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WJ IV™ Scholastic Aptitude/Achievement Comparisons by Age

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The purpose of this Assessment Service Bulletin is to present WJ IV scholastic aptitude (SAPT) data for the following age groups: 6 to 8 years, 9 to 13 years, 14 to 19 years, 20 to 39 years, and 40 to 90+ years, based on the WJ IV standardization sample.

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WJ IV™ Scholastic Aptitude/Achievement Comparisons by Age

One of the major purposes of the *Woodcock-Johnson® IV* (WJ IV; Schrank, McGrew, & Mather, 2014a) is to provide information about a person's predicted aptitude in multiple areas of achievement, referred to as scholastic aptitude (SAPT), and comparisons to actual levels of achievement. Table 1-10 in the *Woodcock-Johnson IV Technical Manual* (McGrew, LaForte, & Schrank, 2014, p. 23) provides a matrix of tests from the *Woodcock-Johnson IV Tests of Cognitive Abilities–Standard and Extended Batteries* (WJ IV COG; Schrank, McGrew, & Mather, 2014b) that are predictive of the *Woodcock-Johnson IV Tests of Achievement* (WJ IV ACH; Schrank, Mather, & McGrew, 2014a) clusters. The WJ IV Technical Manual authors indicated that the SAPTs were generated for all age groups combined and for individual age groups; however, only the SAPTs for the combined age groups were reported (McGrew et al., 2014). As a consequence, the potential impact of development on predicted academic achievement and the implications for selective testing across the age span cannot be ascertained (e.g., McArdle, Ferrer-Caja, Hamagami, & Woodcock, 2002; Tucker-Drob, 2009). Given the impact of development on the prediction of academic achievement, clinicians may be interested in examining differences in the optimal cognitive predictors by age group. The purpose of this Assessment Service Bulletin is to present the SAPT data for the following age groups: 6 to 8 years, 9 to 13 years, 14 to 19 years, 20 to 39 years, and 40 to 90+ years.

Scholastic Aptitude Cluster Scores

According to the WJ IV Technical Manual, the SAPT clusters are "content-specific predictor scores developed for comparison to current achievement levels in reading, mathematics, and written language" (McGrew et al., 2014, p. 22). Aptitude clusters were developed from a series of stepwise multiple regression analyses completed across the entire normative sample. The four cognitive tests that were identified as most associated with each achievement area were then used to calculate the final clusters using the averages of the *W* scores from each of the tests. The WJ IV authors intentionally used only tests from the cognitive battery in the prediction models because not all WJ IV users would have necessarily purchased the additional WJ IV Tests of Oral Language (WJ IV OL; Schrank, Mather, & McGrew, 2014b). Table 1-10 in the WJ IV Technical Manual (McGrew et al., 2014) lists the cognitive tests used to derive the aptitude clusters for each achievement area.

When several groups of four WJ IV COG tests accounted for nearly equal amounts of variance in predicting an achievement area, McGrew et al. (2014) relied on knowledge of theory and prior experience of the constructs (e.g., with the *Woodcock-Johnson Psycho-Educational Battery–Revised* [WJ-R®; Woodcock & Johnson, 1989] and Woodcock-Johnson III [WJ III®; Woodcock, McGrew, & Mather, 2001]) to select the final SAPTs, rather than opting for the most statistically predictive approach (in most cases, the

differences were within 1 to 2 percentage points of variance accounted for anyway). The SAPTs did not include predictor tests in which the content overlapped with the achievement domain being predicted (for example, WJ IV COG Test 2: Number Series would not have been included in a model to predict a cluster that included WJ IV ACH Test 13: Number Matrices). Finally, McGrew et al. (2014) specified that the four tests in each SAPT needed to be from different Cattell-Horn-Carroll (CHC) domains because prior experience with the WJ III had shown that using differentially weighted tests by age and allowing more than one test from a particular CHC domain to be included resulted in SAPTs that were confusing to users. In many cases, one or two tests would often account for far too much variance under that model (for example, tests in the Comprehension-Knowledge [*Gc*] domain at higher grades).

McGrew et al. (2014) kept track, at each step, of predictor variables that did not enter as significant but were always very close to entering. In these cases, some other test typically just barely "beat it out," to the point where its contribution was no longer needed. McGrew (2012) refers to this technique as "keeping track of the bridesmaid tests"—those that were always close to entering, but something similar (often from the same broad domain) edged it out. Bridesmaid tests are important to keep track of as they are strong predictors that can be overlooked.

Disaggregating Predictive Effects Across the Age Span

The methods used in the WJ IV Technical Manual (McGrew et al., 2014) to predict SAPTs, as described above, were different from those used in preparing the results for the analyses presented in this Assessment Service Bulletin. To aid age-specific selective testing on the WJ IV, the predictive effects of cognitive tasks were disaggregated across the following age groups in the normative sample: 6 to 8, 9 to 13, 14 to 19, 20 to 39, and 40 to 90+ years. For each age group, the standard scores (M = 100, SD = 15) for the 18 tests that compose the WJ IV COG Standard and Extended Batteries, along with selected tests from the WJ IV OL, were used to predict the achievement clusters that most closely align with the eight specific learning disability (SLD) areas. Whereas the WJ IV Technical Manual reports that the SAPT clusters were derived from stepwise multiple regression with models constructed using a seven-test stopping rule to determine useful subsets of variables, and the test authors utilized a more "art+science" approach that took into consideration potential constraints on clinicians in the field (McGrew et al., 2014), we adopted a more parsimonious "data-driven" approach to construct our analyses.

Simultaneous multiple regression, with the specified scholastic achievement cluster serving as the dependent variable and the 25 cognitive and oral language tests serving as independent variables, was utilized to provide results that can be compared directly with similar research examining cognitive-achievement relations with the WJ III and WJ IV (e.g., Cormier, Bulut, McGrew, & Frison, 2016; Cormier, McGrew, Bulut, & Funamoto, in press; Evans, Floyd, McGrew, & Leforgee, 2001; Floyd, Evans, & McGrew, 2003).

The scholastic aptitude/achievement comparisons were calculated for the eight areas of SLDs identified by the Individuals with Disabilities Education Act (2004). On the WJ IV, the achievement and oral language clusters that most closely align with the eight SLD areas are Basic Reading Skills, Reading Comprehension, Math Calculation Skills, Math Problem Solving, Written Expression, Oral Expression, and Listening Comprehension.

Initial regression results were inspected to identify potential suppressor variables (i.e., variables with negligible correlations with the dependent variable and a large standardized regression coefficient). The standardized regression coefficients (also known as beta weights or β) obtained for each predictor test are reported in Tables 1 through 8. According to Pedhazur (1997), beta weights can be used to rank the order of a variable's contribution to a prediction equation. Accepted general rules (e.g., Cohen, 1988) for evaluating the significance of coefficients suggest that coefficients from +.10 to +.29 represent *moderate* effects and those +.30 and above are indicative of *strong* effects. The WJ IV COG and OL tests with the strongest coefficients for each criterion achievement cluster indicate the most optimal tasks for use in selective testing for that age group by assessment professionals in clinical practice.

As per Dawes, Faust, and Meehl (1993), secondary analyses were then conducted to evaluate the clinical significance of the most optimal variables identified in the initial regression results. This involved two steps. First, all of the cognitive and oral language indicators that accounted for moderate to strong effects were included in a sequential regression equation to predict the aforementioned achievement clusters. The squared multiple correlation (R^2), indicating the proportion of criterion variance accounted for by the predictor variables as a whole, is reported in Tables 1 through 8. Practical significance was assessed by interpreting R^2 as an effect size estimator, a procedure common in the cognitive assessment literature (e.g., Canivez, 2013; McGill, 2015; McGill & Busse, 2015). The guidelines for interpreting R^2 as an effect size found in Cohen (1988) are small = .01, medium = .09, and large = .25. Second, prediction equations were then constructed using only the two to three indicators with the highest beta weights in the initial analyses to provide an estimate of their potential effectiveness within a more parsimonious selective testing paradigm.

Scholastic Aptitude and Basic Reading Skills Comparison by Age Groups

Table 1 on page 4 presents the beta weights for the scholastic aptitude/basic reading skills (BRS) comparisons. COG Test 2: Number Series was the only WJ IV COG or WJ IV OL test that had a strong predictive relationship with BRS. Test 2: Number Series is an example of a *Gf* measure and a narrow ability of quantitative reasoning. McGrew (K. McGrew, personal communication, July 31, 2016) reported that Test 2: Number Series is the best single test predictor of academic achievement. This finding is certainly true across all age groups for the scholastic aptitude/BRS comparisons.

