

Cognitive Assessment for the Determination of Mental Residual Functional Capacity

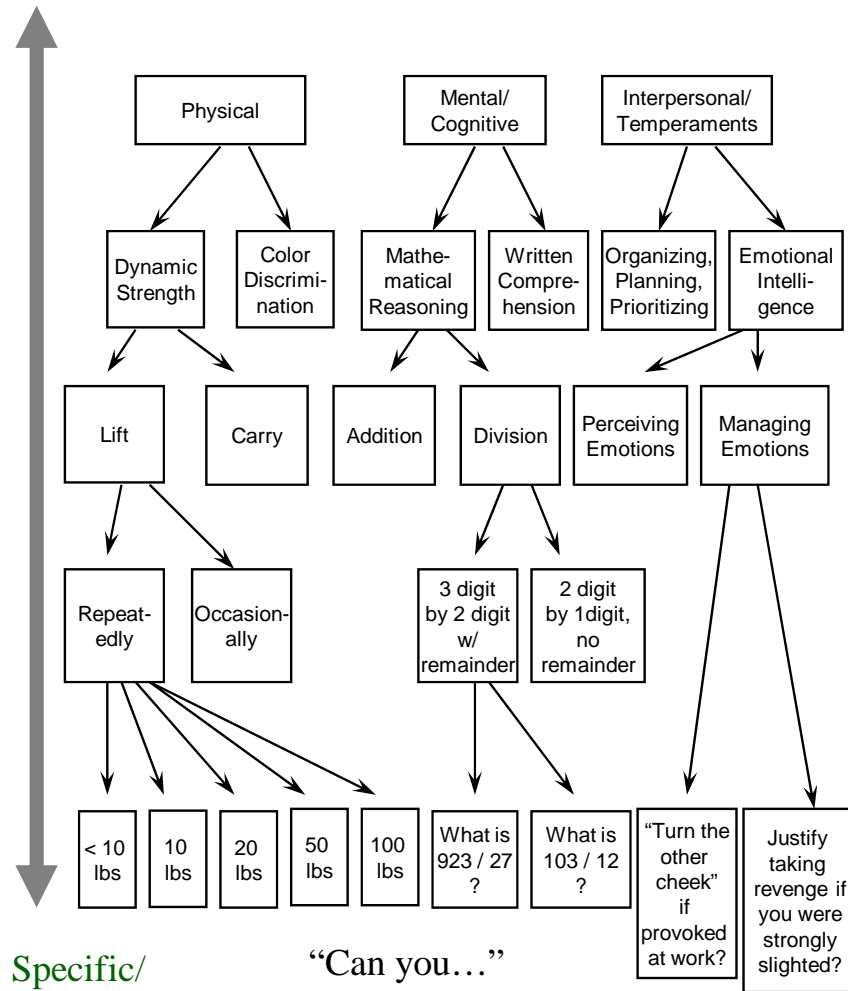
David J. Schretlen, PhD
OIDAP Meeting
April 29, 2009



JOHNS HOPKINS
MEDICINE

Abstract/
Hypothetical

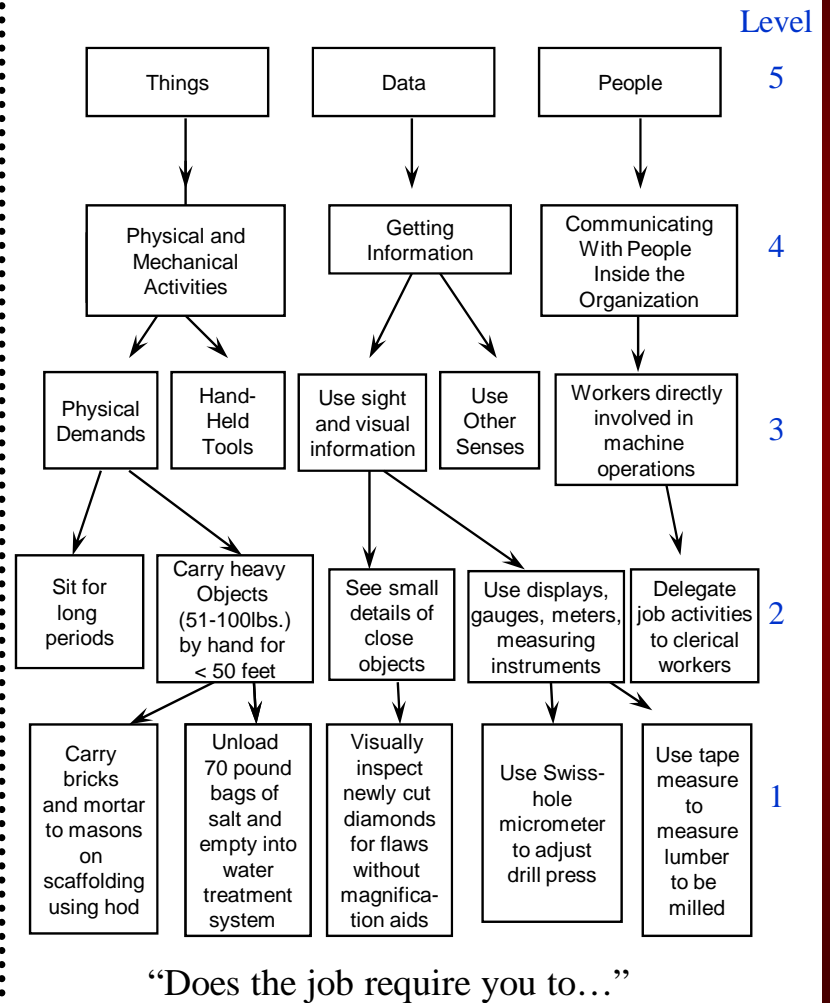
Person-Side



Specific/
Observable/Verifiable

"Can you..."

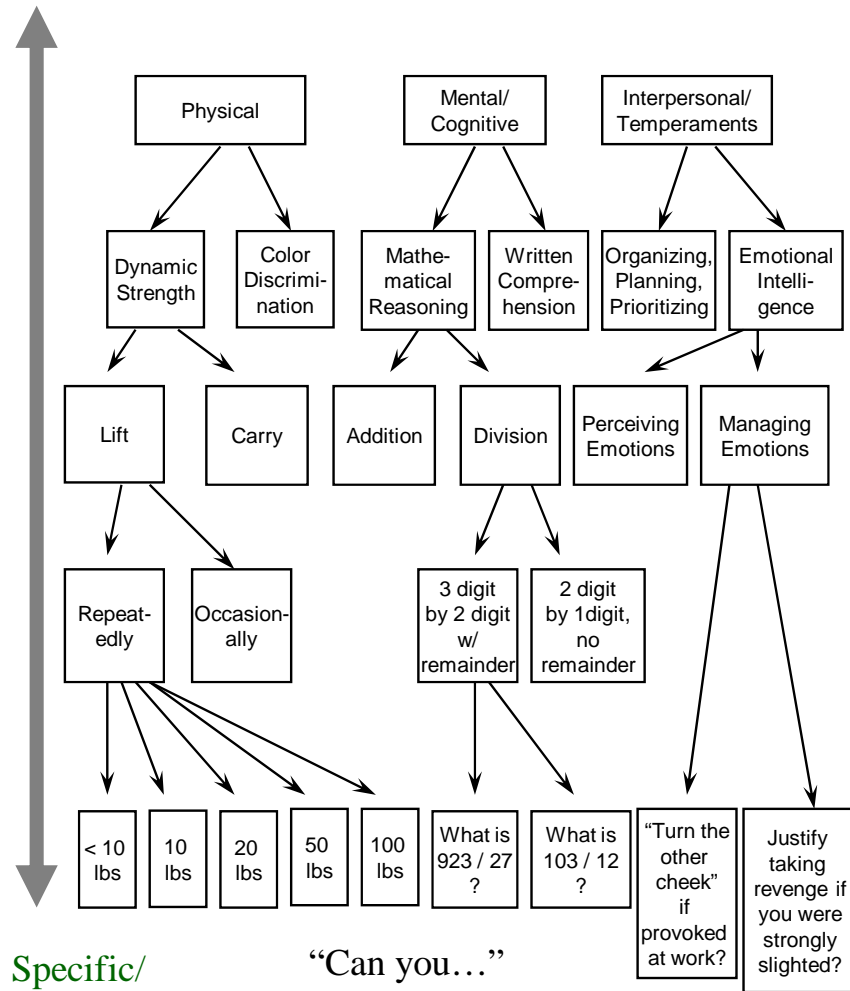
Job-Side



"Does the job require you to..."

