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The WJ IV™ *Gf-Gc* Composite and Its Use in the Identification of Specific Learning Disabilities

Fredrick A. Schrank, PhD, ABPP

Kevin S. McGrew, PhD

Nancy Mather, PhD

The authors of the Woodcock-Johnson® IV *(WJ IV; Schrank, McGrew, & Mather, 2014a) discuss the* WJ IV Tests of Cognitive Abilities *(WJ IV COG; Schrank, McGrew, & Mather, 2014b)* Gf-Gc *Composite, contrast its composition with that of the WJ IV COG General Intellectual Ability (GIA) score, and synthesize important information that supports its use as a reliable and valid measure of intellectual development or intellectual level. The authors also suggest that the associated WJ IV COG* Gf-Gc *Composite/Other Ability comparison procedure can yield information that is relevant to the identification of a specific learning disability (SLD) in any model that is allowed under the 2004 reauthorization of the federal Individuals with Disabilities Education Improvement Act (IDEA).*

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The WJ IV™ *Gf-Gc* Composite and Its Use in the Identification of Specific Learning Disabilities

The *Woodcock-Johnson® IV Tests of Cognitive Abilities* (WJ IV COG; Schrank, McGrew, & Mather, 2014b) include a measure of intellectual development that is derived from the Comprehension-Knowledge (*Gc*) and Fluid Reasoning (*Gf*) tests. This *Gf-Gc* Composite is a special-purpose measure of intellectual level based on four academically predictive tests representing the two highest-order (*g*-loaded or *g*-saturated) factors included in the Cattell-Horn-Carroll (CHC) theory of cognitive abilities (McGrew, 2005, 2009; McGrew, LaForte, & Schrank, 2014; Schneider & McGrew, 2012). The *Gf-Gc* Composite is highly correlated with general intelligence (*g*) as measured by the WJ IV COG General Intellectual Ability (GIA) cluster score, as well as by other global indices of general intelligence. By design, the *Gf-Gc* Composite differs from broad-based measures of intellectual ability in an important way: Only *Gf* and *Gc* ability measures are included in the calculation of the score. Conceptually, the *Gf-Gc* Composite is analogous to the Wechsler General Ability Index (GAI), a composite score developed to remove the influence of working memory (*Gwm*) and processing speed (*Gs*) when estimating intelligence (Wechsler, 2008).

Origins of the *Gf-Gc* Composite in Contemporary CHC Theory

The *Gf-Gc* Composite cluster name evokes an implicit reference to the work of Raymond Cattell, who posited the existence of two fundamentally different and distinguishable types of intellectual ability: fluid intelligence (*Gf*) and crystallized intelligence (*Gc*; Cattell, 1941). The name of the cluster pays tribute to Cattell's seminal influence on CHC theory. His legacy factor-analytic work laid a foundation for identifying all cognitive abilities subsequently classified within contemporary CHC theory (McGrew et al., 2014; Schneider & McGrew, 2012). The cluster name also suggests the primacy of *Gf* and *Gc* as the two most important cognitive abilities—those that are both historically and commonly associated with higher-level human cognition.

In contemporary CHC theory, *Gf* includes such abilities as abstract and inductive reasoning, deductive problem solving, and pattern recognition. *Gc* is associated with learned, acquired knowledge, particularly vocabulary knowledge and general information. By combining four of the most predictive and theoretically valid *Gf* and *Gc* tests into a single composite score, the *Gf-Gc* Composite represents, from roughly equal contributions, both the fundamental human capacity of reasoning via logic and the accumulation of knowledge from learning and experience.

The *Woodcock-Johnson IV* (WJ IV; Schrank, McGrew, & Mather, 2014a) authors do not suggest that other cognitive abilities are unimportant in understanding classroom performance or that the *Gf-Gc* Composite is the best predictor of a wide variety of general life outcomes. However, the authors do suggest that *Gf* and *Gc* are the two primary cognitive abilities that may rely on other critical cognitive processes, storage and retrieval functions, or basic cognitive mechanisms to support their development and functioning. For example, *Gc* relies on Long-Term Retrieval (*Glr*) functions to access information from long-term memory. *Gf* is a complex, hierarchical cognitive ability that often utilizes one or more other cognitive processes to effect induction and deduction, including, in particular, Auditory Processing (*Ga*), Visual Processing (*Gv*), and Long-Term Retrieval (*Glr*). Cognitive Processing Speed (*Gs*) is a parameter of cognitive processing efficiency (Schneider & McGrew, 2012) that can facilitate complex cognitive performance when it is intact and automatic but, when slow or impaired, can inhibit the completion of complex cognitive operations. Short-Term Working Memory (*Gwm*) is the active, conscious processing mechanism that both maintains and transforms information in immediate awareness so that reasoning has a venue for performance and that connections to stored acquired knowledge can occur to enable encoding. In contrast to *Gf* and *Gc*, the other broad cognitive abilities defined by CHC theory (*Glr*, *Ga*, *Gv*, *Gs*, and *Gwm*) are viewed as cognitive processes that can affect the development of the abilities to reason and acquire knowledge.