Table 1 also highlights some moderate predictive relationships between the WJ IV COG/WJ IV OL tests and BRS, specifically within the *Gc*, *Gwm*, and *Ga* domains and, to a lesser degree, in the *Gs* and *Gv* domains. The *Gc* tests OL Test 1: Picture Vocabulary, COG Test 1: Oral Vocabulary, and OL Test 2: Oral Comprehension all have a moderate predictive relationship with BRS, with the exception of COG Test 1: Oral Vocabulary for the 6- to 8-year-olds. These three tests measure the narrow abilities of lexical knowledge (VL), language development (LD), and listening ability (LS). COG Test 3: Verbal Attention, a measure of *Gwm*, was also a moderate predictor of BRS. The Verbal Attention test measures the narrow abilities of working memory (WM) and attentional control (AC). COG Test 14: Picture Recognition is classified by the CHC authors (Schrank, McGrew, & Mather, 2014b) as a measure of *Gv*-MV, but Miller (2013) argued that it is more likely a measure of visual memory (MV) within *Gwm*. COG Test 14: Picture Recognition has a moderate predictive relationship with BRS in only certain age groups.

COG Test 12: Nonword Repetition, a measure of *Ga*, also had a moderate predictive relationship with BRS. Test 12: Nonword Repetition measures the *Ga* narrow abilities of phonetic coding (PC) and memory for sound patterns (UM) in addition to a *Gwm* narrow ability of memory span (MS). OL Test 9: Sound Awareness and OL Test 7: Sound Blending are also measures of *Ga*-PC that predict BRS. It should be mentioned that OL Test 9: Sound Awareness is only intended to be used as a screener because it lacks sufficient ceiling items for some ages (Schrank, Mather, & McGrew, 2014b). These two tests could be used as alternatives to COG Test 12: Nonword Repetition in selective assessments for predicting BRS. COG Test 11: Number-Pattern Matching, a measure of *Gs*, was only a predictor of BRS for children ages 6 to 8 years.

According to the WJ IV Technical Manual (McGrew et al., 2014), the SAPT cluster for BRS includes COG Test 1: Oral Vocabulary (*Gc*-VL/LD), COG Test 3: Verbal Attention (*Gwm*-WM, AC), COG Test 5: Phonological Processing (*Ga*-PC/*Glr*-LA, FW), and COG Test 11: Number-Pattern Matching (*Gs*-P). As noted, the results of the current analyses indicted that COG Test 2: Numbers Series was the strongest predictor of BRS across all age groups. OL Test 1: Picture Vocabulary (*Gc*-VL/LD) and OL Test 2: Oral Comprehension (*Gc*-LS) were the second strongest predictors, varying by age group. The only test in these analyses that was consistent with SAPTs reported in the WJ IV Technical Manual for BRS was COG Test 1: Oral Vocabulary.

Table 1.
Scholastic Aptitude/Basic Reading Skills Comparison Beta Weights by Age Group

	Broad-Narrow Ability	Beta Weights by Age Group					
		6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years	All Ages
WJ IV Test							
COG 2: Number Series	*Gf*-RQ	0.410*	0.400*	0.404*	0.425*	0.412*	0.411*
OL 1: Picture Vocabulary	*Gc*-VL/LD	0.134	0.138	0.203*	0.162*	0.259*	0.180*
OL 2: Oral Comprehension	*Gc*-LS	0.152*	0.170*	0.167*	0.136	0.123	0.154*
COG 3: Verbal Attention	*Gwm*-WM, AC	0.128	0.148	0.139	0.133	0.175*	0.145
COG 1: Oral Vocabulary	*Gc*-VL/LD	0.078	0.131	0.151	0.125	0.112	0.121
COG 12: Nonword Repetition	*Ga*-PC/UM, *Glr*-MS	0.077	0.146	0.098	0.154*	0.100	0.119
OL 9: Sound Awareness	*Ga*-PC	0.126	0.115	0.080	0.063	0.121	0.094
COG 11: Number-Pattern Matching	*Gs*-P	0.142	0.098	0.087	0.084	0.076	0.091
COG 14: Picture Recognition	*Gv*-MV	0.093	0.076	0.100	0.083	0.114	0.091
OL 7: Sound Blending	*Ga*-PC	0.078	0.058	0.092	0.107	0.097	0.085
***R^2* Values**							
R^2 for all significant beta weights by age		0.669	0.576	0.564	0.606	0.664	0.594
R^2 for top 2 to 3 predictors by age[a]		0.606	0.502	0.540	0.572	0.622	0.563

Note. Beta weights greater than +.30 are highlighted in black (strong effects), and beta weights between +.10 and +.29 are highlighted in gray (moderate effects). R^2 values multiplied by 100 represent the proportion of reliable criterion variance accounted for by the independent variables.
[a]The indicators with the top two to three beta weights for each age group used in the regression analyses are designated by asterisks.

Scholastic Aptitude and Reading Comprehension Comparison by Age Groups

Table 2 presents the beta weights for the scholastic aptitude/reading comprehension (RC) comparisons. COG Test 2: Number Series had a strong predictive relationship with reading comprehension (RC), as it did with basic reading skills. Again, Test 2: Number

Series was the only WJ IV COG or OL test that had a strong predictive relationship with RC, and this was consistent across all age groups.

Table 2.
Scholastic Aptitude/ Reading Comprehension Comparison Beta Weights by Age Group

	Broad-Narrow Ability	Beta Weights by Age Group					
		6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years	All Ages
WJ IV Test							
COG 2: Number Series	*Gf*-RQ	0.304*	0.333*	0.304*	0.318*	0.329*	0.320*
COG 4: Letter-Pattern Matching	*Gs*-P	0.160	0.177*	0.217*	0.207*	0.193*	0.196*
COG 9: Concept Formation	*Gf*-I	0.182*	0.170*	0.212*	0.222*	0.191*	0.195*
COG 3: Verbal Attention	*Gwm*-WM, AC	0.162	0.115	0.174	0.141	0.169	0.151
COG 1: Oral Vocabulary	*Gc*-VL/LD	0.141	0.146	0.123	0.186	0.117	0.141
OL 8: Retrieval Fluency	*Glr*-FI, LA	0.087	0.144	0.116	0.171	0.182	0.139
OL 3: Segmentation	*Ga*-PC	0.141	0.102	0.156	0.121	0.139	0.129
COG 11: Number-Pattern Matching	*Gs*-P	0.177*	0.140	0.132	0.103	0.071	0.122
OL 1: Picture Vocabulary	*Gc*-VL/LD	0.105	0.063	0.136	0.114	0.132	0.109
OL 9: Sound Awareness	*Ga*-PC	0.130	0.119	0.085	0.094	0.107	0.103
COG 14: Picture Recognition	*Gv*-MV	0.102	0.074	0.063	0.051	0.055	0.065
***R^2* Values**							
R^2 for all significant beta weights by age		0.666	0.571	0.599	0.620	0.669	0.619
R^2 for top 2 to 3 predictors by age[a]		0.563	0.455	0.494	0.518	0.551	0.507

Note. Beta weights greater than +.30 are highlighted in black (strong effects), and beta weights between +.10 and +.29 are highlighted in gray (moderate effects). R^2 values multiplied by 100 represent the proportion of reliable criterion variance accounted for by the independent variables.
[a]The indicators with the top two to three beta weights for each age group used in the regression analyses are designated by asterisks.

Table 2 also highlights some moderate predictive relationships between the WJ IV COG/OL tests and RC, specifically within the *Gs*, *Gf*, *Gwm*, and *Gc* domains and, to a lesser degree, in the *Glr* and *Ga* domains. *Gs* tests had a predictive relationship with RC but not BRS. COG Test 4: Letter-Pattern Matching, a *Gs* measure, had a moderate predictive relationship with RC across all age groups. COG Test 11: Number-Pattern Matching, another *Gs* measure, had a moderate predictive relationship with RC for all age groups except the older adults, 40 to 90+ years. Both of these *Gs* tests measure the narrow ability of perceptual speed (P).

