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COGNITIVE PROFILE ANALYSIS IN SCHOOL PSYCHOLOGY

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Black Box Warning

"cognitive profile analysis in all of its forms has long been implicated as psychometrically flawed (Canivez, 2013; Kranzler et al., 2016, Macmann & Barnett, 1997; McDermott et al., 1990, 1992; Watkins, 2000) and the ecological/treatment utility of the strengths and weaknesses generated from these analyses has historically been poor (Burns et al., 2016; Elliott & Resing, 2015; Fletcher & Miciak, 2016). As a result, the scores associated with these analyses and the methodologies where employed should be interpreted with caution."

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Cognitive profile analysis in school psychology: History, issues, and continued concerns

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ABSTRACT

Intelligence testing remains a fixture in school psychology training and practice. Despite their popularity, the use of IQ tests is not without controversy and researchers have long debated how these measures should be interpreted with children and adolescents. A controversial aspect of this debate relates to the utility of cognitive profile analysis, a class of interpretive methods that encourage practitioners to make diagnostic decisions and/or treatment recommendations based on the strengths and weaknesses observed in ability score profiles. Whereas numerous empirical studies and reviews have challenged long-standing assumptions about the utility of these methods, much of this literature is nearly two decades old and new profile analysis methods (e.g., XBA, PSW) have been proffered. To help update the field's understanding of these issues, the present review traces the historical development of cognitive profile analysis and (re)introduces readers to a body of research evidence suggesting new and continued concerns with the use of these methods in school psychology practice. It is believed that this review will serve as a useful resource to practitioners and trainers for understanding and promoting a countering view on these matters.

Overview and Goals

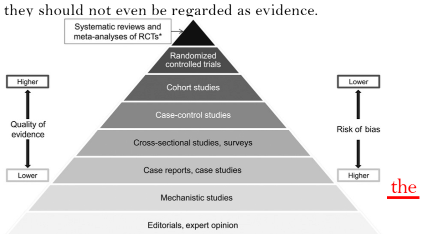
- Discuss historical roots of profile analysis methods.
- Core assumptions of modern profile analytic methods.
- Potential psychometric and conceptual issues.
- Current status of profile analysis in school psychology training and practice.
- Concluding thoughts.
- Q&A.

Some Caveats…

- These are value laden issues.
- Stipulate:.
  - Profile analysis has long made intuitive sense.
  - We were all taught to do this stuff too.

Guiding Principle 1: Sources of Evidence

- *Evidentiary* sources are not equal.
  - Sometimes they should not even be regarded as evidence.
- Things to c
  - Quality of
  - Empirical
  - Peer reviev
  - Are claims
  - Potential c
- Important the evidence ba

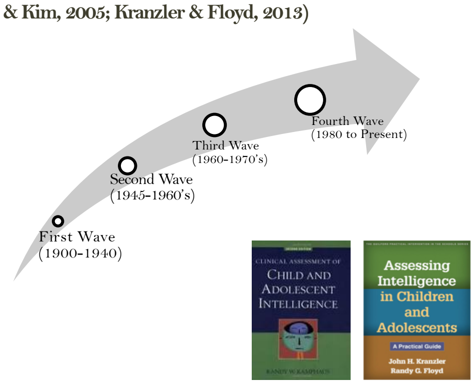


Guiding Principle 2: Measurement Matters

- Reliability (Consistency in scores/measurement).
- Validity (Appropriateness of inferences based on test scores).
- Diagnostic Utility (Individual applications: prediction for the individual, diagnostic utility, classification of individuals).
- Treatment Validity (Link between a test score or score comparison that reliably indicates some specific treatment or differential application produces differential improvement.

Procedures used for diagnostic decision-making in school psychology must be supported with appropriate scientific evidence above and beyond a subjective belief that such procedures are valid (Lilienfeld, Ammirati, & David, 2012).

History of Intelligence Test Interpretation (Kamphaus, Winsor, Rowe, & Kim, 2005; Kranzler & Floyd, 2013)



Profile Analysis 1.0 (1930-1997)

- Clinical influence of the Wechsler Scales.
  - Early speculation about pathognomonic meaning of subtest profiles.
- Abnormal test scatter (Harris & Shakow, 1938).
- Diagnostic psychological testing (Rappaport, Gil, & Shaffer, 1946).
  - First formal system that could be used across tests.
  - Systematic step-by-step level of analysis.
  - Visual inspection of scores.
- Ipsative assessment (Davis, 1959)
  - Deviation of score from reference anchor
  - plus = strength, minus = weakness

Intelligent Testing (IT; Kaufman, 1979; 1993)

- Step 1: Interpret the global composite.
- Step 2: Interpret the index scores.
- Step 3: Interpret subtest scores.
- Step 4: Evaluate index-level strengths and weaknesses.
- Step 5: Evaluate subtest-level strengths and weaknesses.
- Step 6: Evaluate test-session behaviors.