The General Intellectual Ability (GIA) Compared to the *Gf-Gc* Composite

The WJ IV COG GIA cluster score is a measure of psychometric *g*, one of psychology's oldest and most well-researched constructs (Jensen, 1998). The existence of *g* was originally suggested by Galton (1869/1978) and was later empirically established by Spearman (1904). Spearman's student, Raymond Cattell, "concluded that Spearman's *g* was best explained by splitting *g* into general fluid (g_f) and general crystallized (g_c) intelligence" (Schneider & McGrew, 2012, p. 102). More importantly, Cattell (1941) was able to explain how Spearman's *g* arose from interactions between the two "provincial powers" of *Gf* and *Gc*.

The best measure of *g* is based on the broadest spectrum of important cognitive abilities (Jensen, 1998). The WJ IV COG GIA cluster score is derived from seven tests; each test represents the best single measure of one of seven broad CHC abilities. The GIA cluster score is the best estimate of *g* available in the WJ IV as it meets Jensen's *psychometric sampling criterion*: "The particular collection of tests used to estimate *g* should come as close as possible, with some limited number of tests, to being a representative sample of all types of mental tests" (p. 85). Consequently, the WJ IV COG GIA cluster score provides professionals with the best singular predictor—*across individuals*—of overall school achievement and other life outcomes that have some relationship to general intelligence.

Much like the construct of *g*, the WJ IV COG GIA cluster score cannot be defined as a distinct cognitive ability because it is an amalgam of several important cognitive abilities, functions, or processes into a single-score index. Table 1 contains the smoothed *g* weights for each of the seven tests included in the GIA cluster score by technical age groups. A review of these weights suggests that at any one age, the component *Gf* and *Gc* tests combined contribute approximately 35% to the obtained GIA cluster score. The remaining 65% of the obtained GIA cluster score is based on the individual's performance on other tests that Schneider and McGrew (2012), drawing on a number of information processing models (e.g., Kyllonen, 2002; Woodcock, 1993), categorized as either sensory-motor domain-specific abilities or parameters of cognitive efficiency.[1]

Table 1.
General Intellectual Ability Average (Smoothed) g *Weights by Technical Age Groups*

Test	CHC Domain	AGE 2	3	4	5	6	7	8	9	10
Oral Vocabulary	*Gc*	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.18
Number Series	*Gf*	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Verbal Attention	*Gwm*	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.14
Letter-Pattern Matching	*Gs*	0.17	0.16	0.16	0.15	0.14	0.12	0.11	0.11	0.10
Phonological Processing	*Ga*	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.17
Story Recall	*Glr*	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Visualization	*Gv*	0.07	0.07	0.07	0.08	0.08	0.09	0.10	0.10	0.11

Test	CHC Domain	AGE 11	12	13	14	15	16	17	18	19
Oral Vocabulary	*Gc*	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Number Series	*Gf*	0.18	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Verbal Attention	*Gwm*	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Letter-Pattern Matching	*Gs*	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11
Phonological Processing	*Ga*	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Story Recall	*Glr*	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Visualization	*Gv*	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12

Test	CHC Domain	AGE 20–29	30–39	40–49	50–59	60–69	70–79	80+	Median
Oral Vocabulary	*Gc*	0.18	0.18	0.18	0.18	0.17	0.16	0.16	0.18
Number Series	*Gf*	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.17
Verbal Attention	*Gwm*	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.14
Letter-Pattern Matching	*Gs*	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Phonological Processing	*Ga*	0.17	0.17	0.17	0.18	0.18	0.18	0.18	0.17
Story Recall	*Glr*	0.11	0.11	0.12	0.12	0.12	0.12	0.13	0.12
Visualization	*Gv*	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.12

In contrast, 50% of the *Gf-Gc* Composite is derived from two *Gc* tests (Oral Vocabulary and General Information), and the other 50% is derived from two *Gf* tests (Number Series and Concept Formation). When combined, *Gf* and *Gc* represent 100% of the *Gf-Gc* Composite. Although composed of only four tests, the *Gf-Gc* Composite yields highly stable scores, with reliability values comparable to those of the GIA cluster score. The median *Gf-Gc* Composite reliability coefficient is .96 compared to the median GIA reliability coefficient of .97, as reported in Table 2.

[1] Hunt (2011) similarly designates *Gf* and *Gc* as the primary cognitive abilities and all remaining CHC abilities as either measures of short- and long-term memory or abilities related to different sensory modalities.

Table 2.
WJ IV COG Median Intellectual Ability Cluster Reliability Coefficients

Cluster	Median r_{cc}
General Intellectual Ability (GIA)	0.97
Gf-Gc Composite (*Gf-Gc*)	0.96

The *Gf-Gc* Composite as a Measure of Intellectual Development

The rationale for using only *Gf* and *Gc* tests to create an index of intellectual development has its basis in popular, theoretical, and empirically based notions of intelligence. A person's reasoning abilities and knowledge, particularly inductive reasoning and vocabulary knowledge, are the most common expressions of cognitive ability that laypersons observe or perceive and use—*consciously or not*—to gauge the intellectual level of another individual. For example, Sternberg, Conway, Ketron, and Bernstein's (1981) research found that implicit theories of intelligence held by both experts and laypersons typically include three abilities as the hallmarks of intelligence: problem solving abilities, verbal abilities, and social competence. Sternberg et al. (1981) noted that the problem solving and verbal abilities are similar to the Cattell (1941) and Horn (1991) constructs of fluid and crystallized intellectual abilities.

