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Exploratory and Higher Order Factor Analysis of the WJ-III Full Test Battery: A School-Aged Analysis

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Development of the Woodcock-Johnson (3rd ed.; WJ-III; Woodcock, McGrew & Mather, 2001a) was guided in part by Carroll's (1993) 3-stratum theory of cognitive abilities and based on confirmatory factor analysis (CFA), even though Carroll used exploratory factor analysis (EFA) to derive his theory. Using CFA, McGrew and Woodcock (2001) found a 9-factor model across all age ranges. To determine if the 9-factor structure holds for the full WJ-III battery, we applied currently recognized best practices in EFA to 2 school-aged 42-subtest correlation matrices (ages 9–13 and 14–19 years). Six factors emerged at the 9–13 age range, while 5 factors were indicated at the 14–19 age range. The resulting 1st-order factors displayed patterns of both convergence with and divergence from the WJ-III results presented in the Technical Manual. These results also revealed a robust manifestation of general intelligence (*g*) that dwarfed the variance attributed to the lower order factors. It is surprising that this study represents the first time the WJ-III full battery was subjected to EFA analyses given the instrument's significant use by practitioners and that it served as the initial evidentiary basis for Cattell-Horn-Carroll (CHC) theory. The lack of confirmation of CFA results with EFA methods in the current study permits questioning of the structure of the WJ-III and its relationship with CHC theory. Additional independent, structural analyses are clearly indicated for the WJ-III full test battery before we can be confident in its structure.

Keywords: exploratory factor analysis, higher order factor analysis, Cattell-Horn-Carroll theory, Schmid-Leiman orthogonalization, general intelligence

The Woodcock-Johnson III (WJ-III; Woodcock, McGrew & Mather, 2001a) is a battery of two co-normed tests that measure cognitive ability with 20 tests (WJ-III Tests of Cognitive Abilities; Woodcock, McGrew & Mather, 2001b) and academic achievement with 22 tests (WJ-III Tests of Achievement; Woodcock, McGrew & Mather, 2001c). The WJ-III is a reformulation of the Woodcock Johnson–Revised (WJ-R; Woodcock & Johnson, 1989) to include a higher order (*g*) factor and the unification of the cognitive and achievement subtests under one theory known as Cattell-Horn-Carroll (CHC) theory. The inclusion of both cognitive ability and academic achievement tests in one battery under one theory is a novel contribution of the WJ-III. In all other cases, these instruments are presented as separate achievement and cognitive ability instruments without an overarching theory to connect intelligence with academic achievement.

From a theoretical perspective, the authors of the WJ-III reported that they were guided by Carroll's (1993) *three-stratum theory of cognitive abilities* and the work of Horn and Cattell (1966), which were then combined into a new theory called Cattell-Horn-Carroll (CHC) theory. McGrew and Woodcock (2001) claimed that CHC theory is the most comprehensive and empirically validated theory of cognitive abilities ever created and that the WJ-III provided the initial evidentiary basis for the theory. The Technical Manual (McGrew & Woodcock, 2001) indicates that the WJ-III total battery is aligned with nine broad CHC factors (e.g., Crystallized Ability/Comprehension-Knowledge [Gc], Long-Term Retrieval [Glr], Visual-Spatial Thinking [Gv], Auditory Processing [Ga], Fluid Reasoning [Gf], Processing Speed [Gs], Reading-Writing Ability [Grw], and Quantitative Reasoning [Gq[) across the cognitive and achievement subtests. The Technical Manual also reports a higher order (*g*) factor, which contrasts with the WJ-R that recognized lower order factors and distanced itself from full acknowledgment of a higher order factor (Woodcock, 1990). Within the WJ-III Technical Manual, the test authors included the 42 subtest correlation matrix across seven different age ranges (2 to 3; 4 to 5; 6 to 8; 9 to 13; 14 to 19; 20 to 39; 40 plus years) to show the correlation among cognitive and achievement subtests.

When considering the structural validity of the overall WJ-III battery, the test authors relied solely upon confirmatory factory analysis (McGrew & Woodcock, 2001). The Technical Manual describes the proposed alignment of the 42 subtests, in addition to seven nonpublished research subtests, with the nine broad CHC factors by presenting confirmatory factor analysis (CFA) factor loadings (McGrew & Woodcock, 2001, p. 199) and depicting a path-like analysis that does not contain structural relationship

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coefficients (McGrew & Woodcock, 2001, p. 62). This path analysis displays the relationship among the 42 subtests with the nine first-order CHC factors and between the nine factors and *g*. Inexplicably, the Technical Manual did not present fit statistics to support the adequacy of this structural model.

Subsequently, CFA analyses of portions of the WJ-III have tended to support the structure delineated in the Technical Manual (Keith, Reynolds, Patel, & Ridley, 2008; Taub, Floyd, Keith, & McGrew, 2008; Taub & McGrew, 2004). However, all subsequent structural analyses of the WJ-III have relied on CFA methods and none has included all 42 WJ-III tests. Consequently, the legitimacy of the favored McGrew-Woodcock (McGrew & Woodcock, 2001) model rests on one CFA analysis that failed to report fit statistics. Sole reliance on CFA might be ill advised (Brannick, 1995; Canivez & Watkins, 2010; Dombrowski, Watkins, & Brogan, 2009; Goldberg & Velicer, 2006; Gorsuch, 1983; Greenwald, Pratkanis, Leippe, & Baumgardner, 1986; Haig, 2005; Thompson, 2004). There is a complementary relationship between exploratory factor analysis (EFA) and CFA, but factor analysts generally recommend that EFA precede CFA when evaluating a new test or theory (Brown, 2006; Gerbing & Hamilton, 1996; Gorsuch, 1983; Schmitt, 2011). EFA is also appropriate when initial CFA results are unclear or inadequate (Gorsuch, 1997). The strength of CFA is its focused test of a specific hypothesis about a population factor structure. When the hypothesized structure is rejected by a CFA, the "use of exploratory factor analysis, with rotation of the factor matrix, appears preferable" (Browne, 2001, p. 113).

Given the importance of EFA, specific analytic procedures have been recommended for its application to the exploration of internal structure in tests of cognitive ability where factors tend to be hierarchical in nature and highly correlated. These procedures include principal axis factoring (PAF) with an oblique rotation (promax) followed by a Schmid-Leiman (Schmid & Leiman, 1957) orthogonalization (Carroll, 1993; Gorsuch, 1983; Guttman, 1954; Horn, 1965; Schmid & Leiman, 1957; Velicer, 1976; Velicer, Eaton, & Fava, 2000). The Schmid-Leiman orthogonalization helps to uncover simple structure by partialing out the influence of higher order factors (Caretta & Ree, 2001; Carroll, 1993, 1995, 2003; Gustafsson & Snow, 1997).

The omission of EFA analyses to describe the internal structure of the WJ-III, particularly those recommended by Carroll (1993, 1995, 2003), is ironic. Carroll relied on EFA to develop his three-stratum theory of cognitive abilities, and his theory was highly influential in the development of the WJ-III as well as CHC theory. The omission of EFA is unfortunate (e.g., Canivez, 2008; Carroll, 1995; DiStefano & Dombrowski, 2006; Dombrowski, in press; Dombrowski et al., 2009; Fabrigar, Wegener, MacCallum, & Strahan, 1999; Frazier & Youngstrom, 2007; Nelson, Canivez, Lindstrom, & Hatt, 2007; Thompson & Daniel, 1996; Watkins, 2006) and suggests that our understanding of the structure of the full WJ-III test battery may be incomplete. For example, Frazier and Youngstrom (2007) subjected the correlation matrices of the WJ-III Cognitive to Horn's (1965) parallel analysis and the minimum average partial test (Velicer, 1976), yielding the suggested retention of three and two factors, respectively, instead of the Technical Manual's suggested seven factors. Frazier and Youngstrom (2007) indicated that the WJ-III Cognitive may be overfactored by four to five factors but never subjected the full WJ-III battery to analysis.

The purpose of this study is to evaluate the structure of the WJ-III full battery (cognitive and achievement) using best practice EFA procedures (Cudeck, 2000; Fabrigar & Wegener, 2012; Fabrigar et al., 1999; Goldberg & Velicer, 2006; Gorsuch, 1988; Henson & Roberts, 2006; Kline, 1994; Thompson & Daniel, 1996) on the two normative sample correlation matrices (for ages 9 to 13 and 14 to 19) that span the school-aged time period. We chose to restrict our examination to these two age ranges for several reasons. First, all the WJ-III subtests were administered to participants in these age ranges. Second, cognitive abilities have been shown to display a lack of invariance at earlier age ranges (DiStefano & Dombrowski, 2006; Keith & Reynolds, 2010; Tusing & Ford, 2004). Third, the age 9 to 19 time period represents a population that is readily available in the schools to researchers and practitioners. Finally, space limitations allowed a detailed presentation of only two matrices.

For the first EFA analysis, principal axis factoring was applied followed by an oblique rotation (promax). This is consistent with the recommendation of Carroll (1993, 1997) and others (Gorsuch, 1983; Guttman, 1954; Thompson, 2004) who recognized that factors on tests of cognitive ability and achievement tend to be highly correlated. Factor extraction decisions were based on parallel analysis and the minimum average partial test, which are considered among the most accurate (Horn, 1965; Velicer, 1976; Velicer et al., 2000; Zwick & Velicer, 1986). These methods were supplemented by a visual scree test (Cattell, 1966), as suggested by Velicer et al. (2000). Because higher order factors are implicit in all oblique rotations, factors were extracted and examined through the use of the Schmid-Leiman (Schmid & Leiman, 1957) procedure (Carroll, 1993, 1995, 2003; Gorsuch, 1983; Thompson, 2004). This procedure involves making first-order factors orthogonal to second-order factors by first extracting the variance explained by the second-order factors (Schmid & Leiman, 1957). The next step in the procedure is to residualize the first-order factors of all the variance present in the second-order factors. Schmid and Leiman (1957) argued that this process "preserves the desired characteristics of the oblique solution" and "discloses the hierarchical structure of the variables" (p. 53). Carroll (1995) emphasized that orthogonal factors are appropriate only when produced in the context of a Schmid-Leiman solution: "I insist, however, that the orthogonal factors should be those produced by the Schmid-Leiman (1957) orthogonalization procedure" (Carroll, 1995, p. 437).

Thus, from several perspectives, a case can be made that interpretative emphasis in understanding the latent structure of the WJ-III should have also been placed on the EFA procedures of principal axis factoring (promax rotation) followed by a higher order factor analysis using the Schmid-Leiman solution. If the results from both EFA and CFA procedures converge, then we can be confident in the derived factor structure (Gorsuch, 1983). To our knowledge, this study represents the first time that the full WJ-III battery of tests has been subjected to EFA analysis.