Key Elements of 1.0 Approaches

- Encourage subtest-level analysis.
- Largely test specific (i.e., Wechsler Scales).
- De-emphasize interpretation of FSIQ.
- Scatter analyses.
- Heavy emphasis on ipsative analyses.
- Many of these approaches emerged during a time in which the tools for advanced psychometric analyses were largely underdeveloped.
  - Advanced and maintained largely through clinical lore.

Seminal 1.0 Critiques

- "Just say no" (McDermott et al., 1990)
- Illusions of meaning (McDermott et al., 1992).
- Myth of the master detective (Macmann & Barnett, 1997).
- Generalizability of test session BX (Glutting et al., 1996).
- Why does Wechsler subtest profiles analysis persist (Bray, Kehle, & Hintze, 1998)?
- Shared professional myth (Watkins, 2000).
- IQ subtest analysis: Clinical illusion (Watkins, 2003).

"scientific psychological practice cannot be sustained by clinical conjectures and personal anecdotes that have consistently failed empirical validation. Consequently, psychologists should eschew interpretation of cognitive test profiles and must accept that they are acting in opposition to the scientific evidence if they engage in this practice"

-Watkins (2000, p. 476)

Long-Term Stability of S/Ws (Watkins & Canivez, 2004)

0.01-0.20 slight
0.21-0.40 fair
0.41-0.60 moderate
0.61-0.80 substantial
0.81-1.00 almost perfect

Table 2
Kappa Coefficients for WISC–III Subtests and IQ Components Across Shorter (≤2.0 Years), Longer (>2.0 Years), and Total Test–Retest Intervals

Subtest–IQ component	Shorter interval[a]	Longer interval[b]	Total interval[c]
PC	.062	.039	.041
IN	.163	−.007	.017
CD	.179*	.064	.086*
SM	.049	.039	.041
PA	.050	.088*	.085*
AR	—	−.046	−.026
BD	−.066	−.025	−.031
VO	−.086	.072*	.052
OA	−.041	.012	.006
CM	.014	−.008	−.004
SS	—	−.013	.023
DS	—	.022	.006
VIQ–PIQ (±11 points)	.034	−.023	−.013
VIQ–PIQ (±19 points)	.000	.023	.020
VC–FD (±13 points)	−.016	.039	.030
PO–PS (±15 points)	—	−.097	−.126
VC–PO (±12 points)	.121	−.051	−.024
VC–PO (±19 points)	.340*	.024	.075
VIQ scatter (≥7 points)	−.040	−.002	−.009
PIQ scatter (≥9 points)	.023	.107*	.099*
VC scatter (≥7 points)	−.078	−.003	−.015
PO scatter (≥8 points)	−.051	.091*	.078
Mdn κ	.019	.017	.019
M test–retest interval	1.7	3.0	2.8

Note. WISC–III = Wechsler Intelligence Scale for Children—Third Edition. PC = Picture Completion; IN = Information; CD = Coding; SM = Similarities; PA = Picture Arrangement; AR = Arithmetic; BD = Block Design; VO = Vocabulary; OA = Object Assembly; CM = Comprehension; SS = Symbol Search; DS = Digit Span; VIQ = Verbal IQ; PIQ = Performance IQ; VC = Verbal Comprehension Index; FD = Freedom From Distractability Index; PO = Perceptual Organization Index; PS = Perceptual Speed Index; scatter = high–low score of each index–IQ; — = sample size too small to calculate.
[a] N = 13 for PS; 41 for FD; and 66 for VC, PO, VIQ, and PIQ comparisons. [b] N = 132 for PS; 377 for FD; and 513 for VC, PO, VIQ, and PIQ comparisons. [c] N = 145 for PS; 418 for FD; and 579 for VC, PO, VIQ, and PIQ comparisons.
* $p < .05$.

