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Factor Structure of the 10 WISC-V Primary Subtests Across Four Standardization Age Groups

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Abstract The Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V; Wechsler 2014a) *Technical and Interpretation Manual* (Wechsler 2014b) dedicated only a single page to discussing the 10-subtest WISC-V primary battery across the entire 6 to 16 age range. Users are left to extrapolate the structure of the 10-subtest battery from the 16-subtest structure. Essentially, the structure of the 10-subtest WISC-V primary battery remains largely uninvestigated particularly at various points across the developmental period. Using principal axis factoring and the Schmid–Leiman orthogonalization procedure, the 10-subtest WISC-V primary structure was examined across four standardization sample age groups (ages 6–8, 9–11, 12–14, 15–16). Forced extraction of the publisher's promoted five factors resulted in a trivial fifth factor at all ages except 15–16. At ages 6 to 14, the results suggested that the WISC-V contains the same four first-order factors as the prior WISC-IV (Verbal Comprehension, Perceptual Reasoning, Working Memory, Processing Speed; Wechsler 2003). Results suggest interpretation of the Visual Spatial and Fluid Reasoning indexes at ages 6 to 14 may be inappropriate due to the fusion of the Visual Spatial and Fluid Reasoning subtests. At ages 15–16, the five-factor structure was supported. Results also indicated that the WISC-V provides strong measurement of general intelligence and clinical interpretation should reside primarily at that level. Regardless of whether a four- or five-factor index structure is emphasized, the group factors reflecting the WISC-V indices do not account for a sufficient proportion of variance to warrant primary interpretive emphasis.

Keywords WISC-V · Exploratory factor analysis · Factor extraction criteria · Schmid–Leiman higher-order analysis · Structural validity

The Wechsler Intelligence Scale for Children was recently revised and it is now in its fifth iteration (WISC-V; Wechsler 2014a). The WISC-V contains 10 primary subtests (Similarities [SI], Vocabulary [VC], Block Design [BD], Matrix Reasoning [MR], Figure Weights [FW], Digit Span [DS], and Coding [CD], Visual Puzzles [VP], Picture Span [PS], and Symbol Search [SS]) that are most commonly administered. Seven of the subtests are used to produce the full scale score (FSIQ) while three additional subtests (VP, PS, and SS) are needed to produce the five-factor index scores (two subtests each) including Verbal Comprehension (VC), Visual Spatial (VS), Fluid Reasoning (FR), Working Memory (WM), and Processing Speed (PS). The WISC-V attempted to reflect conceptualizations of intellectual measurement articulated by Spearman (1927), Carroll (1993, 2003), Cattell and Horn (1978), Horn (1991), Horn and Blankson (2012), and Horn and Cattell (1966) as well as constructs from neuropsychology.

The field's understanding of the factor structure for the 10 WISC-V primary subtests is substantially incomplete. The WISC-V *Technical and Interpretive Manual* dedicated only approximately one page to discussing the 10-subtest battery.

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Half of this page contains a figure depicting the five-factor higher-order model for the primary subtests for the total age range (ages 6 to 16) (see Fig. 5.2, reproduced here in modified form as Fig. 1). The other approximate one-quarter contains verbiage unrelated to the 10-primary subtest analysis, while the remaining quarter comprises the only description of the structural analyses undertaken on the WISC-V 10-primary subtest battery. Amounting to 115 words including the title, this description is offered below:

Confirmatory Factor Analysis of Primary Subtests

The model selected to represent the WISC-V test structure (Model 5e) was fitted to the ten primary subtests for the entire age range. At this stage, the issue being investigated no longer concerned the number of factors influencing subtests. Rather, this analysis addressed how well the identified factors account for the intercorrelations among the reduced set of primary subtests. Goodness-of-fit results are shown in Table 5.4, and Fig. 5.2 presents the subtest and factor loadings. Fit is excellent, and the loadings are similar to those from the analysis of all primary and secondary subtests. These results support the effectiveness of this five-factor model in accounting for the subtest intercorrelations (Wechsler 2014b, p84).

Of concern, the 10-primary subtest battery CFA analysis included only one model, the five-factor higher-order model. This is surprising and does not reflect customary CFA practice (Kline 2016). Conspicuously absent are competing models including a four-factor model and one-, two-, and three-factor models (oblique, higher order, and bifactor). This paucity of structural analysis within the *Technical and Interpretive Manual* is surprising, particularly when the 10 WISC-V primary subtest battery is likely more frequently administered than the full 16-subtest battery, and the Wechsler scales (especially the WISC) are among the most commonly administered assessment instruments the world over (Oakland et al. 2016). Thus, clinicians and researchers are left to rely upon, and extrapolate, structural validity information for the 10-primary subtest battery from the analyses based upon the 16-subtest total battery. It is considered less reassuring, if not inappropriate, to simply extrapolate a factor structure from a different composition of variables (i.e., subtests; Gorsuch 1983; Kline 2016; Thompson 2004).

Further, even if one were to accept the veracity of extrapolating the structure of the 10 WISC-V subtest battery from the 16 WISC-V subtest battery, several researchers have argued that the structural analyses presented in the WISC-V *Technical and Interpretive Manual* for the 16-subtest battery are incomplete (Beaujean 2016; Canivez and Watkins 2016; Canivez et al. 2016a, b; Dombrowski et al. 2016). These researchers indicated that the test publisher omitted exploratory factor analyses and relied solely upon confirmatory methods when elucidating the internal structure of the WISC-V. It was also noted that the analyses conducted on the WISC-V 16-subtest battery focused on the entire age span (ages 6 to 16). This omnibus type of analysis may not account for subtle differences in WISC-V structure across the developmental period.

The WISC-V publisher supported exclusive reliance upon CFA by claiming that exploratory factor analytic (EFA) procedures are unnecessary because the WISC-V structure was predicated upon prior Wechsler theory as well as current conceptualizations of intellectual and neuropsychological theory. However, the test publisher's rationale for exclusive use of CFA to establish the structural validity of the WISC-V may be challenged. It contrasts with the body of factor analytic literature which posits that both methods provide worthwhile information, particularly when an instrument and its theory have been substantially revised and when the structure of an instrument departs from the previous edition (e.g., Adams 2000; Gorsuch 1983; Kline 2016; Thompson 2004). For instance, with the 10 WISC-V primary subtest battery, a case can be made that the incorporation of new subtests (e.g., Visual Puzzles, Figure Weights, and Picture Span), the reduction in subtests from 10 to 7 needed to calculate the FSIQ, and the replacement of the Perceptual Reasoning index with two new indices (e.g., Visual Spatial and Fluid Reasoning) represents a substantial revision that would benefit from both CFA and EFA. However, the test publisher only superficially examined the structure of the 10-subtest WISC-V battery.

There have been additional criticisms with the CFA structural analyses presented in the WISC-V *Technical and Interpretive Manual* (Beaujean 2016; Canivez and Watkins 2016; Canivez et al. 2015, 2016a, b; Dombrowski et al. 2015). Many of these criticisms were discussed in Canivez and Kush (2013) but were not subsequently addressed by the WISC test publisher in its recent edition. The WISC-V *Technical and Interpretive Manual* does not adequately describe the CFA methods used to establish the WISC-V structure. There was no explicit justification for selecting weighted least squares (WLS) estimation rather than maximum likelihood (ML) estimation and because latent constructs (i.e., factors) have no natural scale of measurement, specification by the researcher is necessary to achieve model identification. The choice of metric can influence unstandardized parameters that may "yield different conclusions regarding the statistical significance of freely estimated parameters" (Brown 2015, p. 133). Kline (2011) also explained that a researcher needs to explicitly justify the use of an estimation method other than maximum likelihood. WLS is typically used with either data that are categorical or non-normally distributed and may not produce chi-square values nor approximate fit indices equivalent to those produced by ML estimation (Yuan and Chan 2005). Neither of these conditions pertains to WISC-V subtest scores (H. Chen et al. 2015) so the use of WLS reflects a

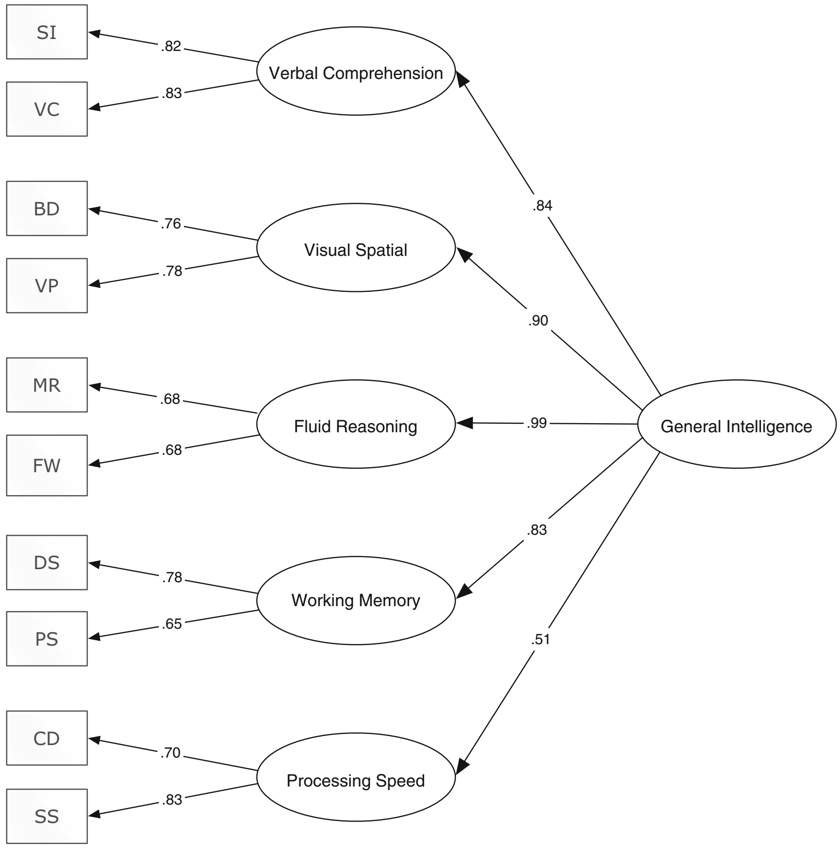

Fig. 1 Higher-order measurement model with standardized coefficients (adapted from Fig. 5.2 [Wechsler 2014b]), for WISC-V standardization sample (*N* = 2200) 10 primary subtests. *SI* Similarities, *VC* Vocabulary, *BD* Block Design, *VP* Visual Puzzles, *MR* Matrix Reasoning, *FW* Figure Weights, *DS* Digit Span, *PS* Picture Span, *CD* Coding, *SS* Symbol Search. *Wechsler Intelligence Scale for Children, Fifth Edition* (*WISC-V*). Copyright © 2014 NCS Pearson, Inc. Reproduced with permission. All rights reserved. "*Wechsler Intelligence Scale for Children*" and "*WISC*" are trademarks, in the USA and/or other countries, of Pearson Education, Inc. or its affiliates(s)

significant departure from the typical approach to using ML estimation in intelligence test CFA. However, this issue deserves follow-up to determine whether there may be any meaningful differences in results between the two estimation methods.