Abstract/
Hypothetical

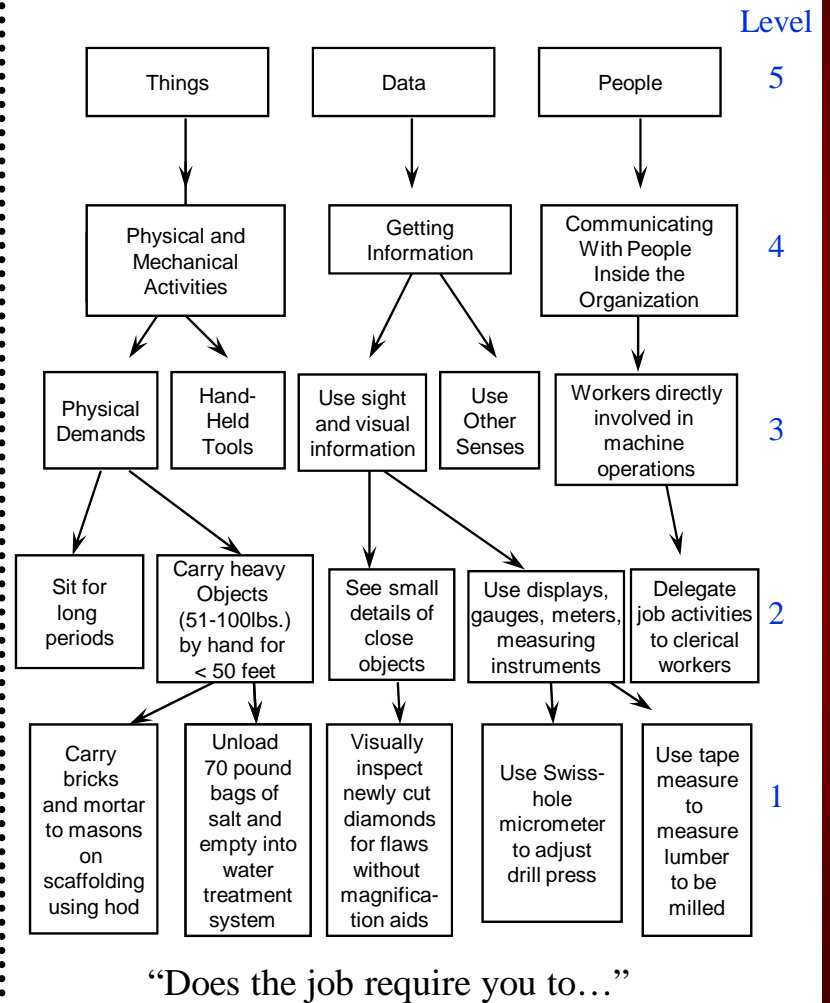
Person-Side



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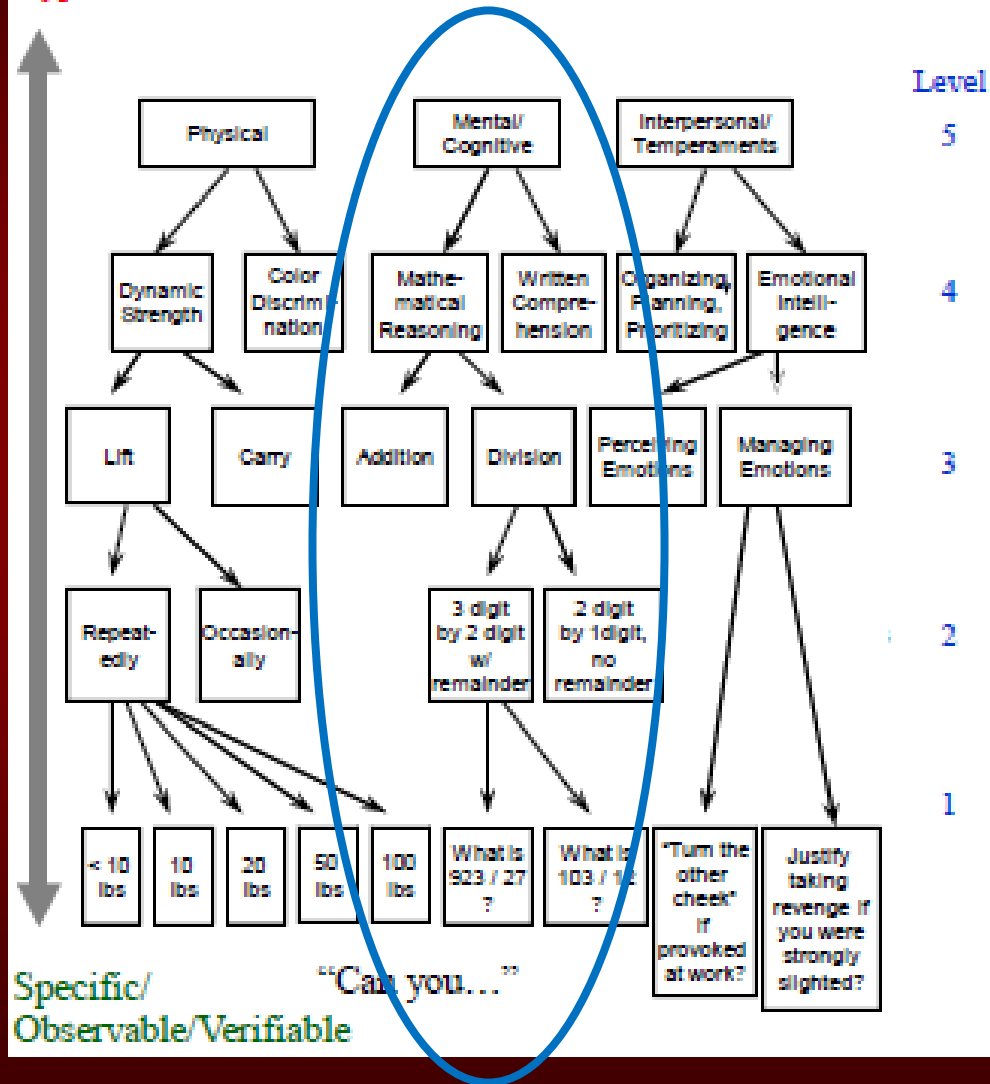
Job-Side



"Does the job require you to..."

Abstract/
Hypothetical

Person-Side



Mental/Cognitive

- Individual differences in cognitive test performance predict occupational attainment in healthy and clinical populations
- Often predicts work outcome better than primary symptom severity (eg, TBI, MS, Schizophrenia, etc.)
- This makes cognitive function a “final common pathway” of work disability in many diseases and conditions
- Thus, it is essential to include cognition in mental RFC
- Two ways to approach this
 - Performance-based measures (IQ, memory, attention testing)
 - Ratings (self- or informant-report)

We must first decide what abilities to assess before we decide how to assess them

Clinical approach: A view from the perspective of what goes wrong

Domain affected	Disease/condition	Manifestation
Intelligence	Fragile X	Intellectual disability
Language	Stroke	Aphasia
Attention	Traumatic brain injury	Distractibility/ADD
Learning/memory	Korsakoff	Amnesia
Processing speed	Parkinson	Bradyphrenia/bradykinesia
Visual-spatial abilities	Lewy body	Agnosia
Executive functioning	Schizophrenia	Dysexecutive & abulia
Arithmetical abilities	Developmental	Acalculia
Skilled movement	Brain tumor	Apraxia
Wakefulness	Narcolepsy	Drowsiness

Psychometric approach: A view from the perspective of factor analyses

- EFA (exploratory factor analysis) is used to elucidate an underlying factor structure
- CFA (confirmatory factor analysis) is used to test *a priori* hypotheses
 - Based on a conceptual model or previous findings
 - Evaluate a model and compare it to specific alternatives
 - Test how well hypothesized models fit the observed data
 - Compare “nested” models (in which some models combine factors from preceding ones)

