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PROFILE ANALYSIS OF THE WOODCOCK-JOHNSON III TESTS OF COGNITIVE ABILITIES WITH GIFTED STUDENTS

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The Cattell-Horn-Carroll (CHC) factor clusters of the Woodcock-Johnson III Tests of Cognitive Abilities (WJ III COG; Woodcock, McGrew, & Mather, 2001) were studied with a group of gifted (*n* = 51) and nongifted individuals (*n* = 51). Specifically, a profile analysis was conducted using the seven CHC factors identified by the WJ III COG authors. The gifted and nongifted individuals were between the ages of 5 and 18 years, and were matched on gender, age, ethnicity, and father's level of education. Each group consisted of 23 females and 28 males. The mean age in months for the gifted group was 135.61 (*SD* = 48.81), and the mean age in months for the nongifted group was 134.25 (*SD* = 47.86). The results of the profile analysis found gifted and nongifted individuals display similar patterns of performance across the CHC factor clusters. As expected, the gifted group, on average, scored consistently higher across the set of CHC factor clusters compared to the nongifted group. In addition, no intracognitive differences were found among the CHC factor clusters for either the gifted or nongifted group. Clinical and educational considerations when using the WJ III COG when assessing giftedness are also discussed.

One of the most prevalent uses of intelligence tests is in the identification of students with exceptional abilities. Professionals rely on the scores and qualitative information obtained from the use of tests of cognitive ability to assist in the identification of students with a broad range of learning disabilities, mental disorders, emotional disabilities, and students who are gifted. For example, the literature on learning disabilities contains a wealth of information concerning the use of intelligence tests as a diagnostic criterion; however, the identification of gifted students with similar measures is scant. Although the majority of this literature examines a variety of methods for identifying giftedness, including standardized intelligence tests (e.g., Wechsler Intelligence Scale for Children—3rd Edition and the Stanford-Binet Intelligence Scale—4th Edition), the Woodcock-Johnson Tests of Cognitive Abilities (WJR-TCA, WJ III COG) are rarely mentioned in the literature (Coleman & Cross, 2001; Davis & Rimm, 1994; VanTassel-Baska & Baska, 1993). The lack of knowledge surrounding the benefits of employing this test indicates a need for research that addresses the useful properties of the test battery, especially when identifying gifted students.

The majority of literature on identification for giftedness supports the use of multiple criteria including scores on standardized measures of cognitive ability, academic achievement, classroom performance, teacher reports, and parent nomination (Borland, 1989; Davis & Rimm, 1994; Renzulli & Reis, 1997). Kaufman and Harrison (1986) also support the use of multiple criteria for gifted assessment but strongly urge the use of an intelligence test as one of the criteria. The very nature of intelligence testing allows professionals to use their observations and diagnostic interviewing skills when assessing ability. A significant amount of qualitative information can be gained during a cognitive evaluation. For example, Robinson and Chamrad (1986) suggest information about a child's level of maturity, expression of thought, ideas, and strategy use can all be gleaned from the interaction between examiner and examinee during the evaluation process. This is the very information that can help teachers in planning for and implementing instruction with gifted students.

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One criticism of using intelligence tests in assessing students with exceptionalities is they provide a limited scope of information. Scores on tests of intellectual ability are often misused in making recommendations for educational programs that would be beneficial to gifted students. For example, the use of a single cutoff score may increase the likelihood of inappropriate placement or placement into programs that do not match the student's strengths (Sparrow & Gurland, 1998). This is often the case for students with learning disabilities, who are also gifted, because they do not match the cutoff requirements for either program and will not be identified for special services of either type (Baum, Owen, & Dixon, 1991; Brody & Mills, 1997). There are also specific cautions associated with testing gifted students. These include, a lack of ceiling for high ability students (Kaufman, 1992), bias toward particular groups (Fishkin, Garlow, & Kampsnider, 1994), the influence of speed on certain scores, and the lack of a firm theoretical basis (Fishkin & Kampsnider, 1996).