COG Test 9: Concept Formation, a measure of induction (I) within the broad CHC classification of fluid reasoning (*Gf*), also had a moderate predictive relationship with RC. COG Test 3: Verbal Attention, a measure of *Gwm*, was also a moderate predictor of RC. The Verbal Attention test measures the narrow abilities of working memory (WM) and attentional control (AC). The *Gc* tests OL Test 1: Picture Vocabulary and COG Test 1: Oral Vocabulary had moderate predictive relationships with RC. These two tests measure the narrow abilities of lexical knowledge (VL) and language development (LD). COG Test 1: Oral Vocabulary had a moderate predictive relationship with RC across all age groups, and OL Test 1: Picture Vocabulary had a moderate predictive relationship for all age groups except the 9- to 13-year-olds. *Ga* tests designed to measure phonetic coding (PC), OL Test 3: Segmentation and OL Test 9: Sound Awareness, also had moderate predictive relationships with RC. The influence of OL Test 3: Segmentation on RC was across all age groups, whereas the influence of OL Test 9: Sound Awareness was only for children ages 6 to 13 years and adults ages 40 to 90+ years.

OL Test 8: Retrieval Fluency, a measure of *Glr*, had a moderate predictive relationship with RC for all age groups except the youngest children, 6 to 8 years. Test 8: Retrieval Fluency was designed to measure the narrow abilities of ideational fluency (FI) and speed of lexical access (LA). Finally, COG Test 14: Picture Recognition, a measure of *Gv*, had a moderate predictive relationship with RC for children ages 6 to 13 years and adults ages 40 to 90+ years.

According to the WJ IV Technical Manual (McGrew et al., 2014), the SAPT cluster for RC includes COG Test 1: Oral Vocabulary (*Gc*-VL/LD), COG Test 5: Phonological Processing (*Ga*-PC/*Glr*-LA, FW), COG Test 9: Concept Formation (*Gf*-I), and COG Test 11: Number-Pattern Matching (*Gs*-P). The results of the current analyses indicted that COG Test 2: Numbers Series was the strongest predictor of RC across all age groups. COG Test 4: Letter-Pattern Matching and COG Test 9: Concept Formation were the second strongest predictors overall, varying by age group. The only test in these analyses that was consistent with SAPTs for RC was COG Test 9: Concept Formation.

Scholastic Aptitude and Reading Fluency Comparison by Age Groups

Table 3 presents the beta weights for the scholastic aptitude/reading fluency (RF) comparisons. Two of the *Gs* tests designed to measure the narrow ability of perceptual speed (P), COG Test 11: Number-Pattern Matching and COG Test 4: Letter-Pattern Matching, both had predictive relationships with RF. Test 11: Number-Pattern Matching had a strong predictive relationship with RF across all age groups. Test 4: Letter-Pattern Matching had a moderate predictive relationship with RF for all ages except the youngest age group (6 to 8 years).

Table 3.
Scholastic Aptitude/Reading Fluency Comparison Beta Weights by Age Group

	Broad-Narrow Ability	Beta Weights by Age Group					
		6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years	All Ages
WJ IV Test							
COG 11: Number-Pattern Matching	*Gs*-P	0.420*	0.370*	0.329*	0.303*	0.324*	0.339*
COG 8: General Information	*Gc*-K0	0.168*	0.300*	0.244*	0.263*	0.277*	0.253*
OL 9: Sound Awareness	*Ga*-PC	0.305*	0.267*	0.231*	0.212	0.275*	0.248*
COG 4: Letter-Pattern Matching	*Gs*-P	0.092	0.120	0.146	0.224*	0.118	0.149
COG 2: Number Series	*Gf*-RQ	0.114	0.118	0.071	0.111	0.167	0.117
COG 1: Oral Vocabulary	*Gc*-VL/LD	0.075	0.111	0.104	0.101	0.081	0.098
COG 9: Concept Formation	*Gf*-I	0.087	0.065	0.113	0.099	0.071	0.089
COG 12: Nonword Repetition	*Ga*-PC, UM/MS	0.053	0.104	0.035	0.095	0.055	0.074
COG 13: Visual-Auditory Learning	*Glr*-MA	0.067	0.103	0.041	0.050	0.103	0.070
COG 18: Memory for Words	*Gwm*-MS	0.035	0.056	0.043	0.049	0.115	0.056
***R^2* Values**							
R^2 for all significant beta weights by age		0.604	0.606	0.582	0.580	0.642	0.592
R^2 for top 2 to 3 predictors by age[a]		0.596	0.576	0.552	0.535	0.622	0.567

Note. Beta weights greater than +.30 are highlighted in black (strong effects), and beta weights between +.10 and +.29 are highlighted in gray (moderate effects). R^2 values multiplied by 100 represent the proportion of reliable criterion variance accounted for by the independent variables.
[a]The indicators with the top two to three beta weights for each age group used in the regression analyses are designated by asterisks.

COG Test 8: General Information is designed to measure the narrow ability of general verbal information (K0), an example of *Gc*. Test 8: General Information had a strong predictive relationship with RF for the 9- to 13-year-olds and a moderate predictive relationship for all other age groups. COG Test 1: Oral Vocabulary, another measure of *Gc*, had a moderate predictive relationship with RF for three age groups (9 to 13, 14 to 19, and 20 to 39 years). As previously stated, Test 1: Oral Vocabulary measures the narrow abilities of lexical knowledge (VL) and language development (LD).

OL Test 9: Sound Awareness, a measure of *Ga* and the narrow ability of phonetic coding (PC), had a strong predictive relationship with RF for the youngest age group (6 to 8 years) and a moderate predictive relationship with RF for all of the other age groups. COG Test 12: Nonword Repetition, another measure of *Ga*, had a moderate predictive relationship with RF for the 9- to 13-year-olds.

COG Test 2: Number Series, a measure of *Gf* and a narrow ability of quantitative reasoning (RQ), consistently had a predictive relationship with all aspects of reading, including RF. COG Test 2: Number Series had a moderate predictive relationship with RF for all age groups except for the 14- to 19-year-olds. COG Test 9: Concept Formation, another measure of *Gf* and a narrow ability measure of induction (I), had a moderate predictive relationship with RF for only the 14- to 19-year-olds.

To a lesser degree, tests measuring two narrow abilities related to memory had moderate predictive relationships with RF. COG Test 13: Visual-Auditory Learning, a measure of *Glr* and the narrow ability of associative memory (MA), had a moderate predictive relationship with RF for the 9 to 13 and 40 to 90+ age groups. Another narrow ability of memory, memory span (MS), is measured by COG Test 18: Memory for Words, which had a moderate predictive relationship with RF for only the 40 to 90+ age group.

According to the WJ IV Technical Manual (McGrew et al., 2014), the SAPT cluster for RF includes COG Test 1: Oral Vocabulary (*Gc*-VL/LD), COG Test 5: Phonological Processing (*Ga*-PC/*Glr*-LA, FW), COG Test 9: Concept Formation (*Gf*-I), and COG Test 11: Number-Pattern Matching (*Gs*-P). The results of the current analyses indicted that COG Test 11: Number-Pattern Matching was the strongest predictor of RF across all age groups. COG Test 8: General Information and OL Test 9: Sound Awareness were the second strongest predictors overall, varying by age group. The only test in these analyses that was consistent with SAPTs for RF was COG Test 11: Number-Pattern Matching.

Scholastic Aptitude and Mathematical Calculations Comparison by Age Groups

Table 4 on page 8 presents the beta weights for the scholastic aptitude/mathematical calculations (MC) comparisons. Narrow abilities from all seven broad CHC abilities had some predictive relationship with MC. COG Test 2: Number Series, a measure of *Gf* and a narrow ability of quantitative reasoning (RQ), had a strong predictive relationship with MC, similar to all of the areas of reading. All three of the processing speed (*Gs*) measures, COG Test 11: Number-Pattern Matching, COG Test 4: Letter-Pattern Matching, and COG Test 17: Pair Cancellation, had predictive relationships with MC. Test 11: Number-Pattern Matching and Test 4: Letter-Pattern Matching both measure the narrow ability of perceptual speed (P) and each had moderate predictive relationships with MC for all age groups. Test 17: Pair Cancellation, which measures the narrow abilities of perceptual speed (*Gs*-P), attentional control (*Gwm*-AC), and spatial scanning (*Gv*-SS), had a moderate predictive relationship with MC for three age groups (9 to 13, 14 to 19, and 40 to 90+ years).