These common conceptualizations of intellectual ability are found among other intelligence scholars as well. For example, 52 prominent intelligence scholars suggested that intelligence could be defined as "a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience" (Gottfredson, 1997, p. 13). Although this definition does not suggest that intelligence is solely a function of *Gf* and *Gc*, the descriptive terms used imply that the *expression* of intelligence—in the classroom and in life—is heavily dependent on *Gf* and *Gc* abilities.

Empirical Research Supports *Gf* and *Gc* as the "King and Queen" of CHC Abilities

Gf, in particular, is often accorded special status as a proxy for general intelligence (*g*). The extant psychometric research demonstrates that *Gf* and *g* are highly correlated, with some researchers suggesting that *Gf* may be isomorphic with *g* (Schneider & McGrew, 2012).[2] *Gc* abilities are also typically considered one of the two most important cornerstones of general intelligence (Hunt, 2000) because "almost any test involving cognition will involve *Gc* and *Gf*, to some degree" (Hunt, 2011, p. 103). To illustrate this idea, Carroll (1993) placed the broad-stratum abilities of *Gf* and *Gc* in closest proximity to the stratum III *g* factor in his three-stratum model figure to designate *Gf* and *Gc* as being more closely aligned with g than the other broad CHC abilities are, establishing their status as the "king and queen".

Selected summary correlations between the *Gf-Gc* Composite and GIA cluster scores in the WJ IV standardization sample are reported in Table 3 for three school-aged groups. Additionally, as reported in McGrew et al. (2014), across all groups spanning ages 6 through late adulthood, the correlations range from .84 to .88 (median $r = .88$). These high correlations support the interpretation of the *Gf-Gc* Composite as a strong proxy

[2] The *Gf* = *g* hypothesis is not a unanimous position among intelligence scholars (see Ackerman, Beier, & Boyle, 2005; Kane, Hambrick, & Conway, 2005). Carroll (2003) believed that the available evidence was sufficient to reject the hypothesis that *Gf* = *g*.

for general intellectual level. The median correlation of .88 indicates that, although highly related, the *Gf-Gc* Composite and GIA cluster scores are not isomorphic—they share approximately 77% common variance. This supports the rationale of the *Gf-Gc* Composite as an alternative index of intellectual level—an alternative that does not include the cognitive processing and efficiency variance that is present in the GIA.

Table 3.
WJ IV COG Intellectual Ability Cluster Score Intercorrelations

	Ages 6 Through 8		Ages 9 Through 13		Ages 14 Through 19	
Cluster	**GIA**	***Gf-Gc***	**GIA**	***Gf-Gc***	**GIA**	***Gf-Gc***
General Intellectual Ability (GIA)	1		1		1	
Gf-Gc Composite (*Gf-Gc*)	0.84	1	0.84	1	0.88	1

As reported in Tables 4 and 5, compared to the GIA cluster score, the *Gf-Gc* Composite sacrifices little in the way of validity when predicting the *Woodcock-Johnson IV Tests of Achievement* (WJ IV ACH; Schrank, Mather, & McGrew, 2014a) reading and mathematics achievement cluster scores when the achievement cluster scores do not also include measures of speed or academic fluency. (The WJ IV ACH Reading, Basic Reading Skills, Reading Comprehension, Reading Comprehension–Extended, Mathematics, and Math Problem Solving clusters do not contain measures of speed or academic fluency.) McGrew et al. (2014) explained, "These findings support the use of the *Gf-Gc* Composite as a predictor of concurrent reading and math achievement" (p. 144).

Table 4.
Correlations Between GIA, Gf-Gc *Composite, and Reading Achievement Cluster Scores Across Five Age Groups*

	Reading Achievement Clusters							
Age Group and Predictor Cluster	**Reading**	**Broad Reading**	**Basic Reading Skills**	**Reading Comprehension**	**Reading Comprehension–Extended**	**Reading Fluency**	**Reading Rate**	**Median**
Ages 6–8 (*n* = 825)								
GIA	0.73	0.73	0.70	0.73	0.77	0.66	0.63	0.73
Gf-Gc Composite	0.72	0.70	0.66	0.70	0.74	0.62	0.55	0.70
Ages 9–13 (*n* = 1,572)								
GIA	0.72	0.73	0.69	0.70	0.75	0.65	0.64	0.70
Gf-Gc Composite	0.71	0.72	0.63	0.69	0.74	0.63	0.58	0.69
Ages 14–19 (*n* = 1,685)								
GIA	0.76	0.75	0.70	0.73	0.78	0.66	0.63	0.73
Gf-Gc Composite	0.75	0.74	0.66	0.72	0.78	0.65	0.58	0.72
Ages 20–39 (*n* = 1,251)								
GIA	0.78	0.77	0.73	0.75	0.80	0.67	0.62	0.75
Gf-Gc Composite	0.77	0.74	0.68	0.74	0.80	0.64	0.54	0.74
Ages 40–90+ (*n* = 1,146)								
GIA	0.80	0.79	0.75	0.77	0.82	0.71	0.68	0.77
Gf-Gc Composite	0.79	0.77	0.70	0.77	0.82	0.68	0.61	0.77

Table 5.
Correlations Between GIA, Gf-Gc *Composite, and Math Achievement Cluster Scores Across Five Age Groups*