Method

Participants

The WJ-III authors collected and reported information relative to seven age groups: 2 to 3 years, 4 to 5 years, 6 to 8 years, 9 to

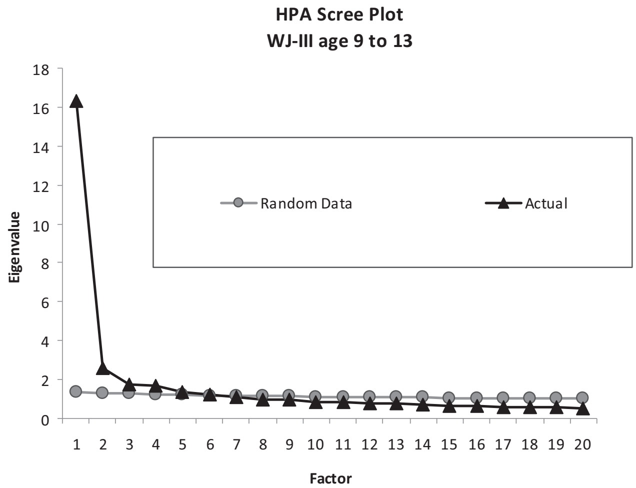

Figure 1. Scree plots for Horn's parallel analysis (HPA) for the Woodcock-Johnson (3rd ed.; WJ-III; Woodcock, McGrew & Mather, 2001a) full battery age 9 to 13 years.

13 years, 14 to 19 years, 20 to 39 years, 40 years and older. The data for the WJ-III norms were collected from a nationally representative sample of 8,818 participants from age 2 through 90 plus. The WJ-III Technical Manual reports that the normative data were matched to the 2000 U.S. Census for geographic region, community size, sex, race, educational level, and occupation. Detailed demographic characteristics are provided in the WJ-III Technical Manual. For this study, we used two school-aged (9 to 13 years and 14 to 19 years) subtest correlation matrices (42 × 42) obtained from the Technical Manual. The 9 to 13 age range contained an average of 1,572 participants while the 14 to 19 age range contained an average of 1,299 participants.

Instrument

The WJ-III is an individually administered measure of cognitive ability and academic achievement that contains 20 cognitive subtests and 22 achievement subtests. The WJ-III is hypothesized to measure *g* and nine CHC factors: Visual-Spatial Thinking (Gv), Fluid Reasoning (Gf), Quantitative Reasoning (Gq), Processing Speed (Gs), Long-Term Retrieval (Glr), Reading-Writing (Grw), Auditory Processing (Ga), Short-Term Memory (Gsm), and Crystallized Ability/Comprehension-Knowledge (Gc). The WJ-III also yields a general intellectual ability score reflective of *g*. The WJ-III Achievement yields a total achievement score reflective of performance on that test. Please see the instrument's respective examiner's manual for a synopsis of subtest demands.

Procedure

The two correlation matrices selected for this study were analyzed using several EFA methodologies. First, the intercorrelation matrices were evaluated using Bartlett's Test of Sphericity (Bartlett, 1954) and the Kaiser-Meyer-Olkin (KMO; Kaiser, 1974) statistic to ensure that the matrices were suitable for factor analysis. Second, each intercorrelation matrix was subjected to principal axis factoring (Cudeck, 2000; Fabrigar et al., 1999; Tabachnick & Fidel, 2007) with promax rotation ($k = 4$; Tataryn, Wood, & Gorsuch, 1999) because of the assumption of correlated factors (Gorsuch, 1983; Schmitt, 2011; Tabachnick & Fidell, 2007). Pattern coefficients of .30 or higher were considered salient (Child, 2006). Next, minimum average partials (MAP; Velicer, 1976) and parallel analysis (Horn, 1965) were used to determine the number of factors to extract. These procedures were conducted using O'Conner's (2000) and Watkins's (2000) programs. Scree plots (Cattell, 1966) were also inspected as a supplemental means to determine the number of factors to retain for rotation. Finally, because the Technical Manual posits that the three-stratum theory of Carroll (1993) was influential in the creation of the WJ-III, a higher order factor analysis using the Schmid-Leiman (Schmid & Leiman, 1957) procedure was applied to the oblique first-order factors with the SPSS program furnished by Wolff and Preising (2005).

Results

Exploratory (First-Order) Analyses

Results from Bartlett's Test of Sphericity (Bartlett, 1950) for both analyses indicated that the correlation matrices were not random (9 to 13 age range $\chi^2 = 44{,}305.6$, $df = 861$, $p < .001$; 14 to 19 age range $\chi^2 = 38{,}814.5$, $df = 861$, $p < .001$). For the 9 to 13 and 14 to 19 age ranges, the KMO (Kaiser, 1974) statistic was .947 and .955, respectively, well above the minimum standard for conducting a factor analysis suggested by Kline (1994). Measures of sampling adequacy for each variable were also within reasonable limits. Thus, the correlation matrices were appropriate for factor analysis.

Factor extraction. Parallel analysis (Horn, 1965) suggested that six factors be retained for the 9 to 13 age range and five factors for the 14 to 19 age range. The MAP (Velicer, 1976) criterion recommended retention of five factors for both age ranges. A visual scree test indicated evidence for one strong factor with the possibility of two to five additional factors (see Figures 1 and 2). Given that it is better to over factor than under factor (Velicer et al., 2000), we extracted five, six, seven, and eight factors. We also attempted to extract nine factors in accord with the theoretical structure delineated in the Technical

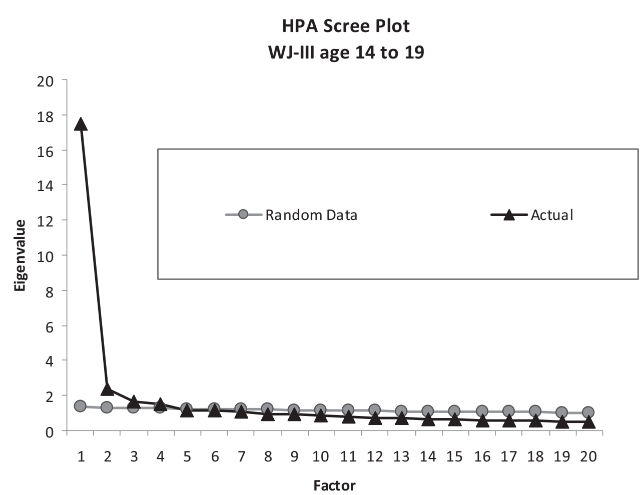

Figure 2. Scree plots for Horn's parallel analysis (HPA) for the Woodcock-Johnson (3rd ed.; WJ-III; Woodcock, McGrew & Mather, 2001a) full battery age 14 to 19 years.

Manual. Extraction of more than six factors yielded either a spurious solution because of Heywood cases (e.g., communalities > 1.0), which often occur when too many factors are extracted, theoretically incoherent factors, or trivial factors with only one or two salient loadings.

Principal axis factoring with promax rotation. The two school-aged correlation matrices were separately subjected to principal axis factoring (PAF) with an oblique (promax) rotation. Tables 1, 2, 3, and 4 present the results of the PAF analyses for the 9 to 13 and 14 to 19 correlation matrices, respectively, in accord with a five- and

Table 1
Age 9- to 13-Year-Old Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001a) Principal Axis Factor With Promax Rotation (Five Factors)

Subtest	Pattern (structure) coefficients						
	F1	F2	F3	F4	F5	h^2	u^2
Picture Vocabulary Gc	***.85*** (.80)	.11 (.53)	−.10 (.24)	−.14 (.41)	.01 (.36)	.88	.12
Verbal Comprehension Gc	***.83*** (.91)	.07 (.66)	−.09 (.35)	.10 (.62)	.02 (.44)	.93	.07
General Information Gc	***.82*** (.84)	.06 (.61)	−.01 (.37)	.02 (.54)	−.04 (.34)	.71	.29
Academic Knowledge Gc	***.79*** (.84)	.05 (.61)	−.10 (.33)	.15 (.60)	−.07 (.33)	.73	.27
Story Recall Gc	***.72*** (.70)	−.24 (.42)	.12 (.37)	.17 (.50)	−.03 (.30)	.67	.33
Oral Comprehension Gc	***.68*** (.72)	−.01 (.51)	.01 (.33)	.01 (.50)	.09 (.30)	.54	.46
Reading Vocabulary Grw	***.56*** (.78)	.22 (.67)	−.03 (.39)	.12 (.61)	.00 (.36)	.66	.44
Story Recall—Delayed Glr	***.55*** (.58)	−.20 (.38)	.14 (.37)	.22 (.48)	−.05 (.23)	.67	.33
Understanding Directions Gc	***.48*** (.63)	−.08 (.48)	.10 (.40)	.26 (.56)	.00 (.29)	.54	.46
Incomplete Words Ga	***.33*** (.39)	.09 (.29)	.08 (.20)	−.15 (.20)	.11 (.25)	.22	.78
Sound Blending Ga	***.33*** (.50)	.09 (.44)	.08 (.24)	−.15 (.36)	.12 (.32)	.39	.61
Auditory Working Memory Gsm	.26 (.53)	.07 (.50)	.16 (.43)	.24 (.53)	.01 (.25)	.42	.58
Word Attack Grw	−.05 (.51)	***.91*** (.79)	−.15 (.33)	−.02 (.51)	.07 (.29)	.65	.35
Letter–Word Identification Grw	.14 (.66)	***.84*** (.88)	−.08 (.44)	−.02 (.60)	−.02 (.30)	.76	.24
Spelling Grw	−.01 (.58)	***.83*** (.87)	.05 (.53)	.03 (.61)	−.02 (.24)	.75	.25
Spelling of Sounds Ga	.07 (.53)	***.80*** (.74)	−.09 (.35)	−.09 (.47)	.09 (.27)	.59	.41
Editing Grw	.13 (.60)	***.54*** (.75)	.07 (.49)	.13 (61)	−.06 (.26)	.62	.38
Sound Awareness Ga	.21 (.65)	***.50*** (.72)	−.07 (.38)	.11 (.60)	.15 (.42)	.74	.26
Writing Samples Grw	.16 (.57)	***.50*** (.70)	.02 (.43)	.14 (.58)	−.06 (.22)	.56	.44
Writing Fluency Grw	.05 (.49)	***.48*** (.69)	***.40*** (.66)	−.04 (.49)	−.06 (.15)	.59	.41
Passage Comprehension Grw	***.38*** (.72)	***.39*** (.73)	.03 (.46)	.10 (.62)	−.01 (.32)	.65	.35
Handwriting Grw	−.20 (.11)	***.32*** (.30)	.18 (.28)	−.00 (.21)	.05 (.08)	.20	.80
Memory for Words Gsm	.21 (.47)	.22 (.47)	.01 (.29)	.11 (.42)	.08 (.28)	.36	.64
Decision Speed Gs	.04 (.29)	−.14 (.32)	***.73*** (.67)	−.01 (.34)	.11 (.18)	.46	.54
Visual Matching Gs	−.23 (.30)	.14 (.52)	***.71*** (.79)	.18 (.52)	.07 (.16)	.61	.39
Pair Cancellation Gs	−.04 (.24)	−.19 (.29)	***.69*** (.65)	.16 (.38)	.04 (.11)	.46	.54
Rapid Picture Naming Gs	***.32*** (.36)	.01 (.31)	***.57*** (.52)	−.36 (.16)	.05 (.14)	.37	.63
Math Fluency Gq	−.22 (.30)	***.34*** (.59)	***.52*** (.72)	.22 (.54)	−.14 (.01)	.63	.37
Retrieval Fluency Glr	***.41*** (.49)	−.07 (.39)	***.52*** (.56)	−.18 (.31)	.05 (.22)	.42	.58
Read Fluency Grw	.25 (.58)	***.42*** (.70)	***.42*** (.68)	−.14 (.49)	−.10 (.15)	.65	.35
Auditory Attention Ga	.07 (.23)	−.00 (.22)	.17 (.25)	.08 (.25)	.08 (.16)	.18	.82
Applied Problems Gq	.13 (.62)	.12 (.67)	−.04 (.46)	***.73*** (.85)	−.07 (.27)	.73	.27
Quantitative Concepts Gq	.09 (.61)	.19 (.68)	−.04 (.46)	***.66*** (.82)	−.03 (.29)	.71	.29
Analysis-Synthesis Gf	.16 (.49)	−.19 (.40)	−.02 (.31)	***.65*** (.66)	.12 (.35)	.49	.51
Calculation Gq	−.08 (.46)	.18 (.62)	.14 (.54)	***.65*** (.76)	−.11 (.15)	.63	.37
Concept Formation Gf	.23 (.59)	−.07 (.50)	−.03 (.35)	***.56*** (.69)	.16 (.43)	.56	.44
Spatial Relations Gv	.03 (.34)	.04 (.33)	−.05 (.20)	***.36*** (.44)	.20 (.33)	.31	.69
Numbers Reversed Gsm	−.07 (.40)	.29 (.54)	.09 (.40)	.09 (.55)	***.31*** (.27)	.40	.60
Planning Gv	.02 (.26)	.02 (.26)	−.02 (.17)	***.30*** (.35)	.11 (.22)	.20	.80
Visual–Auditory Learning Glr	−.00 (.52)	.07 (.44)	.07 (.28)	.11 (.48)	***.85*** (.92)	.86	.14
Visual–Auditory Learning—Delayed Glr	−.01 (.47)	.08 (.40)	.06 (.24)	.06 (.42)	***.82*** (.87)	.85	.15
Picture Recognition Gv	.02 (.19)	−.07 (.15)	.16 (.20)	.07 (.20)	.24 (.27)	.16	.84
Eigenvalue	16.34	2.59	1.78	1.66	1.39		
% Variance	38.90	6.16	4.23	3.96	3.31		
F1	1.0						
F2	.68	1.0					
F3	.42	.56	1.0				
F4	.62	.69	.53	1.0			
F5	.45	.30	.13	.34	1.0		