Table 4.
Scholastic Aptitude/ Mathematical Calculations Comparison Beta Weights by Age Group

	Broad-Narrow Ability	Beta Weights by Age Group					
		6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years	All Ages
WJ IV Test							
COG 2: Number Series	*Gf*-RQ	0.373*	0.382*	0.393*	0.434*	0.443*	0.405*
COG 11: Number-Pattern Matching	*Gs*-P	0.275*	0.176*	0.181*	0.158*	0.160*	0.181*
COG 1: Oral Vocabulary	*Gc*-VL/LD	0.093	0.123	0.128	0.132	0.118	0.122
COG 8: General Information	*Gc*-K0	0.146	0.191*	0.185*	0.169*	0.190*	0.178*
COG 4: Letter-Pattern Matching	*Gs*-P	0.123	0.140	0.107	0.119	0.118	0.121
OL 9: Sound Awareness	*Ga*-PC	0.109	0.140	0.079	0.085	0.111	0.103
COG 7: Visualization	*Gv*-Vz	0.104	0.060	0.135	0.122	0.087	0.102
COG 17: Pair Cancellation	*Gs*-P/ *Gwm*-AC/ *Gv*-SS	0.066	0.106	0.107	0.097	0.101	0.101
OL 8: Retrieval Fluency	*Glr*-FI, LA	0.058	0.072	0.100	0.070	0.141	0.089
OL 7: Sound Blending	*Ga*-PC	0.035	0.032	0.085	0.105	0.122	0.072
***R^2* Values**							
R^2 for all significant beta weights by age		0.675	0.646	0.649	0.620	0.683	0.651
R^2 for top 2 to 3 predictors by age[a]		0.614	0.593	0.615	0.596	0.649	0.612

Note. Beta weights greater than +.30 are highlighted in black (strong effects), and beta weights between +.10 and +.29 are highlighted in gray (moderate effects). R^2 values multiplied by 100 represent the proportion of reliable criterion variance accounted for by the independent variables.
[a]The indicators with the top two to three beta weights for each age group used in the regression analyses are designated by asterisks.

Two of the *Gc* measures, COG Test 1: Oral Vocabulary and COG Test 8: General Information, both had predictive relationships with MC. Test 1: Oral Vocabulary, a narrow ability measure of lexical knowledge (VL) and language development (LD), had a moderate predictive relationship with MC for all age groups except for the youngest group (6 to 8 years). Test 8: General Information, a narrow ability measure of general verbal information (K0), had a moderate predictive relationship with MC across all age groups.

Two of the *Ga* measures, OL Test 9: Sound Awareness and OL Test 7: Sound Blending, both had limited predictive relationships with MC. Test 9: Sound Awareness had a moderate predictive relationship with MC for three out of the five age groups (6 to 8, 9 to 13, and 40 to 90+ years). OL Test 7: Sound Blending had a moderate predictive relationship with MC for the adult age groups (20 to 39 and 40 to 90+ years).

Two other tests had limited predictive relationships with MC, COG Test 7: Visualization (*Gv*-VZ) and OL Test 8: Retrieval Fluency (*Glr*-FI, LA). COG Test 7: Visualization had a moderate predictive relationship with MC for three out of the five age groups (6 to 8, 14 to 19, and 20 to 39 years). OL Test 8: Retrieval Fluency had a moderate predictive relationship with MC for only the 14 to 19 and 40 to 90+ year age groups.

According to the WJ IV Technical Manual (McGrew et al., 2014), the SAPT cluster for MC includes COG Test 1: Oral Vocabulary (*Gc*-VL/LD), COG Test 2: Number Series (*Gf*-RQ), COG Test 7: Visualization (*Gv*-Vz), and COG Test 17: Pair Cancellation (*Gs*-P/ *Gwm*-AC/*Gv*-SS). The results of the current analyses indicted that COG Test 2: Number Series was the strongest predictor of MC across all age groups. COG Test 11: Number-Pattern Matching and COG Test 8: General Information (*Gc*-K0) were the second

strongest predictors overall, varying by age group. The only test in these analyses that was consistent with SAPTs for MC was COG Test 2: Number Series.

Scholastic Aptitude and Mathematical Reasoning Comparison by Age Groups

Table 5 presents the beta weights for the scholastic aptitude/mathematical reasoning (MR) comparisons. COG Test 2: Number Series, a measure of *Gf* and a narrow ability of quantitative reasoning (RQ), had a strong predictive relationship with MC, similar to all of the areas of reading and mathematical calculations. The only other test that had a moderate predictive relationship with MR across all age groups was COG Test 17: Pair Cancellation, which measures the narrow abilities of perceptual speed (P), attentional control (AC), and spatial scanning (SS).

Table 5.
Scholastic Aptitude/ Mathematical Reasoning Comparison Beta Weights by Age Group

	Broad-Narrow Ability	Beta Weights by Age Group					
		6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years	All Ages
WJ IV Test							
COG 2: Number Series	*Gf*-RQ	0.613*	0.571*	0.540*	0.525*	0.552*	0.613*
COG 17: Pair Cancellation	*Gs*-P/ *Gwm*-AC/ *Gv*-SS	0.208*	0.194*	0.169*	0.157*	0.183*	0.208*
OL 8: Retrieval Fluency	*Glr*-FI, LA	0.124	0.129	0.139	0.085	0.122	0.124
COG 8: General Information	*Gc*-K0	0.078	0.107	0.098	0.098	0.098	0.078
COG 13: Visual-Auditory Learning	*Glr*-MA	0.104	0.096	0.077	0.068	0.092	0.104
OL 1: Picture Vocabulary	*Gc*-VL/LD	0.098	0.096	0.088	0.139	0.092	0.098
COG 7: Visualization	*Gv*-Vz	0.143	0.063	0.082	0.086	0.081	0.143
***R^2* Values**							
R^2 for all significant beta weights by age		0.667	0.676	0.672	0.722	0.719	0.703
R^2 for top 2 to 3 predictors by age[a]		0.597	0.601	0.638	0.638	0.688	0.632

Note. Beta weights greater than +.30 are highlighted in black (strong effects), and beta weights between +.10 and +.29 are highlighted in gray (moderate effects). R^2 values multiplied by 100 represent the proportion of reliable criterion variance accounted for by the independent variables.
[a]The indicators with the top two to three beta weights for each age group used in the regression analyses are designated by asterisks.

OL Test 8: Retrieval Fluency, a measure of *Glr*, had a moderate predictive relationship with MR for all of the age groups except the 20- to 39-year-olds. OL Test 8: Retrieval Fluency measures two narrow abilities, ideational fluency (FI) and speed of lexical access (LA). COG Test 13: Visual-Auditory Learning, another measure of *Glr* and the narrow ability of associative memory (MA), had a moderate predictive relationship with MR for only the 6- to 8-year-olds.

Two of the *Gc* tests, COG Test 8: General Information and OL Test 1: Picture Vocabulary, had limited moderate predictive relationships with MR. COG Test 8: General Information, a measure of the narrow ability of general verbal information (K0), had a moderate predictive relationship with MR for only the 9- to 13-year-olds. OL Test 1: Picture Vocabulary, a measure of the narrow abilities of lexical knowledge (VL) and language development (LD), had a moderate predictive relationship with MR for only the 20- to 39-year-olds. Finally, COG Test 7: Visualization had a moderate predictive relationship with MR for the youngest children, ages 6 to 8 years.

According to the WJ IV Technical Manual (McGrew et al., 2014), the SAPT cluster for MR includes COG Test 1: Oral Vocabulary (*Gc*-VL/LD), COG Test 7: Visualization (*Gv*-Vz), COG Test 10: Numbers Reversed (*Gwm*-WM, AC) and COG Test 15: Analysis-Synthesis (*Gf*-RQ). The results of the current analyses indicted that COG Test 2: Number Series was the strongest predictor of MR across all age groups. COG Test 17: Pair Cancellation was the second strongest predictor across all age groups. The two tests in these analyses that were consistent with SAPTs for MR were COG Test 2: Number Series and COG Test 17: Pair Cancellation.