FACTOR ANALYSES	CFA: Confirmatory Factor Analysis, EFA: Exploratory factor analysis, BCPA: block principal component analysis, RCA: Reliable Components Analysis, PCA: Prin Components Analysis; SCFA: Single Confirmatory Factor Analysis, PAF: Prin Axis Factoring			
HEALTHY SAMPLES	Sample / Tests in Domain	Analysis	# Vars	# Factors
Gomez et al., 2006				
	521 Spanish-speaking Normal Control	EFA	27	6
1. Attentional-executive	category formation test, visual search, semantic verbal fluency, phonological verbal fluency, design fluency			
2. Contextual-exec memory	LMI, LMD, Verbal paired associates Immediate, & Delayed, motor functions			
3. Verbal memory	word list encoding, free recall, cued recall, recognition			
4. Sustained attention	time orientation, digit detection, mental control, faces immediate, faces delayed recall			
5. Atten - working memory	digit span forward, & backward, spatial span forward, & backward			
6. Orientation	place orientation, person orientation			
Tulsky et al., 2003				
	1,250 Normal Control (healthy adults aged 16 - 89)	CFA	26	6
1. Verbal comprehension	Vocabulary, Information, Similarities, Comprehension (Verbal Comp of WAIS-III)			
2. Perceptual organization	Matrix Reasoning, Block Design, Picture Completion (WAIS-III) Picture Arrangement (WMS-III)			
3. Auditory memory	Logical Mem I, Logical Mem II, Verbal Paired I, Verbal Paired II, Word List I, Word List II			
4. Visual memory	Faces I, Faces II, Family Picture I, Family Pictures II, Visual Reproduction I, Visual Reproduction II			
5. Working memory	Letter Number Sequencing, Digit Span, Arithmetic, Spatial Span			
6. Processing speed	Symbol Search, Digit Symbol			
Rowe et al., 2007				
	1,316 Normal Controls (mean age = 33, range 6-16)	PCA	19	7
1. Info processing & speed	Verbal Interference Test Part I, and II, Switching of Attention Test Parts I, and II, Choice Reaction Time test			
2. Verbal memory	Verbal Learning and Recall Test: delayed, recognition, immediate recall			
3. Viligance/sustained atten	CPT Reaction Time, CPT Errors			
4. Working memory	Digit Span forward, Digit Span backward, Span of Visual Memory Test			
5. Sensori-motor function	average pause between taps on tapping test for dominant and non-dominant hands			
6. Verbal processing	Letter Fluency, Category Fluency			
7. Executive function	Maze completion time, Maze overrun errors, Span of Visual Memory Test			
Salthouse, 1998				
	Three healthy groups: children (age 5-17) n = 3,155 ; college students (age 18-22) n = 735; nonstudents (age 18-94) n = 1580			
1. General higher-order factor	concept formation, calculation, app probs, science, social studies, humanities, incomplete words, visual closure, sound blending, memory for names, Visual-Auditory learning, memory for sentences, memory for words, visual matching, cross out	SCFA	16	1
Colom et al., 2009				
1. g (General Intelligence)	Adv Progressive Matrices (APM), Induct reason (PMA-R), abs reason (DAT-AR), vocab (PMA-V), verbal reason (DAT-VR)			

1. Gf (fluid intelligence)	Advanced Progressive Matrices (APM), Inductive reasoning subtest (PMA-R), abstract reasoning (DAT-AR)			
2. Gc (crystallized intelligence)	vocabulary (PMA-V), verbal reasoning (DAT-VR), numerical reasoning (DAT-NR)			
3. Gv (verbal intelligence)	Solid Figures, mental rotation (PMA-S), spatial relations (DAT-SR)			
Visser et al., 2006				
	200 Normal Controls (age range = 17-66, M = 22.7 (6.1))			
1. g (General intelligence)	Nec Arith Operations, Diagramming Relationships, Opposites, Paper Folding, Social Translations, Vocab, Map Planning, Subtraction and Multiplication, Consistency, Cartoon Predictions, Stork Stand, Mark Making, Tonal Accuracy	PAF	15	1
MIXED/MULTIPLE GRPS				
Dickinson et al., 2004				
	97 Schizophrenia & 87 Normal Conrols			
1. Common Factor	Vocab, Sim, Info, PC, BD, MR, LNS, Spatial Span, DSym, Sym Search, LM I, LM II, VP I, VP II, Fac Rec I, II, Famly Pict I, II	SCFA	18	1
Dickinson et al., 2006				
	157 Normal Control	CFA	17	6
	148 Schizophrenia	CFA	17	6
1. Verbal comprehension	Vocab (WAIS-R), Visual Naming (MAE)			
2. Perceptual organization	Block Design (WAIS-R), Line Orientation (Benton)			
3. Verbal learning/memory	Trials 1-5 & Delayed Free Recall (CVLT), Logical Mem immediate & delayed (WMS-R)			
4. Visual learning/memory	Figural Memory immediate & delayed (WMS-R)			
5. Info processing speed	Symbol Cancellation Test, Trls A, Animal Naming (BDAE)			
6. Exec/Working memory	Digit Span (WAIS-R), Trls B, Categories & Persev. Erros (WCST)			
Genderson et al., 2007				
	125 NC (-5 due to kurtosis)	CFA*	21	7
	162 probands (-5 due to kurtosis)	CFA*	21	7
	94 SZ (-5 due to kurtosis)	CFA*	21	7
	382 full sample (-15 due to kurtosis)	CFA*	21	7
1. Speed	Trls A, Trls B, Let. Fluency, Cat. Fluency			
2. Target detection	CPT distraction, CPT viligance, Zero-back			
3. N back updating/ exec	One Back, Two Back, Three Back			
4. Verbal episodic memory	CVLT Trails 1-5, WIM Log Memory, WM Pair Assoc I, Pair Assoc II			
5. Visual processing/memory	WM Visual Reprod I, Visual Reprod II, Benton Line,			
6. WCST executive function	WCST Persev Errors, WCST Categories			
7. Digit span	WMSR Forward, WMSR Backward			

<u>Gladsjo et al., 2004</u>				
	209 Psychotic Disorder	CFA	21	6
	131 Normal Control	CFA	21	6
1. Verbal crystalized	WAIS-R Vocab, Info, Similarities; Boston Naming			
2. Attention/working mem	WAIS-R Arith, Digit Span			
3. Verbal episodic	CVLT Monday Total, Story Learning, CVLT Long-Deay Free Recall			
4. Speed of info processing	WAIS-R Digit Symbol, Trls A, Trls B, GPB, Digit Viligance, Let. Fluency			
5. Visual episodic	Figure Learning, Figure Delay			
6. Reasoning/problem solving	Block Design, Category, WCST			
<u>Johnson et al., 2009</u>				
	191 Normal Controls (mean age = 75)	CFA	12	4
	115 autopsy confirmed AD (mean age = 80)	CFA	12	4
1. General (all measures)	** all of the tests are included in this factor			
2. Verbal memory	Information, Paired Associates Learning, BNT, Logical Memory			
3. Visuospatial	BVRT (Benton Visual Rec. Test), Digit Symbol, Trls A, Block Design			
4. Working memory	Word Fluency, Mental Control, Digit Span Backward, Digit Span Forward			
<u>Schretlen et al., 2009</u>				
	340 Normal Control	CFA	15	6
	126 Bipolar Disorder	CFA	15	6
	110 Schizophrenia	CFA	15	6
1. Attention	BTA-L, BTA-N, CPT-II			
2. Speed	TMT-A, TMT-B, GPT			
3. Fluency	Letter, Category, Design			
4. Visual memory	BVMT 1-3, BVMT Del			
5. Verbal memory	HVLT 1-3, HVLT Del			
6. Executive function	WCST Cat, WCST Err			
<u>Siedlecki et al., 2008</u>				
	322 Normal Control	CFA	15	5
	878 Questionable Dementia	CFA	15	5
	639 Alzheimer Disease	CFA	15	5

1. Processing speed	Shape Time (shapes) and TMX Time (letters) of Cancellation Task			
2. Memory	SRT (Selective Reminding Task) Total Recall, Delayed Recall, Delayed Recog, BVRT (Benton Visual) Recog			
3. Language	Naming (BNT), Repetition, Comprehension, Letter Fluency, Category Fluency			
4. Reasoning visual/spatial	WAIS Similarities, Identities/Oddities (MDRS), Rosen (drawing test), BVRT Matching (Benton Visual)			
5. Attention	TMX Omits (Letters)& Shape Omits of Cancellation Test,			
CLINICAL SAMPLES				
<u>Frazier et al., 2004</u>				
	1,364 mixed patient sample	RCA	21	4
1. Memory	WMS-III Auditory Immediate, Visual Immediate, Auditory Delayed, Visual Delayed, Auditory Recognition			
2. Visual motor	Trls A, Trls B, WAIS-III PSI, WAIS-III POI, Finger Tapping Dominant, Finger Tapping Non-Dominant, GBP Dom, GBP Ndom			
3. Language	WAIS-III VCI, WAIS-III POI, WRAT-3 Reading, BNT, Verbal Fluency			
4. Executive	WCST Perseverative Errors, WCST Categories			
<u>Friis et al., 2002</u>				
	219 Schizophrenia	EFA	17	5
1. Working memory	Controlled Oral Word Association Task (COWA), Digit Span w/distractor, Digit Span w/out distractor (Digit Span Distractability Test), CPT hits			
2. Executive function	WCST Categories, WCST Perseverative Responses, WCST # attempts to first category			
3. Verbal learning	CVLT immediate recall, CVLT delayed free recall, CVLT errors			
4. Impulsivity	CPT false alarms (comissions), CPT Reation Time			
5. Motor speed	Finger Tapping			
<u>Jaeger et al., 2003</u>				
	156 Schizophrenia	BPCA	44	6
1. Attention	Concen Endurance (Letters -Errors), Stroop-Words, Stroop-Colors, Trls A, WMS-R Visual Mem, WAIS-R Digit Symbol			
2. Working memory	Concentration Endurance Test (Fluctuation), WAIS-R DS Forward, Letter Number Span # Correct, Longest, WAIS-R Arith, WAIS-R DS Backward, LMI			
3. Ideational fluency + WCST persev.	Ruff Fugural Fluency- Unique Designs, COWAT, Animal Naming, WCST Per Errors			
4. Learning	WMS-R LM I, LM II, WMS-R Verbal Paired I, Verbal Paired II, WMS-R VR I, VR II, WMS-R Visual Paired I, Visual Paired II			
5. Verbal knowledge	WAIS-R Vocab, Info, Comp, Similarities			
6. Non-Verbal function	WMS-R VR I, VR II, WAIS-R Block Design, Object Assembly, Pict Comp, Pict Arrangement			