Second, the publisher's preferred CFA higher-order measurement model produced a standardized path coefficient of 1.00 between the latent general intelligence factor for 16 primary and secondary subtests and .99 for 10 primary subtests (general intelligence mislabeled in Figs. 5.1 and 5.2 as "Full Scale") and the Fluid Reasoning factor suggesting that *g* and FR may well be empirically redundant (i.e, Le et al. 2010) and essentially the same construct. This could constitute a major threat to discriminant validity and could arguably suggest that the WISC-V has been overfactored (Frazier and Youngstrom 2007).

This is not a new issue. Using confirmatory factor analysis, Weiss et al. (2013b) investigated a five-factor structure for the WISC-IV and produced isomorphic path loadings between *g* and Gf (i.e., 1.0) in the final, adopted validation model (see model C2, p118 and Fig. 2, p122). Weiss et al. (2013b) argued that either a four-factor or a five-factor model may be adopted for interpretive purposes. However, it is noted that not only did the final five-factor model depicted by Weiss et al. (2013b) contain a path coefficient of 1.0 between FR and *g* (this loading was constrained in the analysis to 1.0) but also the model contained an intermediate latent variable (Inductive Reasoning) that was correlated with the FR factor and that loaded on the subtests of Picture Concepts (PCn) and Matrix Reasoning (MR). The FR factor did not directly load the FR subtests. Canivez and Kush (2013) questioned the Weiss et al. (2013b) conclusion that interpretation of the WISC-IV five-factor structure is plausible.

Third, the publisher did not test rival *bifactor* models in comparison to higher-order models for the WISC-V CFA (Canivez et al. 2015, 2016a, b; Canivez and Watkins 2016; Dombrowski et al. 2015). Bifactor models offer several benefits over higher-order models (Canivez 2016; Reise 2012): have fit data well from other Wechsler scales (viz., Canivez 2014b; Gignac and Watkins 2013; Nelson et al. 2013; Watkins 2010; Watkins and Beaujean 2014; Watkins et al. 2013) and have been recommended for use with cognitive tests (Alexandre et al. 2015; Brunner et al. 2012; Canivez 2016; Gignac 2005, 2006). A higher-order structural model presents general intelligence as a hierarchical construct fully mediated by the lower-order group factors and only indirectly influences the subtest indicators. The bifactor model, however, portrays general intelligence as a breadth factor with direct influences on the subtests (Canivez 2016; Gignac 2008). The bifactor model appears more consistent with Spearman's (1927) conceptualization of intelligence and may offer a more conceptually parsimonious explanation than the higher-order model (Canivez 2016; Gignac 2006). In fact, some have suggested that Carroll's (1993) description of the structure of intelligence is better represented by the bifactor model (Beaujean 2015a).

One advantage of bifactor modeling is that it permits the calculation of model-based reliability using omega-hierarchical (ω_H) and omega-hierarchical subscale (ω_{HS}) (Reise 2012; Rodriguez et al. 2016), which estimate the proportion of variance due to general and group factors, and consequently determines how much interpretive emphasis should be placed upon the general factor and lower-order factor scores (Gignac and Watkins 2013; Reise 2012; Zinbarg et al. 2006). The need to include omega estimates was highlighted in several reviews and critiques of Wechsler scales including the WAIS-IV, WPPSI-IV, and WISC-IV (Canivez 2010, 2014a; Canivez and Kush 2013); however, omega estimates were not included in the WISC-V *Technical and Interpretive Manual*.

Decomposed variance estimates to disclose how much subtest variance is due to the hierarchical *g* factor and how much is due to the lower-order group factors was also absent from the WISC-V *Technical and Interpretive Manual*. This makes it difficult for clinicians and researchers to judge the adequacy of the group factors (VC, VS, FR, WM, and PS) based on how much *unique* variance the group factors capture when purged of the effects of general intelligence.

An additional concern is that the WISC-V publisher recommended the use of CFA over EFA rather than utilizing the unique advantages of each method. EFA and CFA are considered complementary procedures and answer different questions, so greater confidence in the latent factor structure is achieved when EFA and CFA are in agreement (Gorsuch 1983). Carroll (1995) and Reise (2012) both explained that EFA procedures are particularly useful in suggesting possible models to be tested in CFA. Carroll (1998) noted that "CFA should derive its initial hypotheses from EFA results, rather than starting from scratch or from a priori hypotheses...[and] CFA analyses should be done to check…EFA analyses" (p. 8). The deletion of Word Reasoning and Picture Completion subtests; the addition of Visual Puzzles, Figure Weights, and Picture Span subtests; and the inclusion of new or revised items across all WISC-V subtests suggest that relationships among retained and new subtests may well have resulted in associations and latent structure that could not be adequately anticipated by a priori conceptualizations (Strauss et al. 2000).

As support for this contention, it is noteworthy that the expanding body of intelligence test factor structure research using EFA procedures has consistently produced substantial challenges to the optimistic conclusions from CFA-based latent structures reported in test technical manuals (e.g., Bodin et al. 2009; Canivez 2008; Canivez and Watkins 2010a, 2010b; Canivez 2014b; Canivez et al. 2009; Canivez et al., 2014; DiStefano and Dombrowski 2006; Dombrowski et al. 2016; Dombrowski and Watkins 2013; Dombrowski et al. 2009; Glutting et al. 2006; Glutting et al. 1997; Nelson et al. 2013; Nelson and Canivez 2012; Nelson et al. 2007; Watkins 2006; Watkins et al. 2006).

Finally, with the exception of the brief statement (quoted above) regarding the 10-primary subtest battery across the entire 6 to 16 age range using higher-order CFA by the publisher and the bifactor EFA and CFA analyses across the entire 6 to 16 age range (e.g., Canivez and Watkins 2016 and Canivez et al. 2016a, b), the structure of the 10-primary subtest battery has not been examined using EFA and hierarchical factor analysis within four different age ranges (e.g., ages 6–8, 9–11, 12–14, 15–16). This investigation is necessary not only to determine the consistency of the WISC-V structure across the developmental period but also to better understand the 10-subtest WISC-V structure. The present study sought to fill this critical technical void by investigating the 10 WISC-V primary subtests factor structure across four age groups (6–8, 9–11, 12–14, 15–16) using principal axis factoring with promax rotation followed by the Schmid–Leiman orthogonalization procedure. This information is not contained in the *Technical and Interpretive Manual* nor has it been independently investigated. This is an unfortunate omission as the 10 WISC-V primary subtest battery is likely the main battery administered by clinicians and researchers. The field, therefore, cannot be fully confident in the 10 WISC-V primary subtest battery structure and the suggested approach to interpretation offered in the *Technical and Interpretive Manual* until further investigations such as this one are undertaken.

Method

Participants

Participants were members of the WISC-V standardization sample and included a total of 2200 individuals ranging in age from 6 to 16 years. Participants were divided into four age groups (ages 6–8, 9–11, 12–14, 15–16 years) to allow for an exploration of the structure of the WISC-V 10-subtest main battery across various developmental periods. Demographic characteristics are provided in the WISC-V *Technical and Interpretive Manual* (Wechsler 2014b) and revealed a close match to the US census across age, sex, race/ethnicity, parental education level, and geographic region.

Instrument

The WISC-V is an individual test of general intelligence for children ages 6 to 16 years that includes 16 primary and secondary subtests that provide estimates of general intelligence but also are combined to measure various group factors. The

WISC-V contains 10 primary ability subtests, the 5 group factors, and a FSIQ that estimates general intelligence (Spearman 1927).

The Full Scale IQ (FSIQ) is composed of *seven* primary subtests across the five domains (VC, VS, FR, WM, PS). The Primary Index Scale level includes three additional subtests not used to calculate the FSIQ, which are used to estimate the five WISC-V factor index scores (VCI, VSI, FRI, WMI, PSI).

Procedure

The WISC-V 10-subtest scaled score correlation matrices for the standardization sample were obtained from the WISC-V *Technical and Interpretive Manual Supplement* (Wechsler 2014c) and combined by averaging correlations through Fisher transformations. Four correlation matrices (10 primary intelligence subtests) were created to represent four broad age subgroups (ages 6–8 [n = 600], 9–11[n = 600], 12–14 [n = 600], and 15–16 [n = 400]).

Principal axis exploratory factor analyses (Fabrigar et al. 1999) were used to analyze the WISC-V standardization sample correlation matrices from the four age groups using SPSS 23. Multiple criteria (Gorsuch 1983) were examined to determine the number of factors to extract and retain and included eigenvalues >1 (Kaiser 1960), the scree test (Cattell 1966), standard error of scree (SE_{Scree}; Zoski and Jurs 1996), Horn's parallel analysis (HPA, principal components; Horn 1965), and minimum average partials (MAP; Velicer 1976).