Age Group and Predictor Cluster	Math Achievement Clusters: Mathematics	Broad Mathematics	Math Calculation Skills	Math Problem Solving	Median
Ages 6–8 (*n* = 825)					
GIA	0.75	0.76	0.73	0.74	0.74
Gf-Gc Composite	0.72	0.69	0.62	0.76	0.71
Ages 9–13 (*n* = 1,572)					
GIA	0.77	0.78	0.73	0.76	0.76
Gf-Gc Composite	0.76	0.73	0.65	0.77	0.74
Ages 14–19 (*n* = 1,685)					
GIA	0.80	0.80	0.75	0.80	0.80
Gf-Gc Composite	0.80	0.76	0.69	0.81	0.78
Ages 20–39 (*n* = 1,251)					
GIA	0.79	0.79	0.74	0.81	0.79
Gf-Gc Composite	0.79	0.76	0.68	0.82	0.77
Ages 40–90+ (*n* = 1,146)					
GIA	0.80	0.81	0.76	0.82	0.81
Gf-Gc Composite	0.82	0.79	0.72	0.83	0.80

Table 6 contains the correlations of the GIA and *Gf-Gc* Composite cluster scores with the WJ IV writing achievement cluster scores. For written language, the GIA correlations are consistently higher than those of the *Gf-Gc* Composite, perhaps reflecting the relative importance of other CHC abilities in the prediction of written language performance. Even so, correlations of the *Gf-Gc* Composite with the writing achievement cluster scores remain moderate to moderately high and within an acceptable range for use as a predictor of written language achievement.

Table 6.
Correlations Between GIA, Gf-Gc *Composite, and Writing Achievement Cluster Scores Across Five Age Groups*

Age Group and Predictor Cluster	Writing Achievement Clusters: Written Language	Broad Written Language	Basic Writing Skills	Written Expression	Median
Ages 6–8 (*n* = 825)					
GIA	0.74	0.75	0.73	0.70	0.73
Gf-Gc Composite	0.63	0.62	0.65	0.54	0.62
Ages 9–13 (*n* = 1,572)					
GIA	0.73	0.75	0.74	0.67	0.74
Gf-Gc Composite	0.63	0.63	0.67	0.53	0.63
Ages 14–19 (*n* = 1,685)					
GIA	0.76	0.77	0.76	0.70	0.76
Gf-Gc Composite	0.68	0.68	0.69	0.58	0.68
Ages 20–39 (*n* = 1,251)					
GIA	0.74	0.76	0.76	0.68	0.75
Gf-Gc Composite	0.66	0.65	0.69	0.55	0.65
Ages 40–90+ (*n* = 1,146)					
GIA	0.79	0.80	0.79	0.74	0.79
Gf-Gc Composite	0.71	0.70	0.72	0.63	0.71

Relationship of the GIA and *Gf-Gc* Composite to Other Intelligence Tests

Tables 7, 8, 9, and 10 contain correlations of the WJ IV COG GIA and *Gf-Gc* Composite cluster scores with several other commonly used full scale and subdomain intelligence indices. As shown in Table 7, the WJ IV COG GIA and *Gf-Gc* Composite cluster scores are strongly correlated (.86 and .83, respectively) with general intellectual level as measured by the *Wechsler Intelligence Scale for Children®–Fourth Edition* (WISC®-IV; Wechsler, 2003) Full Scale IQ score. The pattern of correlations of GIA and *Gf-Gc* Composite cluster scores with the WISC-IV index scores provides additional insights. The *Gf-Gc* Composite correlates slightly higher (.79) than the GIA cluster score (.74) with the WISC-IV Verbal Comprehension index and slightly lower (.73) than the GIA cluster score (.74) with the WISC-IV Perceptual Reasoning Index, suggesting similar levels of shared variance. The *Gf-Gc* Composite shows a slightly lower correlation (.66) than the GIA cluster score (.69) with the WISC-IV Working Memory Index and a notably lower correlation (.44) than the GIA cluster score (.57) with the WISC-IV Processing Speed Index. This pattern of correlations between the *Gf-Gc* Composite and the WISC-IV indices supports the recommendation that the WJ IV COG *Gf-Gc* Composite is a valid measure of general intellectual level that can be expressed without a contribution from cognitive efficiency (*Gs* and *Gwm*) factors. A similar pattern of correlations can be found in Table 8, which reports the correlations between the WJ IV COG GIA cluster score (.84) and *Gf-Gc* Composite (.78) and the *Wechsler Adult Intelligence Scale®–Fourth Edition* (WAIS®-IV; Wechsler, 2008) Full Scale IQ score, as well as between the GIA and *Gf-Gc* Composite cluster scores and the WAIS-IV index scores.

Table 7.
Summary Statistics and Correlations for WJ IV COG Intellectual Ability Measures and WISC-IV Scales

			WISC-IV Measures					
WJ IV Measures	**Mean**	***SD***	**Full Scale IQ (*g*)**	**General Ability Index**	**Verbal Comprehension (*Gc*) Index**	**Perceptual Reasoning (*Gf/Gv*) Index**	**Working Memory (*Gwm*) Index**	**Processing Speed (*Gs*) Index**
Cognitive Composite Clusters								
General Intellectual Ability (*g*)	107.2	14.2	0.86	0.81	0.74	0.74	0.69	0.57
Gf-Gc Composite	104.8	15.4	0.83	0.83	0.79	0.73	0.66	0.44
Mean			106.7	108.3	106.2	107.6	101.5	102.8
Standard Deviation			15.2	14.5	13.5	14.8	15.4	15.1

Note. $N = 174$ for all measures. Age range (years) = 6–16, $M = 10.2$, $SD = 2.6$