Scholastic Aptitude and Written Expression Comparison by Age Groups

Table 6 presents the beta weights for the scholastic aptitude/written expression (WE) comparisons. COG Test 2: Number Series remains a strong predictor for WE for two of the age groups, 9 to 13 and 20 to 39 years, and had a moderate predictive relationship for the other three age groups. Two of the *Gs* tests, COG Test 11: Number-Pattern Matching and COG Test 4: Letter-Pattern Matching, had predictive relationships with WE. Test 11: Number-Pattern Matching had a strong predictive relationship with WE for the 6 to 8, 9 to 13, and 20 to 39 year age groups and a moderate predictive relationship with WE for the other age groups. Test 4: Letter-Pattern Matching had a moderate predictive relationship with WE for all age groups.

Table 6.
Scholastic Aptitude/Written Expression Comparison Beta Weights by Age Group

	Broad-Narrow Ability	Beta Weights by Age Group					
		6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years	All Ages
WJ IV Test							
COG 2: Number Series	*Gf*-RQ	0.292*	0.302*	0.295*	0.354*	0.297*	0.312*
COG 11: Number-Pattern Matching	*Gs*-P	0.366*	0.344*	0.324*	0.275*	0.262*	0.309*
COG 4: Letter-Pattern Matching	*Gs*-P	0.105	0.160*	0.167*	0.181*	0.201*	0.169*
COG 3: Verbal Attention	*Gwm*-WM, AC	0.130	0.114	0.108	0.146	0.198	0.135
COG 6: Story Recall	*Glr*-MM/ *Gc*-LS	0.108	0.131	0.119	0.149	0.123	0.127
COG 5: Phonological Processing	*Ga*-PC/ *Glr*-LA, FW	0.136	0.100	0.097	0.121	0.121	0.108
COG 14: Picture Recognition	*Gv*-MV	0.107	0.090	0.127	0.116	0.118	0.108
COG 12: Nonword Repetition	*Ga*-PC, UM/ *Gwm*-MS	0.106	0.129	0.056	0.093	0.109	0.099
***R^2* Values**							
R^2 for all significant beta weights by age		0.628	0.561	0.556	0.560	0.625	0.582
R^2 for top 2 to 3 predictors by age[a]		0.576	0.527	0.524	0.517	0.580	0.540

Note. Beta weights greater than +.30 are highlighted in black (strong effects), and beta weights between +.10 and +.29 are highlighted in gray (moderate effects). R^2 values multiplied by 100 represent the proportion of reliable criterion variance accounted for by the independent variables.
[a]The indicators with the top two to three beta weights for each age group used in the regression analyses are designated by asterisks.

COG Test 3: Verbal Attention, a measure of *Gwm* and the narrow abilities of working memory (WM) and attentional control (AC), had a moderate predictive relationship with WE across all age groups. COG Test 6: Story Recall, a measure of *Glr* and the narrow

ability of meaningful memory (MM) and *Gc* and the narrow ability of listening ability (LS), also had a moderate predictive relationship with WE across all age groups.

To a lesser degree, two measures of *Ga*, COG Test 5: Phonological Processing and COG Test 12: Nonword Repetition, had moderate predictive relationships with WE for some age groups (see Table 6). Likewise, COG Test 14: Picture Recognition, a measure of *Gv*, had a moderate predictive relationship with WE for all age groups except for the 9- to 13-year-olds.

According to the WJ IV Technical Manual (McGrew et al., 2014), the SAPT cluster for WE includes COG Test 1: Oral Vocabulary (*Gc*-VL/LD), COG Test 5: Phonological Processing (*Ga*-PC/*Glr*-LA, FW), COG Test 6: Story Recall (*Glr*-MM/*Gc*-LS), and COG Test 11: Number-Pattern Matching (*Gs*-P). The results of the current analyses indicted that COG Test 2: Number Series was the strongest predictor of WE across all age groups. COG Test 4: Letter-Pattern Matching and COG Test 11: Number-Pattern Matching were the second strongest predictors, varying across age groups. The only test in these analyses that was consistent with SAPTs for WE was COG Test 11: Number-Pattern Matching.

Scholastic Aptitude and Oral Expression Comparison by Age Groups

Table 7 presents the beta weights for the scholastic aptitude/oral expression (OE) comparisons. OL Test 1: Picture Vocabulary, a measure of *Gc* and the narrow abilities of lexical knowledge (VL) and language development (LD), had a strong predictive relationship with OE across all age groups. COG Test 1: Oral Vocabulary, another *Gc* measure, had a moderate predictive relationship with OE across all age groups. Oral Vocabulary measures the narrow ability of listening ability (LS).

Table 7.
Scholastic Aptitude/Oral Expression Comparison Beta Weights by Age Group

	Broad-Narrow Ability	Beta Weights by Age Group					
		6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years	All Ages
WJ IV Test							
OL 1: Picture Vocabulary	*Gc*-VL/LD	0.508*	0.527*	0.543*	0.566*	0.510*	0.535*
COG 1: Oral Vocabulary	*Gc*-LS	0.258*	0.248*	0.253*	0.266*	0.288*	0.257*
COG 18: Memory for Words	*Gwm*-MS	0.198*	0.227*	0.171*	0.182*	0.205*	0.195*
COG 12: Nonword Repetition	*Ga*-PC, UM/ *Gwm*-MS	0.140	0.184	0.165	0.145	0.144	0.158
COG 4: Letter-Pattern Matching	*Gs*-P	0.128	0.129	0.133	0.117	0.131	0.126
COG 5: Phonological Processing	*Ga*-PC/ *Glr*-LA, FW	0.090	0.101	0.139	0.137	0.047	0.110
COG 3: Verbal Attention	*Gwm*-WM, AC	0.105	0.075	0.123	0.111	0.121	0.104
***R^2* Values**							
R^2 for all significant beta weights by age		0.731	0.723	0.734	0.759	0.798	0.746
R^2 for top 2 to 3 predictors by age[a]		0.708	0.684	0.694	0.730	0.770	0.709

Note. Beta weights greater than +.30 are highlighted in black (strong effects), and beta weights between +.10 and +.29 are highlighted in gray (moderate effects). R^2 values multiplied by 100 represent the proportion of reliable criterion variance accounted for by the independent variables.
[a]The indicators with the top two to three beta weights for each age group used in the regression analyses are designated by asterisks.

Two of the *Gwm* tests, COG Test 18: Memory for Words and COG Test 3: Verbal Attention, had varying degrees of moderate predictive relationships with OE. Test 18: Memory for Words, a narrow ability measure of memory span (MS), had a moderate predictive relationship with OE across all age groups. Test 3: Verbal Attention, a narrow ability of working memory (WM) and attentional control (AC), had a moderate predictive relationship with OE for four out of the five age groups (6 to 8, 14 to 19, 20 to 39, and 40 to 90+ years).

Two of the *Ga* tests, COG Test 12: Nonword Repetition and COG Test 5: Phonological Processing, also had varying degrees of moderate predictive relationships with OE. Test 12: Nonword Repetition, a narrow ability measure of phonetic coding (PC) and memory for sound patterns (UM), had a moderate predictive relationship with OE across all age groups. Test 5: Phonological Processing, also a narrow ability measure of phonetic coding (PC), had a moderate predictive relationship with three out of the five age groups (9 to 13, 14 to 19, and 20 to 39 years). Finally, COG Test 4: Letter-Pattern Matching, a measure of *Gs* and the narrow ability of perceptual speed (P), had a moderate predictive relationship with OE for all age groups.

The WJ IV Technical Manual (McGrew et al., 2014) does not report a SAPT cluster for OE. The results of the current analyses indicted that OL Test 1: Picture Vocabulary was the strongest predictor of OE across all age groups. COG Test 1: Oral Vocabulary and COG Test 18: Memory for Words were the second strongest predictors across all age groups.

Scholastic Aptitude and Listening Comprehension Comparison by Age Groups

Table 8 presents the beta weights for the scholastic aptitude/listening comprehension (LC) comparisons. Of all of the scholastic aptitude/achievement comparisons, LC had the fewest predictive relationships with WJ IV COG or OL tests. OL Test 2: Oral Comprehension, a measure of *Gc*, had a strong predictive relationship with LC for all age groups. COG Test 2: Number Series, a measure of *Gf* and a narrow ability measure of quantitative reasoning (RQ), had a moderate predictive relationship with LC for all age groups.