Retained factors were subjected to promax (oblique) rotation (k = 4; Gorsuch 1983). Setting k to 4 produced greater hyperplane count compared to k = 2 with the present data. Salient factor pattern coefficients were defined as those ≥.30 (Child 2006). Factor solutions were examined for interpretability and theoretical plausibility (Fabrigar et al. 1999) with the empirical requirement that each factor should be marked by two or more salient pattern loadings and no salient cross-loadings (Gorsuch 1983). Subtest g loadings (first unrotated factor coefficients) were evaluated based on Kaufman's (1994) criteria (≥.70 = good, .50–.69 = fair, <.50 = poor).

Carroll (1993, 1995, 2003) argued that because cognitive ability subtest scores reflect combinations of both first-order and second-order factor variance, variance from the higher-order factor must be extracted first to residualize the lower-order factors, leaving them orthogonal to the higher-order factor. The Schmid and Leiman (SL; 1957) procedure was used to accomplish this residualization because of Carroll's recommendation and its long-standing use for this purpose (Carroll 1993, 1995, 1997, 2003; Carretta and Ree 2001; Gustafsson and Snow 1997; McClain 1996; Ree et al. 2003; Thompson 2004). The SL procedure is a reparameterization of a higher-order model and an *approximate* bifactor solution (Reise 2012). Accordingly, first-order factor correlation matrices were factor analyzed (principal axis) and first-order factors were orthogonalized by removing all variance associated with the second-order dimension using the Schmid and Leiman (1957) procedure via Wolf and Preising's (2005) SPSS algorithm. This transforms "an oblique factor analysis solution containing a hierarchy of higher-order factors into an orthogonal solution, which not only preserves the desired interpretation characteristics of the oblique solution, but also discloses the hierarchical structuring of the variables" (Schmid and Leiman 1957, p. 53).

Omega-hierarchical and omega-hierarchical subscale coefficients (Reise 2012; Rodriguez et al. 2016) were estimated as model-based reliability estimates of the latent factors (Gignac and Watkins 2013). Chen et al. (2012) noted that "for multidimensional constructs, the alpha coefficient is complexly determined, and McDonald's omega-hierarchical (ω_H; 1999) provides a better estimate for the composite score and thus should be used" (p. 228). These same problems are inherent with other internal consistency estimates such as split-half or KR-20. The ω_H coefficient is the model-based reliability estimate for the hierarchical general intelligence factor independent of the variance of group factors. The ω_{HS} coefficient is the model-based reliability estimate of a group factor with all other group and general factors removed (Reise 2012; Rodriguez et al. 2016). Omega estimates (ω_H and ω_{HS}) may be obtained from EFA SL bifactor solutions and were produced using the *Omega* program (Watkins 2013), which was based on the tutorial by Brunner et al. (2012) and the work of Zinbarg et al. (2005) and Zinbarg et al. (2006). Although omega coefficients have been referred to as model-based reliability estimates, they may also be conceived of as validity estimates as they present data regarding the plausibility of interpreting general and group factors. Omega coefficients should at a minimum exceed .50, but .75 would be preferred (Reise 2012; Reise et al. 2013).

Results

Factor Extraction Criteria Comparisons

Multiple factor extraction criteria (eigenvalues >1, scree test, standard error of scree, HPA, MAP, theory) were used for determining the number of factors to extract and retain across the four age groups. Only the publisher recommended/theory indicated extraction of five factors. All other criteria across the four age groups recommended extraction of only one or two factors with the 10 WISC-V primary subtests.

Five-Factor Exploratory and Hierarchical Analyses

EFA began with extracting five factors to examine the publisher's proposed structures. Tables A1 through A7 (see Appendix A in online supplemental materials) present exploratory factor analyses (principal axis factoring with promax rotation) results (odd numbered Tables A1 to A7) for the five-factor extraction. Extraction of five factors for the 15–16-year-old age group produced salient loadings on all theoretically proposed group factors (Table A7). Extraction of five factors for all other age groups (6–8, 9–11, 12–14) produced psychometrically inadequate results as the fifth factor included only one salient pattern coefficient (Figure Weights [ages 6–8]; Matrix Reasoning [ages 9–11); Visual Puzzles [ages 12–14]). Factors cannot be defined by a singular indicator.

Schmid–Leiman results (see even numbered Tables A2–A6 in online supplemental materials and Table 1) illustrate the dominance of the general intelligence factor. The results across the first three age ranges (ages 6–8, 9–11, 12–14) produced an ill-defined fifth factor. Ages 6–8 results also yielded an ill-defined fourth factor. The exception was the 15–16 age group (Table 1), which produced loadings consistent with the publisher's proposed theory. Because a five-factor solution was not deemed viable across all age ranges (except for the 15–16 age group), the four-factor model similar to the WISC-IV was investigated.

Four-Factor Exploratory and Hierarchical Analyses

Ages 6–8 First-Order EFA: Four Factor Extraction Table B1 (Appendix B in online supplement) presents results of principal axis factoring with promax rotation. The *g* loadings ranged from .394 (Coding) to .726 (Matrix Reasoning and Similarities) and all were within the fair to good range (except Coding). All subtests illustrated salient pattern coefficients on a group factor. Table B1 illustrates a robust Perceptual Reasoning (Visual Puzzles, Block Design, Matrix Reasoning and Figure Weights), Verbal Comprehension (Similarities, Vocabulary), Processing Speed (Coding, Symbol Search), and Working Memory (Digit Span, Picture Span) factors with theoretically consistent subtest associations. There were no subtests with salient cross-loadings. The moderate to high factor correlations presented in Table B1 (.333 to .732) imply a higher-order or hierarchical structure that required explication (Gorsuch 1983). The Schmid–Leiman procedure was applied to better understand variance apportionment among general and group factors.

Ages 6–8 SL Analyses: Four First-Order Factors Results for the Schmid and Leiman orthogonalization of the higher-order factor analysis are presented in Table 2. All subtests were properly associated (higher residual variance) with their theoretically proposed factor after removing *g* variance. The hierarchical *g* factor accounted for 35.1% of the total variance and 66.0% of the common variance. The general factor also accounted for between 7.0% (Picture Span) and 49.0% (Similarities) of individual subtest variability. At the first-order level, PR accounted for an additional 3.9% of the total variance and 7.3% of the common variance, VC accounted for an additional 3.7% of the total variance and 6.9% of the common variance, PS accounted for an additional 4.2% of the total variance and 7.9% of the common variance, and WM accounted for an additional 6.3% of the total variance and 11.8% of the common variance. The general and group factors combined to measure 53.2% of the variance in WISC-V scores resulting in 46.8% unique variance (combination of specific and error variance).

Omega-hierarchical and omega-hierarchical subscale coefficients were estimated based on the SL results in Table 2. The ω_H coefficient for general intelligence (.785) was high and sufficient for scale interpretation; however, the ω_{HS} coefficients for the four group factors (VC, WM, PR, PS) were considerably lower (.168–.357). Thus, the four group factors likely possess too little unique true score variance for clinical interpretation (Reise 2012; Reise et al. 2013) in the 6–8-year-old age group.

Ages 9–11 First-Order EFA: Four Factor Extraction Table B2 (Appendix B in online supplement) presents results of four-factor extraction with promax rotation. The *g* loadings ranged from .480 (Symbol Search) to .747 (Vocabulary) and all were within the fair to good range (except Symbol Search and Coding). Table B2 illustrates robust Perceptual Reasoning (Visual Puzzles, Block Design, Matrix Reasoning and Figure Weights), Verbal Comprehension (Similarities, Vocabulary), Processing Speed (Coding, Symbol Search), and Working Memory (Digit Span, Picture Span) factors with theoretically consistent subtest associations. Digit Span saliently cross-loaded on the PS group factor. There were no other subtests with salient cross-loadings. The moderate to high factor correlations presented in Table B2 (.375 to .712) imply a higher-order or hierarchical structure that required explication (Gorsuch 1983). The Schmid–Leiman procedure was applied to better understand variance apportionment among general and group factors.

Ages 9–11 SL Analyses: Four First-Order Factors Results for the Schmid and Leiman orthogonalization of the higher-order factor analysis are presented in Table 3. All subtests were properly associated (higher residual variance) with the prior WISC-IV theoretical structure after removing *g* variance. The hierarchical *g* factor accounted for 33.9% of the total variance and 57.3% of the common variance.

The general factor also accounted for between 21.6% (Picture Span) and 46.6% (Block Design) of individual subtest variability. At the first-order level, PR accounted for an additional 4.8% of the total variance and 8.1% of the common variance, VC accounted for an additional 5.4% of the total variance and 9.1% of the common variance, PS accounted for an additional 7.1% of the total variance and 12.1% of the

Table 1 Sources of variance in the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V) for the standardization sample 15–16 years old ($N = 400$) according to a SL orthogonalization model with five first-order factors

	General		F1: VS		F2: VC		F3: PS		F4: WM		F5: FR			
WISC-V subtest	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	h^2	u^2
Visual Puzzles	.722	.521	**.502**	**.252**	.013	.000	−.031	.001	−.004	.000	−.035	.001	.776	.224
Block Design	.683	.466	**.313**	**.098**	−.004	.000	.078	.006	−.003	.000	.181	.033	.604	.396
Similarities	.726	.527	−.026	.001	**.497**	**.247**	.036	.001	.011	.000	−.014	.000	.776	.224
Vocabulary	.692	.479	.079	.006	**.373**	**.139**	−.035	.001	.024	.001	.100	.010	.636	.364
Coding	.591	.349	−.067	.004	.019	.000	**.471**	**.222**	−.040	.002	.096	.009	.586	.414
Symbol Search	.703	.494	.078	.006	−.008	.000	**.426**	**.181**	.045	.002	−.136	.018	.703	.297
Digit Span	.626	.392	−.012	.000	−.041	.002	.013	.000	**.416**	**.173**	.169	.029	.595	.405
Picture Span	.612	.375	.003	.000	.068	.005	−.010	.000	**.408**	**.166**	−.097	.009	.555	.445
Figure Weights	.447	.200	.090	.008	.076	.006	−.040	.002	.002	.000	**.460**	**.212**	.427	.573
Matrix Reasoning	.474	.225	.051	.003	.048	.002	.017	.000	.049	.002	**.422**	**.178**	.410	.590
Total S^2		.403		.038		.040		.042		.035		.050	.607	.393
Common S^2		.664		.062		.066		.068		.057		.082		
	$\omega_H = .835$		$\omega_{HS} = .201$		$\omega_{HS} = .224$		$\omega_{HS} = .249$		$\omega_{HS} = .219$		$\omega_{HS} = .227$			

Bold type indicates salient loading ($b \geq .30$). Italic type indicates coefficient and variance estimate alignment ($.20 \leq b < .30$)

VS Visual Spatial, *VC* Verbal Comprehension, *PS* Processing Speed, *WM* Working Memory, *FR* Fluid Reasoning, *b* loading of subtest on factor, S^2 variance explained, h^2 communality, u^2 uniqueness, ω_H omega-hierarchical, ω_{HS} omega-hierarchical subscale

common variance, and WM accounted for an additional 8.0% of the total variance and 13.5% of the common variance. The general and group factors combined to measure 59.1% of the variance in WISC-V scores resulting in 40.9% unique variance (combination of specific and error variance).