When assessing using tests of intelligence, the over reliance on a single score often ignores the complexity of abilities that influence how individuals think and solve problems (Horn & Noll, 1997). Gifted students display characteristics that are not adequately measured on batteries that rely on more broadly defined factors. Most recently, Rizza, Gridley, and Kipfer (1998) found the Woodcock-Johnson Tests of Cognitive Ability-Revised (WJR-TCA; Woodcock & Johnson, 1989) provided more insight into processing and specific skills than the Wechsler Intelligence Scale for Children—3rd Edition (WISC-III; Wechsler, 1991) with gifted students, thus providing more insight into the child's specific strengths and abilities. McGrew (1994) further purports that achievement is related to proficiency in areas like fluid reasoning, auditory and visual processing, and both short- and long-term memory. Thus, ability to achieve is not simply a byproduct of overall "g" but due in part to a combination of specific cognitive and processing abilities.

Several studies have investigated the use of the Woodcock-Johnson Tests of Cognitive Ability–Revised (Woodcock & Johnson, 1989) with a variety of student populations, and have added to the base of information on its validity and stability. In a comparison of the WJR-TCA with the WISC-R with gifted elementary school students, Ingram and Hakari (1985) found significant correlations between WISC-R Full Scale IQ and Broad Cognitive scores on the WJR-TCA. Mather and Udall (1985) also found the two scales displayed comparable scores with high-ability students. Lupart and Pyryt (1996) found the WJR-TCA useful in identifying underachieving gifted students because it identifies a broad range of cognitive processes that are often hidden by the underachieving students' school performance. Intelligence tests are not only effective tools for determining giftedness, they are also outstanding predictors of academic achievement, general development, and success outside the classroom (Kaufman & Harrison, 1986).

Among the numerous measures used to assess cognitive ability, the Woodcock-Johnson Tests of Cognitive Ability–Revised (Woodcock, & Johnson, 1989) is one of the most underused in psychoeducational assessment (Wilson & Reschly, 1996). The development of the WJR-TCA was based on the need for an assessment tool that measured more than the three standard factors (i.e., verbal, nonverbal, and overall intelligence) obtained in most other tests of cognitive ability. The test is an accurate example of the Horn-Cattell model of intelligence that acknowledges a truly multifaceted nature of intelligence. A number of factors were considered in the development of the WJ III COG, including a comprehensive content that utilized a greater range of cognitive functions, the ability to select particular areas to evaluate within the battery as well as the convenience of co-normed tests of academic achievement (Woodcock, 1997). The most notable change between the WJ and the WJ-R was the addition of Broad Ability scales based on the Gf-Gc theory. These include scales measuring Short-term Memory (Gsm), Long-term Retrieval (Glr), Fluid Reasoning (Gf), Processing Speed (Gs), Quantitative Ability (Gq), Comprehension/Knowledge (Gc), Auditory Processing (Ga), and Visual Processing (Gv). Among the several noteworthy revisions of the

Woodcock Johnson Test of Cognitive Ability—3rd Edition (WJ III COG; Woodcock, McGrew, & Mather, 2001) is the division of individual subtests into three broad cognitive areas (Verbal Ability, Thinking Ability, and Cognitive Efficiency). This change in structure measures a more specific aspect of broad ability as defined by the Cattel-Horn-Carroll (CHC) theory and the development of eight new tests measuring information-processing, tests of working memory, naming speed, attention, and planning (Mather & Woodcock, 2001). Two major sources of research were combined, the Horn-Cattell Gf-Gc theory (Horn, 1988, 1991) and Carroll's three-stratum theory of abilities (Carroll, 1993, 1998). The CHC theory combines the subtests on the Cognitive Battery of the WJ III COG into a seven-factor model that includes: Comprehension-Knowledge (Gc), Long-Term Retrieval (Glr), Visual-Spatial Thinking (Gv), Auditory Processing (Ga), Fluid Reasoning (Gf), Processing Speed (Gs), and Short-Term Memory (Gsm).

Given that prior research (Rizza, Gridley, & Kipfer, 1998) has found gifted students display specific strengths on the WJR-TCA, similar research is needed with the WJ III COG to determine if gifted students display specific patterns among the CHC factor clusters. Specifically, this study explored whether gifted and nongifted students displayed similar patterns of performance among the CHC factor clusters. In addition, this study sought to determine whether gifted and nongifted students display different profiles across the CHC factor clusters and what, if any, are the clinical and educational implications for using the WJ III COG when assessing giftedness.