Czobor et al., 2007				
	185 Schizophrenia, 65 Schizoaffective	EFA	29	6
	155 Bipolar Disorder	EFA, CFA	29	6
1. Attention	<i>Concentration Endurance Test (Letters -Errors), Stroop-Words, Stroop-Colors, Trls A, WAIS-R Digit Symbol</i>			
2. Working memory	<i>Concen Endurance (Fluctuation), WMS-R DS Forward, Letter Number Span , WAIS-R Arith, WAIS-R DS Backward, LMI</i>			
3. Ideational fluency + WCST persever.	<i>Ruff Fugural Fluency- Unique Designs, COWAT, Animal Naming</i>			
4. Learning	<i>WMS-R Verbal Paired I, Verbal Paired II, WMS-R Visual Paired I, Visual Paired II</i>			
5. Verbal knowledge	<i>WAIS-R Vocab, Info, Comp, Similarities</i>			
6. Non-Verbal function	<i>WAIS-R Block Design, Pict Comp, Pict Arrangement</i>			
Keefe et al., 2006				
	1,493 Schizophrenia (includes medical and substance abuse comorbidities)	PCA	24	5
1. Processing speed	<i>COWAT, Category instance, GPB, WAIS-R Digit Symbol</i>			
2. Reasoning	<i>WCST (Perseverative errors & categories)</i>			
3. Verbal memory	<i>HVLT (total recall)</i>			
4. Working memory	<i>Computerized test of visuospatial working memory, letter-number sequencing (# correct)</i>			
5. Vigilance	<i>CPT (d-prime)</i>			
Williams et al., 2008	*verified factor structure found in Rowe et al. (2007)			
	56 First Episode Schizophrenia (mean age = 20)	PCA	19	7
1. Information processing & speed	<i>Verbal Interference Test Part I, and II, Switching of Attention Test Parts I, and II, Choice Reaction Time test</i>			
2. Verbal memory	<i>Verbal Learning and Recall Test: delayed, recognition, immediate recall</i>			
3. Vigilance/sustained attention	<i>CPT Reaction Time, CPT Errors</i>			
4. Working memory capacity	<i>Digit Span forward, Digit Span backward, Span of Visual Memory Test</i>			
5. Sensori-motor function	<i>average pause between taps on tapping test for dominant and non-dominant hands</i>			
6. Verbal processing	<i>Letter Fluency, Category Fluency</i>			
7. Executive function	<i>Maze completion time, Maze overrun errors, Span of Visual Memory Test</i>			

General Findings

- Several models of latent cognitive structure have found empirical support in one or more population
 - A few have been replicated in multiple samples
 - And a few have been confirmed by CFA
- The measures included in an assessment strongly affect the nature of the latent cognitive model that is found
- Three “levels” of model complexity deserve particular attention
 - Single factor model: General cognitive ability (*g*)
 - Two-factor models: Crystallized and fluid abilities (*Gc* & *Gf*)
 - Multiple-factor models: Multiple cognitive domains

Lumping vs. splitting

- A single summary measure of impairment or cognitive RFC ability has advantages
 - It is easily understood
 - More reliably measured than specific cognitive domains
 - Separate factors share common variance anyway
 - Summary measures correlate best with most outcomes
- Multiple factors have advantages too
 - No theoretical cognitive construct maps onto a summary impairment index
 - Summary scores might mask specific impairments or aspects of RFC that preclude or support employability
 - Scores for multiple measures are no harder to understand than a single summary score

One-Factor Model: g

- Hundreds of studies document the existence of a single general mental ability, g , on which individuals differ
- g is a construct
 - That is not directly observable
 - Determined by genetic and environmental factors
- Arises from fact that performances on all cognitive tasks are positively correlated
 - All cognitive tests measure g (to varying degrees)
 - Thus, g is not tied to any specific test content such as words, numbers, or geometric patterns
 - Nor is g bound to any sex, age, or cultural group
- The g component of tests accounts for most of their predictive power

Distribution of Test Scores

Wonderlic Personnel Test and
Wonderlic Scholastic Level Exam
1992 Normative Study
Total Number of Questions
Answered Correctly

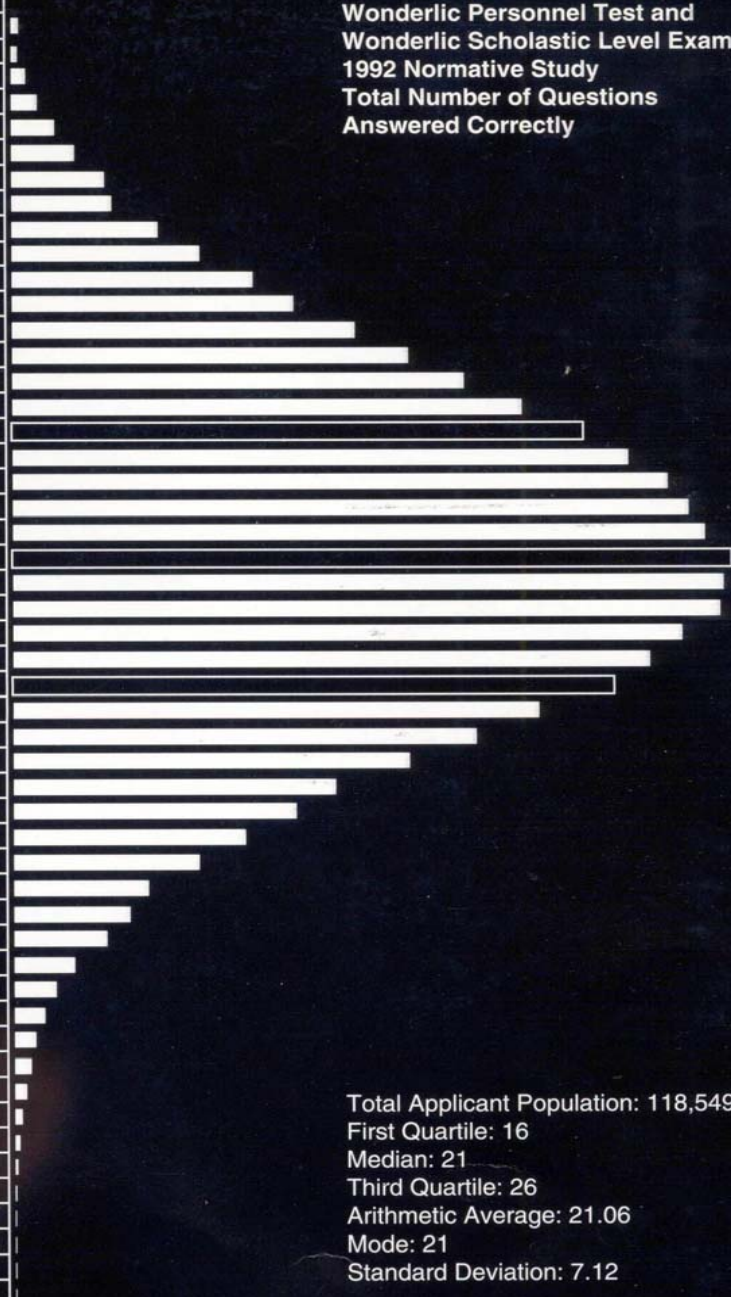
Σ	%	N	Score
0.09	0.09	101	0
0.17	0.08	97	1
0.32	0.15	175	2
0.53	0.22	258	3
0.83	0.29	347	4
1.29	0.46	549	5
1.91	0.63	741	6
2.74	0.83	983	7
3.85	1.11	1,313	8
5.25	1.40	1,654	9
7.09	1.84	2,184	10
9.23	2.15	2,543	11
11.84	2.61	3,089	12
14.86	3.02	3,576	13
18.31	3.45	4,090	14
22.16	3.85	4,564	15
26.51	4.36	5,164	16
31.18	4.67	5,530	17
36.21	5.03	5,965	18
41.37	5.16	6,115	19
46.76	5.39	6,391	20
52.22	5.47	6,482	21
57.69	5.46	6,477	22
63.09	5.40	6,403	23
68.16	5.07	6,013	24
73.04	4.88	5,779	25
77.63	4.60	5,451	26
81.65	4.02	4,761	27
85.19	3.54	4,195	28
88.20	3.01	3,567	29
90.70	2.50	2,963	30
92.84	2.14	2,537	31
94.60	1.77	2,093	32
95.99	1.39	1,645	33
97.04	1.05	1,239	34
97.90	0.86	1,020	35
98.52	0.63	744	36
98.99	0.46	548	37
99.30	0.31	372	38
99.53	0.23	268	39
99.69	0.16	193	40
99.80	0.11	132	41
99.88	0.08	95	42
99.93	0.05	58	43
99.97	0.04	43	44
99.98	0.01	17	45
99.99	0.01	9	46
99.99	0.01	6	47
100.00	0.00	4	48
100.00	0.00	2	49
100.00	0.00	4	50