Table 8.
Summary Statistics and Correlations for WJ IV COG Intellectual Ability Measures and WAIS-IV Scales

WJ IV Measures	Mean	*SD*	WAIS-IV Measures: Full Scale IQ (*g*)	General Ability Index	Verbal Comprehension (*Gc*) Index	Perceptual Reasoning (*Gf/Gv*) Index	Working Memory (*Gwm/Gq*) Index	Processing Speed (*Gs*) Index
Cognitive Composite Clusters								
General Intellectual Ability (*g*)	104.3	12.6	0.84	0.78	0.68	0.69	0.70	0.52
Gf-Gc Composite	105.0	13.8	0.78	0.75	0.69	0.63	0.61	0.41
Mean			107.1	106.7	105.8	106.0	103.2	107.6
Standard Deviation			14.1	14.5	14.1	14.5	15.1	15.0

Note. N = 177 for all measures. Age range (years) = 16–82, *M* = 37.1, *SD* = 14.3

The correlations between the WJ IV COG intellectual ability measures and the *Stanford-Binet Intelligence Scales, Fifth Edition* (SB5; Roid, 2003) Full Scale IQ score presented in Table 9 show strong relationships between the WJ IV COG GIA cluster score (.80) and *Gf-Gc* Composite (.82) and the SB5 Full Scale IQ score, providing additional evidence that both the GIA and *Gf-Gc* Composite cluster scores are valid measures of general intellectual level.

Table 9.
Summary Statistics and Correlations for WJ IV COG Intellectual Ability Measures and SB5 Scales

WJ IV Measures	Mean	*SD*	SB5 Full Scale IQ (*g*)
Cognitive Composite Clusters			
General Intellectual Ability (*g*)	97.8	17.2	0.80
Gf-Gc Composite	95.2	15.4	0.82
Mean			100.0
Standard Deviation			15.4

Note. N = 50 for all measures. Age range (years) = 6–16, *M* = 11.1, *SD* = 3.0

Table 10 displays the correlations between the WJ IV COG intellectual ability scores and broad and narrow CHC factor scores and the *Kaufman Assessment Battery for Children–Second Edition* (KABC™-II; Kaufman & Kaufman, 2004) index scores. Similar to correlations with the WISC-IV and WAIS-IV, the WJ IV COG GIA and *Gf-Gc* Composite cluster scores correlate at high levels (.77 and .71, respectively) with the KABC-II Fluid-Crystallized Index.[3] The *Gf-Gc* Composite cluster score correlates notably higher (.78) than the GIA cluster score (.58) with the KABC-II Knowledge/*Gc* Index score. This pattern is reversed, with the *Gf-Gc* Composite cluster score correlating at a lower level (.41) than the GIA cluster score (.51) with the KABC-II Planning/*Gf* index. McGrew et al. (2014) drew upon the Reynolds, Keith, Fine, Fisher and Low (2007) confirmatory analyses of the KABC-II standardization data to hypothesize that the lower correlations with the KABC-II Planning/*Gf* index may be due to the KABC-II index being a mixed measure of *Gf* and *Gv*. Of particular interest are the consistently lower correlations between the WJ IV COG *Gf-Gc* Composite and the KABC-II processing measures than between the WJ IV COG GIA cluster score and the KABC-II processing measures. The WJ IV COG GIA and *Gf-Gc* Composite cluster scores correlate at .41 and

[3] The KABC-II provides two different global composite g scores based on two different theoretical models of intelligence—the Mental Processing Index and the Fluid-Crystallized Index. The Fluid-Crystallized Index is based on CHC theory and is the most appropriate score to compare to the WJ IV cognitive clusters.

.33, respectively, with the KABC-II Sequential/*Gsm* Index; at .44 and .33, respectively, with the KABC-II Simultaneous/*Gv* Index; and at .60 and .50, respectively, with the KABC-II Learning/*Glr* Index. The lower *Gf-Gc* Composite correlations with the KABC-II processing measures suggest that the WJ IV COG *Gf-Gc* Composite cluster score shares less variance with the KABC-II processing measures than does the WJ IV COG GIA cluster score. This finding supports the interpretation of the WJ IV COG *Gf-Gc* Composite cluster score as a proxy for general intelligence that is less influenced by cognitive processing abilities than is the WJ IV COG GIA cluster score.

Table 10.
Summary Statistics and Correlations for WJ IV COG Clusters and KABC-II Scales

			KABC-II Measures						
WJ IV Measures	**Mean**	***SD***	**Mental Processing Index**	**Fluid-Crystallized Index (*g*)**	**Sequential/*Gsm* Index**	**Simultaneous/*Gv* Index**	**Learning/*Glr* Index**	**Planning/*Gf* Index**	**Knowledge/*Gc* Index**
Cognitive Composite Clusters									
General Intellectual Ability (*g*)	99.5	14.4	0.72	0.77	0.41	0.44	0.60	0.51	0.58
Gf-Gc Composite	97.2	14.8	0.57	0.71	0.33	0.33	0.50	0.41	0.78
Mean			99.7	100.3	100.1	98.0	99.7	102.8	101.6
Standard Deviation			13.6	12.7	14.4	14.9	14.6	15.3	13.0

Note. $N = 50$ for all measures. Age range (years) = 7–18, $M = 11.4$, $SD = 3.3$

