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Factor Structure of the CHC Model for the KABC-II: Exploratory Factor Analyses with the 16 Core and Supplementary Subtests

Abstract

The factor structure of the 16 core and supplementary CHC model subtests for the Kaufman Assessment Battery for Children-Second Edition (KABC-II; Kaufman & Kaufman, 2004a) standardization sample samples aged 7-18 (N = 2,025) was examined using exploratory factor analytic techniques (EFA) not included in the KABC-II manual (Kaufman & Kaufman, 2004b). The present results failed to replicate the five-factor CHC-based structure posited by the test publisher at school-age. Factor extraction for the core battery suggested four factors whereas five factors were supported for the total battery configuration. When these structures were transformed with the Schmid and Leiman (1957) orthgonalization procedure, the second-order general factor accounted for larger portions of total and common variance when compared to the reliable variance accounted for by the resulting four and five first-order factors. Users are encouraged to interpret the KABC-II primarily at the level of the Fluid-Crystallized Index (FCI), with additional consideration of the factor-based scores employed with more caution. Implications for clinical interpretation are discussed.

Keywords: KABC-II, Exploratory factor analysis, Intelligence, Schmid-Leiman procedure

Factor Structure of the CHC Model for the KABC-II: Exploratory Factor Analyses with the 16 Core and Supplementary Subtests

The Kaufman Assessment Battery for Children-Second Edition (KABC-II; Kaufman & Kaufman, 2004a) measures the processing and cognitive abilities of children and adolescents between the ages of 3 years and 18 years. The KABC-II utilizes a dual-theoretical foundation: the Cattell-Horn-Carroll (CHC; Schneider & McGrew, 2012) psychometric model of broad and narrow abilities, and Luria's neuropsychological theory of cognitive processing (Luria, 1966). Although examiners may select either the Luria or CHC interpretive models, the manual (Kaufman & Kaufman, 2004b) advises users to interpret the KABC-II primarily from the CHC perspective.

On the KABC-II, the CHC model for school ages (7-18) features 16 subtests (10 core and 6 supplemental), which combine to yield five first-order factor scale scores (Short-Term memory, Long-Term Storage and Retrieval, Visual Processing, Fluid Reasoning, and Crystallized Ability), and a second-order full scale Fluid Crystallized Index (FCI) that is thought to represent psychometric *g*. Each CHC factor scale is composed of two subtest measures, and the FCI is derived from a linear combination of the 10 core subtests that compose the constituent factor scores. It should be noted that at ages 3-6, users must administer different subset combinations and not all of the school-age factor-based scores are available. As a consequence, the school-age battery (ages 7-18) has served as the primary target of psychometric research conducted by independent researchers since the publication of the KABC-II. Although the KABC-II manual encourages a stepwise progression of interpretation from the FCI to the factor scores, users are encouraged to use the CHC factor scores as the focal point of interpretation for the instrument.

In terms of scale validation, the manual (Kaufman & Kaufman, 2004b) describes a series of procedures that were employed to evaluate the internal structure of the KABC-II. In general, it was noted that "The KABC-II development process relied mainly on the technique of confirmatory factor analysis [CFA], used in an *exploratory fashion* [emphasis added]" (p. 103). Although it was noted that exploratory factor analytic (EFA) methods were used to supplement CFA analyses at earlier stages in the development of the KABC-II, the results from these analyses were not reported. No explanation for this omission was provided although it was noted that "these EFA results did not make a significant contribution to the overall analysis program" (p. 104). Also missing from the KABC-II manual were proportions of variance accounted for by the second-order factor (*g*) and the five first-order factors, second-order subtest loadings, and subtest specificity estimates. This information is vital given the fact that all cognitive measures are composed of reliable variance that is attributable to a higher-order general factor, reliable variance that is attributable to first-order group factors, and error variance (Carroll, 1993; 1995). It has long been known that practitioners predominately attribute performance on cognitive subtests and factor-based scores to the label that is assigned to those measures by the test publisher (Guion, 1974). As a consequence, it is important to demonstrate that those hypothesized dimensions are sampled well by such scores.

Further complicating the matter, the test authors relied exclusively on a *constrained* CFA in which only one model, a higher-order CHC measurement model consistent with publisher theory, was fit to the KABC-II normative data at different points in the age span. That is, the fit afforded by rival models, if examined, was not reported. Whereas the test publisher claimed support for a CHC-based hierarchical model with five first-order factors and one second-order (*g*) factor for the 16 core and supplemental KABC-II subtests at ages 7-18 (see Figures 8.1 and

8.2; Kaufman & Kaufman, 2004b), problems were encountered with that model at those ages. The resulting five-factor core and total battery CFAs for ages 7-12 and 13-18 were found to be psychometrically unsatisfactory due to the presence of Heywood cases (i.e., standardized path loadings between Fluid Reasoning and *g* that were $\geq$ 1.0). According to Brown (2015), these estimates suggest an impermissible solution to the data (i.e., construct redundancy). Inexplicably, this potential limitation was not discussed in the manual. Although the results of subsequent structural validity investigations of the KABC-II (e.g., Bangirana et al., 2009; Morgan, Rothlisberg, McIntosh, & Hunt, 2009; Reynolds, Keith, & Beretvas, 2010; Reynolds, Keith, Flanagan, & Alfonso, 2013; Reynolds, Keith, Fine, Fisher, & Low, 2007) have largely supported the five-factor structure posited by the test publisher at school age, similar isomorphism between Gf and *g* has been observed in virtually all of these studies. Furthermore, it is also worth noting that CFA was utilized in all of these studies to examine the KABC-II factor structure.

Since its publication, structural validation studies of the KABC-II have clearly preferred CFA over EFA. However, it has been suggested that overreliance on CFA procedures for examining the internal structure of intelligence tests can result in the retention of poorly defined factors and has been criticized within the technical literature (Canivez, 2013; Frazier & Youngstrom, 2007; Marsh, Morin, Parker, & Kaur, 2014; Thompson, 2004). As a safeguard, Carroll (1995) previously recommended that “a confirmatory analysis of a dataset should not be published without an accompanying statement or report on one or more appropriate exploratory analyses” (p. 437). With regard to the estimation problems that were encountered in the technical manual CFAs, Brown (2015) noted presciently that “CFA model specification is usually supported by prior (but less restrictive) exploratory analyses (i.e., EFA) that have established the appropriate number of factors, and pattern of indicator-factor relationships…Accordingly, gross misspecifications (e.g., specifying too many or two few factors should be unlikely when the proper groundwork for CFA has been conducted" (p. 141).

Previous investigations of the factor structures of commercial intelligence tests using EFA methods have seriously challenged the CFA-based structural models promoted in technical manuals (e.g., Canivez, 2008; Canivez & Watkins, 2010; Canivez, Watkins, & Dombrowksi, 2016; Dombrowski, McGill, & Canivez, 2017; Dombrowski & Watkins, 2013). As a result, in an earlier review of related evidence, Frazier and Youngstrom (2007) concluded that "that recent commercial tests of cognitive ability are not adequately measuring the number of factors they are purported to measure by test developers" and that the resulting factors "may not possess sufficient reliability to make decisions on the individual level" (pp. 180-181). Unfortunately, an EFA investigation of the 16 subtests that comprise the CHC battery for the KABC-II has yet to be completed. As a result, clinicians do not have the necessary information to consider the convergence or divergence between EFA and CFA results for the CHC interpretive model on the KABC-II.