Note. F1–F5 = Factor 1–Factor 5; h^2 = Communality coefficient; u^2 = Uniqueness; Gc = Crystallized Ability/Comprehension-Knowledge; Grw = Reading-Writing Ability; Glr = Long-Term Retrieval; Ga = Auditory Processing; Gsm = Short-Term Memory; Gs = Processing Speed; Gq = Quantitative Reasoning; Gf = Fluid Reasoning; Gv = Visual-Spatial Thinking. Pattern coefficients > .30 are in bold italics. The eigenvalue of the sixth, unretained factor was 1.222.

Table 2
Age 9- to 13-Year-Old Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001a) Principal Axis Factor With Promax Rotation (Six Factors)

Subtest	Pattern (structure) coefficients						h^2	u^2
	F1	F2	F3	F4	F5	F6		
Story Recall Gc	***.84*** (.73)	−.19 (.44)	.09 (.35)	.08 (.48)	−.15 (.31)	.04 (.31)	.56	.44
Academic Knowledge Gc	***.82*** (.85)	.08 (.62)	−.12 (.30)	.09 (.58)	−.04 (.48)	−.02 (.35)	.74	.26
Picture Vocabulary Gc	***.80*** (.79)	.09 (.53)	−.11 (.21)	−.15 (.40)	.10 (.54)	.03 (.36)	.65	.35
Verbal Comprehension Gc	***.79*** (.91)	.07 (.66)	−.10 (.32)	.08 (.61)	.10 (.61)	.03 (.43)	.84	.16
General Information Gc	***.75*** (.84)	.05 (.60)	−.01 (.34)	.01 (.53)	.12 (.56)	−.04 (.34)	.71	.29
Story Recall—Delayed Glr	***.69*** (.62)	−.14 (.40)	.11 (.36)	.13 (.46)	−.20 (.21)	.03 (.25)	.43	.57
Oral Comprehension Gc	***.65*** (.72)	−.00 (.52)	.01 (.31)	.07 (.49)	.07 (.46)	−.02 (.30)	.52	.48
Reading Vocabulary Grw	***.53*** (.78)	.22 (.67)	−.04 (.36)	.11 (.59)	.07 (.51)	.01 (.36)	.65	.35
Understanding Directions Gc	***.36*** (.62)	−.13 (.48)	−.13 (.38)	.12 (.56)	***.31*** (.48)	.24 (.27)	.47	.53
Spelling Grw	.06 (.61)	***.92*** (.88)	.01 (.49)	−.06 (.59)	−.13 (.32)	.05 (.28)	.79	.21
Word Attack Grw	−.12 (.51)	***.88*** (.77)	−.15 (.29)	−.02 (.49)	.12 (.44)	.06 (.29)	.64	.36
Letter–Word Identification Grw	.13 (.67)	***.86*** (.87)	−.10 (.39)	−.06 (.58)	.02 (.46)	.03 (.32)	.79	.21
Spelling of Sounds Ga	−.11 (.51)	***.73*** (.73)	−.07 (.30)	−.03 (.46)	.31 (.54)	−.03 (.25)	.60	.40
Editing Grw	.17 (.62)	***.59*** (.76)	.04 (.46)	.07 (.59)	−.05 (.35)	.03 (.28)	.61	.39
Writing Samples Grw	.15 (.58)	***.52*** (.70)	.01 (.40)	.11 (.56)	.02 (.37)	−.04 (.23)	.52	.48
Writing Fluency Grw	.03 (.50)	***.52*** (.70)	***.38*** (.64)	−.06 (.50)	.04 (.30)	−.05 (.17)	.59	.41
Read Fluency Grw	.25 (.59)	***.48*** (.71)	***.39*** (.65)	−.18 (.47)	−.01 (.32)	−.06 (.17)	.64	.36
Sound Awareness Ga	.02 (.63)	***.42*** (.71)	−.04 (.34)	.18 (.60)	***.34*** (.62)	.06 (.39)	.64	.36
Passage Comprehension Grw	***.37*** (.72)	***.41*** (.74)	.02 (.43)	.07 (.60)	.03 (.46)	.01 (.33)	.64	.36
Handwriting Grw	−.15 (.13)	***.36*** (.31)	.16 (.27)	−.04 (.20)	−.08 (.04)	.08 (.10)	.13	.87
Decision Speed Gs	−.02 (.29)	−.13 (.33)	***.72*** (.68)	.02 (.34)	.12 (.19)	.06 (.18)	.48	.52
Visual Matching Gs	−.21 (.32)	.20 (.54)	***.68*** (.79)	.15 (.51)	−.03 (.13)	.06 (.18)	.67	.33
Pair Cancellation Gs	−.06 (.25)	−.15 (.31)	***.67*** (.66)	.17 (.38)	.04 (.10)	.01 (.11)	.45	.55
Rapid Picture Naming Gs	.26 (.36)	.02 (.31)	***.55*** (.52)	−.35 (.15)	.10 (.24)	.04 (.15)	.36	.64
Retrieval Fluency Glr	***.34*** (.48)	−.07 (.39)	***.51*** (.55)	−.16 (.31)	.13 (.33)	.03 (.21)	.41	.59
Math Fluency Gq	−.15 (.34)	***.44*** (.62)	***.49*** (.70)	.15 (.53)	−.12 (.08)	−.10 (.05)	.63	.37
Applied Problems Gq	.20 (.64)	.18 (.69)	−.05 (.44)	***.67*** (.84)	−.09 (.30)	−.05 (.28)	.75	.25
Analysis-Synthesis Gf	.14 (.49)	−.20 (.41)	−.01 (.30)	***.67*** (.66)	.08 (.32)	.07 (.34)	.48	.52
Quantitative Concepts Ga	.14 (.63)	.24 (.70)	−.05 (.43)	***.61*** (.81)	−.06 (.33)	−.02 (.30)	.71	.28
Concept Formation Gf	.15 (.58)	−.11 (.50)	.02 (.33)	***.60*** (.70)	.16 (.44)	.09 (.40)	.56	.44
Calculation Gq	.04 (.49)	.28 (.65)	.11 (.52)	***.57*** (.75)	−.20 (.14)	−.06 (.18)	.65	.35
Spatial Relations Gv	−.04 (.33)	−.01 (.33)	−.04 (.18)	***.40*** (.45)	.15 (.31)	.13 (.31)	.24	.76
Numbers Reversed Gsm	−.15 (.40)	.26 (.53)	.10 (.38)	***.35*** (.55)	.17 (.34)	.04 (.26)	.37	.63
Planning Gv	−.05 (.25)	−.02 (.25)	−.01 (.16)	***.34*** (.36)	.15 (.24)	.04 (.20)	.15	.85
Auditory Working Memory Gsm	.16 (.52)	.03 (.50)	.18 (.42)	.28 (.53)	.20 (.40)	−.05 (.23)	.39	.61
Sound Blending Ga	−.00 (.45)	.07 (.41)	.03 (.21)	.13 (.36)	***.58*** (.64)	−.05 (.26)	.43	.57
Memory for Words Gsm	−.02 (.44)	.11 (.45)	.05 (.27)	.22 (.43)	***.41*** (.51)	−.05 (.24)	.35	.65
Incomplete Words Ga	.12 (.35)	−.01 (.27)	.11 (.19)	−.05 (.20)	***.38*** (.45)	.01 (.22)	.23	.77
Auditory Attention Ga	−.07 (.21)	−.07 (.21)	.20 (.25)	.16 (.25)	.26 (.27)	−.01 (.13)	.13	.87
Visual-Auditory Learning—Delayed Glr	.04 (.47)	.10 (.39)	.04 (.23)	.02 (.43)	−.08 (.38)	***.91*** (.94)	.90	.10
Visual-Auditory Learning Glr	.03 (.51)	.06 (.43)	.04 (.26)	.11 (.50)	−.01 (.44)	***.85*** (.93)	.89	.11
Picture Recognition Gv	−.03 (.18)	−.10 (.15)	.16 (.19)	.11 (.21)	.12 (.19)	.19 (.25)	.10	.90
Eigenvalue	16.34	2.59	1.78	1.66	1.39	1.22		
% Variance	38.90	6.16	4.23	3.96	3.31	2.91		
F1	1.0							
F2	.69	1.0						
F3	.41	.54	1.0					
F4	.62	.68	.50	1.0				
F5	.58	.45	.15	.34	1.0			
F6	.42	.30	.14	.36	.42	1.0		

Note. F1–F5 = Factor 1–Factor 5; h^2 = Communality coefficient; u^2 = Uniqueness; Gc = Crystallized Ability/Comprehension-Knowledge; Glr = Long-Term Retrieval; Grw = Reading-Writing Ability; Ga = Auditory Processing; Gs = Processing Speed; Gq = Quantitative Reasoning; Gf = Fluid Reasoning; Gv = Visual-Spatial Thinking; Gsm = Short-Term Memory. Pattern coefficients $>$ .30 are in bold italics. The eigenvalue of the seventh, unretained factor was 1.077.