Profile Analysis 2.0 (1997-Present)

- Modified IT (Flanagan & Alfonso, 2016)
  - De-emphasize subtest and most ipsative comparisons.
  - Scatter analysis?
- CHC-inspired approaches to test interpretation:
  - Cross-battery assessment.
  - Dual/discrepancy consistency model.
  - C-LIM.
- Other within and between test approaches:
  - SNP.
  - Other PSW methods (e.g., Naglieri, 2011; Hale & Fiorello, 2004).

Assumptions of 2.0 Approaches

- Theoretical advances (i.e., CHC) enable us to make more defensible inferences from score profiles.
  - Previous limitations are no longer relevant in most circumstances
- Primary interpretation at the broad ability factor/composite-level
  - The scores reflect legitimate psychological dimensions.
  - If located, these constructs are measured well.
  - Unique profiles and signs are diagnostically valid and have implications for treatment.
  - Score profiles are stable over time.
- FSIQ continues to be de-emphasized.
- Clinicians are able to engage in complex configural analyses (McFall, 1989).

Factor Extraction Criteria for Ability Measures

Criteria Used to Determine the Number of Factors Measured for Ability Measures

Test	Publication Year	Theory	EFA/PCA	CFA	Factors	HPA	MAP
WJ-III	2001	X	X	X	7	3-4	1-2
SB-V	2003	X		X	5	1-2	1
KABC-II	2004	X		X	5	4	1
DAS-II	2007	X		X	3	1	1
WISC-V	2014	X		X	5	2-3	1
WJ-IV	2014	X	X	X	7	3-4	1-2

Note. HPA and MAP values calculated from independent EFA studies.

Applied EFA Example Featuring the WJ-IV (Dombrowski et al., 2018)

Table 3

Sources of WJ IV Subtest Variance According to Schmid-Leiman Orthogonalization of Seven Factors (Ages 9–13)

Subtest (hypothesized CHC factor)	Second-order factor *g* *b*	*g* S^2	First-order factors F1 *b*	F1 S^2	F2 *b*	F2 S^2	F3 *b*	F3 S^2	F4 *b*	F4 S^2	F5 *b*	F5 S^2	F6 *b*	F6 S^2	F7 *b*	F7 S^2	h^2	u^2
Verbal Attention (Gwm)	.58	.33	**.45**	**.21**	−.14	.02	−.04	.00	.03	.00	.15	.02	−.05	.00	.06	.00	.59	.41
Mem for Words (Aud Mem)	.53	.28	**.44**	**.19**	.08	.01	−.10	.01	−.10	.01	−.06	.00	.14	.02	.06	.00	.53	.47
Object Num Sequence (Ga)	.67	.44	**.37**	**.14**	.10	.01	.13	.02	−.04	.00	−.08	.01	−.03	.00	.03	.00	.62	.39
Nonword Repetition (Ga)	.50	.25	**.36**	**.13**	.05	.00	.01	.00	.06	.00	−.09	.01	.04	.00	−.28	*.08*	.47	.53
Phonological Process (Ga)	.59	.35	.26	.07	−.06	.00	.08	.01	.08	.01	.02	.00	*.28*	*.08*	.08	.01	.51	.49
Picture Recognition (Gv)	.42	.17	−.01	.00	**.45**	**.20**	.05	.00	.05	.00	−.12	.01	−.19	.04	.05	.00	.44	.57
Visualization (Gv)	.52	.27	.00	.00	**.45**	**.20**	.00	.00	−.01	.00	.02	.00	.08	.01	−.04	.00	.48	.52
Vis Aud Learning (Glr)	.43	.18	.02	.00	**.38**	**.14**	−.05	.00	−.02	.00	−.07	.00	.20	.04	.11	.01	.38	.62
Analysis-Synthesis (Gf)	.56	.31	−.05	.00	**.34**	**.11**	.01	.00	−.01	.00	.21	.04	.16	.03	.07	.01	.50	.50
Story Recall (Glr)	.47	.22	.08	.01	.25	.06	−.04	.00	.04	.00	.17	.03	−.08	.01	−.08	.01	.34	.66
Pair Cancellation (Gs)	.53	.28	−.01	.00	−.04	.00	**.59**	**.34**	.00	.00	−.08	.01	.13	.02	−.12	.01	.66	.34
Letter-Pattern Match (Gs)	.59	.35	−.03	.00	.03	.00	**.51**	**.26**	.05	.00	−.02	.00	−.05	.00	.23	.05	.66	.34
Number-Pattern Match (PerSpd)	.55	.30	.00	.00	.01	.00	**.44**	**.20**	−.10	.01	.24	.06	−.05	.00	−.01	.00	.56	.44
General Information (Gc)	.51	.26	−.04	.00	.05	.00	−.04	.00	**.61**	**.37**	−.04	.00	−.02	.00	.05	.00	.64	.36
Oral Vocabulary (Gc)	.64	.41	.02	.00	−.03	.00	.02	.00	**.57**	**.33**	.07	.01	.08	.01	−.04	.00	.75	.25
Number Series (Gf)	.53	.28	.00	.00	−.02	.00	.04	.00	.02	.00	**.54**	**.29**	.08	.01	.08	.01	.59	.41
Concept Formation (Gf)	.56	.31	.03	.00	.24	.06	.03	.00	.02	.00	.10	.01	**.39**	**.15**	−.11	.01	.54	.46
Numbers Reversed (Gwm)	.54	.29	.18	.03	.09	.01	.03	.00	.04	.00	.08	.01	−.05	.00	**.33**	**.11**	.45	.55
Common variance		.55		.08		.09		.09		.08		.05		.04		.03	.54	.46
Total variance		.27		.04		.04		.04		.04		.03		.02		.02		
ω_H/ω_{HS}		.83		.27		.28		.37		.42		.29		.16		.11		