Purpose of the Current Study

To address this gap in the literature, the present study examined the latent structure of the KABC-II CHC model using alternative EFA procedures in order to examine the tenability of the five-factor measurement model proposed by the test publisher. Specifically, the study sought to determine (a) the number of latent factors that should be extracted and retained; (b) whether the subtest associations cohere with the CHC structure posited by the test publisher; and (c) the amount of variance accounted for by the first-order group factors after residualizing the variance associated with general intelligence after applying the Schmid and Leiman (1957) procedure as recommend by Carroll (1993, 1995). It is believed that results from the current study will provide practitioners with potentially important information regarding the correct interpretation of the KABC-II measurement instrument within clinical practice as the test publisher has revealed that KABC-II will undergo a normative update in lieu of a structural revision (i.e., will retain its same theoretical structure).

Method

Participants

Subtest score data was obtained for 2,025 participants from the KABC-II standardization sample for ages 7-18. Detailed demographic information are available in the KABC-II manual (Kaufman & Kaufman, 2004b). The normative sample was obtained using stratified proportional sampling across the variables of age, sex, race/ethnicity, parental education level (as a proxy for socioeconomic status), and geographic region. Inspection of the tables in the manual (Kaufman & Kaufman, 2004b) revealed a close match to 2001 U.S. census estimates across the stratification variables.

Measurement Instrument

The KABC-II is an individually administered test of cognitive ability for children and adolescents aged 3-18 years. For ages 7-18, The Fluid-Crystallized Index (FCI) is composed of 10 core subtests across five CHC-related domains (Crystallized Ability [Gc], Fluid Reasoning [Gf], Visual Processing [Gv], Short-Term Memory [Gsm], and Long-Term Retrieval [Glr]. The 10 core subtests also combine to yield five first-order index scores associated with the aforementioned CHC domains. At ages 7-18, The KABC-II also features six additional supplementary subtests that are hypothesized to align with the aforementioned CHC domains but do not contribute to the measurement of the FCI or the five primary level index scores and cannot be used to substitute for any of the core battery measures at any age. It should be noted that at ages 3-6 not all of the CHC-related factors at ages 7-18 could be located by the test publisher[1]. At age 3, it is suggested that the KABC-II is a one-factor test and preliminary analyses for the present study revealed any attempt to extract anything beyond one-factor at age 4 was problematic. As a result, participant data for ages 3-6 were excluded from the current study. Extensive normative and psychometric data can be found in the KABC-II manual (Kaufman & Kaufman, 2004b).

Procedure and Analyses

Subtest intercorrelation matrices for the 10 subtest core and 16 subtest total battery configurations were extracted from the KABC-II normative data from participants aged 7-18. Consistent with Fabrigar et al. (1999), and Sass and Schmitt (2010), multiple criteria were examined to determine the number of factors to retain, with additional consideration given to factor interpretability as well as theoretical convergence in the resulting EFA solutions. Specifically, the visual scree test (Cattell, 1966), Horn's parallel analysis (HPA; Horn, 1965), minimum average partials (MAP; Velicer, 1976), and Bayesian Information Criterion (BIC; Schwartz, 1978) were examined. All factor extraction tests were produced using the *psych* package (Revelle, 2016) within the R Statistical System (R Core Development Team, 2017). As recommended by Keith, Caemmerer, and Reynolds (2016), HPA estimates were obtained using the principle axis factoring method.

Next, principal axis EFA (Fabrigar, et al., 1999) was used to analyze the KABC-II standardization sample correlation matrices using SPSS version 23 for Macintosh. Due to the fact that the Visual Processing factor is produced from different subtest combinations at ages 7-

[1] At ages 4-6, it is suggested that the KABC-II measures four CHC-based factors. However, at these ages, Fluid Reasoning and Visual Processing measures combine to form a complexly determined factor which the publisher curiously chose to label Visual Processing.

12 (Triangles and Rover) and 13-18 (Block Counting and Rover), separate EFA analyses were conducted for both age groups. Retained factors were subjected to promax rotation (k = 4; Gorsuch, 1983). Salient pattern loading coefficients were defined as those ≥ .30 (Child, 2016).

To account for the fact that subtest scores on cognitive ability tests such as the KABC-II reflect the combined influence of both first-order and second-order factors, the Schmid-Leiman (SL; 1957) procedure, as coded in the *MacOrtho* program (Watkins, 2004), was applied to the factor pattern coefficients from the first-order oblique solutions and the second-order factor loading coefficients produced by EFA of the first-order factor intercorrelations. The SL procedure apportions common variance first to the hierarchical general factor and the residual common variance is then apportioned to the first-order group-specific factors. According to Schmid and Leiman, this “not only preserves the desired interpretation characteristics of the oblique solution, but also discloses the hierarchical structuring of variables” (1957, p. 53). Consistent with first-order EFA analyses, salient factor loadings were defined as those ≥ .30. As recommended by Carroll (1993) observed variables with residual loadings that ranged from .20 to .29 were considered to be *aligned* with a group-factor due to the attenuation that can occur in the SL transformation.

Finally, as the SL transformation produces an approximate bifactor structure (Mansolf & Reise, 2016) that hypothesizes that each KABC-II subtest is influenced simultaneously by two orthogonal latent constructs: a general ability factor (g) and a first-order domain-specific group factor (e.g., Gc, Gf, etc.). Omega-hierarchical (ω_h) and omega-hierarchical subscale (ω_{hs}) were estimated as model-based reliability estimates of the latent factors (Gignac & Watkins, 2013). The ω_h coefficient is the model based reliability estimate for the general intelligence factor with variability of group factors removed while the ω_{hs} coefficient is the model based reliability estimate of a group factor with all other group *and* the general factor removed (Brunner, Nagy, & Wilhelm, 2012; Rodriguez, Reise, & Haviland, 2016). Omega estimates were obtained from the decomposed variance estimates from the SL hierarchical models using the *Omega* program (Watkins, 2013). Although subjective, it has been suggested that omega coefficients should at a minimum exceed .50, but .75 is preferred (Reise, 2012; Reise, Bonifay, & Haviland, 2013).

Results

Factor Extraction Criteria

For the 10 subtest core battery configurations for both age groups MAP suggested one factor whereas BIC, HPA, and visual scree supported the retention of four factors. In contrast, the test publisher recommended five CHC factors. As it has been recommended that it is better to overextract rather than underextract in EFA (e.g., Wood, Tatyrn, & Gorsuch, 1996), core battery EFAs began by extracting four factors and a five-factor model was subsequently examined to comport with publisher theory. For the 16 subtest core and supplementary battery configurations for ages 7-12 and 13-18, MAP criterion suggested one factor whereas remaining criteria converged to support a five factor extraction, consistent with publisher theory. As a result, five factors were extracted in the total battery EFAs and examined for adequacy. Scree plots from HPA for the KABC-II core and supplemental subtest configurations for ages 7-12 and 13-18 are illustrated in Figures 1-4 (available in the supplemental appendix).

Exploratory Factor Analyses Ages 7-12 (*n* = 1,142)

Results from Bartlett's Test of Sphericity (Bartlett, 1950) revealed that the correlation matrices for the core ($\chi^2 = 3,856.60$, $df = 45$, $p < .01$) and total ($\chi^2 = 8,072.21$, $df = 120$, $p < .01$) subtests were not random. The Kaiser-Meyer-Olkin (KMO) statistic for the core battery (.889) and total battery (.894) configurations for ages 7-12, were both well above the minimum standard for conducting a factor analysis (Kaiser, 1994). On the basis of these values, it was determined that the correlation matrices were appropriate for the EFA procedures that were employed.