six-factor extraction. Included within both tables are pattern/structure coefficients, eigenvalues for each factor retained, percentage of variance accounted for by each factor, communality coefficients, uniqueness, and the correlation among the extracted factors. Additionally, the eigenvalue of the first, unretained factor is furnished. The 9 to 13 and 14 to 19 analyses suggested that the first factor accounted for 38.9% and 41.57% of the variance, respectively. This dwarfed the variance accounted for by the second factor at the 9 to 13 and 14 to 19 age range (6.16% and 5.71%, respectively). Given the data in Tables 1–4, it appears that the six-factor solution at ages 9 to 13 and

Table 3
Age 14- to 19-Year-Old Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001a) Principal Axis Factor With Promax Rotation (Five Factors)

Subtest	Pattern (structure) coefficients						
	F1	F2	F3	F4	F5	h^2	u^2
Picture Vocabulary Gc	***.81*** (.83)	.22 (.65)	−.13 (.27)	−.12 (.48)	−.02 (.45)	.71	.29
Story Recall Gc	***.80*** (.74)	−.26 (.47)	.13 (.39)	.08 (.49)	.04 (.44)	.57	.43
General Information Gc	***.76*** (.87)	.20 (.72)	−.09 (.35)	.10 (.64)	−.11 (.44)	.79	.21
Story Recall–Delayed Glr	***.75*** (.67)	−.28 (.40)	.18 (.39)	.03 (.42)	.04 (.39)	.48	.52
Academic Knowledge Gc	***.74*** (.86)	.05 (.69)	−.11 (.35)	.25 (.64)	−.05 (.44)	.79	.21
Verbal Comprehension Gc	***.72*** (.91)	.22 (.77)	−.11 (.37)	.08 (.66)	.04 (.56)	.86	.14
Oral Comprehension Gc	***.58*** (.74)	.14 (.63)	.04 (.39)	.04 (.54)	.04 (.47)	.57	.43
Reading Vocabulary Grw	***.55*** (.78)	.23 (.69)	−.12 (.32)	.20 (.64)	−.04 (.44)	.66	.34
Understanding Directions Gc	***37*** (.66)	.21 (.62)	.14 (.45)	.−.02 (.50)	.16 (.51)	.51	.49
Passage Comprehension Grw	***.36*** (.70)	***.30*** (.70)	.02 (.42)	.15 (.61)	.04 (.47)	.58	.42
Spelling of Sounds Ga	−.09 (.49)	***.80*** (.73)	−.03 (.36)	.08 (.53)	−.09 (.30)	.55	.45
Word Attack Grw	−.16 (.48)	.74 (.74)	−.07 (.36)	.27 (.62)	−.06 (.32)	.59	.41
Sound Blending Ga	.10 (.50)	***.72*** (.65)	.06 (.35)	−.32 (.32)	.10 (.40)	.47	.53
Memory for Words Gsm	−.04 (.47)	***.59*** (.63)	.04 (.36)	−.06 (.43)	−.16 (.43)	.41	.59
Sound Awareness Ga	.08 (.59)	***.59*** (.73)	−.06 (.36)	.12 (.58)	.06 (.44)	.55	.45
Letter–Word Identification Grw	.16 (.69)	***.56*** (.81)	−.05 (.43)	.27 (.72)	−06 (.42)	.72	.28
Incomplete Words Ga	.19 (.44)	***.55*** (.53)	.06 (.29)	−.26 (.27)	−.01 (.28)	.32	.68
Numbers Reversed Gsm	−.22 (.43)	***.47*** (.62)	.10 (.43)	.19 (.54)	.25 (.49)	.47	.53
Auditory Working Memory Gsm	.04 (.51)	***.41*** (.62)	.13 (.44)	.08 (.51)	.11 (.42)	.41	.59
Writing Samples Grw	.23 (.63)	***.32*** (.67)	.08 (.45)	.20 (.61)	.03 (.43)	.52	.48
Visual Matching Gs	−.19 (.33)	.02 (.46)	***.67*** (.76)	***.32*** (.55)	.02 (.30)	.64	.36
Decision Speed Gs	.11 (.32)	−.01 (.34)	***.66*** (.65)	−.15 (.27)	.06 (.28)	.43	.57
Reading Fluency Grw	.19 (.56)	.16 (.62)	***.59*** (.77)	.11 (.58)	−.12 (.32)	.68	.32
Rapid Picture Naming Gs	.17 (.36)	.07 (.37)	***.58*** (.60)	−.18 (.26)	.02 (.26)	.38	.62
Pair Cancellation Gs	−.09 (.16)	−.08 (.21)	***.57*** (.53)	.03 (.23)	.07 (.19)	.29	.71
Writing Fluency Grw	.10 (.53)	***.31*** (.62)	***.39*** (.62)	.09 (.54)	−.05 (.34)	.52	.48
Retrieval Fluency Glr	***.36*** (.50)	.01 (.45)	***.38*** (.53)	.03 (.42)	−.08 (.27)	.38	.62
Handwriting Grw	−.12 (.11)	.10 (.20)	.23 (.28)	.12 (.22)	−.03 (.09)	.10	.90
Calculation Gq	.14 (.53)	−.24 (.48)	.01 (.38)	***.80*** (.77)	.08 (.41)	.61	.39
Applied Problems Gq	***.31*** (.70)	−.11 (.62)	−.09 (.37)	***.70*** (.83)	.11 (.51)	.75	.25
Quantitative Concepts Gq	.27 (.71)	−.07 (.65)	−.05 (.42)	***.68*** (.84)	.13 (.54)	.77	.23
Math Fluency Gq	−.14 (.36)	−.06 (.47)	***.55*** (.71)	***.57*** (.67)	−12 (.22)	.67	.33
Spelling Grw	.05 (.59)	***.35*** (.72)	.09 (.49)	***.49*** (.76)	−.12 (.34)	.66	.34
Editing Grw	.23 (.60)	.19 (.62)	.04 (.42)	***.44*** (.68)	−.13 (.31)	.54	.46
Analysis-Synthesis Gf	.14 (.56)	−.00 (.53)	.02 (.37)	***.38*** (.62)	***.31*** (.56)	.49	.51
Auditory Attention Ga	.12 (.27)	.27 (.31)	.21 (.29)	−.28 (.12)	.06 (.22)	.16	.84
Visual-Auditory Learning Glr	−.01 (.53)	.04 (.48)	−.01 (.29)	.04 (.43)	***.86*** (.87)	.80	.20
Visual-Aud Learning—Delayed Glr	.02 (.52)	.03 (.48)	−.05 (.29)	.04 (.43)	***.84*** (.87)	.76	.24
Concept Formation Gf	.14 (.60)	.18 (.61)	.05 (.42)	.19 (.58)	***.34*** (.61)	.53	.47
Spatial Relations Gv	−.03 (.42)	.20 (.48)	.04 (.32)	.17 (.45)	***.33*** (.50)	.33	.67
Picture Recognition Gv	.22 (.37)	−.09 (.29)	.23 (.34)	−.05 (.26)	.28 (.41)	.23	.77
Planning Gv	−.10 (.22)	.15 (.29)	.02 (.20)	.16 (.29)	.18 (.28)	.12	.88
Eigenvalue	17.46	2.40	1.63	1.52	1.51		
% Variance	41.57	5.71	3.89	3.63	3.59		
F1	1.0						
F2	.73	1.0					
F3	.43	.52	1.0				
F4	.64	.70	.50	1.0			
F5	.56	.51	.35	.45	1.0		

Note. F1–F5 = Factor 1–Factor 5; h^2 = Communality coefficient; u^2 = Uniqueness; Gc = Crystallized Ability/Comprehension-Knowledge; Glr = Long-Term Retrieval; Grw = Reading-Writing Ability; Ga = Auditory Processing; Gsm = Short-Term Memory; Gs = Processing Speed; Gq = Quantitative Reasoning; Gf = Fluid Reasoning; Gv = Visual-Spatial Thinking. Pattern coefficients > .30 are in bold italics. The eigenvalue of the sixth, unretained factor was 1.171.

the five-factor solution at ages 14 to 19 are the most psychometrically appropriate.

Higher Order Factor Analysis (Schmid-Leiman Orthogonalization)

As expected, correlations among the extracted five and six-factor solution were substantial, with medians ranging from .42 to .52. High correlation among factors suggests the possible presence of a higher order factor which should be extracted and examined (Carroll, 1993; Gorsuch, 1983; Schmid & Leiman, 1957; Thompson, 2004). Results from the Schmid and Leiman (1957) procedure on the five and six-factor extracted solutions are presented in Tables 5, 6, 7, and 8. All tables furnish the proportion of variance ascribed to the higher order (*g*) factor and lower order factors.

Table 4
14- to 19-Year Old Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001a) Principal Axis Factor With Promax Rotation (Six Factors)