Omega-hierarchical and omega-hierarchical subscale coefficients were estimated based on the SL results in Table 3. The ω_H coefficient for general intelligence (.776) was high and sufficient for scale interpretation; however, the ω_{HS} coefficients for the four group factors (VC, WM, PR, PS) were considerably lower (.180–.439). Thus, the four group factors likely possess too little unique true score variance for clinical interpretation (Reise 2012; Reise et al. 2013) for the 9–11-year-old age group.

Table 2 Sources of variance in the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V) for the standardization sample 6–8 years old ($N = 600$) according to an exploratory SL orthogonalization model with four first-order factors

	General		F1: Perceptual Reasoning		F2: Verbal Comprehension		F3: Processing Speed		F4: Working Memory			
WISC-V subtest	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	h^2	u^2
Visual Puzzles	.635	.403	**.399**	**.159**	−.012	.000	−.059	.003	−.006	.000	.566	.434
Block Design	.688	.473	**.353**	**.125**	.009	.000	.075	.006	−.135	.018	.622	.378
Matrix Reasoning	.620	.384	*.243*	.059	.012	.000	.022	.000	*.217*	.047	.490	.510
Figure Weights	.494	.244	.170	.029	.097	.009	−.023	.001	.094	.009	.292	.708
Similarities	.701	.491	−.044	.002	**.437**	**.191**	.031	.001	.056	.003	.689	.311
Vocabulary	.661	.437	.071	.005	**.398**	**.158**	−.039	.002	−.107	.011	.613	.387
Coding	.586	.343	−.021	.000	−.019	.000	**.516**	**.266**	−.039	.002	.612	.388
Symbol Search	.617	.381	.035	.001	.019	.000	**.375**	**.141**	.049	.002	.525	.475
Picture Span	.264	.070	−.029	.001	−.028	.001	−.012	.000	**.656**	**.430**	.502	.498
Digit Span	.536	.287	.091	.008	.088	.008	.029	.001	**.328**	**.108**	.411	.589
Total variance		.351		.039		.037		.042		.063	.532	.468
ECV		.660		.073		.069		.079		.118		
Model-based reliability	$\omega_H = .785$		$\omega_{HS} = .168$		$\omega_{HS} = .191$		$\omega_{HS} = .255$		$\omega_{HS} = .357$			

Bold type indicates salient loading ($b \geq .30$). Italic type indicates coefficient and variance estimate alignment ($.20 \leq b < .30$)*PR* Perceptual Reasoning, *VC* Verbal Comprehension, *PS* Processing Speed, *WM* Working Memory, *b* loading of subtest on factor, S^2 variance explained, h^2 communality, u^2 uniqueness, ω_H omega-hierarchical, ω_{HS} omega-hierarchical subscale, *ECV* Explained Common Variance

Table 3 Sources of variance in the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V) for the standardization sample 9–11 years old (N = 600) according to a SL orthogonalization model with four first-order factors

	General		F1: Perceptual Reasoning		F2: Verbal Comprehension		F3: Processing Speed		F4: Working Memory			
WISC-V subtest	b	S^2	b	S^2	b	S^2	b	S^2	b	S^2	h^2	u^2
Figure Weights	.601	.361	**.367**	**.135**	−.004	.000	−.068	.005	−.024	.001	.501	.499
Block Design	.683	.466	**.367**	**.135**	−.022	.000	.068	.005	−.037	.001	.608	.392
Visual Puzzles	.634	.402	**.335**	**.112**	.046	.002	−.033	.001	−.019	.000	.517	.483
Matrix Reasoning	.508	.258	*.254*	*.065*	−.020	.000	.052	.003	.035	.001	.327	.673
Similarities	.680	.462	−.023	.001	**.608**	**.370**	.014	.000	−.040	.002	.834	.166
Vocabulary	.681	.464	.093	.009	**.401**	**.161**	−.013	.000	.057	.003	.637	.363
Symbol Search	.495	.245	−.004	.000	.018	.000	**.599**	**.359**	−.029	.001	.605	.395
Coding	.490	.240	.002	.000	−.012	.000	**.584**	**.341**	.026	.001	.582	.418
Picture Span	.465	.216	−.023	.001	−.015	.000	−.007	.000	**.837**	**.701**	.918	.082
Digit Span	.525	.276	.144	.021	.044	.002	.026	.001	*.292*	*.085*	.385	.615
Total variance		.339		.048		.054		.071		.080	.591	.409
ECV		.573		.081		.091		.121		.135		
Model-based reliability	ω_H = .776		ω_{HS} = .180		ω_{HS} = .298		ω_{HS} = .439		ω_{HS} = .428			

Bold type indicates salient loading ($b \geq .30$). Italic type indicates coefficient and variance estimate alignment ($.20 \leq b < .30$)

PR Perceptual Reasoning, *VC* Verbal Comprehension, *PS* Processing Speed, *WM* Working Memory, b loading of subtest on factor, S^2 variance explained, h^2 communality, u^2 uniqueness, ω_H omega-hierarchical, ω_{HS} omega-hierarchical subscale, *ECV* Explained Common Variance

Ages 12–14 First-Order EFA: Four Factor Extraction Table B3 (Appendix B in online supplement or from first author) presents results of four factor extraction with promax rotation. The g loadings ranged from .500 (Coding) to .773 (Vocabulary) and all were within the fair to good range. Table B3 illustrates robust Perceptual Reasoning (Visual Puzzles, Block Design, Matrix Reasoning and Figure Weights), Verbal Comprehension (Similarities, Vocabulary), Processing Speed (Coding, Symbol Search) and Working Memory (Digit Span, Picture Span) factors with theoretically consistent subtest loadings with the prior WISC-IV theoretical structure. The moderate to high factor correlations presented in Table B3 (.341 to .734) imply a higher-order or hierarchical structure that required explication (Gorsuch 1983) and the Schmid–Leiman procedure was applied to better understand variance apportionment among general and group factors.

Ages 12–14 SL Analyses: Four First-Order Factors Results for the Schmid and Leiman orthogonalization of the higher-order factor analysis are presented in Table 3. All subtests were properly associated (higher residual variance) with their theoretically proposed factor after removing g variance. The hierarchical g factor accounted for 40.6% of the total variance and 65.3% of the common variance.

The general factor also accounted for between 15.7% (Coding) and 55.3% (Vocabulary) of individual subtest variability. At the first-order level, PR accounted for an additional 3.8% of the total variance and 6.1% of the common variance, VC accounted for an additional 3.7% of the total variance and 6.0% of the common variance, PS accounted for an additional 4.0% of the total variance and 6.5% of the common variance, and WM accounted for an additional 10.0% of the total variance and 16.0% of the common variance. The general and group factors combined to measure 62.1% of the variance in WISC-V scores resulting in 37.9% unique variance (combination of specific and error variance).

Omega-hierarchical and omega-hierarchical subscale coefficients were estimated based on the SL results in Table 4. The ω_H coefficient for general intelligence (.814) was high and sufficient for scale interpretation; however, the ω_{HS} coefficients for four group factors (VC, WM, PR, PS) were considerably lower (.149–.503, .173–.503). Thus, the four group factors, with the possible exception of PS, likely possess too little unique true score variance for clinical interpretation (Reise 2012; Reise et al. 2013) for 12–14 years old.

Ages 15–16 First-Order EFA: Four Factor Extraction Table B4 (Appendix B in online supplement) presents results of four-factor extraction with promax rotation. The g loadings ranged from .426 (Coding) to .788 (Vocabulary) and all were within the fair to good range (except Coding and Symbol Search). Table B4 illustrates robust Perceptual Reasoning (Visual Puzzles, Block Design, Matrix Reasoning and Figure Weights), Verbal Comprehension (Similarities, Vocabulary), Processing Speed (Coding, Symbol Search), and Working Memory (Digit Span, Picture Span) factors with theoretically consistent subtest loadings with the prior WISC-

Table 4 Sources of variance in the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V) for the standardization sample 12–14 years old (N = 600) according to a SL orthogonalization model with four first-order factors

	General		F1: Perceptual Reasoning		F2: Verbal Comprehension		F3: Working Memory		F4: Processing Speed			
WISC-V subtest	b	S^2	b	S^2	b	S^2	b	S^2	B	S^2	h^2	u^2
Visual Puzzles	.709	.503	**.407**	**.166**	.003	.000	−.029	.001	−.036	.001	.671	.329
Block Design	.677	.458	**.369**	**.136**	−.012	.000	−.026	.001	.081	.007	.602	.398
Figure Weights	.687	.472	.192	.037	.080	.006	.144	.021	−.043	.002	.538	.462
Matrix Reasoning	.632	.399	.151	.023	.089	.008	.129	.017	.012	.000	.448	.552
Vocabulary	.750	.563	−.015	.000	**.499**	**.249**	−.033	.001	.016	.000	.813	.187
Similarities	.729	.531	.059	.003	**.330**	**.109**	.056	.003	-.016	.000	.648	.352
Digit Span	.657	.432	−.050	.003	.023	.001	**.463**	**.214**	.025	.001	.649	.351
Picture Span	.586	.343	.035	.001	−.034	.001	**.380**	**.144**	.003	.000	.490	.510
Coding	.396	.157	−.033	.001	.015	.000	−.016	.000	**.873**	**.762**	.921	.079
Symbol Search	.444	.197	.082	.007	−.020	.000	.049	.002	**.473**	**.224**	.431	.569
Total variance		.406		.038		.037		.040		.010	.621	.379
ECV		.653		.061		.060		.065		.160		
	ω_H = .814		ω_{HS} = .121		ω_{HS} = .201		ω_{HS} = .308		ω_{HS} = .570			

Bold type indicates salient loading ($b \geq .30$). Italic type indicates coefficient and variance estimate alignment ($.20 \leq b < .30$)

PR Perceptual Reasoning, *VC* Verbal Comprehension, *PS* Processing Speed, *WM* Working Memory, b loading of subtest on factor, S^2 variance explained, h^2 communality, u^2 uniqueness, ω_H omega-hierarchical, ω_{HS} omega-hierarchical subscale, *ECV* Explained Common Variance

IV theoretical structure. The moderate to high factor correlations presented in Table B4 (.290 to .750) imply a higher-order or hierarchical structure that required explication (Gorsuch 1983) and the Schmid–Leiman procedure was applied to better understand variance apportionment among general and group factors.