Core battery four-factor model. Table 1 presents results from extracting four KABC-II factors for the 10 core subtests with promax (k = 4) rotation. The g-loadings (factor structure coefficients from first un-rotated factor) ranged from .459 (Number Recall) to .764 (Riddles). All, with the exception of Number Recall, were within the fair to good range based on Kaufman's (1994) criteria. All KABC-II subtests were saliently and properly associated with a theoretically consistent factor (i.e., alignment with the CHC structure posited by test theory and/or the pattern of loadings permitted identification of a related factor); however, Story Completion was observed to cross-load on Perceptual Reasoning and Crystallized Ability with a higher loading on the theoretically inconsistent factor (Gc). The moderate to high factor correlations presented in Table 1 (.48 to .76) imply a higher-order dimension requiring additional analysis (Gorsuch, 1983).

As recommended by Carroll (1993, 1995), the four first-order oblique EFA factor solution was transformed with the Schmid–Leiman (SL) orthogonalization procedure. Results for the SL higher-order factor analysis of the four-factor model are presented in Table 2. The hierarchical g-factor accounted for 34.1% of the total variance and 68.3% of the common variance. The general factor also accounted for between 17.9% (Number Recall) and 51.7% (Riddles) of individual subtest variability. At the first-order level, the Crystallized Ability factor accounted for an additional 3.7% of the total variance and 7.5% of the common variance, the Perceptual Reasoning factor accounted for an additional 2.6% of the total variance and 5.2% of the common variance, the Short-Term Memory factor accounted for an additional 5.9% of the total variance and 11.9% of the common variance, and the Long-Term Retrieval factor accounted for an additional 3.6% of the total variance and 7.2% of the common variance. Omega-hierarchical and omega-hierarchical subscale coefficients were estimated based on the SL results in Table 1 to estimate the latent factor reliabilities. The ω_h coefficient for general intelligence (.800) was high and sufficient for scale interpretation; however, the ω_{hs} coefficients for the four group factors (Gc, PR, Gsm, Glr) were considerably lower, ranging from .127 (PR) to .393 (Gsm). Thus, the four KABC-II first-order factors likely possess too little true score variance for confident interpretation (Reise, 2012; Reise et al., 2013).

Core battery five-factor model. Extracting five KABC-II factors with promax rotation resulted in a fifth factor that could not be identified as it as it did not contain any salient pattern coefficient loadings (see Table 9 in the supplementary appendix). Triangles, Rover, and Pattern Reasoning loaded on a broad Perceptual Reasoning factor but Story Completion produced no salient loadings on any factor. Thus, there was insufficient common variance to constitute a separate Fluid Reasoning dimension in the five-factor extraction as suggested by publisher theory. Methodologists (e.g. Gorsuch, 1983; Preacher & MacCallum, 2003; Wood et al. 1996), have long noted that psychometric results such as these are emblematic of overextraction in EFA. Given the under-identification observed in the five-factor model, transformation via the SL orthogonalization procedure did not proceed as the four-factor solution appeared to be the most reasonable explanation for these data.

Total battery five-factor model. Table 3 presents results from extracting four KABC-II factors for the 16 core and supplemental subtests with promax (k = 4) rotation. The g-loadings (factor structure coefficients from first un-rotated factor) ranged from .410 (Gestalt Closure) to .761 (Riddles). All, with the exception of Number Recall, Rebus, Hand Movements, Rover, Block Counting, and Gestalt Closure, were within the fair to good range based on Kaufman's (1994) criteria. Extraction of five factors produced latent dimensions that failed to cohere with the CHC structure posited by the test publisher. Specifically, a Fluid Reasoning factor could not be located as Visual Processing and Fluid Reasoning measures converged to produce a factorially complex Perceptual Reasoning factor. Additionally, the recall measures associated with Long-Term Retrieval (Atlantis Delayed, Rebus Delayed) converged to produce a separate Delayed Recall factor. All KABC-II subtests were saliently and properly associated with a theoretically consistent factor with the exception of Gestalt Closure which migrated saliently to load on Crystallized Ability rather than Perceptual Reasoning. Additionally, Hand Movements was observed to cross-load on Perceptual Reasoning and Short-Term Memory with a higher loading on the theoretically inconsistent factor (PR). The moderate to strong factor correlations presented in Table 3 (.36 to .68) imply a higher-order dimension requiring additional analysis (Gorsuch, 1983).

As recommended by Carroll (1993, 1995), the five first-order oblique EFA factor solution was transformed with the Schmid–Leiman (SL) orthogonalization procedure. Results for the SL higher-order factor analysis of the five-factor model are presented in Table 4. The hierarchical *g*-factor accounted for 31.4% of the total variance and 58.6% of the common variance. The general factor also accounted for between 13.8% (Gestalt Closure) and 47.3% (Riddles) of individual subtest variability. At the first-order level, the Crystallized Ability factor accounted for an additional 5.2% of the total variance and 9.6% of the common variance, the Perceptual Reasoning factor accounted for an additional 3.9% of the total variance and 7.3% of the common variance, the Short-Term Memory factor accounted for an additional 4.3% of the total variance and 7.9% of the common variance, the Long-Term Retrieval factor accounted for an additional 4.5% of the total variance and 8.4% of the common variance, and the Delayed Recall factor accounted for an additional 4.4% of the total variance and 8.1% of the common variance. Omega-hierarchical and omega-subscale coefficients were estimated based on the SL results in Table 4 to estimate the latent factor reliabilities. The ω_h coefficient for general intelligence (.821) was high and sufficient for scale interpretation; however, the ω_s coefficients for the five group factors (Gc, PR, Gsm, Glr, DR) were considerably lower, ranging from .202 (PR) to .433 (Glr). Thus, the five KABC-II first-order factors likely possess too little true score variance for confident interpretation (Reise, 2012; Reise et al., 2013).

Exploratory Factor Analyses Ages 13-18 (*n* = 883)

Results from Bartlett's Test of Sphericity (Bartlett, 1950) revealed that the correlation matrices for the core ($\chi^2 = 3{,}341.30$, $df = 45$, $p < .01$) and total ($\chi^2 = 7{,}213.92$, $df = 120$, $p < .01$) subtests were not random. The Kaiser-Meyer-Olkin (KMO) statistic for the core battery (.871) and total battery (.903) configurations for ages 13-18, were both well above the minimum standard for conducting a factor analysis (Kaiser, 1994). On the basis of these values, it was determined that the correlation matrices were appropriate for the EFA procedures that were employed.

Core battery four-factor model. Table 5 presents results from extracting four KABC-II factors for the 10 core subtests with promax ($k = 4$) rotation. The *g*-loadings (factor structure coefficients from first un-rotated factor) ranged from .482 (Number Recall) to .771 (Riddles). All, with the exception of Number Recall, were within the fair to good range based on Kaufman’s (1994) criteria. All KABC-II subtests were saliently and properly associated with a theoretically consistent factor however Story Completion was observed to cross-load on Perceptual Reasoning and Crystallized Ability with a higher loading on the theoretically inconsistent factor (Gc). The moderate to high factor correlations presented in Table 1 (.53 to .71) imply a higher-order dimension requiring additional analysis (Gorsuch, 1983).