Subtest	Pattern (structure) coefficients							
	F1	F2	F3	F4	F5	F1	h^2	u^2
Story Recall Gc	***.88*** (.90)	−.08 (.67)	.10 (.31)	−.12 (.65)	−.14 (.73)	.12 (.46)	.60	.40
Story Recall Delayed Glr	***.86*** (.87)	−.06 (.67)	.15 (.30)	−.15 (.51)	−.27 (.70)	.16 (.39)	.57	.43
Picture Vocabulary Gc	***.77*** (.86)	−.16 (.65)	−.11 (.30)	***.30*** (.59)	.10 (.66)	−.09 (.35)	.73	.27
Academic Knowledge Gc	***.75*** (.80)	.07 (.50)	−.10 (.20)	.05 (.63)	.17 (.58)	−.07 (.36)	.79	.21
General Information Gc	***.74*** (.79)	.05 (.68)	−.08 (.27)	.19 (.50)	.12 (.61)	−.14 (.40)	.79	.21
Verbal Comprehension Gc	***.70*** (.75)	−.01 (.48)	−.14 (.37)	.23 (.32)	.20 (.46)	−.03 (.42)	.87	.13
Reading Vocabulary Grw	***.59*** (.74)	***.30*** (.56)	.04 (.35)	.09 (.52)	−.02 (.57)	.01 (.40)	.67	.33
Oral Comprehension Gc	***.58*** (.71)	.01 (.65)	.35 (.37)	.16 (.54)	.06 (.63)	.01 (.41)	.57	.43
Retrieval Fluency Glr	***.39*** (.69)	.11 (.43)	.15 (.38)	.03 (.26)	−.15 (.37)	−.02 (.40)	.38	.62
Understanding Directions Gc	***.36*** (.65)	−.01 (.53)	.02 (.41)	.23 (.54)	.12 (.56)	.08 (.44)	.51	.49
Passage Comprehension Gc	***.35*** (.52)	.20 (.47)	.04 (.51)	.19 (.30)	.14 (.36)	.00 (.27)	.58	.42
Spelling Grw	.12 (.64)	***.77*** (.83)	−.09 (.46)	−.03 (.37)	−.03 (.61)	−.00 (.34)	.70	.30
Word Attack Grw	−.15 (.71)	***.76*** (.82)	−.02 (.37)	.26 (.55)	.03 (.64)	−.02 (.40)	.60	.40
Editing Grw	***.32*** (.65)	***.68*** (.75)	−.08 (.39)	−.13 (.29)	−.14 (.53)	.03 (.33)	.61	.39
Letter–Word Identification Grw	.19 (.50)	***.67*** (.74)	−.04 (.31)	.18 (.50)	−.05 (.55)	.02 (.30)	.74	.26
Spelling of Sounds Ga	−.10 (.60)	***.60*** (.67)	−.08 (.30)	***.40*** (.56)	.01 (.56)	−.08 (.41)	.54	.46
Sound Awareness Ga	.10 (.49)	***.49*** (.66)	.09 (.41)	.27 (.57)	.00 (.50)	.08 (.27)	.55	.45
Numbers Reversed Gsm	−.20 (.64)	***.43*** (.66)	.07 (.58)	.19 (.49)	.14 (.60)	.21 (.38)	.46	.54
Writing Samples Grw	.23 (.54)	***.30*** (.61)	.20 (.40)	.16 (.45)	.11 (.51)	.01 (.31)	.52	.48
Handwriting Grw	−.09 (.45)	***.30*** (.60)	***.66*** (.40)	−.03 (.45)	−.11 (.54)	.04 (.46)	.11	.89
Decision Speed Gs	.07 (.51)	−.22 (.55)	***.66*** (.76)	.18 (.49)	.08 (.53)	−.03 (.36)	.45	.55
Visual Matching Gs	−.18 (.36)	.21 (.55)	***.60*** (.74)	−.02 (.22)	.21 (.48)	−.03 (.27)	.64	.36
Pair Cancellation Gs	−.13 (.59)	−.20 (.66)	***.55*** (.71)	.09 (.39)	.25 (.48)	−.06 (.32)	.34	.66
Reading Fluency Grw	.22 (.42)	.29 (.65)	***.53*** (.64)	.10 (.13)	−.12 (.52)	−.06 (.21)	.69	.31
Rapid Picture Naming Gs	.17 (.32)	.04 (.29)	***.53*** (.58)	.13 (.30)	−.24 (.31)	.07 (.24)	.39	.61
Math Fluency Gq	−.08 (.36)	***.42*** (.35)	***.37*** (.55)	−.19 (.29)	.19 (.23)	−.09 (.28)	.67	.33
Writing Fluency Grw	.10 (.16)	.26 (.21)	.06 (.28)	.20 (.16)	.04 (.27)	−.06 (.14)	.52	.48
Sound Blending Ga	.04 (.13)	.14 (.26)	.06 (.29)	***.57*** (.07)	−.01 (.14)	.01 (.11)	.48	.52
Incomplete Words Ga	.15 (.47)	.13 (.45)	.04 (.31)	***.44*** (.67)	−.08 (.41)	−.05 (.34)	.32	.68
Memory for Words Gsm	−.05 (.46)	***.30*** (.52)	.23 (.24)	***.37*** (.55)	.05 (.47)	.10 (.39)	.41	.59
Auditory Attention Ga	.07 (.42)	−.14 (.38)	.14 (.26)	***.33*** (.53)	.01 (.32)	−.02 (.24)	.17	.83
Auditory Working Memory Gsm	.03 (.24)	.21 (.18)	.09 (.40)	.26 (.36)	.17 (.20)	.03 (.18)	.42	.58
Spatial Relations Gv	−.11 (.75)	−.15 (.73)	−.02 (.35)	.23 (.36)	***.61*** (.85)	.08 (.43)	.42	.58
Quantitative Concepts Gq	***.30*** (.74)	.16 (.71)	.04 (.38)	−.14 (.33)	***.60*** (.83)	−.01 (.40)	.79	.21
Applied Problems Gq	.19 (.59)	.18 (.63)	−.06 (.35)	−.30 (.16)	***.60*** (.73)	−.02 (.32)	.77	.23
Calculation Gq	***.34*** (.58)	.15 (.53)	.05 (.38)	−.17 (.38)	***.60*** (.70)	−.01 (.46)	.62	.38
Analysis-Synthesis Gf	.13 (.60)	−.04 (.54)	−.05 (.30)	.01 (.51)	***.54*** (.70)	.13 (.51)	.52	.48
Concept Formation Gf	.11 (.41)	−.05 (.39)	.09 (.18)	.18 (.44)	***.46*** (.60)	.15 (.39)	.56	.44
Planning Gv	−.15 (.22)	−.07 (.24)	.06 (.26)	.14 (.25)	***.46*** (.39)	−.00 (.20)	.17	.83
Visual-Auditory Learning—Delayed Glr	.06 (.52)	.07 (.43)	−.10 (.18)	−.03 (.41)	.04 (.52)	***.92*** (.95)	.91	.09
Visual-Auditory Learning Glr	.03 (.52)	.02 (.43)	−.03 (.31)	.02 (.44)	.13 (.55)	***.83*** (.91)	.84	.16
Picture Recognition Gv	.22 (.36)	−.16 (.25)	.22 (.33)	.04 (.26)	.06 (.31)	.23 (.38)	.23	.77
Eigenvalue	17.46	2.40	1.63	1.52	1.51	1.17		
% Variance	41.57	5.71	3.89	3.63	3.59	2.79		
F1	1.0							
F2	.71	1.0						
F3	.41	.52	1.0					
F4	.54	.45	.24	1.0				
F5	.71	.72	.41	.46	1.0			
F6	.48	.39	.32	.42	.48	1.0		

Note. F1–F5 = Factor 1–Factor 5; h^2 = Communality coefficient; u^2 = Uniqueness; Gc = Crystallized Ability/Comprehension-Knowledge; Glr = Long-Term Retrieval; Grw = Reading-Writing Ability; Ga = Auditory Processing; Gsm = Short-Term Memory; Gs = Processing Speed; Gq = Quantitative Reasoning; Gv = Visual-Spatial Thinking; Gf = Fluid Reasoning. Pattern coefficients > .30 are in bold italics. The eigenvalue of the seventh, unretained factor was 1.107.

Age 9 to 13. In the age 9 to 13 Schmid-Leiman (SL) analysis across the respective five- and six-factor solutions (see Tables 5 and 6), the higher order factor accounted for 33.1% and 33.8% of the total variance and 63.9% and 62.4% of the common variance. The *g* factor accounted for between 4% and 59% (*Mdn* = 36%) of individual subtest variance in the age 9 to 13, five-factor analysis. The *g* factor accounted for between 4% and 64% (*Mdn* = 38%) of individual subtest variance in the age 9 to 13, six-factor analysis. For the age 9 to 13 analyses, the first-order factors accounted for a small proportion of the total variance (2.4% to 5.0%) and

Table 5

WJ-III Sources of Variance According to a Schmid-Leiman Orthogonalization (Five Factor) Ages 9 to 13

	Second-order factor		First-order factors											
Subtest	*g*	Var	F1	Var	F2	Var	F3	Var	F4	Var	F5	Var	h^2	u^2
Picture Vocabulary Gc	.60	35	***.52***	27	.05	00	−.08	01	−.08	01	.01	00	.64	.36
Verbal Comprehension Gc	.76	57	***.51***	26	.04	00	−.07	01	.06	00	.02	00	.84	.16
General Information Gc	.69	47	***.50***	25	.03	00	−.01	00	.01	00	−.04	00	.72	.28
Academic Knowledge Gc	.70	49	***.48***	23	.02	00	−.08	01	.09	01	−.06	00	.74	.26
Story Recall Gc	.56	31	***.44***	19	−.13	02	.09	01	.10	01	−.03	00	.54	.46
Oral Comprehension Gc	.60	36	***.41***	17	.00	00	.01	00	.05	00	−.03	00	.53	.47
Reading Vocabulary Grw	.72	52	***.34***	12	.11	01	−.03	00	.07	01	.00	00	.65	.35
Story Recall—Delayed Glr	.50	25	***.34***	11	−.10	01	.11	01	.13	02	−.04	00	.41	.59
Understanding Dir Gc	.58	34	.29	08	−.04	00	.08	01	.15	02	.00	00	.46	.54
Incomplete Words Ga	.31	10	.20	04	.05	00	.06	00	−.09	01	.11	01	.16	.84
Sound Blending Ga	.46	21	.19	04	.11	01	−.02	00	−.01	00	.11	01	.27	.73
Aud Working Memory Gsm	.56	31	.16	02	.03	00	.13	02	.14	02	.01	00	.37	.63
Word Attack Grw	.65	43	−.03	00	***.46***	21	−.12	02	−.01	00	.06	00	.66	.34
Letter–Word ID Grw	.77	59	.09	01	***.43***	18	−.07	00	−.01	00	.00	00	.79	.21
Spelling Grw	.75	57	−.01	00	***.43***	18	.04	00	.02	00	−.02	00	.75	.25
Spelling of Sounds Ga	.63	40	.04	00	***.41***	16	−.07	01	−.05	00	.03	00	.57	.43
Edit Grw	.71	50	.08	01	.28	08	.05	00	.07	01	−.02	00	.59	.41
Sound Awareness Ga	.70	50	.13	02	.26	07	−.05	00	.06	00	.14	02	.60	.40
Writing Samples Grw	.66	43	.10	01	.26	07	.02	00	.08	01	−.05	00	.52	.48
Writing Fluency Grw	.63	40	.03	00	.24	06	***.32***	10	−.02	00	−.05	00	.57	.43
Passage Comprehension Grw	.73	54	.23	05	.20	04	.02	00	.06	00	−.01	00	.64	.36
Handwriting Grw	.24	06	−.12	01	.16	03	.15	02	.00	00	.04	00	.12	.88
Memory for Words Gsm	.48	23	.13	02	.11	01	.01	00	.06	00	.07	01	.27	.73
Decision Speed Gs	.38	14	.03	00	−.07	01	***.59***	34	−.01	00	.10	01	.50	.50
Visual Matching Gs	.52	27	−.14	02	.07	00	***.57***	33	.10	01	.06	00	.64	.36
Pair Cancellation Gs	.36	13	−.03	00	−.10	01	***.55***	31	.09	01	.04	00	.45	.55
Rapid Naming Gs	.32	10	.19	04	.01	00	***.46***	21	−.21	04	.04	00	.40	.60
Math Fluency Gq	.55	30	−.13	02	.17	03	***.42***	18	.13	02	−.12	02	.56	.44
Retrieval Fluency Glr	.44	19	.25	06	−.04	00	***.42***	17	−.11	01	.05	00	.44	.56
Read Fluency Grw	.65	42	.15	02	.22	05	***.34***	12	−.08	01	−.09	01	.62	.38
Aud Attention Ga	.26	07	.05	00	.00	00	.14	02	.05	00	.07	01	.09	.91
Applied Problems Gq	.75	56	.08	01	.06	00	−.03	00	***.42***	18	−.06	00	.76	.24
Quantitative Concepts Gq	.75	56	.06	00	.10	01	−.03	00	***.38***	15	−.03	00	.72	.28
Analysis Synthesis Gf	.54	29	.10	01	−.10	01	−.01	00	***.38***	14	.11	01	.46	.54
Calculation Gq	.66	44	−.05	00	.09	01	.11	01	***.38***	14	−.10	01	.61	.39
Concept Formation Gf	.63	39	.14	02	−.03	00	−.03	00	***.32***	10	.15	02	.54	.46
Spatial Relations Gv	.39	16	.02	00	.02	00	−.04	00	.21	04	.18	03	.23	.77
Numbers Reversed Gsm	.54	29	−.04	00	.15	02	.07	00	.18	03	.09	01	.36	.64
Planning Gv	.31	09	.01	00	.01	00	−.02	00	.17	03	.10	01	.13	.87
Visual-Aud Ln Glr	.54	29	.00	00	.04	00	.06	00	.07	00	***.78***	60	.90	.10
Visual-Aud Ln—Del Glr	.48	23	−.01	00	.04	00	.05	00	.03	00	***.75***	56	.80	.20
Picture Recognition Gv	.20	04	.01	00	−.04	00	.13	02	.04	00	.22	05	.11	.89
% Total Variance	33.1		5.0		3.1		4.6		2.5		3.4		51.8	48.2
% Common Variance	63.9		9.7		6.0		8.9		4.8		6.6			