Ages 15–16 SL Analyses: Four First-Order Factors

Results for the Schmid and Leiman orthogonalization of the higher-order factor analysis are presented in Table 5. All subtests were properly associated (higher residual variance) with their theoretically proposed factor after removing *g* variance. However, the loadings for Figure Weights and Matrix Reasoning were below the threshold of salience. The hierarchical *g* factor accounted for 38.7% of the total variance and 63.2% of the common variance.

The general factor also accounted for between 15.0% (Digit Span) and 57.0% (Block Design) of individual subtest variability. At the first-order level, PR accounted for an additional 4.1% of the total variance and 6.8% of the common variance, VC accounted for an additional 4.6% of the total variance and 7.8% of the common variance, PS accounted for an additional 4.8% of the total variance and 7.3% of the common variance, and WM accounted for an additional 9.4% of the total variance and 15.3% of the common variance. The general and group factors combined to measure 61.3% of the variance in WISC-V scores resulting in 38.7% unique variance (combination of specific and error variance).

Omega-hierarchical and omega-hierarchical subscale coefficients were estimated based on the SL results in Table 5. The ω_H coefficient for general intelligence (.811) was high and sufficient for scale interpretation; however, the ω_{HS} coefficients for the four group factors (VC, WM, PR, PS) were considerably lower (.145–.524). Thus, the four group factors, with the possible exception of WM, likely possess too little true score variance for clinical interpretation (Reise 2012; Reise et al. 2013) for the 15–16-year-old age group. As noted previously, the five-factor solution appears superior at ages 15 to 16 for the 10 WISC-V primary subtests (see Table 5).

One, Two, and Three Factors

Examination of fewer than four factors resulted in structures that were not consistent with previous versions of the WISC or other Wechsler scales. One-, two-, and three-factor models fused theoretically meaningful constructs indicative of underextraction and were complexly determined confounding meaningful clinical interpretation. They were subsequently judged unsatisfactory (Gorsuch 1983).

Discussion

The WISC-V *Technical and Interpretive Manual* included minimal analyses of the 10-primary subtest structure incorporating only a higher-order CFA with five group factors and no comparison with competing models including the model based on the four-factor WISC-IV model or three-, two-, and one-factor models (higher order, bifactor, oblique). While the 16-subtest WISC-V structure was investigated in the

Table 5 Sources of variance in the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V) for the standardization sample 15–16 years old (N = 400) according to a SL orthogonalization model with four first-order factors

	General		F1: Perceptual Reasoning		F2: Verbal Comprehension		F3: Processing Speed		F4: Working Memory			
WISC-V subtest	b	S^2	b	S^2	b	S^2	b	S^2	b	S^2	h^2	u^2
Block Design	.754	.569	**.407**	**.166**	−.042	.002	.064	.004	−.015	.000	.740	.260
Visual Puzzles	.715	.511	**.398**	**.158**	.016	.000	−.002	.000	−.055	.003	.673	.327
Figure Weights	.549	.301	*.219*	*.048*	.133	.018	-.074	.005	.112	.013	.385	.615
Matrix Reasoning	.546	.298	.175	.031	.110	.012	−.011	.000	.167	.028	.368	.632
Similarities	.723	.523	−.024	.001	**.500**	**.250**	.047	.002	−.029	.001	.777	.223
Vocabulary	.723	.523	.101	.010	**.403**	**.162**	−.031	.001	.003	.000	.696	.304
Symbol Search	.701	.491	.022	.000	−.007	.000	**.514**	**.264**	−.008	.000	.756	.244
Coding	.571	.326	−.014	.000	.028	.001	**.409**	**.167**	.036	.001	.496	.504
Digit Span	.383	.147	.003	.000	−.042	.002	.000	.000	**.856**	**.733**	.881	.119
Picture Span	.427	.182	−.005	.000	.120	.014	.045	.002	**.400**	**.160**	.358	.642
Total variance		.387		.041		.046		.048		.094	.613	.387
ECV		.632		.068		.078		.073		.153		
	ω_H = .811		ω_{HS} = .145		ω_{HS} = .236		ω_{HS} = .264		ω_{HS} = .524			

Bold type indicates salient loading ($b \geq .30$). Italic type indicates coefficient and variance estimate alignment ($.20 \leq b < .30$)

PR Perceptual Reasoning, *VC* Verbal Comprehension, *PS* Processing Speed, *WM* Working Memory, b loading of subtest on factor, S^2 variance explained, h^2 communality, u^2 uniqueness, ω_H omega-hierarchical, ω_{HS} omega-hierarchical subscale, *ECV* Explained Common Variance

Technical and Interpretive Manual through CFA, independent reviews and peer reviewed research criticized the analyses as they were deemed either incomplete or potentially inappropriate (Beaujean 2016; Canivez and Watkins 2016; Canivez et al. 2015, 2016a, b; Dombrowski et al. 2015).

Because of these substantial criticisms and considering the paucity of analyses undertaken on the 10-subtest battery, which is likely the main battery administered by clinicians and researchers alike, the present study investigated the 10 WISC-V primary subtest structure across four different age ranges (6–8, 9–11, 12–14, 15–16) using principal axis factoring with an oblique (promax) rotation followed by the Schmid–Leiman transformation. This investigation enabled not only a test of the consistency of the structure with that proposed by the test publisher but also an examination of the stability of the 10 WISC-V primary subtest structure across much of the developmental period. These age group analyses were not included in the *Technical and Interpretive Manual* for either the 10 or 16 WISC-V subtest configurations and can provide important information. If the structure is consistent across all four developmental ages analyzed, then greater confidence may be engendered when interpreting the instrument.

The results of this study provided evidence for the test publisher's five-factor structure only for the 15–16-year-old age group. All 10 primary subtests saliently loaded on their theoretically proposed factors (VS, VC, PS, WM, FR). However, there was no such evidence for the publisher's proposed five-factor structure for the other three age ranges (6–8, 9–11, 12–14). Five-factor extractions resulted in either a trivial fourth (ages 6–8) and/or trivial fifth (ages 6–8, 9–11, 12–14) factor that consisted of single subtest loadings. This is psychometrically impermissible. The results of this study across ages 6 to 14 are more consistent with the previous WISC-IV four-factor theoretical structure that comprised Working Memory, Verbal Comprehension, Processing Speed, and Perceptual Reasoning factors (i.e., fusing of fluid reasoning and visual spatial). For three of the age groups, the Verbal Comprehension subtests (Similarities, Vocabulary), Working Memory subtests (Digit Span, Picture Span), Perceptual Reasoning subtests (Block Design, Visual Puzzles, Matrix Reasoning, Figure Weights), and Processing Speed subtests (Coding, Symbol Search) were consistently associated with the theoretical constructs previously posited in Wechsler Scales (i.e., WISC-IV, WAIS-IV, WPPSI-IV) despite changes in subtest content. The subtests *thought to* represent separate Visual Spatial (Block Design and Visual Puzzles) and Fluid Reasoning (Matrix Reasoning and Figure Weights) factors merged together for all but the 15–16-year-old age group and appear to represent the former Perceptual Reasoning factor present in the WISC-IV and WAIS-IV. The finding of a separate perceptual reasoning factor at ages 6 to 14 is consistent with the results from Canivez et al. (2015) and Dombrowski et al. (2015) who investigated the 16-subtest battery across the entire age range without looking at differences in structure at different age ranges. The present study's results failed to support the publisher's creation of separate Visual Spatial and Fluid Reasoning factors and standardized factor index scores that represent them outside of the 15–16 age group for the 10-subtest battery. For the 15–16-year-old age group, the separation of the Perceptual

Reasoning factor into Visual Spatial and Fluid Reasoning factors appears empirically justified. This finding deserves further study. Perhaps it is related to Cattell's (1987) notion of age differentiation where individuals begin life with a single general ability that differentiates into separate abilities through contact with the environment?

When extracting the *g* variance through the Schmid–Leiman procedure for the four-factor solution the PR factor was diluted slightly as either Figure Weights or Matrix Reasoning no longer saliently loaded on the PR factor (but still remained aligned with it). Across all four age groups, the WISC-V *g* factor accounted for five to six times more variance than any single group factor and approximately twice the variance of all four group factors combined. Omega-hierarchical coefficients for the *g* factor in all four age groups (.776–.835) were uniformly high and indicated large portions of true score variance. Omega-hierarchical subscale coefficients for the four group factors in all four age groups were considerably lower and ranged from .121 to .570 for the VC, PR, PS, and WM factors. Many of these estimates fell far below the minimum threshold (.50) suggested by Reise (2012) and Reise et al. (2013) for confident clinical interpretation due to capturing too little unique true score variance once *g* variance was removed. Only the 12–14-year-old group (PS) and the 15–16 age group (WM) obtained a ω_{HS} coefficient that exceeded the minimum standard for possible interpretation. The finding of higher ω_{HS} coefficients for the PS factor is consistent with prior research (Canivez et al. 2016a, b; Dombrowski 2013; Dombrowski et al. 2016) and may suggest a specific, interpretable ability relatively distinct from general cognitive ability. However, this result did not consistently emerge. The finding of a higher ω_{HS} coefficient for the WM factor at ages 15–16 is inexplicable and was not consistently found at other age ranges. Perhaps this finding is developmental in nature and related to the continued development of working memory through late adolescence (Luciana et al. 2005).