As recommended by Carroll (1993, 1995), the four first-order oblique EFA factor solution was transformed with the Schmid–Leiman (SL) orthogonalization procedure. Results for the SL higher-order factor analysis of the four-factor model are presented in Table 6. The hierarchical *g*-factor accounted for 35.9% of the total variance and 67.9% of the common variance. The general factor also accounted for between 20% (Number Recall) and 53.1% (Riddles) of individual subtest variability. At the first-order level, the Crystallized Ability factor accounted for an additional 4.4% of the total variance and 8.3% of the common variance, the Perceptual Reasoning factor accounted for an additional 4.1% of the total variance and 7.8% of the common variance, the Short-Term Memory factor accounted for an additional 5.6% of the total variance and 10.7% of the common variance, and the Long-Term Retrieval factor accounted for an additional 2.8% of the total variance and 5.3% of the common variance. Omega-hierarchical and omega-hierarchical subscale coefficients were estimated based on the SL results in Table 6 to estimate the latent factor reliabilities. The ω_h coefficient for general intelligence (.808) was high and sufficient for scale interpretation; however, the ω_{hs} coefficients for the four group factors (Gc, PR, Gsm, Glr) were considerably lower, ranging from .179 (Glr) to .360 (Gsm). Thus, the four KABC-II first-order factors likely possess too little true score variance for confident interpretation (Reise, 2012; Reise et al., 2013).

Core battery five-factor model. Extracting five KABC-II factors with promax rotation resulted in a fifth factor that could not be identified as it was produced from only one salient pattern coefficient loading from Story Completion (see Table 10 in the supplementary appendix). Triangles, Rover, and Pattern Reasoning loaded on a broad Perceptual Reasoning factor but

Story Completion failed to align with this dimension. Thus, there was insufficient common variance to constitute a separate Fluid Reasoning dimension in the five-factor extraction as suggested by publisher theory. Methodologists (e.g. Gorsuch, 1983; Preacher & MacCallum, 2003; Wood et al. 1996), have long noted that psychometric results such as these are emblematic of overextraction in EFA. Given the under-identification observed in the five-factor model, transformation via the SL orthogonalization procedure did not proceed as the four-factor solution appeared to be the most reasonable explanation for these data.

Total battery five-factor model. Table 7 presents results from extracting four KABC-II factors for the 16 core and supplemental subtests with promax (k = 4) rotation. The *g*-loadings (factor structure coefficients from first un-rotated factor) ranged from .466 (Number Recall) to .769 (Riddles). All, with the exception of Number Recall, were within the fair to good range based on Kaufman's (1994) criteria. Similar to ages 7-12, the five-factor model produced latent factors that failed to cohere with the CHC structure posited by the test publisher. Specifically, a Fluid Reasoning factor could not be located as Visual Processing and Fluid Reasoning measures converged to produce a factorially complex Perceptual Reasoning factor. Additionally, Rebus and Atlantis aligned with their respective recall measures to produce separate Long-Term Retrieval dimensions. All KABC-II subtests were saliently and properly associated with a theoretically consistent factor with the exception of Gestalt Closure which migrated saliently to load on Crystallized Ability rather than Perceptual Reasoning. The moderate to strong factor correlations presented in Table 7 (.41 to .70) imply a higher-order dimension requiring additional analysis (Gorsuch, 1983).

As recommended by Carroll (1993, 1995), the five first-order oblique EFA factor solution was transformed with the Schmid–Leiman (SL) orthogonalization procedure. Results for the SL higher-order factor analysis of the five-factor model are presented in Table 8. The hierarchical *g*-factor accounted for 35.6% of the total variance and 61.7% of the common variance. The general factor also accounted for between 19.6% (Number Recall) and 50.1% (Riddles) of individual subtest variability. At the first-order level, the Crystallized Ability factor accounted for an additional 5.3% of the total variance and 9.1% of the common variance, the Perceptual Reasoning factor accounted for an additional 3.9% of the total variance and 6.8% of the common variance, the Short-Term Memory factor accounted for an additional 4.2% of the total variance and 7.2% of the common variance, the Long-Term Retrieval (Glr I) factor associated with Atlantis accounted for an additional 5.1% of the total variance and 8.9% of the common variance, and the Long-Term Retrieval factor associated with Rebus (Glr II) accounted for an additional 3.7% of the total variance and 6.3% of the common variance. Omega-hierarchical and omega-hiearchical subscale coefficients were estimated based on the SL results in Table 8 to estimate the latent factor reliabilities. The ω_h coefficient for general intelligence (.852) was high and sufficient for scale interpretation; however, the ω_{hs} coefficients for the five group factors (Gc, PR, Gsm, Glr I, Glr II) were considerably lower, ranging from .212 (PR) to .475 (Glr I). Thus, the five KABC-II first-order factors likely possess too little true score variance for confident interpretation (Reise, 2012; Reise et al., 2013).

Discussion

Consistent with the trend in cognitive ability scale development in recent years, the KABC-II test publisher overlooked EFA analyses and instead relied exclusively upon CFA to investigate the internal structure of the measurement instrument. However, overreliance on CFA may be problematic as researchers (e.g., Canivez, 2013; Frazier & Youngstrom, 2007; MacCallum & Austin, 2000; MacCoun & Perlmutter, 2017; Robles, 1996) have long suggested that CFA and other related structural equation modeling techniques may not provide users with appropriate protection against confirmation bias and can result in the retention of structural models that evade replication using more flexible technologies such as EFA.

Since its publication, the KABC-II CHC structure has yet to be examined using EFA. As a consequence, the present study sought to examine internal structure of the 10 subtest core and 16 subtest total batteries for the KABC-II at ages 7-12 and 13-18 using recommended EFA procedures (i.e., Carroll, 1993, 1995) to disclose the higher-order structuring of the variables suggested by the test publisher. As the CHC model provides the primary basis for interpreting KABC-II scores in clinical practice (Singer et al., 2012), it is believed that the evidence furnished by this investigation will be instructive for users as the test publisher has indicated that the structure of the measurement instrument will not be revised but will instead undergo a forthcoming normative update.

Core Battery Analyses

For the core battery, empirical factor extraction criteria (e.g., MAP, HPA, BIC) suggests that the 10 subtest configuration measures four factors at ages 7-12 and 13-18. For both age groups, the subtests that measure Visual Processing (Rover, Triangles, and Block Counting) converged with Pattern Reasoning to form a complex Perceptual Reasoning factor similar to the Perceptual Reasoning Index from previous incarnations of the Wechsler scales. Whereas Story Completion aligned with both Crystallized Ability and Perceptual Reasoning in the oblique four-factor solution, application of the SL transformation revealed that Story Completion failed to align with any of the first-order group factors once variance in that indicator was sourced appropriately to higher- and lower-order dimensions.

When casting aside the results from the extraction tests, forcing a five-factor solution to the KABC-II normative data did not result in a model that was consistent with publisher theory. For both age groups, four viable group-factors (Gc, PR, Gsm, Glr) were obtained consistent with the previous four-factor extraction. However, a fifth factor was not able to be identified as it did not contain two or more salient subtest loadings. According to Preacher and MacCallum (2003), a factor produced from less than two indicators is not mathematically permissible and suggests overfactoring in EFA. In sum, a Fluid Reasoning factor evaded identification in the two core battery configurations for ages 7-18. As a result, clinicians are encouraged to interpret the factor-based score associated with that dimension on the KABC-II with caution.

Total Battery Analyses

Although extraction tests supported a five-factor extraction for both age groups when the six supplementary subtests were used to compliment the 10 subtest core CHC battery, the resulting factor structure diverged from that posited in the KABC-II manual. Similar to the core battery analyses, Visual Processing and Fluid Reasoning measures combined to form a complex Perceptual Reasoning factor. The present EFAs did not support the presence of a Fluid Reasoning factor at ages 7-12 or 13-18 in the 16 subtest core and supplementary configurations. Interestingly, the recall measures associated with Atlantis and Rebus combined to form a separate Delayed Recall factor providing empirical support for clinical interpretation of the Delayed Recall score that is provided to KABC-II users that was not modeled in the CFA validation studies reported in the manual. However, this factor was not replicated at ages 13-18 as those same measures aligned with their reference tests to form two separate and distinct Glr factors.