Note. WJ-III = Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001a); *g* = general ability; Var = variance; F1–F5 = Factor 1–Factor 5; h^2 = Communality coefficient; u^2 = Uniqueness; Gc = Crystallized Ability/Comprehension-Knowledge; Grw = Reading-Writing Ability; Del = delayed; Glr = Long-Term Retrieval; Dir = directions; Ga = Auditory Processing; Aud = auditory; Gsm = Short-Term Memory; Gs = Processing Speed; Gq = Quantitative Reasoning; Gf = Fluid Reasoning; Gv = Visual-Spatial Thinking; Ln = learning. Loadings > .30 are in bold italics and are considered to be aligned with their respective first order factors. Note that alignment of subtests with respective nine broad Cattell-Horn-Carroll first order factors posited in the WJ-III Technical Manual is indicted following each subtest name (Gc, Grw, Ga, etc.). F1 = Gc; F2 = Grw; F3 = Gs; F4 = Combined Gf/Gq; F5 = Glr.

common variance (4.5% to 9.8%) across both the five and six-factor analyses. For the age 9 to 13 analyses, the first and second-order factors combined to account for over 50% of the variance in the WJ-III (51.8%, five-factor solution; 54.1%, six-factor solution), reflecting 48.2% and 45.9% respective unique variance across the five and six-factor solutions.

Age 14 to 19. In the age 14 to 19 SL analysis across the respective five- and six-factor solutions (see Tables 7 and 8), the higher order factor accounted for 36.0% and 36.9% of the total variance and 67.6% and 66.5% of the common variance. The *g* factor accounted for between 4% and 67% (*Mdn* = 40%) of individual subtest variability in the age 14 to 19 five-factor analysis. The *g* factor accounted for between 4% and 65% (*Mdn* = 39%) of individual subtest variability in the age 14 to 19 six-factor analysis. For the age 14 to 19 analyses, the five first-order factors accounted for 2.4% to 4.5% of the total variance and 4.6% to 8.5%

Table 6
WJ-III Sources of Variance According to a Schmid-Leiman Orthogonalization (Six Factor) Ages 9 to 13

	Second-order factor		First-order factors													
Subtest	*g*	Var	F1	Var	F2	Var	F3	Var	F4	Var	F5	Var	F6	Var	h^2	u^2
Story Recall Gc	.60	36	***.44***	19	−.10	01	.06	00	.07	00	−.13	02	.04	00	.60	.40
Academic Knowledge Gc	.74	55	***.43***	18	.04	00	−.07	01	.08	01	−.03	00	−.02	00	.69	.31
Picture Vocabulary Gc	.64	41	***.42***	17	.05	00	−.07	00	−.13	02	.08	01	.02	00	.63	.37
Verbal Comprehension Gc	.80	64	***.42***	17	.04	00	−.06	00	.07	00	.08	01	.03	00	.76	.24
General Information Gc	.73	53	***.39***	15	.03	00	−.01	00	.01	00	.10	01	−.04	00	.68	.32
Story Recall—Delayed Glr	.53	28	***.36***	13	−.07	01	.07	00	.11	01	−.17	03	.02	00	.47	.53
Oral Comprehension Gc	.63	40	***.34***	11	−.01	00	.00	00	.06	00	.06	00	−.02	00	.50	.50
Reading Vocabulary Grw	.74	55	.28	08	.12	01	−.03	00	.09	01	.06	00	.01	00	.60	.40
Understanding Dir Gc	.60	36	.19	03	−.07	01	.08	00	.26	07	.20	04	−.06	00	.46	.54
Spelling Grw	.74	54	.03	00	***.50***	25	.01	01	−.05	00	−.11	01	.05	00	.84	.16
Word Attack Grw	.63	40	−.06	00	***.47***	22	−.10	00	−.02	00	.10	01	.05	00	.61	.39
Letter–Word ID Grw	.76	58	.07	00	***.46***	22	−.06	01	−.05	00	.02	00	.03	00	.79	.31
Spelling of Sounds Ga	.62	38	−.06	00	***.39***	16	−.05	00	−.02	00	.26	07	−.03	00	.56	.44
Edit Grw	.70	49	.09	01	***.32***	10	.03	00	.06	00	−.05	00	.02	00	.60	.40
Writing Samples Grw	.65	42	.08	01	.28	08	.00	00	.09	01	.02	00	−.04	00	.49	.51
Writing Fluency Grw	.62	39	.02	00	.28	08	.24	06	−.05	00	.03	00	−.04	00	.65	.35
Read Fluency Grw	.66	43	.13	02	.26	07	.25	06	−.15	02	−.01	00	−.05	00	.78	.22
Sound Awareness Ga	.70	50	.01	00	.23	05	−.03	00	.15	02	.29	08	.05	00	.57	.43
Passage Comprehension Grw	.74	55	.19	04	.22	05	.01	00	.06	00	.03	00	.01	00	.62	.38
Handwriting Grw	.23	05	−.08	01	.20	04	.10	01	−.03	00	−.07	01	.07	00	.14	.86
Decision Speed Gs	.38	15	−.01	00	−.07	00	***.46***	21	.01	00	.10	01	.06	00	.51	.49
Visual Matching Gs	.50	25	−.11	01	.11	01	***.43***	19	.13	02	−.02	00	.05	00	.62	.38
Pair Cancellation Gs	.35	12	−.03	00	−.08	01	***.43***	18	.14	02	.03	00	.01	00	.43	.57
Rapid Naming Gs	.35	12	.14	02	.01	00	***.35***	12	−.29	08	.09	01	.03	00	.52	.48
Retrieval Fluency Glr	.47	22	.18	03	−.04	00	***.32***	10	−.13	02	.11	01	.02	00	.54	.46
Math Fluency Gq	.52	27	−.08	01	.24	06	***.31***	10	.12	02	−.10	01	−.09	01	.55	.45
Applied Problems Gq	.73	54	.11	01	.09	01	−.03	00	***.55***	30	−.08	01	−.04	00	.68	.32
Analysis Synthesis Gf	.54	29	.07	01	−.11	01	−.00	00	***.55***	30	.07	00	.06	00	.48	.52
Quantitative Concepts Gq	.73	53	.07	01	.13	02	−.03	00	***.51***	26	−.05	00	−.17	00	.63	.37
Concept Formation Gf	.63	39	.08	01	−.06	00	−.01	00	***.50***	25	.14	02	.08	01	.52	.48
Calculation Gq	.63	40	.02	00	.15	02	.07	00	***.47***	22	−.17	03	−.06	00	.57	.43
Spatial Relations Gv	.39	15	−.02	00	−.00	00	−.02	00	***.33***	11	.13	02	.11	01	.23	.78
Numbers Reversed Gsm	.52	27	−.08	01	.14	02	.06	00	.29	08	.14	02	.03	00	.35	.65
Planning Gv	.30	09	−.03	00	−.01	00	−.00	00	.28	08	.13	02	.04	00	.15	.85
Aud Working Memory Gsm	.56	31	.08	01	.02	00	.11	01	.23	05	.17	03	−.04	00	.39	.61
Sound Blending Ga	.47	22	−.01	00	.04	00	.02	00	.10	01	***.49***	24	−.04	00	.44	.56
Memory for Words Gsm	.48	23	−.01	00	.06	00	.03	00	.18	03	***.35***	12	−.04	00	.35	.65
Incomplete Words Ga	.33	11	.06	00	−.01	00	.07	01	−.04	00	***.33***	11	.01	00	.24	.76
Aud Attention Ga	.26	07	−.04	00	−.04	00	.13	02	.13	02	.22	05	−.01	00	.15	.85
Visual-Aud Ln—Del Glr	.52	27	.02	00	.06	00	.02	00	.02	00	−.07	00	***.81***	66	.95	.05
Visual-Aud Ln Glr	.57	32	.01	00	.03	00	.03	00	.09	01	−.00	00	***.76***	58	.89	.11
Picture Recognition Gv	.21	04	−.02	00	−.05	00	.10	01	.09	01	.10	01	.17	3	.11	.89
% Total Variance	33.8		3.4		3.6		2.7		5.0		2.4		3.2		54.1	45.9
% Common Variance	62.4		6.3		6.7		5.0		9.2		4.5		5.9			

Note. WJ-III = Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001a); *g* = general ability; Var = variance; F1–F5 = Factor 1–Factor 5; h^2 = Communality coefficient; u^2 = Uniqueness; Gc = Crystallized Ability/Comprehension-Knowledge; Del = delayed; Grw = Reading-Writing Ability; Dir = directions; Ga = Auditory Processing; Gs = Processing Speed; Glr = Long-Term Retrieval; Gq = Quantitative Reasoning; Gf = Fluid Reasoning; Gv = Visual-Spatial Thinking; Gsm = Short-Term Memory; Aud = auditory; Ln = learning. Loadings > .30 are in bold italics and are considered to be aligned with their respective first order factors. Note that alignment of subtests with respective nine broad Cattell-Horn-Carroll first order factors posited in the WJ-III Technical Manual is indicted following each subtest name (Gc, Grw, Ga, etc.). F1 = Gc; F2 = Grw; F3 = Gs; F4 = Combined Gf/Gq/Gv; F5 = Ga; F6 = Glr.

of the common variance. Across the age 14 to 19 six-factor analysis, the first-order factors accounted for 2.0% to 4.7% of the total variance and 3.6% to 8.5% of the common variance. The first and second-order factors of the age 14 to 19 analysis combined to measure 53.3% (five-factor) and 55.3% (six-factor) of the variance in the WJ-III, reflecting 46.75% (five-factor) and 44.7% (six-factor) unique variance.

The results of all analyses demonstrate a robust manifestation of general intelligence in the WJ-III, where the combined influence of general intelligence and uniqueness exceeded the contributions made by the first-order factors. The influence of the general factor was also noted across nearly all subtests in all analyses where the general factor accounted for a higher proportion of subtest variance relative to the subtest variance accounted for by any of the lower order factors.