The pervasive influence of general intelligence observed in all four age groups, whether four or five factors were extracted, is similar to other studies of Wechsler scales using both EFA and CFA methods (Bodin et al. 2009; Canivez 2014b; Canivez and Watkins 2010a, 2010b; Canivez et al. 2016a, b; Gignac and Watkins 2013; Nelson et al. 2013; Watkins 2006, 2010; Watkins and Beaujean 2014; Watkins et al. 2013; Watkins et al. 2006) and other intelligence tests (Canivez 2008; Canivez et al. 2009; Canivez and McGill 2016; DiStefano and Dombrowski 2006; Dombrowski, 2013, 2014a, 2014b; Dombrowski and Watkins 2013; Dombrowski et al. 2009; Nelson and Canivez 2012; Nelson et al. 2007). These results are also consistent with the broader professional literature on the importance of general intelligence (Deary 2013; Jensen 1998; Lubinski 2000; Ree et al. 2003).

As Frazier and Youngstrom (2007) might predict, too little true score variance was associated with the four group factors, with the possible exception of PS at ages 12–14 and WM at ages 15–16, to warrant confident clinical interpretation (Reise 2012; Reise et al. 2013). Most of the WISC-V variance was contributed by a broad general factor so the WISC-V general factor is of definite interest (Gorsuch 1983) but the group factors are likely of little interest (Wolff and Preising 2005).

Conclusions

Researchers and clinicians must rely on more than test technical manuals in order to use test scores appropriately (Dombrowski 2015). Ultimately, clinicians bear "…responsibility for appropriate test use and interpretation" (AERA, APA, and NCME 2014, p. 141). It is recognized, however, that most psychologists may not have the capacity to independently review an instrument's technical manual. Thus, studies such as this one will assist users of the WISC-V to understand the structure and therefore appropriately interpret the WISC-V 10-primary subtest battery (Weiner 1989).

Results from this study provide important considerations for clinical interpretation of basic scores from the WISC-V. The results of analyses across all four age groups (ages 6–8, 9–11, 12–14, 15–16) support interpretation of the hierarchical general intelligence estimate (FSIQ). The results also support the test publisher's posited five-factor structure at ages 15–16, but did not support the five-factor structure for any of the other age range. Instead, a four-factor structure reminiscent of the WISC-IV seems more tenable with the caveat that following the SL transformation either Figure Weights or Matrix Reasoning failed to saliently load, but still aligned with the Perceptual Reasoning factor. The overfactoring of the WISC-V in the WISC-V *Technical and Interpretive Manual* may possibly result in misinterpretation and errors in clinical decision-making for ages 6 to 14 should clinicians and researchers rely upon the proposed interpretative approach recommended in the manual (Beaujean 2015b).

Overall, primary interpretive emphasis of the WISC-V should be placed upon the FSIQ with only secondary consideration given to the four index score areas for ages 6–14 and five index areas for ages 15–16. The evidence from this study suggests that there is an insufficient amount of residual variance in group factors once the general factor is accounted for to confidently recommend anything other than secondary, yet extremely cautious, interpretive emphasis with the WISC-V index scores (e.g., four index scores at ages 6 to 14 and five at ages 15 to 16). It is important to be mindful of a rigid, dogmatic (i.e., Dombrowski et al. 2007) stance, and consider that when multiple methods of factor analysis converge then greater confidence may be engendered in the structure of an instrument. Ultimately, when considering how to interpret the

WISC-V, it will be useful to consider the extant WISC-V peer-reviewed factor analytic literature, including this study, within a preponderance of the evidence framework (Dombrowski 2015). This will permit interpretation of the WISC-V based upon empirical rather than intuitive grounds.

Compliance with Ethical Standards

Conflict of Interest Stefan Dombrowski, Gary Canivez, and Marley Watkins declare that they have no conflict of interest.

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

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Appendix A

Supplemental Tables

Tables A1–A7 are exploratory factor analyses results (odd numbered tables) extracting five factors and subsequent Schmid and Leiman (1957) exploratory Schmid-Leiman (SL) bifactor models (orthogonalized higher-order factor models) with five first–order factors (even numbered tables) for the 10 subtest, four WISC–V age groups (6–8, 9–11, 12–14, 15–16) from standardization sample correlation matrices (Wechsler, 2014c). The SL bifactor model for the 15-16 year–old group is presented in the article due to acceptable results.

Table A1

Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) Exploratory Factor Analysis: Five Oblique Factor Solution for the Standardization Sample 6–8 Year Olds (N = 600)

WISC-V Subtest	*g*	F1: Perceptual Reasoning	F2: Verbal Comprehension	F3: Processing Speed	F4: Working Memory	F5: ?	h^2
Block Design	.651	**.810 (.723)**	.026 (.504)	.092 (.396)	-.108 (.427)	-.101 (.499)	.539
Visual Puzzles	.692	**.840 (.759)**	.001 (.562)	-.111 (.279)	.021 (.512)	.054 (.605)	.587
Matrix Reasoning	.723	**.435 (.707)**	.027 (.579)	.045 (.404)	.195 (.615)	.132 (.634)	.545
Vocabulary	.661	.102 (.573)	**.840 (.789)**	-.070 (.208)	-.099 (.442)	-.050 (.540)	.636
Similarities	.716	-.086 (.574)	**.765 (.798)**	.056 (.334)	.073 (.561)	.040 (.597)	.644
Coding	.390	-.024 (.290)	-.041 (.185)	**.846 (.785)**	-.042 (.294)	-.038 (.207)	.629
Symbol Search	.515	.041 (.419)	.030 (.335)	**.643 (.702)**	.026 (.411)	.044 (.360)	.506
Picture Span	.538	-.043 (.426)	-.039 (.412)	-.032 (.313)	**.855 (.732)**	-.080 (.431)	.547
Digit Span	.666	.152 (.590)	.183 (.578)	.068 (.384)	**.300 (.617)**	.095 (.573)	.461
Figure Weights	.588	.012 (.538)	.006 (.507)	-.009 (.248)	-.084 (.443)	**.761 (.714)**	.513
Eigenvalue		4.311	1.275	.809	.734	.655	
% Variance		43.108	12.755	8.092	7.344	6.546	
<u>Factor Correlations</u>							
Perceptual Reasoning		1.000					
Verbal Comprehension		.725	1.000				
Processing Speed		.474	.352	1.000			
Working Memory		.670	.644	.478	1.000		
F5		.765	.722	.380	.682	1.000	

Note. g = general structure coefficients based on first unrotated factor coefficients (*g* loadings), h^2 = Communality. 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 A2

Sources of Variance in the Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) for the Standardization Sample 6–8 Year Olds (N = 600) According to a SL Orthogonalization Model with Five First–Order Factors

WISC–V	General		F1: VS		F2: VC		F3: PS		F4: ?		F5: ?			
Subtest	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	h^2	u^2
Block Design	.675	.456	**.380**	**.144**	.013	.000	.054	.003	-.065	.004	-.087	.008	.615	.385
Visual Puzzles	.621	.386	**.354**	**.125**	.001	.000	-.065	.004	.013	.000	.047	.002	.518	.482
Matrix Reasoning	.666	.444	*.204*	*.042*	.014	.000	.026	.001	.117	.014	.114	.013	.513	.487
Vocabulary	.650	.423	.048	.002	**.431**	**.186**	-.041	.002	-.059	.003	-.043	.002	.618	.382
Similarities	.704	.496	-.040	.002	**.393**	**.154**	.033	.001	.044	.002	.035	.001	.656	.344
Coding	.577	.333	-.011	.000	-.021	.000	**.495**	**.245**	-.025	.001	-.033	.001	.580	.420
Symbol Search	.626	.392	.019	.000	.015	.000	**.376**	**.141**	.016	.000	.038	.001	.536	.464
Picture Span	.546	.298	-.020	.000	-.020	.000	-.019	.000	**.513**	**.263**	-.069	.005	.568	.432
Digit Span	.634	.402	.071	.005	.094	.009	.040	.002	.180	.032	.082	.007	.457	.543
Figure Weights	.323	.104	.006	.000	.003	.000	-.005	.000	-.050	.003	**.658**	**.433**	.540	.460
Total S^2		.373		.032		.035		.040		.032		.047	.560	.440
Common S^2		.666		.057		.063		.071		.058		.084		
	ω_H = .812		ω_{HS} = .141		ω_{HS} = .207		ω_{HS} = .249							

Note. VS = Visual Spatial, VC = Verbal Comprehension, PS = Processing Speed. *b* = loading of subtest on factor, S^2 = variance explained, h^2 = communality, u^2 = uniqueness. ω_H = Omega-hierarchical, ω_{HS} = Omega-hierarchical subscale. Bold type indicates salient loading ($b \geq .30$). Italic type indicates coefficient and variance estimate alignment ($.20 \leq b < .30$). Omega coefficients not estimated for F4 and F5.