The EFA results from the current study are not consistent with the final validation model that was supported using CFA on the same 16 subtest configuration and age-based normative sample data reported by Reynolds and colleagues (2007). However, it is important to highlight the salient differences between EFA and CFA and the potential threat of method variance in factor analytic research. According to Carroll (1993), CFA yields information on the probability that the data could be generated by a hypothesized model. That is, it does not necessarily confirm a theoretical model, but rather simply determines that degree to which it is plausible to retain a model for a given dataset. On the other hand, EFA methods are more flexible, and "let the data speak for themselves" (p. 82).

Reynolds et al. (2007) began with the publisher suggested five-factor model as their baseline model and then employed several post-hoc adjustments (based on theory) to evaluate the degree to which those changes yielded an improvement in model fit. Although some CFA researchers have been critical of this practice (e.g., Canivez & Kush, 2013; MacCallum, Roznowski, & Necowitz, 1992), many of the modifications that were made by Reynolds and colleagues were consistent with the departures from simple structure (i.e., theoretically inconsistent subtest migration, cross-loading) that were observed in the present study. Nevertheless, the baseline model (assuming that the KABC-II measures five distinct CHC factors) again produced a problematic loading between Gf and *g* suggesting that this model was impermissible (see Brown, 2015). The final validation model, permitting Story Completion to load on both Gf and Gv, remedied this problem though a near perfect relationship between Gf and *g* was again observed suggesting those dimensions may be isomorphic. Furthermore, none of the post-hoc modifications resulted in a meaningful improvement in model fit. As a result, the question as to whether the KABC-II measures Fluid Reasoning apart from *g* remains unresolved.

Furthermore, it should be noted that it is difficult for clinicians to disentangle these constructs at the level of the individual.

Variance Apportionment and Clinical Interpretation

Application of the SL transformation (see Tables 2, 4, 6, and 8) revealed that reliable variance in all of the KABC-II subtests can be sourced to multiple cognitive dimensions: a second-order (*g*) factor as well as a first-order domain specific group-factor (Gc, PR, Gsm, Glr). For all age groups and subtest configurations, examination of variance apportions to the hierarchical *g*-factor and the specific group factors found greater total and common variance associated with the hierarchical *g*-factor. This is a result observed in numerous other studies examining the latent factor structure of intelligence tests using both EFA and CFA procedures (Canivez, 2014; Canivez & McGIll, 2016; Canivez, Watkins, & Dombrowski, 2016, 2017; DiStefano and Dombrowski, 2006; Dombrowski, 2013; Dombrowski, Canivez, Watkins, & Beaujean, 2015; Gignac & Watkins, 2013; McGill, 2016; McGill & Canivez, 2016; Watkins & Beaujean, 2014).

As a consequence, model-based reliability estimates (i.e., omega coefficients) for general intelligence were consistently strong. In contrast, the coefficients for the first-order factors was considerably weaker. As such, the principal interpretation of KABC-II should be of the FCI, the estimate of *g* with additional consideration of the factor-based scores employed more cautiously. Additionally, the smaller portions of unique variance captured by the group-factors apart from *g* is likely why these scores failed to account for meaningful portions of achievement variance in recent KABC-II incremental validity studies by McGill (2015) and McGill and Spurgin (2016).

Study Limitations

This study is not without limitations that should be considered when interpreting the results. The most important limitation is the use of an archived standardization sample. Although psychometric analyses with these same data provided the evidentiary basis for the interpretive procedures that were recommended to users in the KABC-II manual (Kaufman & Kaufman, 2004b), research to determine if these results are invariant across different clinical samples and/or settings would be instructive for furthering our understanding of relations between KABC-II variables. More specifically, additional CFA research comparing the models supported in the present study against the five-factor CHC model suggested by the test publisher would help to clarify what psychological constructs are measured by the KABC-II subtests at school age.

Additionally, although the manual suggests that KABC-II scores can be interpreted using an alternative theoretical framework based on the Luria processing model, the present study largely employed the verbiage associated with the CHC interpretive model as it is suggested by Kaufman and Kaufman (2004b) that model should be given primary consideration by clinicians who elect to use the measurement instrument in applied practice. Although important psychometric evidence to support the use of the of the alternative Luria model is absent from the manual, recent Luria construct validity studies (e.g., McGill & Spurgin, 2016, 2017) have raised concerns about the psychometric integrity of the alternative Luria structure and its resulting scores. Furthermore, it is psychometrically implausible for KABC-II subtests to measure two distinct, and theoretically divergent, constructs simultaneously (Braden & Ouzts, 2005). As a result, clinicians using the KABC-II are encouraged to employ a consistent theoretical framework (i.e., CHC) to interpret scores from that test, no matter which subset configuration they elect to administer (i.e., Flanagan, Alfonso, Ortiz, & Dynda, 2013).

Implications for Practice

While factor analytic studies of the internal structure of tests may seem esoteric to many clinicians, the results produced from these studies are important because they provide the statistical rationale for how the instrument should be interpreted (Bruner, Nagy, & Wilhelm, 2012). Whereas popular models of test interpretation (e.g., cross-battery assessment [XBA], PSW) encourage school psychologists to relate performance on ability tests such as the KABC-II to the CHC-related labels assigned by the test publisher, we encourage clinicians to be mindful of the inherent complexity of these measures when engaging in these interpretive practices[2].

Since PSW methods and related variants such as XBA emphasize primary interpretation and decision-making via broad ability indicators such as the factor-based scores (i.e., CHC) on the KABC-II, it should be stipulated that clinicians who elect to utilize these interpretive schemes implicitly endorse the psychometric integrity of these measures (i.e., it is assumed that most, if not all, clinicians would hesitate to utilize measures that have inadequate reliability or validity for individual decision-making). The present results illustrate well that such assumptions for the KABC-II may be problematic.

As an example, if a practitioner using profile analytic methods such as PSW obtains a Gsm standard score of < 85 on the KABC-II, they may conclude that the examinee presents with a processing weakness in Short-Term Memory. At first glance, this diagnostic inference appears to be on firm ground given that Gsm was factorially supported across all of the age groups and subtest configurations in the current study. Nevertheless, even in these relatively optimum

[2] To be fair, some of the dimensional complexity issues for the KABC-II are noted in the XBA system as Pattern Reasoning is included as an indicator for both Fluid Reasoning (Gf) and Visual Processing (Gv). Nevertheless, practitioners using the XBA system must arbitrarily assign the test to one dimension at the expense of the other which the present results suggest may obscure important sources of influence on that particular task.

measurement outcomes clinicians are still presented with an important interpretive confound. For instance, in the total battery configuration for ages 7-12 (see Table 4), the amount of reliable variance attributable to Short-Term Memory (22%) in the Gsm-aligned subtests was roughly equivalent to that of general intelligence (20%). That is, the target construct (Gsm) accounted for only half of the reliable variance in its own reference measures. More concerning, the present analyses suggest that approximately 80% of the variance in the Gsm score may be attributable to things *other* than Gsm. Given this reality, it is difficult to envision a scenario in which these indices would be useful for individual decision-making (e.g., specific learning disability identification). Ample empirical evidence suggest that these concerns are not limited to the scores on the KABC-II nor to their use in any particular form of cognitive profile analysis (e.g., Canivez, 2013; Kranzler et al., 2017; Watkins, 2000).