Discussion

The WJ-III test authors eschewed EFA analyses in favor of exclusive reliance on CFA. This has become an unfortunate trend in cognitive ability scale development in recent years (e.g., Elliot,

Table 7
WJ-III Sources of Variance According to a Schmid-Leiman Orthogonalization (Five Factor) Ages 14 to 19

	Second-order factor		First-order factors											
Subtest	*g*	Var	F1	Var	F2	Var	F3	Var	F4	Var	F5	Var	h^2	u^2
Picture Vocabulary Gc	.68	47	***.45***	21	.11	01	−.11	01	−.07	01	−.02	00	.70	.30
Story Recall Gc	.59	35	***.45***	20	−.12	02	.10	01	.05	00	.03	00	.58	.42
General Information Gc	.77	59	***.43***	18	.10	01	−.07	01	.06	00	−.09	01	.79	.21
Story Recall—Delayed Glr	.53	28	***.42***	18	−.13	02	.15	02	.02	00	.03	00	.50	.50
Academic Knowledge Gc	.76	58	***.42***	17	.02	00	−.09	01	.16	02	−.04	00	.79	.21
Verbal Comprehension Gc	.82	67	***.41***	16	.10	01	−.09	01	.05	00	.04	00	.85	.15
Oral Comprehension Gc	.68	46	***.33***	11	.07	00	.03	00	.02	00	.03	00	.57	.43
Reading Vocabulary Grw	.72	52	***.31***	10	.11	01	−.10	01	.12	01	−.03	00	.66	.34
Understanding Dir Gc	.65	42	.21	04	.10	01	.12	01	−.02	00	.12	02	.51	.49
Passage Comprehension Grw	.71	51	.20	04	.14	02	.01	00	.09	01	.04	00	.58	.42
Spelling of Sounds Ga	.63	39	−.05	00	***.38***	14	−.02	00	.05	00	−.07	00	.55	.45
Word Attack Grw	.65	42	−.09	01	***.35***	12	−.05	00	.17	03	−.05	00	.58	.42
Sound Blending Ga	.56	31	.06	00	***.34***	12	.05	00	−.20	04	.08	01	.48	.52
Memory for Words Gsm	.57	32	−.02	00	.28	08	.04	00	−.03	00	.12	02	.42	.58
Sound Awareness Ga	.68	46	.05	00	.28	08	−.05	00	.07	01	.05	00	.55	.45
Letter–Word ID Grw	.78	60	.09	01	.27	07	−.04	00	.17	03	−.05	00	.71	.29
Incomplete Words Ga	.46	21	.11	01	.26	07	.05	00	−.16	03	−.01	00	.32	.68
Numbers Reversed Gsm	.59	35	−.12	01	.22	05	.08	01	.12	01	.20	04	.47	.53
Aud Working Memory Gsm	.60	36	.02	00	.19	04	.11	01	.05	00	.09	01	.41	.59
Writing Samples Grw	.68	47	.13	02	.15	02	.07	00	.12	01	.02	00	.52	.48
Visual Matching Gs	.51	26	−.11	01	.01	00	***.55***	30	.19	04	.02	00	.61	.39
Decision Speed Gs	.38	15	.06	00	−.01	00	***.54***	29	−.09	01	.05	00	.45	.55
Read Fluency Grw	.65	42	.11	01	.08	01	***.48***	23	.07	00	−.10	01	.69	.31
Rapid Naming Gs	.40	16	.09	01	.03	00	***.47***	22	−.11	01	.02	00	.40	.60
Pair Cancellation Gs	.26	07	−.05	00	−.04	00	***.47***	22	.02	00	.05	00	.29	.71
Writing Fluency Grw	.62	39	.06	00	.15	02	***.31***	10	.06	00	−.04	00	.52	.48
Retrieval Fluency Glr	.50	25	.20	04	.00	00	***.31***	10	.02	00	−.06	00	.39	.61
Handwriting Grw	.20	04	−.07	00	.05	00	.19	04	.08	01	−.02	00	.09	.91
Calculation Gq	.60	36	.08	01	−.11	01	.01	00	***.49***	24	.07	00	.62	.38
Applied Problems Gq	.73	53	.17	03	−.05	00	−.07	01	***.43***	18	.09	01	.76	.24
Quantitative Concepts Gq	.76	57	.15	02	−.03	00	−.04	00	***.42***	17	.10	01	.78	.22
Math Fluency Gq	.54	29	−.08	01	−.03	00	***.45***	20	***.35***	12	−.09	01	.63	.37
Spelling Grw	.72	51	.03	00	.17	03	.07	00	***.30***	09	−.09	01	.65	.35
Editing Grw	.65	43	.13	02	.09	01	.04	00	.27	07	−.10	01	.53	.47
Analysis Synthesis Gf	.61	37	.08	01	.00	00	.02	00	.23	05	.24	06	.50	.50
Aud Attention Ga	.28	08	.07	00	.13	02	.18	03	−.17	03	.05	00	.16	.84
Visual-Aud Ln Glr	.58	34	.00	00	.02	00	.00	00	.03	00	***.68***	46	.80	.20
Visual-Aud Ln—Del Glr	.56	31	.01	00	.01	00	−.04	00	.03	00	***.67***	44	.76	.24
Concept Formation Gf	.66	43	.08	01	.08	01	.04	00	.12	01	.27	07	.53	.47
Spatial Relations Gv	.50	25	−.02	00	.10	01	.03	00	.10	01	.26	07	.34	.66
Picture Recognition Gv	.36	13	.12	02	−.04	00	.19	03	−.03	00	.22	05	.23	.77
Planning Gv	.30	09	−.05	00	.07	00	.02	00	.10	01	.14	02	.13	.87
% Total Variance	36.0		4.0		2.4		4.5		3.1		3.2		53.3	46.7
% Common Variance	67.6		7.4		4.6		8.5		5.8		6.0			

Note. WJ-III = Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001a); *g* = general ability; Var = variance; F1–F5 = Factor 1–Factor 5; h^2 = Communality coefficient; u^2 = Uniqueness; Gc = Crystallized Ability/Comprehension-Knowledge; Del = delayed; Glr = Long-Term Retrieval; Grw = Reading-Writing Ability; Dir = directions; Ga = Auditory Processing; Gsm = Short-Term Memory; Gs = Processing Speed; Gq = Quantitative Reasoning; Gf = Fluid Reasoning; Aud = auditory; Ln = learning; Gv = Visual-Spatial Thinking. Loadings > .30 are in bold italics and are considered to be aligned with their respective first order factors. Note that alignment of subtests with respective nine broad Cattell-Horn-Carroll first order factors posited in the WJ-III Technical Manual is indicted following each subtest name (Gc, Grw, Ga, etc.). F1 = Gc; F2 = Ga; F3 = Gs; F4 = Gq; F5 = Glr.

2007; Roid, 2003; Wechsler, 2008) because this approach can lead to overfactoring (see Frazier & Youngstrom, 2007) and may be vulnerable to confirmatory bias (Greenwald et al., 1986). Subsequent research on the WJ-III has also been based primarily on CFA methodology (e.g., Floyd, McGrew, Rafael, & Rogers, 2009; Keith et al., 2008; Locke, McGrew & Ford, 2011; Taub et al., 2008; Taub & McGrew, 2004; Vanderwood, McGrew, Flanagan, & Keith, 2001). This body of CFA research has generally found support for the CHC factor structure of the WJ-III (Keith & Reynolds, 2010).

In contrast, we are unaware of any EFA analyses that have been conducted on the WJ-III full battery of tests. This lack of independent evaluation of the full WJ-III is inexplicable particularly because the full WJ-III battery served as the initial evidentiary basis for the newly created CHC theory. McGrew and Woodcock (2001) claimed that "CHC taxonomy is the most comprehensive and empirically supported framework available for understanding the structure of human cognitive abilities" (p. 9). Although their claim was guided by prior, relevant theory, it was predicated on the empirical data furnished in the Technical Manual. Keith and Reyn-

Table 8
WJ-III Sources of Variance According to a Schmid-Leiman Orthogonalization (Six Factor) Ages 14 to 19

	Second-order factor		First-order factors														
Subtest	*g*	Var	F1	Var	F2	Var	F3	Var	F4	Var	F5	Var	F6	Var	h^2	u^2
Story Recall Gc	.61	37	***.46***	21	−.05	00	.09	01	−.10	01	−.08	01	.08	01	.62	.38
Story Recall—Delayed Glr	.54	29	***.45***	20	−.03	00	.13	02	−.12	02	−.15	02	.11	01	.57	.43
Picture Vocabulary Gc	.68	46	***.40***	16	−.09	01	−.10	01	***.25***	06	.05	00	−.07	00	.71	.29
Academic Knowledge Gc	.78	60	***.39***	15	.04	00	−.08	01	.04	00	.10	01	−.05	00	.78	.22
General Information Gc	.76	58	***.39***	15	.03	00	−.07	00	.16	02	.07	00	−.10	01	.78	.25
Verbal Comprehension Gc	.82	67	***.37***	13	−.01	00	−.08	01	.19	03	.11	01	−.02	00	.86	.15
Reading Vocabulary Grw	.72	52	***.30***	09	.17	03	−.12	01	.07	00	−.01	00	.01	00	.66	.33
Oral Comprehension Gc	.67	45	***.30***	09	.01	00	.03	00	.13	02	.03	00	.01	00	.56	.43
Retrieval Fluency Glr	.49	24	.20	04	.06	00	***.30***	09	.03	00	−.08	01	−.01	00	.38	.62
Understanding Dir Gc	.64	41	.19	03	−.01	00	.13	02	.19	03	.06	00	.06	00	.51	.48
Passage Comprehension Grw	.71	50	.19	03	.11	01	.02	00	.15	02	.08	01	.00	00	.58	.42
Spelling Grw	.71	51	.06	00	***.43***	18	.03	00	−.03	00	−.02	00	−.00	00	.70	.30
Word Attack Grw	.62	39	−.08	01	***.42***	18	−.08	01	.21	05	.02	00	−.02	00	.62	.38
Edit Grw	.66	43	.17	03	***.38***	14	−.01	00	−.10	01	−.08	01	.02	00	.62	.37
Letter–Word ID Grw	.76	57	.10	01	***.38***	14	−.07	00	.15	02	−.03	00	.01	00	.75	.24
Spelling of Sounds Ga	.59	34	−.05	00	***.33***	11	−.03	00	***.32***	10	.01	00	−.06	00	.57	.45
Sound Awareness Ga	.66	43	.05	00	.28	08	−.07	00	.22	05	.00	00	.06	00	.57	.42
Numbers Reversed Gsm	.58	34	−.10	01	.24	06	.08	01	.16	02	.08	01	.15	02	.47	.51
Writing Samples Grw	.68	46	.12	02	.17	03	.06	00	.13	02	.06	00	.01	00	.52	.47
Handwriting Grw	.19	04	−.05	00	.17	03	.17	03	−.02	00	−.06	00	.03	00	.10	.90
Decision Speed Gs	.37	14	.03	00	−.12	02	***.57***	32	.15	02	.05	00	−.02	00	.50	.50
Visual Matching Gs	.51	26	−.09	01	.12	01	***.56***	31	−.01	00	.11	01	−.02	00	.61	.39
Pair Cancellation Gs	.25	06	−.07	00	−.11	01	***.51***	26	.07	00	.14	02	−.04	00	.37	.63
Read Fluency Grw	.63	39	.11	01	.16	03	***.47***	22	.08	01	−.07	00	−.04	00	.67	.34
Rapid Naming Gs	.38	15	.09	01	.02	00	***.46***	21	.11	01	−.13	02	.05	00	.39	.60
Math Fluency Gq	.55	30	−.04	00	***.23***	05	***.45***	20	−.16	02	.11	01	−.07	00	.60	.42
Writing Fluency Grw	.60	36	.05	00	.14	02	***.32***	10	.16	03	.02	00	−.04	00	.52	.49
Sound Blending Ga	.51	26	.02	00	.08	01	.06	00	***.47***	22	−.01	00	.01	00	.49	.51
Incomplete Words Ga	.42	17	.08	01	.07	01	.05	00	***.35***	13	−.04	00	−.03	00	.32	.68
Memory for Words Gsm	.54	29	−.03	00	.17	03	.04	00	***.30***	09	.03	00	.07	01	.42	.57
Aud Attention Ga	.26	07	.04	00	−.08	01	.19	04	.27	07	.01	00	−.01	00	.18	.82
Aud Working Memory Gsm	.58	34	.02	00	.12	01	.12	01	.21	05	.09	01	.02	00	.42	.58
Spatial Relations Gv	.51	26	−.06	00	−.08	01	.08	01	.19	03	***.34***	11	.06	00	.43	.56
Quantitative Concepts Gq	.79	63	.16	02	.09	01	−.01	00	.11	01	***.33***	11	−.01	00	.79	.22
Calculation Gq	.65	42	.10	01	.10	01	.03	00	−.24	06	***.33***	11	−.01	00	.61	.40
Applied Problems Gq	.77	59	.18	03	.09	01	−.05	00	−.14	02	***.33***	11	−.01	00	.76	.24
Analysis Synthesis Gf	.64	41	.07	00	−.02	00	.05	00	.01	00	***.30***	09	.01	01	.52	.46
Concept Formation Gf	.67	45	.06	00	−.03	00	.08	01	.14	02	.25	06	.11	01	.56	.42
Planning Gv	.30	09	−.08	01	−.04	00	.05	00	.12	01	.25	06	−.00	00	.18	.82
Visual-Aud Ln—Del Glr	.59	35	.03	00	.04	00	−.08	01	−.03	00	.02	00	***.66***	43	.93	.05
Visual-Aud Ln Glr	.61	37	.01	00	.01	00	−.03	00	.01	00	.07	00	***.60***	35	.84	.13
Picture Recognition Gv	.36	13	.12	01	−.09	00	.19	03	.03	00	.03	00	.16	03	.23	.76
% Total Variance	36.0		3.70		3.00		4.70		3.10		2.00		2.90		55.3	44.7
% Common Variance	65.0		6.60		5.30		8.50		5.60		3.60		5.30			