Total Applicant Population: 118,549
First Quartile: 16
Median: 21
Third Quartile: 26
Arithmetic Average: 21.06
Mode: 21
Standard Deviation: 7.12

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TABLE 3: TEST SCORES BY POSITION APPLIED FOR SUMMARY (1992 NORMS)

Position Applied for	No. of Companies Reporting	Percentile Ranges							N	Arith. Avg.	Mode	Std. Dev.
		10	15	20	25	30	35	40				
Attorney	7								18	29.67	16	6.95
Research Analyst	6								13	27.92	14	7.88
Editor & Assistant	12								116	28.84	30	5.56
Manager, Advertising	16								165	28.36	28	5.25
Chemist	12								61	27.85	30	6.28
Engineer	33								215	28.06	27	6.89
Executive	46								361	28.70	28	6.02
Manager, Trainee	20								5,586	28.18	28	5.65
Systems Analyst	12								33	27.52	31	6.12
Auditor	16								198	26.93	25	5.60
Copywriter	5								116	26.88	28	5.68
Accountant	49								503	26.26	26	6.07
Manager/Supervisor	73								446	25.59	22	6.24
Manager, Sales	48								380	25.45	27	5.72
Programmer, Analyst	59								979	26.42	25	6.71
Teacher	10								500	26.01	24	6.51
Adjuster	7								150	25.24	25	6.14
Manager, General	43								456	24.63	24	5.80
Purchasing Agent	33								404	24.94	24	5.71
Nurse, Registered	13								121	23.56	25	5.82
Sales, Account Exec.	28								480	23.91	26	6.11
Administrative Asst.	70								710	23.56	24	6.13
Manager, Store	8								209	23.90	27	5.82
Bookkeeper	62								742	23.36	25	6.27
Clerk, Credit	25								615	22.53	24	6.14
Drafter, Designer	38								326	23.24	20	6.49
Lab Tester & Tech.	21								217	22.69	18	6.28
Manager, Assistant	20								315	22.80	26	6.01
Sales, General	73								1,139	23.39	24	6.22
Sales, Telephone	17								620	23.09	23	5.32
Secretary	195								2,992	22.49	23	6.02
Clerk, Accounting	119								1,534	22.48	22	6.36
Collector, Bad Debt	28								456	22.22	22	6.49
Operator, Computer	52								588	21.89	24	7.25
Rep., Cust. Svc.	110								2,866	22.06	24	6.17
Sales Rep., Insurance	11								9,340	21.65	22	6.06
Technician	35								714	22.39	23	6.81
Automotive Salesman	9								266	21.18	21	6.46
Clerk, Typist	25								785	21.48	23	6.37
Dispatcher	27								703	21.41	22	6.20
Office, General	66								784	21.82	20	6.32
Police, Patrol Off.	15								1,854	20.93	21	6.14
Receptionist	143								1,364	20.50	20	5.89
Cashier	38								1,411	20.21	22	6.02
Clerical, General	123								4,768	20.32	22	6.15
Inside Sales Clerk	54								2,448	19.98	21	6.68
Meter Reader	4								1,135	20.59	22	6.74
Printer	18								332	19.87	21	6.10
Teller	48								4,002	20.34	20	6.46
Data Entry	93								1,200	19.47	18	6.45
Electrical Helper	7								407	19.99	18	6.88
Machinist	31								381	19.54	18	6.43
Manager, Food Dept.	9								389	19.14	21	6.95
Quality Control Chkr.	14								248	19.19	19	6.39
Claims Clerk	17								629	18.31	17	5.62
Driver, Deliveryman	60								1,865	18.58	17	7.21
Guard, Security	28								534	18.19	17	7.32
Labor, Unskilled	56								1,887	18.07	18	6.44
Maintenance	71								952	18.08	19	7.03
Operator, Machine	65								1,433	18.44	17	6.72
Arc Welder, Die Sett.	26								456	17.81	13	6.67
Mechanic	38								376	17.05	19	6.54
Medical-Dental Asst.	22								292	18.05	14	5.99
Messenger	5								163	17.95	15	6.98
Production, Factory	50								5,325	17.05	18	6.87
Assembler	35								682	16.27	16	6.36
Food Service Worker	11								349	16.31	12	6.54
Nurse's Aide	7								424	16.59	18	6.47
Warehouseman	72								6,830	16.44	16	7.07
Custodian & Janitor	28								460	15.12	14	7.48
Material Handler	15								400	15.57	10	6.66
Packer	12								199	14.69	10	5.94

The bold horizontal line shows the range between the 25th and 75th percentile. The bold vertical crossmark shows the 50th percentile (median).

Some Implications & Questions

TABLE 3: TEST SCORES BY POSITION APPLIED FOR SUMMARY (1992 NORMS)

Position Applied for	No. of Companies Reporting	Percentiles										Arith. N	Arith. Avg.	Mode	Std. Dev.
		10	15	20	25	30	35	40	45	50	55				
Attorney	7											18	23.67	16	3.35
Research Analyst	6											13	27.92	14	7.88
Editor & Assistant	12											116	28.84	30	5.56
Manager, Advertising	16											165	28.36	28	5.25
Chemist	12											81	27.83	30	6.28
Engineer	33											215	28.06	27	6.89
Executive	46											361	28.70	28	6.02
Manager, Trainee	20											5,586	28.18	28	5.65
Systems Analyst	12											33	27.52	31	6.12
Auditor	16											198	26.93	25	5.50
Copywriter	5											116	26.88	28	5.68
Accountant	49											503	26.26	26	6.07
Manager/Supervisor	73											446	25.59	22	6.24
Manager, Sales	48											380	25.45	27	5.72
Programmer, Analyst	59											979	26.42	25	6.71
Teacher	10											500	26.01	24	6.51
Adjuster	7											150	25.24	25	6.14
Manager, General	43											456	24.63	24	5.80
Purchasing Agent	33											404	24.94	24	5.71
Nurse, Registered	13											121	23.56	25	5.82
Sales, Account Exec.	28											480	23.91	26	6.11
Administrative Asst.	70											710	23.56	24	6.13
Manager, Store	8											209	23.90	27	5.82
Bookkeeper	62											742	23.36	25	6.27
Clerk, Credit	25											616	22.53	24	6.14
Drafter, Designer	38											326	23.24	20	6.49
Lab Tester & Tech.	21											217	22.69	18	6.28
Manager, Assistant	20											315	22.80	26	6.01
Sales, General	73											1,139	23.39	24	6.22
Sales, Telephone	17											620	23.09	23	5.32
Secretary	195											2,992	22.49	23	6.02
Clerk, Accounting	119											1,534	22.48	22	6.36
Collector, Bad Debt	29											486	22.22	22	6.49
Operator, Computer	52											588	21.89	24	7.25
Rep., Cust. Svc.	110											2,886	22.06	24	6.17
Sales Rep., Insurance	11											930	21.65	22	6.06
Technician	35											714	22.39	23	6.91
Automotive Salesman	9											266	21.18	21	6.46
Clerk, Typist	25											785	21.48	23	6.37
Dispatcher	27											703	21.41	22	6.20
Office, General	66											794	21.82	20	6.32
Police, Patrol Off.	15											1,854	20.93	21	6.14
Receptionist	143											1,364	20.50	20	5.89
Cashier	38											1,411	20.21	22	6.02
Clerical, General	123											4,768	20.32	22	6.16
Inside Sales Clerk	54											2,448	19.98	21	6.68
Meter Reader	4											1,135	20.59	22	6.74
Printer	48											532	19.87	21	6.10
Teller	48											4,002	20.34	20	6.46
Data Entry	93											1,200	19.47	18	6.45
Electrical Helper	7											407	19.99	18	6.88
Machinist	21											381	19.54	18	6.43
Manager, Food Dept.	9											389	19.14	21	6.95
Quality Control Chkr.	14											248	19.19	19	6.39
Claims Clerk	17											629	18.31	17	5.62
Driver, Deliveryman	60											1,865	18.58	17	7.21
Guard, Security	28											534	18.19	17	7.32
Labor, Unskilled	56											1,887	18.07	18	6.44
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Exc. Worker, Die Sett.	70											4,457	17.51	16	6.57
Mechanic	38											376	17.05	19	6.54
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Packer	12											199	14.69	10	5.94