Conclusion

As "the ultimate responsibility for appropriate test use and interpretation lies predominantly with the test user" (AERA, APA, & NCME, 2014, p. 141), clinicians using the KABC-II in clinical evaluations must seriously consider the present information to make informed decisions about which KABC-II scores have satisfactory reliability, validity, and utility. The results from the present study demonstrated both convergence and divergence with the theoretical structure posited in the manual and in subsequent validation studies in the professional literature (e.g., Reynolds et al., 2007). This conflicting pattern of results has implications for how the instrument should be interpreted and/or employed for high stakes decision-making in clinical practice. In sum, practitioners are encouraged to “just say no” to primary interpretation of the CHC-based factor scores until more compelling evidence is furnished to support their use

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Table 1

Kaufman Assessment Battery for Children (KABC-II) Exploratory Factor Analysis: Four Oblique Factor Solution for the 10 Core Subtests Ages 7-12 (N = 1,142)

Subtest	*g*	F1: Gc		F2: PR		F3: Gsm		F4: Glr		h^2
Verbal Knowledge	.741	**.846**	(.825)	.019	(.622)	-.019	(.434)	-.037	(.550)	.682
Riddles	.764	**.762**	(.817)	-.046	(.621)	.047	(.480)	.093	(.608)	.674
Triangles	.600	.049	(.513)	**.670**	(.664)	-.021	(.369)	-.045	(.442)	.443
Rover	.509	-.090	(.402)	**.572**	(.565)	.033	(.342)	.061	(.409)	.323
Pattern Reasoning	.681	.149	(.598)	**.545**	(.696)	.036	(.443)	.026	(.522)	.498
Story Completion	.606	**.359**	(.587)	**.317**	(.576)	-.028	(.352)	.006	(.458)	.386
Number Recall	.459	.031	(.372)	-.027	(.380)	**.705**	(.691)	-.032	(.310)	.479
Word Order	.518	-.026	(.408)	.048	(.448)	**.697**	(.724)	.028	(.378)	.526
Atlantis	.540	.031	(.464)	-.054	(.445)	.007	(.321)	**.683**	(.671)	.451
Rebus	.627	.004	(.531)	.110	(.558)	-.019	(.363)	**.661**	(.730)	.539
Eigenvalue		4.34		1.11		.88		.81		
% Variance		43.39		11.09		8.78		8.09		
Factor Correlations										
F1		1.00								
F2		.76		1.00						
F3		.54		.58		1.00				
F4		.69		.69		.48		1.00		

Note. g = general structure coefficients based on first un-rotated factor coefficients (*g*–loadings); h^2 = communality; Gc = Crystallized Ability; PR = Perceptual Reasoning; Gsm = Short-Term Memory; Glr = Long-Term Storage and Retrieval. Factor pattern coefficients (structure coefficients) based on principal factors extraction with promax rotation (k = 4). Salient pattern coefficients presented in bold (pattern coefficient ≥ .30).

Table 2

Sources of Variance in Kaufman Assessment Battery for Children (KABC-II) for the 10 Subtest Core Battery Ages 7-12 (N = 1,142) According to a SL Hierarchical Model With Four First-Order Factors

	General		F1: Gc		F2: PR		F3: Gsm		F4: Glr			
Subtest	*b*	*S²*	*b*	*S²*	*b*	*S²*	*b*	*S²*	*b*	*S²*	*h²*	*u²*
Verbal Knowledge	.706	.498	**.427**	**.182**	.009	.000	-.015	.000	-.023	.001	.413	.587
Riddles	.719	.517	**.385**	**.148**	-.021	.000	.036	.001	.058	.003	.425	.575
Triangles	.587	.345	.025	.001	**.312**	**.097**	-.016	.000	-.028	.001	.107	.893
Rover	.497	.247	-.045	.002	**.266**	**.071**	.026	.001	.038	.001	.053	.947
Pattern Reasoning	.654	.428	.075	.006	**.254**	**.065**	.028	.001	.016	.000	.168	.832
Story Completion	.577	.333	.181	.033	.148	.022	.022	.000	.004	.000	.225	.775
Number Recall	.423	.179	.016	.000	-.013	.000	**.546**	**.298**	-.020	.000	.563	.437
Word Order	.482	.232	-.013	.000	.022	.000	**.540**	**.292**	.017	.000	.528	.472
Atlantis	.517	.267	.016	.000	-.025	.001	.005	.000	**.426**	**.181**	.203	.797
Rebus	.606	.367	.002	.000	.051	.003	-.015	.000	**.412**	**.170**	.159	.841
Total Variance		.341		.037		.026		.059		.036	.500	.500
Common Variance		.683		.075		.052		.119		.072		
	ωh = .800		ωhs = .197		ωhs = .127		ωhs = .393		ωhs = .236			

Note. *b* = loading of subtest on factor; *S²* = variance explained; *h²* = communality; *u²* = uniqueness; ωh = omega hierarchical; ωhs = omega hierarchical subscale; Gc = Crystallized Ability; PR = Perceptual Reasoning; Gsm = Short-Term Memory; Glr = Long-Term Storage and Retrieval. Bold type indicates coefficients and variance estimates that are in alignment with a latent factor. Because Story Completion failed to align on any factor it was not included in ωh and ωhs estimation.

Table 3

Kaufman Assessment Battery for Children (KABC-II) Exploratory Factor Analysis: Five Oblique Factor Solution for the 16 Core and Supplemental Subtests (N = 1,142) Ages 7-12

Subtest	*g*	F1: Gc		F2: PR		F3: DR		F4: Glr		F5: Gsm		*h²*
Verbal Knowledge	.741	**.789**	(.835)	.117	(.620)	-.014	(.466)	-.035	(.406)	-.015	(.432)	.704
Riddles	.761	**.769**	(.837)	.028	(.607)	.012	(.498)	.009	(.447)	.074	(.485)	.707
Expressive Vocabulary	.723	**.833**	(.829)	-.101	(.532)	.029	(.490)	.058	(.466)	.039	(.428)	.694
Triangles	.595	.080	(.497)	**.712**	(.690)	-.064	(.370)	.012	(.317)	-.074	(.371)	.484
Rover	.495	-.057	(.363)	**.548**	(.561)	.049	(.355)	.007	(.276)	.034	(.360)	.318
Block Counting	.477	.107	(.405)	**.464**	(.526)	-.007	(.301)	-.057	(.220)	.033	(.342)	.284
Gestalt Closure	.410	**.312**	(.424)	.291	(.405)	-.084	(.229)	.020	(.226)	-.096	(.205)	.216
Pattern Reasoning	.662	.068	(.532)	**.589**	(.703)	.008	(.451)	.053	(.389)	.064	(.476)	.505
Story Completion	.596	.286	(.548)	**.364**	(.575)	.123	(.435)	-.065	(.312)	-.041	(.353)	.385
Number Recall	.439	.064	(.351)	-.041	(.389)	-.056	(.261)	-.015	(.214)	**.705**	(.683)	.471
Word Order	.503	.015	(.381)	.013	(.456)	.016	(.339)	-.020	(.258)	**.718**	(.733)	.538
Hand Movements	.482	-.159	(.311)	**.376**	(.515)	.051	(.355)	.045	(.287)	**.327**	(.512)	.343
Atlantis	.608	.038	(.473)	-.005	(.430)	.056	(.574)	**.774**	(.836)	.028	(.344)	.705
Atlantis Delayed	.693	-.001	(.509)	.027	(.535)	**.897**	(.905)	.007	(.575)	-.028	(.390)	.819
Rebus	.486	-.004	(.370)	.008	(.335)	-.029	(.458)	**.797**	(.766)	-.042	(.232)	.590
Rebus Delayed	.681	.010	(.502)	-.027	(.510)	**.900**	(.898)	.013	(.572)	.001	(.395)	.807
Eigenvalue		6.26		1.48		1.21		.99		.84		
% Variance		39.12		9.23		7.59		6.17		5.24		
Factor Correlations												
F1		1.00										
F2		.68		1.00								
F3		.56		.58		1.00						
F4		.51		.47		.63		1.00				
F5		.50		.60		.45		.36		1.00		

Note. *g* = general structure coefficients based on first un-rotated factor coefficients (*g*–loadings); h^2 = communality; Gc = Crystallized Ability; PR = Perceptual Reasoning; Gsm = Short-Term Memory; Glr = Long-Term Storage and Retrieval; DR = Delayed Recall. Factor pattern coefficients (structure coefficients) based on principal factors extraction with promax rotation (k = 4). Salient pattern coefficients presented in bold (pattern coefficient ≥ .30).