Method

Participants

The sample included 51 gifted students and 51 nongifted students between the ages of 53 and 227 months. The gifted and nongifted students were matched on gender, age, ethnicity, and father's level of education. Each group consisted of 23 females and 28 males. The mean age in months for the gifted group was 135.61 (SD = 48.81) and the mean age in months for the nongifted group was 134.25 (SD = 47.86). The mean for the two groups is not exactly the same due to how the groups were matched. Although the two groups were matched as close as possible using age in months, there were participants who did not match exactly on age but matched exactly on gender, ethnicity, and father's education. When this occurred, participants were typically matched on age within 1–6 months from each other. There was no difference in mean age in months between the two groups, $t(100) = .141$, $p = .888$. Eighty percent of each group was composed of Caucasians (n = 41) and 20% of each group was composed of Asian/Pacific Islanders (n = 10). Socio-economic status was based upon the father's highest level of education. For each group, eight fathers were high school graduates, seven had 1–3 years of college, and 36 had a Bachelors degree or higher.

Instrumentation

The Woodcock-Johnson III Tests of Cognitive Abilities (WJ III COG; Woodcock, McGrew, & Mather, 2001) is an individually administered measure of cognitive abilities designed for students ranging in age from 2 to over 90 years. The standardization sample included over 8,000 individuals that closely matched the demographic and community characteristics of the U.S. population (Mather & Woodcock, 2001). The WJ III COG is comprised of 20 individual tests, each measuring a specific aspect of cognitive ability. These individual tests are combined to form cognitive performance clusters and Cattell-Horn-Carroll (CHC) factor clusters. For the purpose of this study, only the CHC factor clusters and the individual tests that comprise the clusters will be described. Seven CHC factor clusters were identified by the WJ III COG authors based upon the work of Cattell (1941, 1943, 1950), Horn (1988, 1991), and Carroll (1993, 1998). The median reliabilities for the CHC factor clusters ranged from .80 to .95 for children and adolescents ages 5 to 19. The CHC factor clusters include the following:

Comprehension-Knowledge (Gc) is composed of the Verbal Comprehension and General Information tests and is described as assessing crystallized intelligence (Mather & Woodcock, 2001). Crystallized intelligence is often described as one's verbal comprehension and verbal reasoning skills based on acquired knowledge.

Long-Term Retrieval (Glr) is composed of the Visual-Auditory Learning and Retrieval Fluency tests. The Glr factor assesses the ability to retrieve previously stored information from long-term memory (Mather & Woodcock, 2001).

Visual-Spatial Thinking (Gv) is the ability to perceive, analyze, and synthesize visually presented information and patterns. The Visual-Spatial Thinking factor also assesses the ability to store and recall visual information (Mather & Woodcock, 2001). The Visual-Spatial Thinking factor is composed of the Spatial Relations and Picture Recognition tests.

Auditory Processing (Ga) includes the ability to discriminate speech sounds that have been distorted or masked and the ability to process auditory information (Mather & Woodcock, 2001). In addition, the Auditory Processing factor assesses an individual's ability to analyze and synthesize speech and other auditory information. The Sound Blending and Auditory Attention tests contribute to the Auditory Processing factor.

Fluid Reasoning (Gf) is composed of the Concept Formation and Analysis-Synthesis tests. Reasoning, problem-solving, and concept formation is assessed by the Fluid Reasoning factor (Mather & Woodcock, 2001).

Processing Speed (Gs) is the ability to perform simple and speeded tasks efficiently (Mather & Woodcock, 2001). The Visual Matching and Decision Speed tests compose the Processing Speed factor.

Short-Term Memory (Gsm) assesses the ability to retain information in immediate memory then share that information within seconds (Mather & Woodcock, 2001). The Short-Term Memory factor is composed of the Numbers Reversed and Memory for Words tests.

Procedures

All 102 students were selected from a subset of the Woodcock-Johnson III Tests of Cognitive Abilities (WJ III COG; Woodcock, McGrew, & Mather, 2001) standardization sample. The gifted students were identified based upon a General Intellectual Ability Extended (GIAE) score of 125 or higher. In addition, only gifted students who had data for all seven of the Cattell-Horn-Carroll (CHC) factor clusters were selected. The selection of a cutoff score of 125 to designate giftedness allows for a broadened view of student strengths and weaknesses. Once the gifted students were identified, they were matched on age in months, gender, ethnicity, and father's highest level of education with nongifted students (GIAE score $\leq$ 124) from the standardization sample. Although the two groups were matched exactly on gender, ethnicity, and father's highest level of education, it was more difficult to match exactly on age in months. Therefore, a small number of participants who did not match exactly on age in months but matched on all the other variables were typically matched within 1–6 months of each other.