Note. WJ-III = Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001a); *g* = general ability; Var = variance; F1–F5 = Factor 1–Factor 5; h^2 = Communality coefficient; u^2 = Uniqueness; Gc = Crystallized Ability/Comprehension-Knowledge; Del = delayed; Glr = Long-Term Retrieval; Grw = Reading-Writing Ability; Dir = directions; Ga = Auditory Processing; Gsm = Short-Term Memory; Gs = Processing Speed; Gq = Quantitative Reasoning; Aud = auditory; Gv = Visual-Spatial Thinking; Gf = Fluid Reasoning; Ln = learning. Loadings $>$ .30 are in bold italics and are considered to be aligned with their respective first order factors. Note that alignment of subtests with respective nine broad Cattell-Horn-Carroll first order factors posited in the WJ-III Technical Manual is indicted following each subtest name (Gc, Grw, Ga, etc.). F1 = Gc; F2 = Grw; F3 = Gs; F4 = Combined Ga; F5 = Gf/Gq/Gv; F6 = Glr.

olds (2010) noted in their article summarizing CHC theory and cognitive ability tests over the past 20 years that if an instrument such as the WJ-III measured fewer factors than what is indicated in the Technical Manual then this would be inconsistent with CHC theory and considered a "blow" to it (p. 645). The results of our study raise questions about the robustness of CHC theory and suggest that the field more fully consider Keith et al.'s. statement. Our position should not be construed as pitting EFA against CFA. Each approach has its strengths and weakness so to suggest that one approach or the other is superior is unwarranted. As noted by Gorsuch (2003), the replication of CFA results with EFA methods and the confirmation of EFA results with CFA methods are both useful. However, the lack of confirmation of CFA results with EFA methods in the current study permits questioning of the structure of the WJ-III and its relationship with CHC theory. And, these results also might suggest need for structural validity studies on the separate WJ-III Cognitive and WJ-III Achievement batteries across all age ranges.

Even the CFA analyses presented in the Technical Manual may give one pause. The test authors did not present CFA fit statistics for the broad, nine factor CHC model despite presenting CFA correlation coefficients between WJ-III subtests (achievement and cognitive) and CHC factors (p. 199), a path-like analysis without structural relationship coefficients (p. 62), and then the 42 $\times$ 42 correlation matrix for the WJ-III subtests that contributed to the broad nine factor model. The absence of CFA fit statistics for the full WJ-III battery and the omission of EFA and higher order procedures might indicate that our understanding of the structure of the full instrument is incomplete. Because of these evidentiary, theoretical, and logical omissions, we subjected the correlation matrices of the full WJ-III test battery at two age ranges (9 to 13 years; 14 to 19 years) to EFA.

The results of our analysis on the full WJ-III battery are generally inconsistent with those presented in the Technical Manual. Our results suggest the existence of six factors across the 9 to 13 age range and five factors at the 14 to 19 age range. This contrasts with the nine factor CFA model presented in the Technical Manual. Our results also suggest the prominence of a hierarchical model as the total and common variance accounted for by the higher order (g) factor dwarfed that apportioned to the lower order factors. At the individual subtest level, the variance accounted for by the higher order (*g*) factor exceeds that apportioned to any lower order factor. This too supports the primacy of the higher order factor.

The orthogonalized five (age 14 to 19) and six (age 9 to 13) factor lower order solutions suggest patterns of both convergence with and divergence from the results presented in the Technical Manual. Our results indicate the possibility of a Crystallized Ability/Comprehension-Knowledge (Gc) factor; however, this factor looks different from the Gc factor presented in the Technical Manual across both age ranges. Subtests identified in the Technical Manual to load on Grw (Reading Vocabulary) and Glr (Story Recall Delayed) instead loaded on the first extracted factor (presumably Gc) in our analysis.

Our analysis also found evidence for a Reading-Writing factor (presumably Grw) within the 9 to 13 age range. However, our results on this factor are not identical with those presented in the Technical Manual. Instead, our analysis at age 9 to 13 suggests that subtests posited in the Technical Manual to load on Ga (e.g., Spelling of Sounds; Sound Awareness) instead load on our second factor (presumably Grw). Moreover, our results suggest that Grw contains fewer subtests (e.g., Spelling and Word Attack) than what is indicated in the Technical Manual. At age 14 to 19 years the five-factor solution did not produce a Grw factor.

Our analysis suggests a factor possibly measuring processing speed/fluency (Gs) across both age ranges. However, compared with the results in the Technical Manual, our findings suggest that additional subtests load the processing speed factor (e.g., Retrieval Fluency [Glr], Math Fluency [Gq], and Writing Fluency [Grw] at age 14 to 19). This may indicate that these subtests are a better measure of processing speed than they are of Glr, Gq, and Glr, respectively.

Our results also produced a factor resembling auditory processing (Ga) with Spelling of Sounds (Ga), Sound Blending (Ga) and Word Attack (Grw) loading this factor at age 14 to 19 and Memory for Words (Gsm), Sound Blending (Ga) and Incomplete Words (Ga) loading the factor at age 9 to 13. This factor also failed to capture several auditory processing subtests (e.g., Sound Awareness [Ga] and Auditory Attention [Ga]).

A fourth factor produced the most divergent results between our analysis and the WJ-III full model presented in the Technical Manual. At age 9 to 13 years, the fourth factor appears to be a combination of subtests that purportedly measure Gq, Gf, and Gv (e.g., Applied Problems [Gq], Analysis-Synthesis [Gf], Quantitative Concepts [Gq], Concept Formation [Gf], and Spatial Relations [Gv]). At age 14 to 19, this factor appears to be generally a Gq factor but also loads Spelling (Grw).

The last factor in our analysis appears to be a long term retrieval factor (Glr). However, this factor contains only two subtests across both age ranges which may be decried by methodologists as too few variables to be considered a distinct factor (Fabrigar et al., 1999; Gorsuch, 1988). Notably absent from our analyses across both age ranges are clear Gsm and Gv factors.

Conclusion and Implications

Although we recognize that our EFA analyses were not conducted on independent samples, they produced some interesting results. First, they indicate that the structure of the WJ-III is hierarchical with the majority of its variance accounted for by the higher order *g* factor. Our results also suggest six lower order factors at age 9 to 13 and five at age 14 to 19, but the factors uncovered in our analysis are difficult to interpret because of divergence from the posited alignment of subtests within the Technical Manual. Third, there were some areas of convergence. There seems to be evidence for a Grw factor at age 9 to 13, which is consistent with CHC theory (Keith & Reynolds, 2010) and contrasts with Carroll's three-stratum theory, where Grw was subsumed by Gc. Still, this is tepid convergent evidence because selected subtests posited in the Technical Manual to load Grw did not, while subtests posited to load Gc and Ga instead loaded our second factor (Grw). And, at age 14 to 19, our results did not produce a Grw factor with the five-factor solution. Although we located a quantitative reasoning factor at age 14 to 19, we found evidence for a combined Gq, Gf, and Gv factor at age 9 to 13. Our analysis also found evidence for a two-subtest Glr factor across both age ranges, but this may be criticized as technically too few for extraction even though the practice is fairly common in cognitive ability scale development (e.g., Reynolds Intellectual Assessment Scales; Stanford-Binet, 5th ed.).

Overall, our results diverge from the nine factor model posited in the WJ-III Technical Manual and therefore suggest caution in moving to an interpretation of broad WJ-III factors until additional research is conducted. Interpretation much beyond *g* has been discussed as potentially problematic because of concern over predictive validity of lower order factors (e.g., Glutting, Watkins, Konold, & McDermott, 2006; Kotz, Watkins, & McDermott, 2008; Oh, Glutting, Watkins, Youngstrom, & McDermott, 2004; Parkin & Beaujean, 2012; Watkins, Glutting, & Lei, 2007). Our structural validity analysis of the WJ-III lends support to these criticisms. It is time that the field, particularly the practitioner community, recognizes the psychometric danger in placing greater emphasis on individual subtest or index scores at the expense of interpretation of the higher order factor. Our analysis indicates the primacy of the *g* factor in the WJ-III and reaffirms the strong stance against moving much beyond this level of interpretation due to structural validity concerns (Canivez & Watkins, 2010; DiStefano & Dombrowski, 2006; Dombrowski, in press; Dombrowski et al., 2009; Nelson & Canivez, 2012; Watkins, 2010).

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See page 390 for a correction to this article.

Correction to Dombrowski and Watkins (2013)

In the article "Exploratory and Higher Order Factor Analysis of the WJ-III Full Test Battery: A School-Aged Analysis" by Stefan C. Dombrowski and Marley W. Watkins (*Psychological Assessment*, Advanced online publication, January 28, 2013. doi:10.1037/a0031335), in Table 4 the last column heading appears as F1. It should appear as F6. The captions for Tables 2, 4, 6, and 8 include the language F1-F5 = Factor 1-5. The captions should read F1-F6 = Factor 1-6.

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