Table 4

Sources of Variance in Kaufman Assessment Battery for Children (KABC-II) for the 16 Subtest Core and Supplemental Battery Ages 7-12 (N = 1,142) According to a SL Hierarchical Model With Five First-Order Factors

	General		F1: Gc		F2: PR		F3: DR		F4: Glr		F5: Gsm			
Subtest	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	h^2	u^2
Verb. Knowledge	.672	.452	**.490**	**.240**	.067	.004	-.009	.000	-.026	.001	-.012	.000	.697	.303
Riddles	.688	.473	**.477**	**.228**	.016	.000	.008	.000	.007	.000	.057	.003	.704	.296
Ex. Vocabulary	.655	.429	**.517**	**.267**	-.058	.003	.019	.000	.044	.002	.030	.001	.703	.297
Triangles	.559	.312	.050	.003	**.470**	**.221**	-.042	.002	.009	.000	-.057	.003	.541	.459
Rover	.469	.220	-.035	.001	**.313**	**.098**	.032	.001	.005	.000	.026	.001	.321	.679
Block Counting	.443	.196	.066	.004	**.265**	**.070**	-.005	.000	-.043	.002	.025	.001	.273	.727
Gestalt Closure	.372	.138	.194	.038	.166	.028	-.055	.003	.015	.000	-.074	.005	.212	.788
Pattern Reasoning	.618	.382	.042	.002	**.336**	**.113**	.005	.000	.040	.002	.049	.002	.501	.499
Story Completion	.548	.300	.178	.032	**.208**	**.043**	.080	.006	-.049	.002	-.032	.001	.385	.615
Number Recall	.413	.171	.040	.002	-.023	.001	-.036	.001	-.011	.000	**.544**	**.296**	.470	.530
Word Order	.478	.228	.009	.000	.007	.000	.010	.000	-.015	.000	**.554**	**.307**	.536	.464
Hand Movements	.460	.212	-.099	.010	.215	.046	.033	.001	.034	.001	**.252**	**.064**	.333	.667
Atlantis	.592	.350	.024	.001	-.003	.000	.036	.001	**.586**	**.343**	.022	.000	.696	.304
Atlantis Delayed	.690	.476	-.001	.000	.015	.000	**.583**	**.340**	.005	.000	-.022	.000	.817	.183
Rebus	.474	.225	-.002	.000	.005	.000	-.019	.000	**.603**	**.364**	-.032	.001	.590	.410
Rebus Delayed	.679	.461	.006	.000	-.015	.000	**.585**	**.342**	.010	.000	.001	.000	.804	.196
Total Variance		.314		.052		.039		.044		.045		.043	.536	.464
Common Variance		.586		.096		.073		.081		.084		.079		
		ωh = .821		ωhs = .307		ωhs = .202		ωhs = .377		ωhs = .433		ωhs = .339		

Note. *b* = loading of subtest on factor; S^2 = variance explained; h^2 = communality; u^2 = uniqueness; ωh = omega hierarchical; ωhs = omega hierarchical subscale; Gc = Crystallized Ability; PR = Perceptual Reasoning; Gsm = Short-Term Memory; Glr = Long-Term Storage and Retrieval; DR = Delayed Recall. Bold type indicates coefficients and variance estimates that are in alignment with a latent factor. Because Gestalt Closure failed to align on any factor it was not included in ωh and ωhs estimation.

Table 5

Kaufman Assessment Battery for Children (KABC-II) Exploratory Factor Analysis: Four Oblique Factor Solution for the 10 Core Subtests (N = 883) Ages 13-18

Subtest	*g*	F1: Gc		F2: PR		F3: Gsm		F4: Glr		h^2
Verbal Knowledge	.762	**.830**	(.846)	.028	(.609)	.014	(.479)	-.016	(.599)	.717
Riddles	.771	**.832**	(.857)	-.053	(.596)	.047	(.504)	.051	(.628)	.737
Block Counting	.568	.024	(.452)	**.705**	(.653)	.031	(.372)	-.121	(.411)	.433
Rover	.527	-.112	(.385)	**.630**	(.605)	.040	(.352)	.044	(.432)	.371
Pattern Reasoning	.690	.145	(.583)	**.582**	(.712)	.037	(.446)	.011	(.545)	.521
Story Completion	.590	**.319**	(.560)	**.363**	(.573)	-.116	(.299)	.069	(.491)	.386
Number Recall	.482	.040	(.391)	-.020	(.377)	**.701**	(.696)	-.029	(.355)	.486
Word Order	.595	-.018	(.467)	.088	(.502)	**.675**	(.752)	.072	(.478)	.578
Atlantis	.536	.052	(.468)	-.139	(.413)	.056	(.368)	**.682**	(.651)	.432
Rebus	.703	.000	(.584)	.223	(.650)	-.049	(.413)	**.641**	(.773)	.620
Eigenvalue		4.54		1.05		.92		.77		
% Variance		45.36		10.47		9.23		7.86		
Factor Correlations										
F1		1.00								
F2		.70		1.00						
F3		.55		.56		1.00				
F4		.71		.71		.53		1.00		

Note. g = general structure coefficients based on first un-rotated factor coefficients (*g*–loadings); h^2 = communality; Gc = Crystallized Ability; PR = Perceptual Reasoning; Gsm = Short-Term Memory; Glr = Long-Term Storage and Retrieval. Factor pattern coefficients (structure coefficients) based on principal factors extraction with promax rotation (k = 4). Salient pattern coefficients presented in bold (pattern coefficient ≥ .30).

Table 6

Sources of Variance in Kaufman Assessment Battery for Children (KABC-II) for the 10 Subtest Core Battery Ages 13-18 (N = 883) According to a SL Hierarchical Model With Four First-Order Factors

	General		F1: Gc		F2: PR		F3: Gsm		F4: Glr			
Subtest	*b*	*S²*	*b*	*S²*	*b*	*S²*	*b*	*S²*	*b*	*S²*	*h²*	*u²*
Verbal Knowledge	.719	.517	**.446**	**.199**	.015	.000	.011	.000	-.009	.000	.716	.284
Riddles	.729	.531	**.448**	**.201**	-.028	.001	.036	.001	.028	.001	.735	.265
Block Counting	.536	.287	.013	.000	**.376**	**.141**	.024	.001	-.067	.004	.434	.566
Rover	.501	.251	-.060	.004	**.336**	**.113**	.030	.001	.024	.001	.369	.631
Pattern Reasoning	.648	.420	.078	.006	**.310**	**.096**	.028	.001	.006	.000	.523	.477
Story Completion	.558	.311	.172	.030	.194	.038	-.088	.008	.038	.001	.388	.612
Number Recall	.447	.200	.022	.000	-.011	.000	**.534**	**.285**	-.016	.000	.486	.514
Word Order	.557	.310	-.010	.000	.047	.002	**.514**	**.264**	.040	.002	.578	.422
Atlantis	.531	.282	.028	.001	-.074	.005	.043	.002	**.377**	**.142**	.432	.568
Rebus	.691	.477	.000	.000	.119	.014	-.037	.001	**.355**	**.126**	.619	.381
Total Variance		.359		.044		.041		.056		.028	.528	.472
Common Variance		.679		.083		.078		.107		.053		
	ωh = .808		ωhs = .232		ωhs = .187		ωhs = .360		ωhs = .179			

Note. *b* = loading of subtest on factor; *S²* = variance explained; *h²* = communality; *u²* = uniqueness; ωh = omega hierarchical; ωs = omega subscale; Gc = Crystallized Ability; PR = Perceptual Reasoning; Gsm = Short-Term Memory; Glr = Long-Term Storage and Retrieval. Bold type indicates coefficients and variance estimates that are in alignment with a latent factor. Because Story Completion failed to align on any factor it was not included in ωh and ωhs estimation.