Table A3

Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) Exploratory Factor Analysis: Five Oblique Factor Solution for the Standardization Sample 9–11 Year Olds (N = 600)

WISC-V Subtest	*g*	F1: Perceptual Reasoning	F2: Verbal Comprehension	F3: Processing Speed	F4: Working Memory	F5:?	h^2
Block Design	.719	**.863 (.791)**	-.068 (.527)	.091 (.402)	-.036 (.407)	-.062 (.511)	.637
Visual Puzzles	.673	**.729 (.734)**	.069 (.551)	-.042 (.283)	-.009 (.389)	-.030 (.486)	.542
Matrix Reasoning	.634	**.546 (.681)**	.045 (.507)	-.088 (.239)	-.019 (.363)	.220 (.579)	.495
Vocabulary	.733	-.054 (.606)	**.962 (.902)**	.023 (.326)	-.051 (.406)	-.008 (.441)	.818
Similarities	.746	.181 (.665)	**.641 (.797)**	-.014 (.325)	.073 (.483)	-.008 (.478)	.658
Coding	.486	.035 (.348)	-.023 (.283)	**.774 (.782)**	.032 (.343)	-.031 (.272)	.613
Symbol Search	.476	-.042 (.335)	.041 (.300)	**.751 (.301)**	-.033 (.301)	.060 (.307)	.575
Picture Span	.616	-.064 (.444)	-.025 (.415)	-.006 (.385)	**.975 (.925)**	.000 (.378)	.861
Digit Span	.602	.266 (.542)	.071 (.465)	.774 (.782)	**.372 (.572)**	.015 (.413)	.407
Figure Weights	.569	.067 (.539)	-.015 (.401)	.751 (.756)	.007 (.354)	**.673 (.728)**	.534
Eigenvalue		4.372	1.268	.877	.782	.639	
% Variance		43.724	12.678	8.772	7.822	6.391	
Factor Correlations							
Perceptual Reasoning		1.000					
Verbal Comprehension		.710	1.000				
Processing Speed		.432	.364	1.000			
Working Memory		.542	.500	.411	1.000		
F5		.686	.521	.358	.449	1.000	

Note. *g* = general structure coefficients based on first unrotated factor coefficients (*g* loadings), h^2 = Communality. 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 A4

Sources of Variance in the Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) for the Standardization Sample 9-11 Year Olds (N = 600) According to a SL Orthogonalization Model with Five First–Order Factors

WISC–V	General		F1: PR		F2: VC		F3: PS		F4: WM		F5: ?			
Subtest	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	h^2	u^2
Block Design	.740	.548	**.367**	**.135**	-.044	.002	.063	.004	-.027	.001	-.053	.003	.692	.308
Visual Puzzles	.661	.437	**.310**	**.096**	.045	.002	-.029	.001	-.007	.000	-.026	.001	.536	.464
Figure Weights	.565	.319	*.232*	*.054*	.029	.001	-.061	.004	-.015	.000	.189	.036	.414	.586
Similarities	.660	.436	-.023	.001	**.627**	**.393**	.016	.000	-.039	.002	-.007	.000	.831	.169
Vocabulary	.683	.466	.077	.006	**.418**	**.175**	-.010	.000	.056	.003	-.007	.000	.650	.350
Coding	.576	.332	.015	.000	-.015	.000	**.538**	**.289**	.024	.001	-.027	.001	.622	.378
Symbol Search	.542	.294	-.018	.000	.027	.001	**.522**	**.272**	-.025	.001	.052	.003	.571	.429
Picture Span	.549	.301	-.027	.001	-.016	.000	-.004	.000	**.744**	**.554**	.000	.000	.856	.144
Digit Span	.565	.319	.113	.013	.046	.002	.022	.000	*.284*	*.081*	.013	.000	.415	.585
Matrix Reasoning	.425	.181	.029	.001	-.010	.000	.026	.001	.005	.000	**.578**	**.334**	.517	.483
Total S^2		.363		.031		.058		.057		.064		.038	.610	.390
Common S^2		.595		.050		.094		.094		.105		.062		
		ω_H = .809		ω_{HS} = .135		ω_{HS} = .319		ω_{HS} = .353		ω_{HS} = .347				

Note. PR = Perceptual Reasoning, VC = Verbal Comprehension, PS = Processing Speed, WM = Working Memory. *b* = loading of subtest on factor, S^2 = variance explained, h^2 = communality, u^2 = uniqueness. ω_H = Omega-hierarchical, ω_{HS} = Omega-hierarchical subscale. Bold type indicates salient loading ($b \geq .30$). Italic type indicates coefficient and variance estimate alignment ($.20 \leq b < .30$). Omega coefficients not estimated for F5.

Table A5

Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) Exploratory Factor Analysis: Five Oblique Factor Solution for the Standardization Sample 12-14 Year Olds (N = 600)

WISC-V Subtest	*g*	F1: Verbal Comprehension	F2: Visual Spatial	F3: Working Memory	F4: Processing Speed	F5: ?	h^2
Vocabulary	.757	**.853 (.846)**	-.020 (.573)	-.038 (.609)	.015 (.356)	.043 (.572)	.717
Similarities	.764	**.825 (.841)**	.060 (.603)	.027 (.625)	-.023 (.350)	-.053 (.532)	.710
Matrix Reasoning	.661	.216 (.605)	.203 (.571)	.184 (.586)	.029 (.355)	.156 (.534)	.448
Block Design	.728	.019 (.572)	**.889 (.856)**	.023 (.544)	.028 (.431)	-.132 (.402)	.743
Visual Puzzles	.724	.028 (.610)	**.609 (.765)**	-.056 (.551)	-.018 (.344)	**.322 (.643)**	.654
Picture Span	.637	-.070 (.516)	.054 (.487)	**.787 (.740)**	-.035 (.364)	-.021 (.445)	.550
Digit Span	.699	.139 (.618)	-.083 (.491)	**.659 (.765)**	.061 (.434)	.040 (.514)	.597
Coding	.468	.026 (.304)	-.026 (.337)	.037 (.392)	**.808 (.796)**	-.109 (.146)	.641
Symbol Search	.527	-.036 (.356)	.045 (.411)	-.045 (.421)	**.734 (.754)**	.132 (.313)	.582
Figure Weights	.716	.152 (.645)	.260 (.634)	.751 (.756)	-.030 (.341)	.263 (.632)	.553
Eigenvalue		4.925	1.209	.768	.644	.535	
% Variance		49.247	12.088	7.677	6.445	5.350	
Factor Correlations							
Verbal Comprehension		1.000					
Visual Spatial		.687	1.000				
Working Memory		.733	.646	1.000			
Processing Speed		.420	.472	.520	1.000		
F5		.656	.562	.624	.283	1.000	

Note. *g* = general structure coefficients based on first unrotated factor coefficients (*g* loadings), h^2 = Communality. 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 A6

Sources of Variance in the Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) for the Standardization Sample 12-14 Year Olds (N = 600) According to a SL Orthogonalization Model with Five First–Order Factors

WISC–V	General		F1: VC		F2: VS		F3: WM		F4: PS		F5: ?			
Subtest	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	*b*	S^2	h^2	u^2
Vocabulary	.724	.524	**.428**	**.183**	-.010	.000	-.023	.001	.011	.000	.036	.001	.709	.291
Similarities	.742	.551	**.414**	**.171**	.030	.001	.017	.000	-.016	.000	-.045	.002	.726	.274
Matrix Reasoning	.611	.373	.108	.012	.102	.010	.113	.013	.020	.000	.132	.017	.426	.574
Block Design	.753	.567	.010	.000	**.448**	**.201**	.014	.000	.020	.000	-.112	.013	.780	.220
Visual Puzzles	.664	.441	.014	.000	**.307**	**.094**	-.034	.001	-.013	.000	*.273*	*.075*	.611	.389
Picture Span	.573	.328	-.035	.001	.027	.001	**.481**	**.231**	-.025	.001	-.018	.000	.563	.437
Digit Span	.634	.402	.070	.005	-.042	.002	**.403**	**.162**	.043	.002	.034	.001	.574	.426
Coding	.545	.297	.013	.000	-.013	.000	.023	.001	**.570**	**.325**	-.092	.008	.631	.369
Symbol Search	.562	.316	-.018	.000	.023	.001	-.028	.001	**.518**	**.268**	.112	.013	.598	.402
Figure Weights	.640	.410	.076	.006	.131	.017	.128	.016	-.021	.000	*.223*	*.050*	.499	.501
Total S^2		.421		.038		.033		.043		.060		.018	.612	.388
Common S^2		.688		.062		.053		.070		.098		.029		
		ω_H = .848		ω_{HS} = .207		ω_{HS} = .174		ω_{HS} = .251		ω_{HS} = .370				

Note. VC = Verbal Comprehension, VS = Visual Spatial, WM = Working Memory, PS = Processing Speed. *b* = loading of subtest on factor, S^2 = variance explained, h^2 = communality, u^2 = uniqueness. ω_H = Omega-hierarchical, ω_{HS} = Omega-hierarchical subscale. Bold type indicates salient loading ($b \geq .30$). Italic type indicates coefficient and variance estimate alignment ($.20 \leq b < .30$). Omega coefficient not estimated for F5.

Table A7

Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) Exploratory Factor Analysis: Five Oblique Factor Solution for the Standardization Sample 15-16 Year Olds (N = 400)

WISC-V Subtest	*g*	F1: Visual Spatial	F2: Verbal Comprehension	F3: Processing Speed	F4: Working Memory	F5: Fluid Reasoning	h^2
Visual Puzzles	.754	**.922 (.881)**	.022 (.603)	-.054 (.341)	-.007 (.520)	-.040 (.598)	.717
Block Design	.748	**.575 (.771)**	-.007 (.575)	.136 (.454)	-.006 (.552)	*.207* (*.647*)	.710
Similarities	.747	-.047 (.572)	**.864 (.853)**	.062 (.323)	.019 (.585)	-.016 (.604)	.448
Vocabulary	.786	.146 (.669)	**.648 (.838)**	-.060 (.271)	-.041 (.610)	.114 (.688)	.743
Coding	.437	-.123 (.294)	.033 (.245)	**.819 (.779)**	-.069 (.360)	.110 (.280)	.654
Symbol Search	.482	.144 (.399)	-.014 (.264)	**.740 (.785)**	.078 (.420)	-.155 (.242)	.550
Digit Span	.708	-.022 (.519)	-.071 (.541)	.023 (.415)	**.722 (.805)**	.193 (.628)	.597
Picture Span	.602	.006 (.437)	.119 (.509)	-.017 (.338)	**.707 (.706)**	-.111 (.456)	.641
Figure Weights	.669	.165 (.595)	.132 (.601)	-.070 (.226)	.004 (.517)	**.526 (.714)**	.582
Matrix Reasoning	.655	.093 (.553)	.084 (.559)	.030 (.304)	.085 (.543)	**.482 (.676)**	.553
Eigenvalue		4.823	1.328	.803	.597	.586	
% Variance		48.226	13.285	8.028	5.970	5.859	
<u>Factor Correlations</u>							
Visual Spatial		1.000					
Verbal Comprehension		.685	1.000				
Processing Speed		.439	.322	1.000			
Working Memory		.615	.666	.497	1.000		
Fluid Reasoning		.700	.716	.341	.683	1.000	

Note. g = general structure coefficients based on first unrotated factor coefficients (*g* loadings), h^2 = Communality. Factor pattern coefficients (structure coefficients) based on principal factors extraction with promax rotation ($k = 4$). Salient pattern coefficients presented in bold (pattern coefficient ≥ .30).