The bold horizontal line shows the range between the 25th and 75th percentile. The bold vertical crossmark shows the 50th percentile (median).

- 25% of workers fall below 1st quartile
- What point in the distribution of incumbents' scores defines insufficient RFC to meet job demands?
 - 25th %ile, 2nd %ile
- How “well” must a disability applicant be able to perform a job in order to be not disabled?
 - Poor employees are the first laid off
 - Job placement vs. job maintenance
- What is “fair” to non-disabled workers?

Comment

- The single-factor g model has advantages
 - It is parsimonious
 - g is well documented and highly defensible
 - We can measure it reliably in many languages
 - Individual differences in g are robust, easily assessed, and strongly predictive of occupational attainment, work performance, and income in normal, healthy persons
 - We can obtain a reasonable estimate of g in a few minutes, using such instruments as the Wonderlic Personnel Test
- It also has limitations
 - Lacks sensitivity to many types of brain dysfunction
 - Does not capture more circumscribed cognitive deficits
 - Thus, might not measure residual functional capacity very well

Two-Factor Model

- Many studies distinguish between highly over-learned skills or knowledge (Crystallized abilities or Gc) and current, online information processing (Fluid abilities or Gf)
 - Gc: vocabulary, fund of information, mathematical ability
 - Gf: novel problem solving, reasoning, speed of processing
 - Gc grows rapidly in childhood, and more slowly in adulthood, and then declines in very late life
 - Gf grows rapidly in childhood, peaks around age 20, and then declines throughout adulthood
 - Gc is more affected than Gf by education
 - Gf is more sensitive than Gc to brain dysfunction

Application of a Two-Factor Model (well, sort of)

_____	(____)	____/____/____	____	_____
Name	Phone	Date	Age	Sex

Test Item & Instructions	Scoring Criteria	Score
1. <i>What is today's date?</i> (Prompt for each part as needed.)	____ Day ____ Date ____ Month ____ Year Score 1 point for each correct part of date.	____/4
2. <i>Next I am going to read a list of nine words. Please listen carefully. When I am done, tell me as many words as you can remember in any order. Ready?</i> (Recite each word only once)	____ dentist ____ pepper ____ shoes ____ mustard ____ waitress ____ pants ____ teacher ____ hat ____ vanilla Score 1 point for each word recalled.	____/9
3. <i>Now I am going to read the same list of nine words. After I am through, tell me as many words as you can remember, including words you said the first time. Ready?</i>	____ dentist ____ pepper ____ shoes ____ mustard ____ waitress ____ pants ____ teacher ____ hat ____ vanilla Score 1 point for each word recalled.	____/9
4. <i>How much is 100 minus 7? And how much is 7 from that? And 7 from that? Keep going.</i> (Do not correct errors, but allow subject to subtract from each prior response)	____ 93 ____ 86 ____ 79 ____ 72 ____ 65 ____ Write subject's response after each subtraction and score 1 point for each correct difference (e.g., "93-85-77-70-64" would receive a score of 2).	____/5
5. <i>The opposite of up is down. What is the opposite of empty? What is the opposite of shallow? And the opposite of remain? And the opposite of seldom? And the opposite of learn?</i> Score 1 point for each correct answer.	____ full or fill ____ deep (not clear, dark, full or wide) ____ depart, leave, go, move or change (not stay) ____ often or frequently (not always) ____ forget or teach (not dumb, fail, or ignore)	____/5
6. <i>How much does 5 + 6 equal?</i> <i>How much does 17 - 9 equal?</i> <i>How much does 4 x 16 equal?</i> <i>How much does 70 ÷ 5 equal?</i> Score 1 point for each correct answer.	____ 11 ____ 8 ____ 64 ____ 14	____/4
7. <i>How many months are there in a year?</i> <i>Who was the first President of the United States?</i> <i>On what continent is the Sahara Desert?</i> <i>What kind of tree will grow from an acorn?</i> <i>How many square feet are in a square yard?</i> Score 1 point for each correct answer.	____ 12 ____ George Washington (or Washington) ____ Africa (or African continent) ____ oak (or oak tree) ____ 9	____/5
8. <i>A few minutes ago I read a list of nine words to you. Now I want you to tell me as many of the words on that list as you can remember.</i> Score 1 point for each word recalled	____ dentist ____ pepper ____ shoes ____ mustard ____ waitress ____ pants ____ teacher ____ hat ____ vanilla	____/9

Total correct: ____/50

MSE-TV in SSDI/SSI Beneficiaries

Variable	ABC Full Sample (n = 234)	ABC Matched Sample (n = 139)	SSA Sample (n = 139)
Age (years)	54 \pm 17	43 \pm 13	41 \pm 11
Sex (M:F%)	44:56	42:58	45:55
Race (W:B:O%)	79:18:2	68:29:3	26:64:5
Educ. (years)	14 \pm 3	14 \pm 3	N/A
MMSE	28 \pm 2	28 \pm 2	24 \pm 4

PCA with Varimax Rotation Factor Loadings for ABC and SSA Samples

Question	Factor 1 General Ability		Factor 2 Learning/Memory		Factor 3 Orientation	
	ABC	SSA	ABC	SSA	ABC	SSA
Orientation					.93	.99
Word recall (1)			.75	.84		
Word recall (2)			.83	.86		
Serial 7's	.77	.79				
Opposites	.68	.80				
Arithmetic	.60	.80				
Information	.73	.69				
Word recall (3)			.82	.78		