Table 8.
Scholastic Aptitude/ Listening Comprehension Comparison Beta Weights by Age Group

	Broad-Narrow Ability	Beta Weights by Age Group					
		6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years	All Ages
WJ IV Test							
OL 2: Oral Comprehension	*Gc*-LS	0.653*	0.676*	0.688*	0.661*	0.687*	0.674*
COG 2: Number Series	*Gf*-RQ	0.118	0.157*	0.167*	0.111	0.118	0.136
COG 3: Verbal Attention	*Gwm*-WM, AC	0.099	0.096	0.120	0.098	0.055	0.096
COG 12: Nonword Repetition	*Ga*-PC, UM/ *Gwm*-MS	0.054	0.095	0.100	0.101	0.077	0.091
***R^2* Values**							
R^2 for all significant beta weights by age		0.807	0.755	0.718	0.801	0.813	0.776
R^2 for top 2 to 3 predictors by age[a]		0.783	0.755	0.460	0.741	0.793	0.750

Note. Beta weights greater than +.30 are highlighted in black (strong effects), and beta weights between +.10 and +.29 are highlighted in gray (moderate effects). R^2 values multiplied by 100 represent the proportion of reliable criterion variance accounted for by the independent variables.
[a]The indicators with the top two to three beta weights for each age group used in the regression analyses are designated by asterisks.

COG Test 3: Verbal Attention, a measure of *Gwm* and the narrow abilities of working memory (WM) and attentional control (AC), had a moderate predictive relationship for LC for only the 14- to 19-year-olds. COG Test 12: Nonword Repetition, a measure of *Ga* and the narrow ability of phonetic coding (PC), as well as *Gsm* and the narrow ability of memory span (MS), had a moderate predictive relationship with LC for two age groups, 14 to 19 and 20 to 39 years.

The WJ IV Technical Manual (McGrew et al., 2014) does not report a SAPT cluster for LC. The results of the current analyses indicated that COG 1: Oral Vocabulary was the strongest predictor of OE across all age groups. COG Test 2: Number Series was the second strongest predictor, varying by age groups.

Summary of Scholastic Aptitude and Academic Achievement Comparisons by Age Groups

Table 9 provides a summary of all of the scholastic aptitude/achievement comparisons across age groups with the strong predictive relationships shaded in black and the moderate predictive relationships shaded in gray.

Table 9.
Summary of All Scholastic Aptitude/Achievement Comparisons by Age Groups

WJ IV COG/OL Test	Age Range	Scholastic Aptitude/Achievement Comparisons: Basic Reading Skills	Reading Comprehension	Reading Fluency	Mathematical Calculations	Mathematical Reasoning	Written Expression	Oral Expression	Listening Comprehension
Comprehension-Knowledge (*Gc*)									
COG 1: Oral Vocabulary (VL/LD)	6–8		M					M	
	9–13	M	M	M	M			M	
	14–19	M	M	M	M			M	
	20–39	M	M	M	M			M	
	40–90+	M	M		M			M	
COG 8: General Information (K0)	6–8			M	M				
	9–13			S	M	M			
	14–19			M	M				
	20–39			M	M				
	40–90+			M	M				
OL 1: Picture Vocabulary (VL/LD)	6–8	M	M					S	
	9–13	M						S	
	14–19	M	M					S	
	20–39	M	M			M		S	
	40–90+	M	M					S	

Table 9. *(cont.)*
Summary of All Scholastic Aptitude/Achievement Comparisons by Age Groups

WJ IV COG/OL Test	Age Range	Scholastic Aptitude/Achievement Comparisons							
		Basic Reading Skills	Reading Comprehension	Reading Fluency	Mathematical Calculations	Mathematical Reasoning	Written Expression	Oral Expression	Listening Comprehension
OL 2: Oral Comprehension (LS)	6–8	M							S
	9–13	M							S
	14–19	M							S
	20–39	M							S
	40–90+	M							S
Fluid Reasoning (*Gf*)									
COG 2: Number Series (RQ)	6–8	S	S	M	S	S	M		M
	9–13	S	S	M	S	S	S		M
	14–19	S	S		S	S	M		M
	20–39	S	S	M	S	S	S		M
	40–90+	S	S	M	S	S	M		M
COG 9: Concept Formation (I)	6–8		M						
	9–13		M						
	14–19		M	M					
	20–39		M						
	40–90+		M						
COG 15: Analysis-Synthesis (RQ)	6–8								
	9–13								
	14–19								
	20–39								
	40–90+								
Short-Term Working Memory (*Gwm*)									
COG 3: Verbal Attention (WM, AC)	6–8	M	M				M	M	
	9–13	M	M				M		
	14–19	M	M				M	M	M
	20–39	M	M				M	M	
	40–90+	M	M				M	M	
COG 10: Numbers Reversed (WM, AC)	6–8								
	9–13								
	14–19								
	20–39								
	40–90+								

Table 9. *(cont.)*
Summary of All Scholastic Aptitude/Achievement Comparisons by Age Groups

WJ IV COG/OL Test	Age Range	Scholastic Aptitude/Achievement Comparisons							
		Basic Reading Skills	Reading Comprehension	Reading Fluency	Mathematical Calculations	Mathematical Reasoning	Written Expression	Oral Expression	Listening Comprehension
COG 16: Object-Number Sequencing (WM)	6–8								
	9–13								
	14–19								
	20–39								
	40–90+								
COG 18: Memory for Words (MS)	6–8							M	
	9–13							M	
	14–19							M	
	20–39			M				M	
	40–90+							M	
Processing Speed (*Gs*)									
COG 4: Letter-Pattern Matching (P)	6–8		M		M		M	M	
	9–13		M	M	M		M	M	
	14–19		M	M	M		M	M	
	20–39		M	M	M		M	M	
	40–90+		M	M	M		M	M	
COG 11: Number-Pattern Matching (P)	6–8	M	M	S	M		S		
	9–13		M	S	M		S		
	14–19		M	S	M		S		
	20–39		M	S	M		M		
	40–90+			S	M		M		
COG 17: Pair Cancellation (P/AC/SS)	6–8					M			
	9–13				M	M			
	14–19				M	M			
	20–39					M			
	40–90+				M	M			
Auditory Processing (*Ga*)									
COG 5: Phonological Processing (PC/LA, FW)	6–8						M		
	9–13						M	M	
	14–19							M	
	20–39						M	M	
	40–90+						M		

Table 9. *(cont.)*
Summary of All Scholastic Aptitude/Achievement Comparisons by Age Groups

WJ IV COG/OL Test	Age Range	Scholastic Aptitude/Achievement Comparisons							
		Basic Reading Skills	Reading Comprehension	Reading Fluency	Mathematical Calculations	Mathematical Reasoning	Written Expression	Oral Expression	Listening Comprehension
COG 12: Nonword Repetition (PC, UM/MS)	6–8						M	M	
	9–13	M		M			M	M	
	14–19							M	M
	20–39	M						M	M
	40–90+	M					M	M	
OL 3: Segmentation (PC)	6–8		M						
	9–13		M						
	14–19		M						
	20–39		M						
	40–90+		M						
OL 7: Sound Blending (PC)	6–8								
	9–13								
	14–19								
	20–39	M			M				
	40–90+				M				
OL 9: Sound Awareness (PC)	6–8	M	M	S	M				
	9–13	M	M	M	M				
	14–19			M					
	20–39			M					
	40–90+	M	M	M	M				
Long-Term Retrieval (*Glr*)									
COG 6: Story Recall (MM/LS)	6–8						M		
	9–13						M		
	14–19						M		
	20–39						M		
	40–90+						M		
COG 13: Visual-Auditory Learning (MA)	6–8					M			
	9–13			M					
	14–19								
	20–39								
	40–90+			M					

Table 9. *(cont.) Summary of All Scholastic Aptitude/Achievement Comparisons by Age Groups*

WJ IV COG/OL Test	Age Range	Scholastic Aptitude/Achievement Comparisons							
		Basic Reading Skills	Reading Comprehension	Reading Fluency	Mathematical Calculations	Mathematical Reasoning	Written Expression	Oral Expression	Listening Comprehension
OL 4: Rapid Picture Naming (NA, LA)	6–8								
	9–13								
	14–19								
	20–39								
	40–90+								
OL 8: Retrieval Fluency (FI, LA)	6–8					M			
	9–13		M			M			
	14–19		M		M	M			
	20–39		M						
	40–90+		M		M	M			
Visual Processing (*Gv*)									
COG 7: Visualization (Vz)	6–8				M	M			
	9–13								
	14–19				M				
	20–39				M				
	40–90+								
COG 14: Picture Recognition (MV)	6–8		M				M		
	9–13		M						
	14–19	M					M		
	20–39						M		
	40–90+	M	M				M		

Note. M = moderate predictive relationship, S = strong predictive relationship

Comprehension-Knowledge (*Gc*) Aptitude/Achievement Predictive Relationships

As illustrated in Table 9, WJ IV COG and OL tests designed to measure Comprehension-Knowledge (*Gc*) had strong to moderate predictive relationships with all of the academic areas except for written expression. For mathematical reasoning, two of the four *Gc* tests, COG Test 8: General Information and OL Test 1: Picture Vocabulary, had moderate predictive relationships for only one age group each. OL Test 1: Picture Vocabulary, measuring the narrow abilities of lexical knowledge (VL) and language development (LD), had the strongest predictive relationship with oral expression for all age groups. OL Test 2: Oral Comprehension had a moderate predictive relationship with basic reading skills and oral expression for all age groups.