Table 7

Kaufman Assessment Battery for Children (KABC-II) Exploratory Factor Analysis: Five Oblique Factor Solution for the 16 Core and Supplemental Subtests (N = 883) Ages 13-18

Subtest	*g*	F1: Gc		F2: PR		F3: Glr I		F4: Glr II		F5: Gsm		*h²*
Verbal Knowledge	.757	**.816**	(.850)	.045	(.617)	.009	(.435)	.007	(.527)	-.011	(.488)	.724
Riddles	.769	**.885**	(.883)	-.037	(.604)	.016	(.452)	.000	(.529)	.028	(.517)	.781
Expressive Vocabulary	.724	**.830**	(.832)	-.017	(.572)	.027	(.424)	-.047	(.480)	.050	(.500)	.694
Triangles	.640	.132	(.550)	**.719**	(.720)	.021	(.325)	-.048	(.476)	-.114	(.375)	.531
Rover	.529	-.104	(.384)	**.600**	(.600)	.026	(.283)	.029	(.425)	.069	(.393)	.366
Block Counting	.565	.011	(.457)	**.704**	(.662)	-.011	(.262)	-.072	(.409)	.005	(.391)	.441
Gestalt Closure	.517	**.347**	(.509)	.186	(.469)	-.044	(.259)	.057	(.382)	.035	(.354)	.287
Pattern Reasoning	.674	.030	(.540)	**.644**	(.724)	.053	(.374)	-.004	(.516)	.064	(.486)	.532
Story Completion	.590	.264	(.534)	**.314**	(.573)	-.099	(.287)	.255	(.519)	-.092	(.331)	.394
Number Recall	.466	.037	(.391)	-.028	(.385)	-.007	(.259)	-.074	(.294)	**.739**	(.704)	.500
Word Order	.573	.049	(.472)	-.006	(.477)	.004	(.341)	.038	(.418)	**.706**	(.751)	.568
Hand Movements	.567	-.053	(.426)	.296	(.553)	-.029	(.303)	.117	(.458)	**.381**	(.574)	.404
Atlantis	.586	.046	(.465)	-.040	(.395)	**.805**	(.851)	.039	(.551)	.042	(.395)	.729
Atlantis Delayed	.537	-.024	(.406)	.061	(.381)	**.829**	(.826)	.004	(.514)	-.048	(.319)	.685
Rebus	.753	-.006	(.556)	.026	(.634)	.027	(.575)	**.878**	(.912)	.007	(.468)	.833
Rebus Delayed	.712	.001	(.525)	-.042	(.582)	.041	(.569)	**.904**	(.894)	-.017	(.427)	.801
Eigenvalue		6.90		1.38		1.14		.78		.73		
% Variance		43.14		8.64		7.12		4.87		4.56		
Factor Correlations												
F1		1.00										
F2		.70		1.00								
F3		.50		.44		1.00						
F4		.60		.68		.61		1.00				
F5		.57		.60		.41		.50		1.00		

Note. g = general structure coefficients based on first un-rotated factor coefficients (g–loadings); h^2 = communality; Gc = Crystallized Ability; PR = Perceptual Reasoning; Gsm = Short-Term Memory; Glr = Long-Term Storage and Retrieval; DR = Delayed Recall. Factor pattern coefficients (structure coefficients) based on principal factors extraction with promax rotation (k = 4). Salient pattern coefficients presented in bold (pattern coefficient ≥ .30).

Table 8

Sources of Variance in Kaufman Assessment Battery for Children (KABC-II) for the 16 Subtest Core and Supplemental Battery Ages 13-18 (N = 883) According to a SL Hierarchical Model With Five First-Order Factors

	General		F1: Gc		F2: PR		F3: Glr I		F4: Glr II		F5: Gsm			
Subtest	*b*	*S²*	*b*	*S²*	*b*	*S²*	*b*	*S²*	*b*	*S²*	*b*	*S²*	*h²*	*u²*
Verb. Knowledge	.696	.484	**.487**	**.237**	.025	.001	.007	.000	.004	.000	-.008	.000	.722	.278
Riddles	.708	.501	**.529**	**.280**	-.021	.000	.012	.000	.000	.000	.021	.000	.782	.218
Ex. Vocabulary	.664	.441	**.496**	**.246**	-.009	.000	.021	.000	-.028	.001	.037	.001	.690	.310
Triangles	.601	.361	.079	.006	**.400**	**.160**	.016	.000	-.028	.001	-.084	.007	.536	.464
Rover	.532	.283	.007	.000	**.392**	**.154**	-.009	.000	-.043	.002	.004	.000	.439	.561
Block Counting	.502	.252	-.062	.004	**.334**	**.112**	.020	.000	.017	.000	.051	.003	.371	.629
Gestalt Closure	.475	.226	***.207***	***.043***	.103	.011	-.034	.001	.034	.001	.026	.001	.282	.718
Pattern Reasoning	.633	.401	.018	.000	**.358**	**.128**	.041	.002	-.002	.000	.047	.002	.533	.467
Story Completion	.554	.307	.158	.025	.175	.031	-.077	.006	.151	.023	-.068	.005	.396	.604
Number Recall	.443	.196	.022	.000	-.016	.000	-.005	.000	-.044	.002	**.543**	**.295**	.494	.506
Word Order	.546	.298	.029	.001	-.003	.000	.003	.000	.022	.000	**.519**	**.269**	.569	.431
Hand Movements	.538	.289	-.032	.001	.165	.027	-.023	.001	.069	.005	**.280**	**.078**	.401	.599
Atlantis	.569	.324	.027	.001	-.022	.000	**.626**	**.392**	.023	.001	.031	.001	.718	.282
Atlantis Delayed	.523	.274	-.014	.000	.034	.001	**.645**	**.416**	.002	.000	-.035	.001	.692	.308
Rebus	.747	.558	-.004	.000	.014	.000	.021	.000	**.519**	**.269**	.005	.000	.828	.172
Rebus Delayed	.710	.504	.001	.000	-.023	.001	.032	.001	**.534**	**.285**	-.012	.000	.791	.209
Total Variance		.356		.053		.039		.051		.037		.042	.578	.422
Common Variance		.617		.091		.068		.089		.063		.072		
		ωh = .852		ωhs = .270		ωhs = .212		ωhs = .475		ωhs = .307		ωhs = .316		

Note. *b* = loading of subtest on factor; *S²* = variance explained; *h²* = communality; *u²* = uniqueness; ωh = omega hierarchical; ωhs = omega hierarchical subscale; Gc = Crystallized Ability; PR = Perceptual Reasoning; Gsm = Short-Term Memory; Glr = Long-Term Storage and Retrieval. Bold type indicates coefficients and variance estimates that are in alignment with a latent factor. Bold italics indicates alignment with a theoretically inconsistent factor. Because Story Completion failed to align on any factor it was not included in ωh and ωhs estimation.