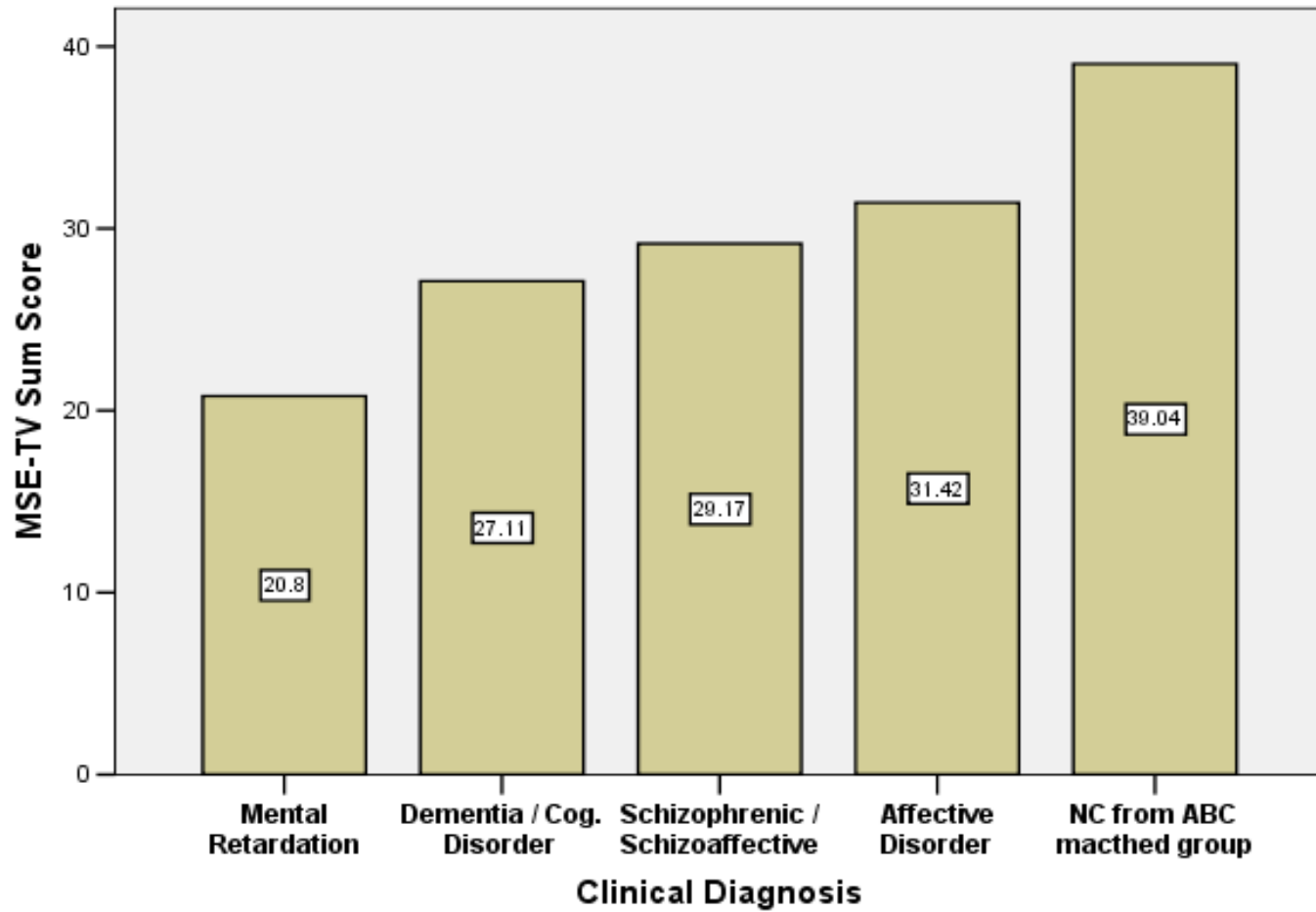
Correlations of MSE-TV Scores with Other Cognitive Measures

Variable	MSE-TV Total	MMSE Total	Factor 1 General Ability	Factor 2 Learning & Memory	Factor 3 Temporal Orientation
WAIS-R Sum SS	0.63**	0.53**	0.66**	0.42**	0.02
NART IQ	0.58**	0.37**	0.69**	0.32**	0.03
HVLT Learning	0.48**	0.30**	0.27**	0.50**	0.05
HVLT Delay	0.44**	0.27**	0.27**	0.45**	0.13
BVMT Learning	0.44**	0.33**	0.27**	0.40**	0.06
BVMT Delay	0.35**	0.33**	0.21**	0.40**	0.07

Group Differences in MSE-TV Scores

MSE-TV Variable	Healthy Controls (N = 139)	Affective Disorder (N = 59)	Schizophrenia Spectrum (N = 36)	Cognitive Disorder (N = 18)	Mental Retardation (N = 20)
Total	39.0 ± 5.5 _a	31.4 ± 7.5 _b	29.2 ± 5.8 _b	27.1 ± 6.6 _b	20.8 ± 6.4 _c
Factor 1	14.5 ± 3.2 _a	10.9 ± 4.4 _b	10.8 ± 3.5 _b	8.9 ± 4.5 _b	4.7 ± 3.0 _c
Factor 2	20.6 ± 3.4 _a	16.5 ± 3.9 _b	14.5 ± 3.8 _b	14.2 ± 4.0 _b	12.2 ± 4.5 _c
Factor 3	3.9 ± 0.3	4.0 ± 0.0	3.9 ± 0.4	3.9 ± 0.2	4.0 ± 0.2

MSE-TV Score by Clinical Diagnosis



Comment on Two-Factor Models

- Allow for slightly more fine-grained assessment of cognitive functioning and impairments
- Gc reflects over-learned “premorbid” verbal abilities that are relatively insensitive to aging and brain dysfunction
- Gf reflects current nonverbal problem solving abilities that are sensitive to age and brain dysfunction
- These two factors can be combined into one

Multiple-Factor Models

- Several multiple-factor models emerged from our (selective) review of the literature
- The most robust and well-replicated factors include
 - General mental ability (*g*)
 - Verbal learning and memory
 - Processing speed
- Somewhat less clear (in terms of independence)
 - Working memory
 - Attention/concentration
 - Executive functioning
 - Ideational fluency

Johns Hopkins Confirmatory Factor Analysis in Three Populations

- Determine whether the same hypothesized latent factors would characterize cognitive functioning in three groups
- Test hypothesized model against specific alternatives
- Hypothesized model based on previous study (Schretlen et al, 2007)

Participants and Method

Recruited 576 participants, including 340 reasonably healthy adults (NC), 110 relatively stable individuals with schizophrenia (SZ), and 126 relatively stable persons with bipolar disorder (BD).

All participants underwent cognitive testing.

	NC (n = 340)	SZ (n=110)	BD (n=126)	Statistic	<i>p</i>
Age (years)	54 ± 19	40 ± 11	42 ± 11	$F_{(2,571)} = 44.1$	<.001
Sex (male, %)	44	70	40	$\chi^2_{(2)} = 28.2$	<.001
Race (w:b:o %)	79:18:3	39:55:6	55:40:5	$\chi^2_{(4)} = 68.9$	<.001
Education (years)	14 ± 3	12 ± 2	14 ± 3	$F_{(2,571)} = 19.5$	<.001
Est. premorbid IQ	105 ± 10	97 ± 11	103 ± 12	$F_{(2,,571)} = 23.3$	<.001

Clinical Characteristics of the Patients

	SZ (n=110)	BD (n=126)	Statistic	<i>p</i>
Age at onset , years	23 ± 7	25 ± 9	$t_{(212)} = -1.8$	.064
Illness duration, years	17 ± 11	18 ± 11	$t_{(212)} = -0.6$	.519
# Hospitalizations	5.0 ± 5.6	3.7 ± 5.1	$t_{(210)} = 1.8$	.066
SANS (sum)	8.9 ± 5.5	1.8 ± 2.4	$t_{(193)} = 8.6$	.001
SAPS (sum)	4.7 ± 3.8	1.0 ± 1.8	$t_{(191)} = 11.9$	.001
Typical antipsychotic (%)	34	5	$\chi^2_{(1)} = 14.7$	.001
Atypical antipsychotic (%)	74	47	$\chi^2_{(1)} = 13.9$	.001
Antidepressant (%)	23	48	$\chi^2_{(1)} = 12.0$	.002
Lithium (%)	4	56	$\chi^2_{(1)} = 58.6$	.001
Anticonvulsant (%)	12	44	$\chi^2_{(1)} = 23.7$	.001

Competing Models

Six-Factor Model

Factor	Measures
Psychomotor Speed	TMT-A, TMT-B, and GPT (mean of both hands)
Attention	BTA-L, BTA-N, and CPT Hit RTse
Ideational Fluency	Letter, Category, and Design Fluency
Verbal Memory	HVLT-R Learning and delayed recall
Visual Memory	BVMT-R Learning and delayed recall
Executive Function	mWCST category sorts and errors

Six-Factor Model with TMT-B on EF

Factors	Measures
Psychomotor Speed	TMT-A and GPT (mean of both hands)
Attention	BTA-L, BTA-N, and CPT Hit RTse
Ideational Fluency	Letter, Category, and Design Fluency
Verbal Memory	HVLT-R Learning and delayed recall
Visual Memory	BVMT-R Learning and delayed recall
Executive Function	TMT-B, mWCST categories and errors

Five-Factor “Speed” Model

Factors	Measures
Psychomotor Speed	TMT-A, TMT-B, GPT, Letter, Category, and Design
Attention	BTA-L, BTA-N and CPT Hit RTse
Verbal Memory	HVLT-R Learning and delayed recall
Visual Memory	BVMT-R Learning and delayed recall
Executive Function	mWCST category sorts and errors

Five-Factor “Memory” Model

Factors	Measures
Psychomotor Speed	TMT-A, TMT-B and GPT (mean of both hands)
Attention	BTA-L, BTA-N and CPT Hit RTse
Ideational Fluency	Letter, Category, and Design Fluency
Memory	HVLT-R and BVMT-R learning and delayed recall
Executive Function	Wcst categories and Wcst errors

Four-Factor Model

Factors	Measures
Psychomotor Speed	TMT-A, TMT-B, GPT, Letter, Category, and Design
Attention	BTA-L, BTA-N and CPT Hit RTse
Memory	HVLT-R and BVMT-R learning and delayed recall
Executive Function	mWCST category sorts and errors