COG Test 1: Oral Vocabulary, measuring the narrow abilities of lexical knowledge (VL) and language development (LD), had a moderate predictive relationship with basic

reading skills, reading comprehension, reading fluency, mathematical calculations, oral expression, and listening comprehension for most age ranges.

COG Test 8: General Information, measuring the narrow ability of general verbal information (K0), had strong to moderate predictive relationships with reading fluency and mathematical calculations across all age groups.

Fluid Reasoning (*Gf*) Aptitude/Achievement Predictive Relationships

Across all of the WJ IV COG and OL tests, COG Test 2: Number Series had the most consistently strong predictive relationship with multiple areas of academic achievement. Test 2: Number Series is considered high in cognitive complexity and overall *g* loading. Test 2: Number Series measures the narrow ability of quantitative reasoning (RQ), or the ability to use related cues from single to multidimensional matrices of information to solve a problem. An argument could be made that Test 2: Number Series is tapping the *Gf* narrow ability of sequential reasoning or deductive reasoning using sequential problem solving. In other words, it requires sequencing bits of information, figuring out what the sequence is, then using that information to complete the series correctly so that a complete string of complex information is achieved. Given the complexity of many of the academic achievement areas, such complex cognitive problem solving functions appear to be co-requisite skills for success.

COG Test 9: Concept Formation, measuring the narrow ability of induction (I), had a moderate predictive relationship with reading comprehension. Within the context of other predictors used in the model, COG Test 15: Analysis-Synthesis was not predictive of any of the academic areas.

Short-Term Working Memory (*Gwm*) Aptitude/Achievement Predictive Relationships

As illustrated in Table 9, two WJ IV COG tests designed to measure Short-Term Working Memory (*Gwm*) had moderate predictive relationships with several of the academic areas. COG Test 3: Verbal Attention, a new test to the WJ IV, had a moderate predictive relationship with basic reading skills, reading comprehension, and written expression for all age groups as well as with oral expression for the majority of age groups. Test 3: Verbal Attention measures the narrow abilities of working memory (WM) and attentional control (AC).

COG Test 18: Memory for Words, designed to measure the narrow ability of memory span (MS), had a moderate predictive relationship with oral expression across all age groups. The other two tests of *Gwm*, COG Test 10: Numbers Reversed and COG Test 16: Object-Number Sequencing, did not have any predictive relationships with any of the achievement areas.

Processing Speed (*Gs*) Aptitude/Achievement Predictive Relationships

As illustrated in Table 9, WJ IV COG tests designed to measure Processing Speed (*Gs*) had strong to moderate predictive relationships with all academic achievement areas except for basic reading skills and listening comprehension. COG Test 4: Letter-Pattern

Matching, measuring the narrow ability of perceptual speed (P), had moderate predictive relationships with reading comprehension, reading fluency, mathematical calculations, written expression, and oral expression for the majority of the age groups.

COG Test 11: Number-Pattern Matching, also designed to measure the narrow ability of perceptual speed (P), had a strong predictive relationship with reading fluency for all age groups and a strong to moderate predictive relationship with written expression for all ages. Test 11: Number-Pattern Matching also had moderate predictive relationships with mathematical calculations for all age groups, with reading comprehension for all age groups except older adults, and with basic reading skills for very young children (6 to 8 years).

COG Test 17: Pair Cancellation measures the narrow abilities of perceptual speed (P), attentional control (AC), and spatial scanning (SS). Test 17: Pair Cancellation had a moderate predictive relationship with mathematical reasoning across all age groups and with mathematical calculations for several age groups.

Auditory Processing (*Ga*) Aptitude/Achievement Predictive Relationships

As illustrated in Table 9, WJ IV COG and OL tests designed to measure Auditory Processing (*Ga*) had moderate predictive relationships with all of the academic areas except for mathematical reasoning. OL Test 9: Sound Awareness, a measure of the narrow ability of phonetic coding (PC), had moderate predictive influences for basic reading skills, reading comprehension, and mathematical calculations for the two youngest age groups (6 to 8 and 9 to 13 years) and for the older adults (40 to 90+ years). For reading fluency, the predictive influence of Test 9: Sound Awareness was strong for the youngest age group and moderate across all other age groups.

Two other tests designed to measure the narrow ability of PC, OL Test 7: Sound Blending and OL Test 3: Segmentation, only had a few moderate predictive relationships. Test 7: Sound Blending had a limited influence on basic reading skills for young adults, ages 20 to 39 years, and on mathematical calculations for both adult age groups. Test 3: Segmentation had a moderate predictive relationship with reading comprehension across all age groups.

COG Test 12: Nonword Repetition measures several narrow abilities: phonetic coding (PC), memory for sound patterns (UM), and *Gwm* memory span (MS). Test 12: Nonword Repetition had a moderate predictive relationship with oral expression across all age groups, with written expression for the two youngest age groups (6 to 13 years) and for older adults (40 to 90+ years), and with listening comprehension for adolescents (14 to 19 years) and for young adults (20 to 39 years). Test 12: Nonword Repetition also had a few other limited predictive influences with other academic areas for isolated ages groups but had no consistent pattern.

COG Test 5: Phonological Processing measures the narrow abilities of phonetic coding (PC), speed of lexical access (*Glr*-LA), and word fluency (*Glr*-FW). Test 5: Phonological Processing had moderate predictive relationships with written expression for all age groups except for the 14- to 19-year-olds and with oral expression for the following age groups: 9 to 13, 14 to 19, and 20 to 39 years.

Long-Term Retrieval (*Glr*) Aptitude/Achievement Predictive Relationships

As illustrated in Table 9, WJ IV COG and OL tests designed to measure Long-Term Retrieval (*Glr*) had moderate predictive relationships with reading comprehension, reading fluency, mathematical calculations, mathematical reasoning, and written expression. COG Test 6: Story Recall, a measure of the narrow abilities of meaningful memory (MM) and listening ability (LS), had a moderate predictive relationship with written expression for all age groups. OL Test 8: Retrieval Fluency, a measure of the narrow abilities of ideational fluency (FI) and speed of lexical access (LA), had a moderate predictive relationship with reading comprehension for all except the youngest age group (6 to 8 years) and a moderate predictive relationship with mathematical reasoning for all age groups except the 20- to 39-year-olds. OL Test 8: Retrieval Fluency also had a moderate predictive relationship with mathematical calculations for two age groups: 14 to 19 years and 40 to 90+ years.

COG Test 13: Visual-Auditory Learning, a measure of the narrow ability of associative memory (MA), had only a few moderate predictive relationships across two academic areas, without much consistency across age groups. OL Test 4: Rapid Picture Naming, a measure of the narrow abilities of naming facility (NA) and speed of lexical access (LA), did not have any predictive relationships with any academic area.