Note. CHC = Cattell-Horn-Carroll; Gwm = short-term memory; Aud Mem = auditory memory; Ga = auditory processing; Gv = visual-spatial thinking; Glr = long-term retrieval; Gf = fluid reasoning; Gs = processing speed; PerSpd = perceptual speed; Gc = comprehension-knowledge; *b* = factor loading, S^2 = variance explained, h^2 = communality, u^2 = uniqueness, ω_H = Omega hierarchical (*g*), ω_{HS} = Omega-hierarchical subscale (group factors F1-F7). Loadings ≥ .30 are bolded (Carroll, 1993, p. 108; Child, 2006). Note that alignment of subtests with respective CHC stratum I or II factors posited in the Woodcock-Johnson, 4th ed. (WJ IV) *Technical Manual* is indicted following each subtest name.

CFA Replication (Dombrowski et al., 2018)

Table 2

CFA Fit Statistics for the Age 9 to 13 Group

Model	χ^2	*df*	CFI	TLI	SRMR	RMSEA	RMSEA 90% CI	BIC	AIC
g	4,084.860	135	.679	.636	.078	.132	[.128, .135]	144,444	144,152
Three-factor (Gc, Gf, Gs) bifactor	Inadmissible model—not positive definite covariance matrix, negative residual variance OV –.14								
Three-factor oblique (Gc, Gf, Gs)	2,700.708	132	.791	.758	.060	.108	[.104, .111]	143,083	142,774
Three-factor (Gc, Gf, Gs) higher order Woodcock cognitive processing model	2,794.331	132	.784	.749	.068	.11	[.106, .113]	142,867	143,177
Seven-factor oblique	Inadmissible model—not positive definite covariance matrix, negative residual variance (Gwm loads Ga 1.041; OV loads Gc .989)								
Seven-factor higher order (theoretically proposed but not tested by publisher)	Inadmissible model—not positive definite covariance matrix, Ga loads g 1.02 & neg residual variance –.039								
Seven-factor bifactor	2,289.285	124	.824	.783	.059	.102	[.098, .106]	142,730	142,378
Four-factor oblique	2,073.499	129	.842	.813	.062	.095	[.091, .098]	142,478	142,152
Four-factor higher order	2,077.775	131	.842	.815	.062	.094	[.090, .098]	142,467	142,153
Four-factor bifactor (Dombrowski, McGill, & Canivez, 2017a; Age 9 to 13)	1,665.445	118	.874	.837	.046	.088	[.085, .092]	142,152	141,766

Note. *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; SRMR = standardized root mean square residual; RMSEA = root mean square error of approximation; CI = confidence interval; BIC = Bayesian information criterion; AIC = Akaike information criterion; *g* = general intelligence. Gwm = working memory; Ga = auditory processing; Gv = visual-spatial thinking; Glr = long-term retrieval; Gf = fluid reasoning; Gs = processing speed; Gc = comprehension-knowledge/crystallized ability; OV = Oral Vocabulary.