Appendix B

Tables B1-B4 are exploratory factor analyses results extracting four factors for the 10 subtest, four WISC–V age groups (6–8, 9–11, 12–14, 15–16) from standardization sample correlation matrices (Wechsler, 2014c). Schmid and Leiman (1957) exploratory bifactor models (orthogonalized higher-order factor models) with four first–order factors for the four WISC–V standardization sample age groups (6–8, 9–11, 12–14, 15–16) from standardization sample correlation matrices (Wechsler, 2014c) are presented in the article.

Table B1

Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) Exploratory Factor Analysis: Four Oblique Factor Solution for the Standardization Sample 6–8 Year Olds (N = 600)

	General[1]	F1: Perceptual Reasoning		F2: Verbal Comprehension		F3: Processing Speed		F4: Working Memory		
WISC–V Subtest	*S*	*P*	*S*	*P*	*S*	*P*	*S*	*P*	*S*	h^2
Visual Puzzles	.697	**.836**	.772	-.022	.554	-.097	.265	-.007	.530	.605
Block Design	.647	**.741**	.697	.018	.495	.124	.385	-.156	.445	.504
Matrix Reasoning	.726	**.509**	.719	.022	.577	.036	.389	.250	.646	.554
Figure Weights	.562	**.357**	.552	.184	.507	-.038	.234	.108	.470	.332
Similarities	.726	-.092	.587	**.833**	.827	.051	.318	.065	.591	.689
Vocabulary	.655	.148	.585	**.757**	.759	-.065	.194	-.123	.467	.591
Coding	.394	-.043	.277	-.037	.184	**.852**	.799	-.045	.306	.349
Symbol Search	.515	.073	.417	.037	.335	**.619**	.691	.057	.430	.495
Picture Span	.526	-.060	.434	-.054	.412	-.019	.299	**.757**	.669	.453
Digit Span	.670	.190	.603	.167	.579	.048	.369	**.378**	.650	.475
Eigenvalue		4.31		1.28		0.81		0.73		
% Variance		43.11		12.76		8.81		7.34		
Promax Based Factor Correlations		F1: PR		F2: VC		F3: PS		F4: WM		
F1: Perceptual Reasoning (PR)		–								
F2: Verbal Comprehension (VC)		.732		–						
F3: Processing Speed (PS)		.445		.333		–				
F4: Working Memory (WM)		.715		.681		.478		–		

Note. [1]Factor structure coefficients from first unrotated factor (*g* loadings) are correlations between the subtest and the general factor. *S* = Structure Coefficient, *P* = Pattern Coefficient, h^2 = Communality. Salient pattern coefficients presented in bold (pattern coefficient ≥ .30).

Table B2

Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) Exploratory Factor Analysis: Four Oblique Factor Solution for the Standardization Sample 9–11 Year Olds (N = 600)

	General[1]	F1: Perceptual Reasoning		F2: Verbal Comprehension		F3: Processing Speed		F4: Working Memory		
WISC–V Subtest	*S*	*P*	*S*	*P*	*S*	*P*	*S*	*P*	*S*	h^2
Figure Weights	.637	**.770**	.711	-.006	.496	-.088	.249	-.028	.346	.514
Block Design	.712	**.770**	.762	-.035	.526	.089	.408	-.044	.388	.588
Visual Puzzles	.671	**.702**	.722	.073	.546	-.043	.294	-.023	.370	.526
Matrix Reasoning	.540	**.532**	.562	-.032	.392	.067	.314	.042	.339	.322
Similarities	.736	-.049	.614	**.955**	.904	.018	.335	-.047	.389	.821
Vocabulary	.747	.194	.671	**.630**	.794	-.017	.335	.067	.464	.657
Symbol Search	.480	-.008	.348	.029	.299	**.779**	.772	-.034	.293	.597
Coding	.484	.004	.352	-.019	.283	**.759**	.766	.031	.334	.588
Picture Span	.626	-.048	.462	-.023	.412	-.009	.365	**.991**	.950	.907
Digit Span	.603	**.302**	.551	.069	.461	.034	.338	**.346**	.554	.401
Eigenvalue		4.37		1.27		0.88		0.78		
% Variance		43.72		12.68		8.77		7.82		
Promax Based Factor Correlations		F1: PR		F2: VC		F3: PS		F4: WM		
Perceptual Reasoning (PR)		–								
Verbal Comprehension (VC)		.712		–						
Processing Speed (PS)		.455		.375		–				
Working Memory (WM)		.535		.476		.409		–		

Note. [1]Factor structure coefficients from first unrotated factor (*g* loadings) are correlations between the subtest and the general factor. *S* = Structure Coefficient, *P* = Pattern Coefficient, h^2 = Communality. Salient pattern coefficients presented in bold (pattern coefficient ≥ .30).

Table B3

Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) Exploratory Factor Analysis: Four Oblique Factor Solution for the Standardization Sample 12–14 Year Olds (N = 600)

	General[1]	F1: Perceptual Reasoning		F2: Verbal Comprehension		F3: Working Memory		F4: Processing Speed		
WISC–V Subtest	*S*	*P*	*S*	*P*	*S*	*P*	*S*	*P*	*S*	h^2
Visual Puzzles	.725	**.868**	.818	.006	.591	-.052	.569	-.041	.285	.672
Block Design	.705	**.786**	.770	-.023	.550	-.048	.551	.092	.377	.601
Figure Weights	.713	**.408**	.693	.154	.630	.261	.652	-.048	.285	.536
Matrix Reasoning	.661	**.322**	.624	.172	.585	.234	.602	.013	.305	.446
Vocabulary	.773	-.031	.637	**.959**	.899	-.060	.634	.018	.306	.810
Similarities	.754	.126	.659	**.635**	.796	.101	.654	-.018	.295	.650
Digit Span	.709	-.107	.551	.045	.595	**.839**	.806	.028	.377	.655
Picture Span	.628	.075	.531	-.065	.499	**.688**	.696	.003	.320	.487
Coding	.500	-.070	.324	.029	.292	-.029	.383	**.986**	.954	.915
Symbol Search	.512	.175	.426	-.038	.339	.089	.429	**.534**	.631	.437
Eigenvalue		4.93		1.21		0.77		0.64		
% Variance		49.25		12.09		7.68		6.45		
Promax Based Factor Correlations		F1: PR		F2: VC		F3: WM		F4: PS		
F1: Perceptual Reasoning (PR)		–								
Verbal Comprehension (VC)		.734		–						
F3: Working Memory (WM)		.731		.738		–				
F4: Processing Speed (PS)		.400		.341		.449		–		

Note. [1]Factor structure coefficients from first unrotated factor (*g* loadings) are correlations between the subtest and the general factor. *S* = Structure Coefficient, *P* = Pattern Coefficient, h^2 = Communality. Salient pattern coefficients presented in bold (pattern coefficient ≥ .30).

Table B4

Wechsler Intelligence Scale for Children–Fifth Edition (WISC–V) Exploratory Factor Analysis: Four Oblique Factor Solution for the Standardization Sample 15–16 Year Olds (N = 400)

	General[1]	F1: Perceptual Reasoning		F2: Verbal Comprehension		F3: Processing Speed		F4: Working Memory		
WISC–V Subtest	*S*	*P*	*S*	*P*	*S*	*P*	*S*	*P*	*S*	h^2
Block Design	.757	**.843**	.822	-.073	.578	.105	.433	-.017	.529	.687
Visual Puzzles	.732	**.826**	.804	.028	.604	-.004	.326	-.062	.493	.649
Figure Weights	.661	**.454**	.660	.233	.622	-.122	.191	.126	.526	.487
Matrix Reasoning	.648	**.362**	.620	.192	.583	-.018	.270	.187	.543	.433
Similarities	.743	-.049	.620	**.876**	.840	.078	.298	-.033	.552	.711
Vocabulary	.788	.210	.718	**.705**	.849	-.052	.242	.003	.587	.738
Symbol Search	.495	.045	.389	-.012	.262	**.849**	.861	-.009	.372	.742
Coding	.426	-.029	.319	.049	.250	**.676**	.695	.040	.340	.487
Digit Span	.739	.007	.579	-.074	.571	.000	.388	**.961**	.916	.842
Picture Span	.590	-.011	.472	.210	.573	.075	.322	**.449**	.614	.405
Eigenvalue		4.82		1.33		0.80		0.59		
% Variance		48.23		13.29		8.03		5.97		
Promax Based Factor Correlations		F1: PR		F2: VC		F3: PS		F4: WM		
Perceptual Reasoning (PR)		–								
Verbal Comprehension (VC)		0.750		–						
Processing Speed (PS)		0.422		0.290		–				
Working Memory (WM)		0.653		0.666		.423		–		

Note. [1]Factor structure coefficients from first unrotated factor (*g* loadings) are correlations between the subtest and the general factor. *S* = Structure Coefficient, *P* = Pattern Coefficient, h^2 = Communality. Salient pattern coefficients presented in bold (pattern coefficient ≥ .30).