Visual Processing (*Gv*) Aptitude/Achievement Predictive Relationships

As illustrated in Table 9, WJ IV COG tests designed to measure Visual Processing (*Gv*) had moderate predictive relationships with basic reading skills, reading comprehension, mathematical calculations, mathematical reasoning, and written expression for some age groups. Specifically, COG Test 7: Visualization, a measure of the narrow ability with the same name, had a moderate predictive relationship with mathematical calculations for the following three age groups: 6 to 8, 14 to 19, and 20 to 39 years. Test 7: Visualization also had a moderate predictive relationship with mathematical reasoning for the youngest age group (6 to 8 years). COG Test 14: Picture Recognition, a measure of the narrow ability of visual memory (MV), had a moderate predictive relationship with written expression for all age groups except the 9- to 13-year-olds. Test 14: Picture Recognition also had a moderate predictive relationship with reading comprehension for three of the age groups: 6 to 8, 9 to 13, and 40 to 90+ years. Finally, Test 14: Picture Recognition had a moderate predictive relationship with basic reading skills for two age groups: 14 to 19 and 40 to 90+ years.

Putting These Data Analyses Into Clinical Practice

McGrew (2015) suggested several uses for scholastic aptitude clusters:

- Predicting near-term academic performance
- Time-efficient, referral-focused selective testing
- Time-efficient, academic, domain-specific screening
- Time-efficient annual review evaluations
- Gifted and talented screening; identifying domain-specific talents
- Potentially estimating quickness of response to intervention

- Providing information regarding the concept of "expected underachievement"
- Formulation of differential academic domain expectations

One of the most useful applications of scholastic aptitude/achievement comparisons is the implementation of referral-focused selective testing. The WJ IV COG and OL tests that were strongly or moderately predictive of each of the eight areas of academic achievement are presented by each age group in Table 10. This table will provide clinicians with the fewest WJ IV COG and OL tests that would be predictive of potential academic disorders, which should improve the time efficiency of assessment.

Table 10.
Selective WJ IV Assessment Based on Scholastic Aptitude/Achievement Comparisons

	6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years
Basic Reading Skills					
Comprehension-Knowledge (*Gc*):					
OL 1: Picture Vocabulary (VL/LD)			■	■	■
OL 2: Oral Comprehension (LS)	■	■	■		■
Fluid Reasoning (*Gf*):					
COG 2: Number Series (RQ)	■	■	■	■	■
Reading Comprehension					
Fluid Reasoning (*Gf*):					
COG 2: Number Series (RQ)	■	■	■	■	■
COG 9: Concept Formation (I)	■	■	■	■	■
Processing Speed (*Gs*):					
COG 4: Letter-Pattern Matching (P)		■	■	■	■
COG 11: Number-Pattern Matching (P)	■				
Reading Fluency					
Comprehension-Knowledge (*Gc*):					
COG 8: General Information (K0)	■	■	■	■	■
Processing Speed (*Gs*):					
COG 4: Letter-Pattern Matching (P)				■	
COG 11: Number-Pattern Matching (P)	■	■	■	■	■
Auditory Processing (*Ga*):					
OL 9: Sound Awareness (PC)	■	■	■	■	■
Mathematical Calculations					
Comprehension-Knowledge (*Gc*):					
COG 8: General Information (K0)		■	■	■	■
Fluid Reasoning (*Gf*):					
COG 2: Number Series (RQ)	■	■	■	■	■
Processing Speed (*Gs*):					
COG 11: Number-Pattern Matching (P)	■	■	■	■	■
Mathematical Reasoning					
Fluid Reasoning (*Gf*):					
COG 2: Number Series (RQ)	■	■	■	■	■
Processing Speed (*Gs*):					
COG 17: Pair Cancellation (P/AC/SS)	■	■	■	■	■

Table 10. *(cont.)*
Selective WJ IV Assessment Based on Scholastic Aptitude/Achievement Comparisons

	6–8 Years	9–13 Years	14–19 Years	20–39 Years	40–90+ Years
Written Expression					
Fluid Reasoning (*Gf*):					
COG 2: Number Series (RQ)	■	■	■	■	■
Processing Speed (*Gs*):					
COG 4: Letter-Pattern Matching (P)		■	■	■	■
COG 11: Number-Pattern Matching (P)	■	■	■	■	■
Oral Expression					
Comprehension-Knowledge (*Gc*):					
OL 1: Picture Vocabulary (VL/LD)	■	■	■	■	■
COG 1: Oral Vocabulary (LS)	■	■	■	■	■
Short-Term Working Memory (*Gwm*):					
COG 18: Memory for Words (MS)	■	■	■	■	■
Listening Comprehension					
Comprehension-Knowledge (*Gc*):					
OL 2: Oral Comprehension (LS)	■	■	■	■	■
Fluid Reasoning (*Gf*):					
COG 2: Number Series (RQ)		■	■		

Note. The COG and/or OL tests that were the best predictors of each academic area were selected based on the highest beta weights. Those tests are marked with asterisks in Tables 1 through 8.

As an example, if a basic reading skills deficit is suspected in an 8-year-old student, the suggested WJ IV assessment battery would include measures of basic reading skills and the following two WJ IV COG tests:

- COG Test 2: Number Series
- OL Test 2: Oral Comprehension

Sometimes the type of specific learning disability (SLD) is not known and a more general assessment battery would be required. A review of our data analyses would suggest that a clinician could give 11 tests from the WJ IV COG and OL that would provide a good prediction of what problems might be expected for a diagnosis of SLD. These 11 tests are as follows:

- COG Test 1: Oral Vocabulary (*Gc*-VL/LD) for OE
- COG Test 2: Number Series (*Gf*-RQ) for BRS, RC, MC, MR, WE, and LC
- COG Test 4: Letter-Pattern Matching (*Gs*-P) for RC and WE
- COG Test 8: General Information (*Gc*-K0) for RF and MC
- COG Test 9: Concept Formation (*Gf*-I) for RC
- COG Test 11: Number-Pattern Matching (*Gs*-P) for RC, RF, MC, and WE
- COG Test 17: Pair Cancellation (*Gs*-P/AC/SS) for MR
- COG Test 18: Memory for Words (*Gwm*-MS) for OE
- OL Test 1: Picture Vocabulary (*Gc*-VL) for BRS and OE
- OL Test 2: Oral Comprehension (*Gc*-LS) for BRS and LC
- OL Test 9: Sound Awareness (*Ga*-PC) for RF

This suggested battery of tests could be used as a screener for SLDs.

Summary

In the past two decades, research on the relationship between cognitive abilities and specific academic skills has converged with research on cognitive-academic relationships within the context of CHC theory, the Woodcock-Johnson series of instruments, and the use of cognitive-academic relationships in the identification of SLDs. A significant amount of research has established that cognitive processes are relevant to learning and academic success. This connection between cognition and achievement is well documented (Flanagan & Alfonso, 2010; Flanagan, Ortiz, & Alfonso, 2013; Flanagan, Ortiz, Alfonso, & Mascolo, 2006; Fletcher, Lyon, Fuchs, & Barnes, 2007; Mascolo, Flanagan, & Alfonso, 2014; McGrew & Wendling, 2010; Miller, 2013).

The WJ IV Technical Manual (McGrew et al., 2014) presents scholastic aptitude clusters comprised of cognitive tests that are intended to be used to predict performance in related academic skills areas. The WJ IV Technical Manual reports the four tests from the WJ IV cognitive battery that are most predictive (according to the authors' analyses) of performance in a specific area of academic achievement (e.g., basic reading skills or math calculation). As previously mentioned, the analyses used in the present study were different from those used in the WJ IV Technical Manual; therefore, we expected that the results would be different as well. Again, our goal was not to replicate the WJ IV SAPT analyses, but rather to extend the research in the area of selective assessment with this measurement instrument.

The purpose of this Assessment Service Bulletin is to provide clinicians and researchers with knowledge of which tests of cognitive abilities and oral language are the best predictors of academic achievement across five developmental age ranges. Rather than administering all tests from the WJ IV COG and OL batteries to children suspected of having learning disabilities, clinicians can select from the 11 tests that were identified as the best predictors. Using a selective assessment approach based on scientific evidence will improve diagnostic accuracy and make assessments more time efficient. A processing strengths and weaknesses (PSW) approach to interpretation would suggest that these particular predictor variables or tasks (singularly or in combination) would be weaknesses (i.e., at least one standard deviation below the mean) for individuals with various types of learning difficulties. Thus, the predictor tasks (cognitive and/or oral language) would predict weak performance (i.e., at least one standard deviation below the mean) on their associated academic variables/tasks. However, future research needs to be conducted to determine how low the scores in these predictive cognitive and oral language domains must be to be reflective of specific academic deficits.

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