One-Factor Model

Factors	Measures
General Cognition	All measures

Evaluating CFA Results

Statistic	Name	Recommended Values
χ^2/df	Chi-square/df	< 3 is a good fit
RMSEA	Root mean square error of approximation	< 0.05 is a very good fit < 0.08 is a reasonable fit
NNFI	Non-normed fit index	> 0.95 is a close fit > 0.90 is a good fit
CFI	Comparative fit index	> 0.95 is a close fit > 0.90 is a good fit

CFA Results: Six-Factor Models

Six-Factor Model

Group	χ^2/df	RMSEA	NNFI	CFI
Combined	2.50	0.051	0.99	0.99
NC	1.79	0.048	0.98	0.99
BD	1.63	0.071	0.96	0.97
SZ	1.40	0.060	0.98	0.98

Six-Factor Model
with TMT-B in EF

Group	χ^2/df	RMSEA	NNFI	CFI
Combined	4.92	0.083	0.95	0.96
NC	3.44	0.085	0.93	0.95
BD	1.93	0.087	0.94	0.95
SZ	2.03	0.097	0.92	0.94

CFA Results: Five-Factor Models

Five-Factor “Speed”
Model

Group	χ^2/df	RMSEA	NNFI	CFI
Combined	4.75	0.081	0.96	0.97
NC	3.38	0.084	0.95	0.96
BD	1.82	0.081	0.95	0.96
SZ	1.54	0.071	0.96	0.97

Five-Factor “Memory”
Model

Group	χ^2/df	RMSEA	NNFI	CFI
Combined	10.16	0.126	0.89	0.92
NC	4.41	0.100	0.91	0.93
BD	2.59	0.112	0.87	0.90
SZ	2.68	0.124	0.89	0.91

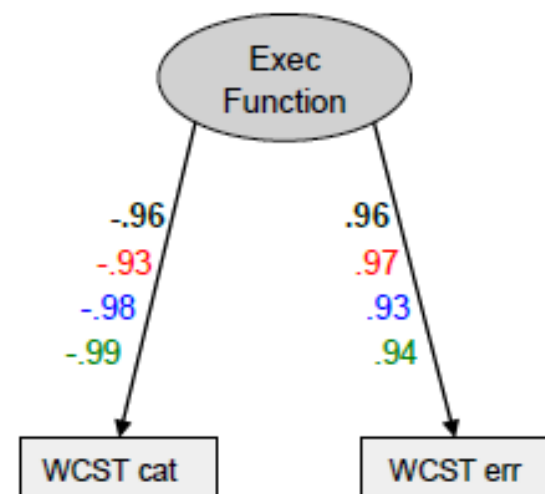
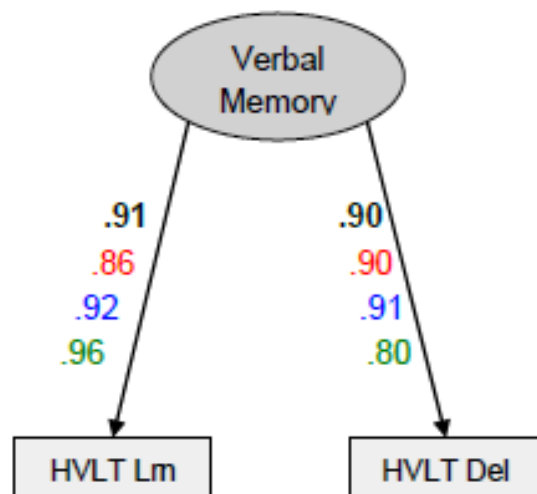
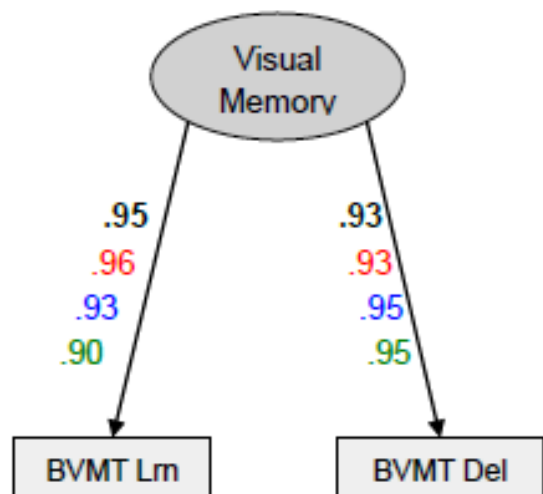
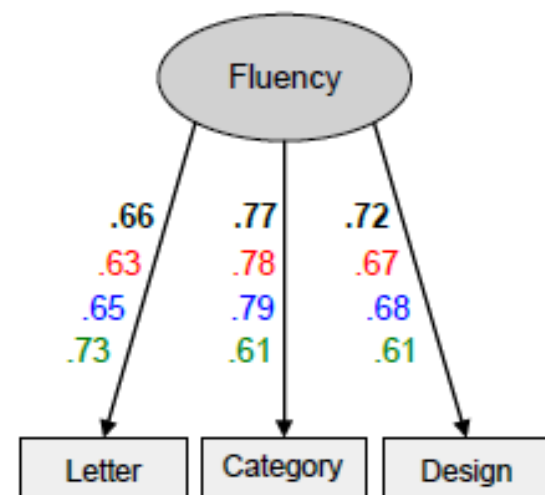
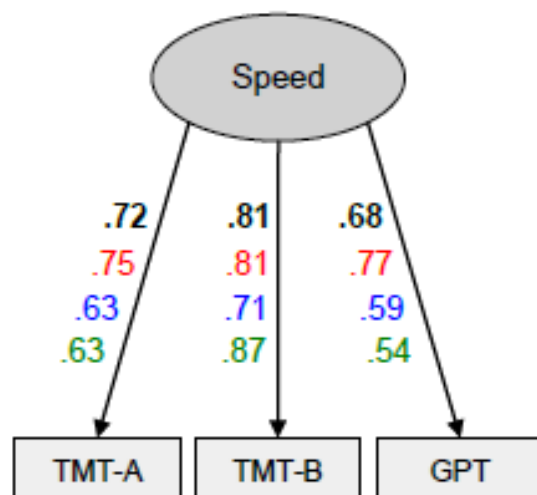
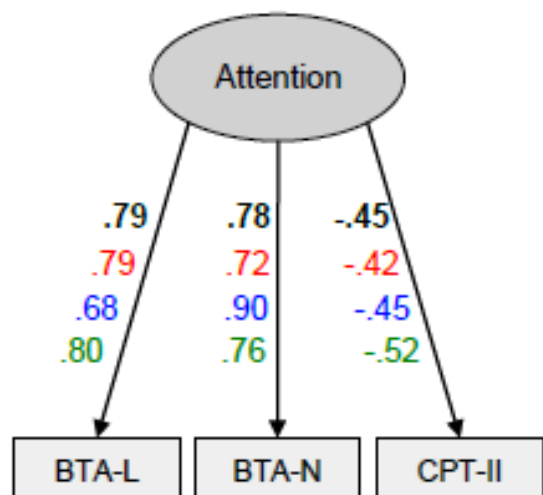
CFA Results: Remaining Models

Four-Factor Model

Group	χ^2/df	RMSEA	NNFI	CFI
Combined	11.01	0.132	0.90	0.92
NC	5.69	0.117	0.89	0.91
BD	2.75	0.118	0.87	0.89
SZ	2.76	0.127	0.88	0.91

One-Factor (*g*) Model

Group	χ^2/df	RMSEA	NNFI	CFI
Combined	18.89	0.176	0.76	0.80
NC	12.15	0.181	0.70	0.74
BD	3.95	0.165	0.78	0.81
SZ	4.65	0.171	0.72	0.76



Factor loadings: Entire Sample; Normal Controls; Bipolar disorder; Schizophrenia

Comment

- In this CFA, the hypothesized six-factor model showed a good to excellent fit by all evaluative measures
- Other hypothesized models did not fit the data as well
- However, another ensemble of tests almost certainly would yield a different “optimal” solution
- Therefore, the question of whether to assess mental FRA using a multi-factor model probably should precede the selection of which domains to assess
 - My personal recommendation is to assess 3–6 domains

Other Big Issues

- Shall we use performance-based measures or informant rating scales, or both?
 - And who should administer them? Change models?
- How shall we validate decision criteria?
 - I know of no existing data defining disability “thresholds”
- Shall we use available measures or create a proprietary set that SSA creates, standardizes, and updates?
 - This would be my recommendation for many reasons
 - Existing tests become obsolete, raise royalty issues
- There is a theme: The need to design and conduct a couple studies