Gf-Gc Composite/Other Ability Comparison Procedure in Specific Learning Disability Determination

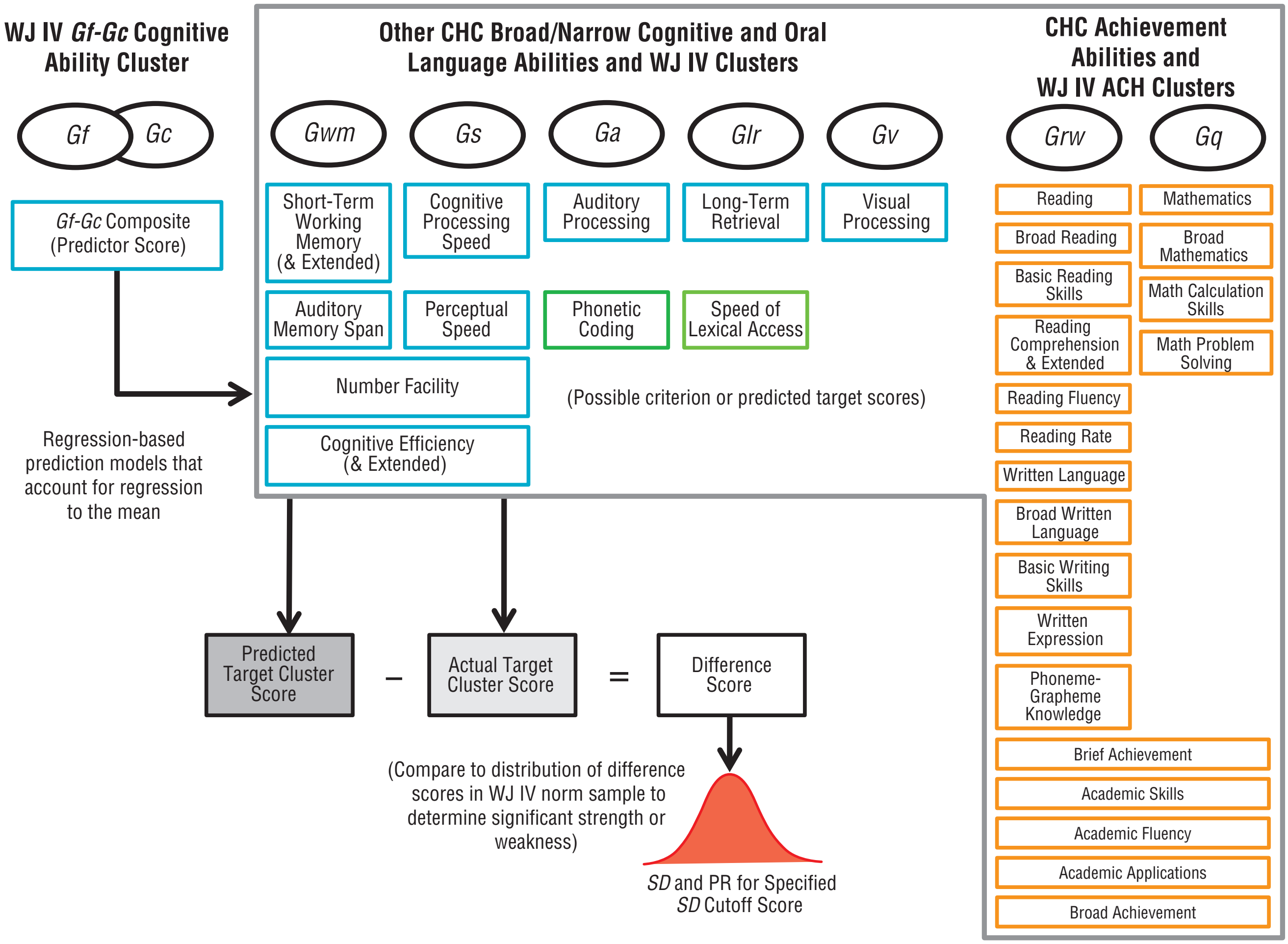
In some cases, the WJ IV COG GIA cluster score or a full scale intelligence score obtained from another battery may not provide the best description of attained intellectual level for an individual suspected of having a specific learning disability (SLD). This is particularly true when a significant limitation is present in one of the basic cognitive processes, storage and processing functions, or mechanisms of cognitive efficiency. Although these abilities often contribute to a general intellectual ability or full scale intelligence score, they also can be identified as possible contributors to the disability itself. In such cases, the *Gf-Gc* Composite may be the preferred measure of intellectual development because it does not include the psychological processing abilities that might underlie an SLD. The removal of processing mechanisms from the measure of intellectual development can help professionals isolate the specific cognitive limitations that may be related to learning difficulties and, thus, may be important in identifying the nature of the SLD itself.

In the Individuals with Disabilities Education Improvement Act (IDEA) of 2004 reauthorization, the definition of *specific learning disability* was maintained as "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which . . . may manifest itself in the imperfect ability to listen, think, speak, read well, or do mathematical calculations" (IDEA, 2004; 20 U.S.C. §1401 [30]). Basic psychological processing abilities that are often impaired in individuals with SLD include aspects of phonological processing, orthographic processing, working memory, and processing speed. Essentially, these types of processing abilities support the ease and efficiency of symbolic learning, which is required in tasks such as learning sound-symbol associations, memorizing multiplication tables, or writing the letters of the alphabet quickly. Problems in any one of these areas can affect an individual's development and performance in the basic academic skills of reading, writing, and/or mathematics. As Bateman (1992) observed, children with SLD have more trouble acquiring, applying, and retaining information than would be predicted on the basis of other information about the child.