Another Potential Confound (Carroll, 1993; 1995)

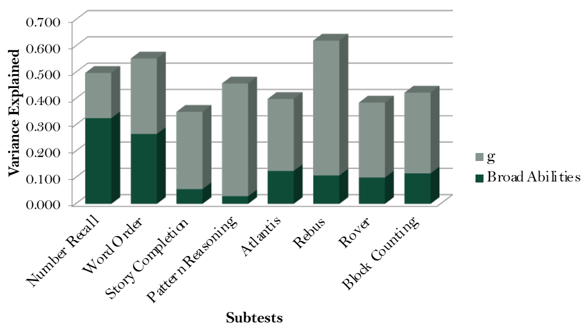


Table 7

Sources of Variance in the Wechsler Intelligence Scale for Children-Fifth Edition (WISC–V) 10 Primary Subtests for the Total Standardization Sample (N = 2,200) According to an Exploratory Bifactor Model (Orthogonalized Higher-Order Factor Model) with Five First–Order Factors

WISC-V	General		F1: VS		F2: VC		F3: PS		F4: WM		F5: FR			
Subtest	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	h^2	u^2
SI	.676	.457	.004	.000	**.433**	**.187**	.021	.000	.030	.001	.002	.000	.646	.354
VC	.688	.473	.022	.000	**.496**	**.246**	-.014	.000	-.014	.000	-.004	.000	.720	.280
BD	.652	.425	**.312**	**.097**	.014	.000	.108	.012	-.018	.000	.086	.007	.542	.458
VP	.667	.445	**.543**	**.295**	.010	.000	-.042	.002	.017	.000	-.036	.001	.743	.257
MR	.646	.417	.089	.008	.009	.000	.011	.000	.049	.002	**.213**	**.045**	.473	.527
FW	.642	.412	.125	.016	.059	.003	-.060	.004	.010	.000	**.203**	**.041**	.476	.524
DS	.653	.426	.004	.000	.038	.001	.019	.000	**.342**	**.117**	.041	.002	.547	.453
PS	.564	.318	.008	.000	-.009	.000	-.003	.000	**.417**	**.174**	-.020	.000	.493	.507
CD	.374	.140	-.029	.001	.001	.000	**.715**	**.511**	-.010	.000	-.008	.000	.652	.348
SS	.425	.181	.037	.001	.001	.000	**.589**	**.347**	.016	.000	-.007	.000	.529	.471
Total S^2		.369		.042		.044		.088		.030		.010	.582	.418
Common S^2		.635		.072		.075		.151		.051		.017		
	ω_h = .812		ω_s = .228		ω_s = .257		ω_s = .538		ω_s = .191		ω_s = .059			

Note. WISC–V Subtests: SI = Similarities, VC = Vocabulary, BD = Block Design, VP = Visual Puzzles, MR = Matrix Reasoning, FW = Figure Weights, DS = Digit Span, PS = Picture Span, CD = Coding, SS = Symbol Search. WISC–V Factors: VS = Visual Spatial, VC = Verbal Comprehension, PS = Processing Speed, WM = Working Memory, FR = Fluid Reasoning. *b* = loading of subtest on factor, S^2 = variance explained, h^2 = communality, u^2 = uniqueness. Bold type indicates coefficients and variance estimates consistent with the theoretically proposed factor.

Interpret | Don't Interpret | Maybe Interpret | Don't Interpret

Table 1

Omega Estimates for Contemporary Cognitive Measures Based Upon Suggested Alignment with CHC Theory

Test	Source	Method	g	Gc	Gf	Ga	Gv	Gsm/wm	Glr	Gs
DAS-II	Canivez & McGill (2016)	EFA	.819	.266	.066		.140			
KABC-II	McGill & Dombrowski (2017)	EFA	.800	.197	*		*	.393	.236	
WAIS-IV	Gignac & Watkins (2013)	CFA	.840	.290	*		*	.280		.390
WISC-IV Spanish	McGill & Canivez (2016)	EFA	.833	.280	*		*	.120		.179
	McGill & Canivez (2017)	CFA	.870	.280	.000		.150	.150		.320
WISC-V	Dombrowski et al. (2015)	EFA	.849	**	*		*	.190		.162
	Canivez, Watkins, & Dombrowski (2016)	EFA	.828	.251	*		*	.185		.505
	Canivez, Watkins, & Dombrowski (2017)	CFA	.849	.200	*		*	.182		.516
WPPSI-IV	Watkins & Beaujean (2014)	CFA	.860	.270	.050		.120	.110		.330
WJ IV Cognitive	Dombrowski, McGill, & Canivez (2017)	EFA	.797	.489	*	**	*	.213	*	.355
	Dombrowski, McGIll, & Canivez (in press)	CFA	.829	.373	*	*	*	.211	*	.282

