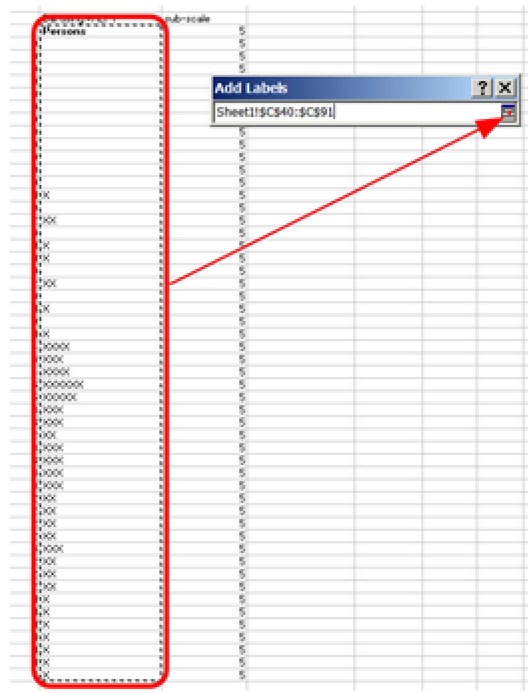
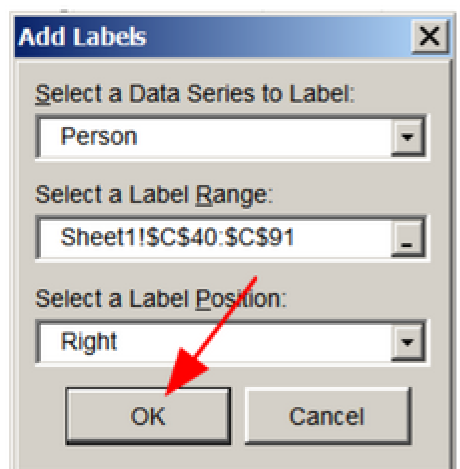
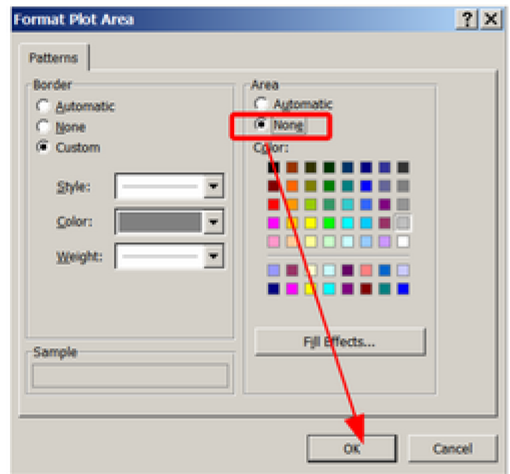
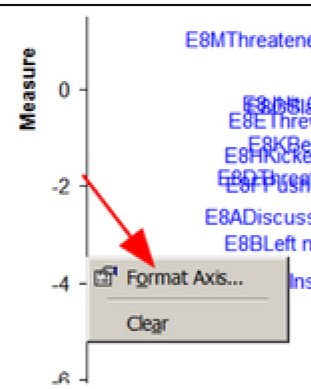
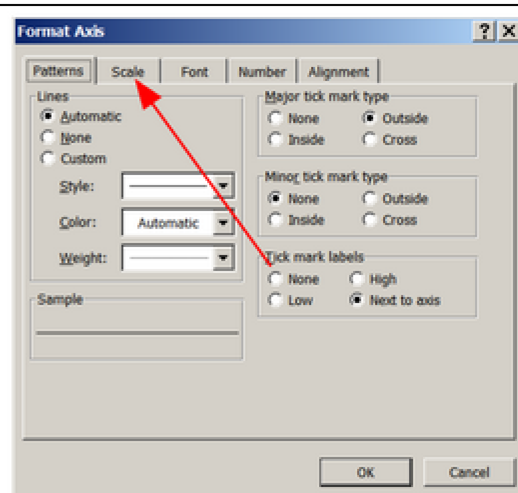
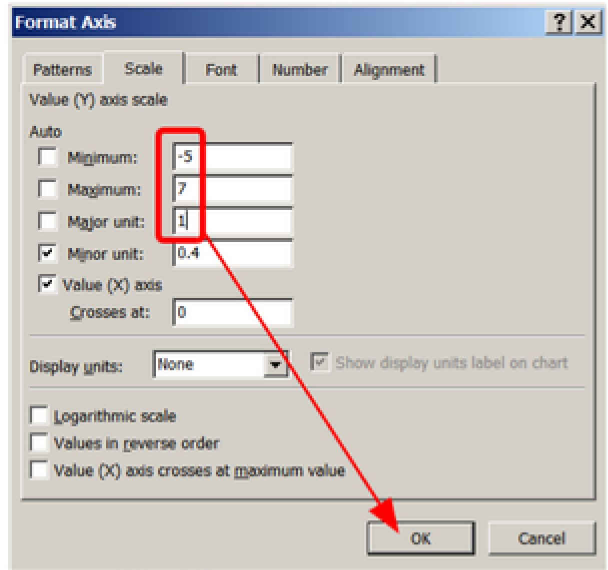
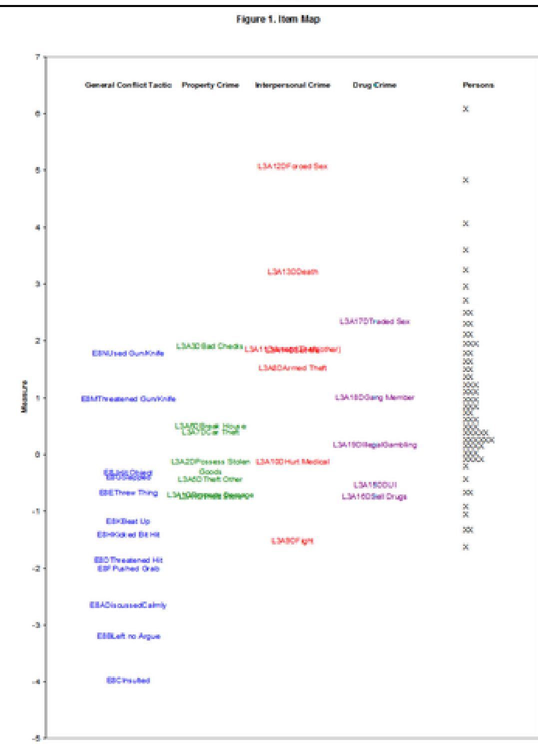
</tr>
<tr>
<td>27. Select “Center” using pull-down menu
Click on “Label Range” selector</td>
<td>
</td>
</tr>
<tr>
<td>28. Click on Worksheet Tab</td>
<td></td>
</tr>
</table>

29. Drag mouse to select all item names Click on range-selector	
30. Click on OK	
31. Same again for the other item sub-scales: "Select a Data Series to Label" select each item sub-scale	

32. The once more for the Person sub-scale, but with Label Position: Right	
33. On the Worksheet, Drag the mouse to select the XXXX column Click on the range-selector	
34. Click on OK	

<table>
<tr><td>35. Right-click on plot background
Click on Format Plot Area</td><td></td></tr>
<tr><td>36. Click on “Area: None”
Click on OK</td><td>
</td></tr>
<tr><td>37. Right-click on the Y-axis
Click on “Format Axis”</td><td>
</td></tr>
<tr><td>38. Click on the Scale Tab</td><td>
</td></tr>
</table>

39. Choose suitable ranges and units, Click OK	
40. You can now right-click on the labels to change the font size. You can also drag them so they don't overprint	
41. To copy the plot, click on it to select all of it Copy then Paste Special - Picture into your Word document. This is what I have done here:	

Index of Specifications and Files