Despite impairments in processing abilities, and in contrast to these impairments, students with SLD often have intact oral language and reasoning abilities. In fact, many have average or even above-average performance in verbal abilities (Orton, 1966). For example, in the case of students with reading disabilities, or dyslexia (the most common type of learning disability), what distinguishes these individuals from other poor readers is that their listening comprehension abilities are higher than their ability to decode words (Rack, Snowling, & Olson, 1992). In discussing a common profile of students with dyslexia, Shaywitz (2003) described a "sea of strengths," where the students' reading and spelling problems are often surrounded by their strengths in vocabulary knowledge, language comprehension, and reasoning abilities. Thus, in cases involving the determination of SLD, it makes sense to compare the often intact *Gf-Gc* Composite with the individual's other, less efficient, abilities, both in cognitive processing and academic achievement.

The *Gf-Gc* Composite can be compared to all other cognitive, language, and achievement clusters in the WJ IV that are not primarily measures of *Gf* or *Gc*. This comparison includes cognitive abilities representing the other broad domains of CHC theory (e.g., *Gwm*, *Glr*, *Ga*, *Gv*, *Gs*); many narrow ability clusters from the cognitive and oral language batteries (e.g., Perceptual Speed [P], Cognitive Efficiency, Quantitative Reasoning [RQ], Auditory Memory Span [MS], Number Facility [N], Phonetic Coding [PC], Speed of Lexical Access [LA]); and, importantly for SLD, measures of academic achievement. Figure 1, from the *Woodcock-Johnson IV Technical Manual* (McGrew et al., 2014), portrays in visual-graphic format the complete set(s) of obtained cognitive, language, and achievement clusters that can be compared to the predicted scores based on an individual's *Gf-Gf* Composite cluster score.

Figure 1.
Gf-Gc *Composite/Other Ability comparison procedure.*



In the WJ IV, the *Gf-Gc* Composite/Other Ability comparison procedure is sometimes called a hybrid model (*Gf-Gc* hybrid variation/comparison procedure) because it employs the methodology of a traditional ability/achievement discrepancy procedure and presents any observed discrepancies as a profile of intra-individual strengths and weaknesses. If any cluster score is identified as discrepant, the target area is flagged as a strength or weakness relative to the person's level of intellectual development as defined by the *Gf-Gc* Composite. Discrepant cluster scores that are significantly higher than would be predicted by the *Gf-Gc* Composite cluster score are interpreted as relative strengths; discrepant cluster scores that are significantly lower than would be predicted by the *Gf-Gc* Composite cluster score are interpreted as relative weaknesses.

Use of the WJ IV COG *Gf-Gc* Composite in SLD-Identification Models

Based on guidance provided by the U.S. Department of Education Office of Special Education Programs (OSEP; U.S. Department of Education, OSEP, 2006), schools are required to use one of the learning disability identification procedures provided in the 2004 IDEA reauthorization and the criteria issued by their state department of education. In general, three alternatives for identification of an SLD are permitted: (a) an ability/achievement discrepancy model, (b) a response-to-intervention (RTI) model, and (c) a pattern of strengths and weaknesses (PSW) model. In determining an SLD, a comprehensive evaluation is required regardless of the model used by the school district or agency. The *Gf-Gc* Composite/Other Ability comparison procedure can provide information relevant to the identification of an SLD within the context of any of these models.

Ability/Achievement Discrepancy Model

Although school districts may now opt out of the traditional ability/achievement discrepancy requirement, assessment of intellectual development is specifically cited in the federal regulations. An ability/achievement discrepancy methodology may provide information relevant to the identification of an SLD.

The ability/achievement discrepancy model has been validly criticized for several reasons, many of which are beyond the scope of this paper. However, two reasons are germane to the current discussion. First, the traditional ability/achievement discrepancy model places undue emphasis on a single score (the full scale intelligence score used to predict achievement) for SLD identification and too little emphasis on understanding the nature of an individual's learning problems. Second, the commonly used full scale or general ability measures typically include tests of cognitive processing and efficiency that are often related to the individual's learning disability and, as a consequence, lower the obtained general ability index score. This second situation often causes individuals with identifiable learning disabilities in basic psychological processing to be ineligible for special services—an example of the paradoxical Catch-22.[4]

In many instances, the *Gf-Gc* Composite/Other Ability comparison procedure can circumvent the ability-achievement Catch-22 by minimizing the effects of a cognitive processing or efficiency disability on the index of intellectual development that is defined exclusively by the tests of *Gf* and *Gc*. The *Gf-Gc* Composite can be compared to IDEA-aligned measures of basic reading skills, reading fluency, reading comprehension, mathematics calculation, mathematics problem solving, and written expression from the WJ IV ACH (Schrank et al., 2014a) and/or measures of oral expression and listening comprehension from the *Woodcock-Johnson IV Tests of Oral Language* (WJ IV OL; Schrank, Mather, & McGrew, 2014b), among other abilities from the cognitive processing and oral language domains that may be helpful in understanding the nature of an individual's learning problems.