Stability of Composite Scores

- Long-term stability of scores and unique PSWs (e.g., Watkins & Smith, 2013).
  - ~30-40% of participants' index scores fluctuated by >10 points.
- Examiner bias (McDermott, Watkins, & Rhoad, 2014).
  - All scores suffered from non-trivial assessor bias.
  - Implications for PSW?

Diagnostic Utility of PSW

- These findings have been replicated in every subsequent study examining DV of various PSW methods and permutations (Kranzler et al., 2016, 2019; McGill, Conoyer, & Fefer, 2018, Miciak et al., 2014, Miciak, Taylor, Denton, & Fletcher, 2015; Taylor, Miciak, Fletcher, & Francus 2017).
- No comparable study reporting positive findings has been produced.
- Factors that degrade decision utility:
  - Test selection.
  - More assessment.
    - Dilution effect (Faust, 1989; Nisbett et al., 1981)

Evidence-Based?

> "Most defenders of the role of cognitive assessment in the diagnosis and treatment of learning disabilities believe that a comprehensive cognitive assessment is essential and that knowing about a person's cognitive abilities leads to better decisions about interventions (Hale et al., 2010). After rereading dozens of papers defending such assertions, including our own, we can say that this position is mostly backed by rhetoric in which assertions are backed by citations of other scholars making assertions backed by citations of still other scholars making assertions. There is nothing wrong with making and citing assertions, but to confuse such assertions with epistemological bedrock is to be epistemologically confused and groundless
>
> Schneider & Kaufman, 2017, p. 8.

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Schneider & Kaufman, 2017, p. 8.

Treatment Utility: Can 200 Studies Be Wrong?

School Psychology Quarterly
2016, Vol. 31, No. 1, 28–42

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Meta-Analysis of Academic Interventions Derived From Neuropsychological Data

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Several scholars have recommended using data from neuropsychological tests to develop interventions for reading and mathematics. The current study examined the effects of using neuropsychological data within the intervention process with meta-analytic procedures. A total of 1,126 articles were found from an electronic search and compared to inclusion criteria, which resulted in 37 articles that were included in the current study. Each article was coded based on how the data were used (screening—86% or designing interventions—14%), size of the group for which interventions were delivered (small group—45%, individual students—45%, or entire classroom—10%),

How Popular is Profile Analysis?

- Contemporary surveys continue to indicate that it remains extremely popular among practitioners (Benson et al., 2018; Sotelo & Dynega Dixon, 2014).
  - ~50-70% of respondents report using index-level profile analysis on a routine basis.
  - Over 25% indicate that they continue to interpret subtest-level profiles.
  - Over half indicate that they rely exclusively on the levels-of-analysis approach championed by Kaufman and Sattler.
  - 46% indicate that they *never* interpret the FSIQ when there is significant scatter.
- Majority of training programs emphasize intelligent testing and/or XBA (Lockwood & Farmer, 2019).
- Rise of PSW.

Concluding Thoughts

- Despite being characterized as new and modern, 2.0 profile analysis methods are in many ways simply re-paramterizations of previous practices.
  - Same and in some cases new psychometric issues apply.
  - The Voorhees effect.
  - What can you say versus what can you say with confidence?
- Costs associated with these methods (Williams & Miciak, 2018).
- Implications for informed consent (Posada, 2004).

"He that forsakes measure, measure forsakes him"

-Scottish Proverb

A Thought Experiment…

"I ask myself with humility, if my daughter begins struggling with reading, mathematics, or writing…what questions would I want a school psychologist to ask about her?...What does her profile of CHC broad cognitive abilities look like?...Or would I prefer that the school psychologist determine the existence of a perceived problem, complete an ecologically minded assessment and develop low-inference hypotheses to explain the reason for the problem, draw on empirically based interventions to remedy the problem, and collect data to determine whether the interventions led to reductions in the problem? There is no doubt that I would prefer the second option."

-Floyd (2010, pp. 62-63)

Where Do You Go From Here?

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