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[4] From the novel of the same name by Heller (1961), a *Catch-22* is a problem for which the only solution is denied by a circumstance inherent in the problem or by a rule; an illogical, unreasonable, or senseless situation where a solution to the problem is unattainable because the rules established to identify the problem prohibit it (Merriam-Webster, 2014). The analogy is appropriate to learning disabilities identification when, for example, a child's low achievement can be linked to an identified processing disability, but the child is denied special services because the processing disability is included in the measure of general intellectual development, which then reduces the likelihood of an ability/achievement discrepancy.

Response-to-Intervention Model

The federal regulations allow schools to employ a process to determine whether an individual responds to scientific, research-based intervention as a part of the evaluation process. Response to intervention (RTI) is a schoolwide intervention model intended to improve and expedite research-based educational service delivery through careful observation and measurement of outcomes. In this model, the individual's level of response to intervention can help determine whether the individual has an SLD.

RTI procedures can provide valuable information to determine whether an SLD exists. However, RTI is not a substitute for a comprehensive evaluation, which must include a variety of assessment tools and strategies and cannot rely on any single procedure as the sole criterion for determining eligibility for services. When using the RTI model to determine whether a student has an SLD, the regulations specifically state that a team must consider, at a minimum, the relationship of the student's achievement to his or her intellectual level. In addition, the regulations stipulate that it is the role of the professionals who hold the expertise in and responsibility for conducting or contributing to the comprehensive evaluation to determine what additional information is relevant for disability determination and program planning.

The *Gf-Gc* Composite/Other Ability comparison procedure provides relevant information for the RTI evaluation team because it includes a measure of intellectual level devoid of measures of cognitive processing. The *Gf-Gc* Composite also can be compared to measures of academic achievement and other cognitive or cognitive-linguistic clusters that professional examiners or the evaluation team deem relevant to the evaluation.

Pattern of Strengths and Weaknesses Model

The U.S. Department of Education OSEP (2006) issued guidance to clarify that an evaluation team may diagnose SLD when "the child exhibits a pattern of strengths and weaknesses in performance, achievement, or both, relative to age, State-approved grade-level standards, or intellectual development, that is determined by the group to be relevant to the identification of a specific learning disability, using appropriate assessments . . ." (p. 2). This research-based methodology is often described as the pattern of strengths and weaknesses (PSW) model.

The *Gf-Gc* Composite/Other Ability comparison procedure is well-suited for use in PSW models for a number of reasons. First, the *Gf-Gc* Composite provides a reliable and valid index of intellectual development derived exclusively from tests of fluid reasoning, verbal comprehension, and knowledge abilities, thus minimizing the impact of a psychological processing deficit in the obtained intellectual composite score. Second, the required pattern of strengths and weaknesses in achievement can be observed when comparing other clusters from the WJ IV COG, WJ IV OL, or WJ IV ACH to the *Gf-Gc* Composite.

The OSEP guidelines yield to the clinical judgment of professionals and professional teams to determine what constitutes a pattern relevant to the identification of an SLD. The WJ IV can provide information that allows knowledgeable professionals working within PSW models to go beyond the minimal requirements and align the defining characteristic of SLD—a deficit in basic psychological processing—with the procedures to be used for identification. The *Gf-Gc* Composite/Other Ability comparison procedure allows areas of academic achievement and other cognitive and cognitive-linguistic processes to emerge as strengths or weaknesses relative to the overall index of *Gf* and *Gc* abilities in a single analysis. This procedure evaluates domain-specific achievement skills jointly with related cognitive and linguistic abilities, allowing patterns to emerge that may be particularly informative to understanding the nature of an SLD.

Summary and Discussion

The theoretical foundation, predictive validity, concurrent validity, and reliability evidence summarized in this paper suggest that the WJ IV COG *Gf-Gc* Composite can be used as a measure of intellectual level or development. A review of the correlational evidence with other measures of global intelligence, including their respective cluster or index scores, suggests that the *Gf-Gc* Composite cluster score, when compared to the GIA cluster score, is less influenced by cognitive processing and cognitive efficiency abilities. By implication, when compared to the GIA cluster score and other full scale intelligence scores, an obtained *Gf-Gc* Composite cluster score may be less attenuated by the effects of a cognitive processing or cognitive efficiency disability for some individuals, particularly those with an SLD.

The WJ IV authors propose two reasons why the *Gf-Gc* Composite can be useful in SLD identification. First, the relative influence of any functional limitations in one or more of the basic cognitive processes, storage and processing functions, or cognitive efficiency mechanisms is minimized in the *Gf-Gc* Composite. This is particularly useful when an individual has benefited from the investment of effort and experience in spite of limitations in *Gwm*, *Ga*, *Gv*, *Glr*, *Gs*, or any of their associated narrow abilities, such as perceptual speed, working memory capacity, or phonetic coding.

Second, the *Gf-Gc* Composite can be compared to levels of academic achievement as well as to measures of basic cognitive processes, storage and retrieval functions, mechanisms of cognitive efficiency, and/or critical cognitive-linguistic competencies. The *Gf-Gc* Composite/Other Ability comparison procedure yields a profile of cognitive, linguistic, and achievement abilities that may reveal a pattern of strengths and weaknesses relative to the *Gf-Gc* Composite. Based on the judgment of the evaluation team, an observed pattern may be relevant to the identification of an SLD. The *Gf-Gc* Composite/Other Ability comparison procedure can be useful in any model of SLD identification that is allowed by IDEA (2004).

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