Results

Table 1 presents the Cattell-Horn-Carroll (CHC) factor cluster means and standard deviations for the gifted and nongifted students. A profile analysis was computed using the seven CHC factor cluster scores. A profile analysis was chosen to allow comparison of performance between the gifted and nongifted students on the CHC factors. Specifically, profile analysis answered the following three questions regarding the data:

Table 1
CHC Factor Means, Standard Deviations, and Ranges for the Gifted and Nongifted Groups

Factor	Gifted (*n* = 51)			Nongifted (*n* = 51)			Total (*n* = 102)		
	Mean	*SD*	Range	Mean	*SD*	Range	Mean	*SD*	Range
GSM	122.53	11.55	100–159	102.65	14.38	67–138	112.59	16.38	67–159
Gs	115.39	12.12	95–142	99.51	11.24	70–123	107.45	14.10	70–142
Gv	117.06	14.24	74–144	100.86	10.35	84–130	108.96	14.82	74–144
Ga	116.08	12.94	92–154	100.63	13.24	74–131	108.35	15.16	74–154
Glr	120.90	8.93	103–148	102.78	11.44	74–139	111.84	13.68	74–148
Gf	122.12	10.76	80–148	104.47	13.14	67–124	113.29	14.88	67–148
Gc	120.31	7.71	94–135	104.02	11.82	60–125	112.17	12.87	60–135
GIA	129.37	4.58	125–143	104.41	11.05	74–123	116.89	15.11	74–143

Note: Gsm = Short-Term Memory, Gs = Processing Speed, Gv = Visual-Spatial Thinking, Ga = Auditory Processing, Glr = Long-Term Retrieval, Gf = Fluid Reasoning, Gc = Comprehension-Knowledge, GIA = General Intellectual Ability (Extended).

1. Do gifted and nongifted students display the same pattern of highs and lows (Parallelism test) across the CHC factors?
2. Regardless of whether the profiles are parallel, does the gifted group, on average score higher (Levels test) across the CHC factors, as a set, compared to the non-gifted group?
3. If the profiles are parallel (gifted and nongifted students display similar CHC factor patterns), do the gifted and nongifted students when combined into one group display significantly higher or lower CHC factor scores?

Prior to computing the profile analysis, several assumptions regarding multivariate normality, outliers, homogeneity of variance–covariance matrices, and linearity were addressed. Multivariate normality was considered adequate because the sample sizes were identical and the samples far exceeded the number of dependent variables (Tabachnick & Fidell, 1996). Because the sample sizes were equal, examination of homogeneity of variance–covariance matrices was not needed (Tabachnick & Fidell). Also, because profile analysis can be sensitive to outliers, the presence of both univariate and multivariate outliers were assessed. Evaluation of frequencies and Box Plots did not find any univariate outliers, while no multivariate outliers were found using the Mahalanobis statistic.

The test for parallelism was not significant indicating that the gifted and nongifted students displayed similar patterns of highs and lows (see Figure 1) across the CHC factors, $F(6,95) = .492$, $p = .813$. The levels test was significant, $F(1,100) = 189.47$, $p = .001$, indicating that the gifted students, on average, scored consistently higher across the set of CHC factor clusters compared to the nongifted students. Because the gifted and nongifted students displayed the same pattern across the set of CHC factor clusters, the test of flatness was conducted. The test of flatness was significant, $F(6,95) = 4.066$, $p = .001$, indicating that when the gifted and nongifted groups were combined into one group, their scores were markedly higher or lower among the CHC factors. As a follow-up to the flatness test and to determine which CHC factor clusters were significantly different from each other, *t*-tests for dependent samples was computed for all possible pairwise comparisons. In addition, to control for alpha slippage due to multiple comparisons and to ensure a mean difference was significant at the .05 level, the Bonferroni procedure was used. Results found the Short-Term Memory (Gsm; Mean = 112.59) factor was significantly higher compared to the Processing Speed (Gs; Mean = 107.45) factor, $t(101) = 3.182$, $p = .04$. The Processing Speed factor was also found to be significantly lower compared to the Fluid Reasoning

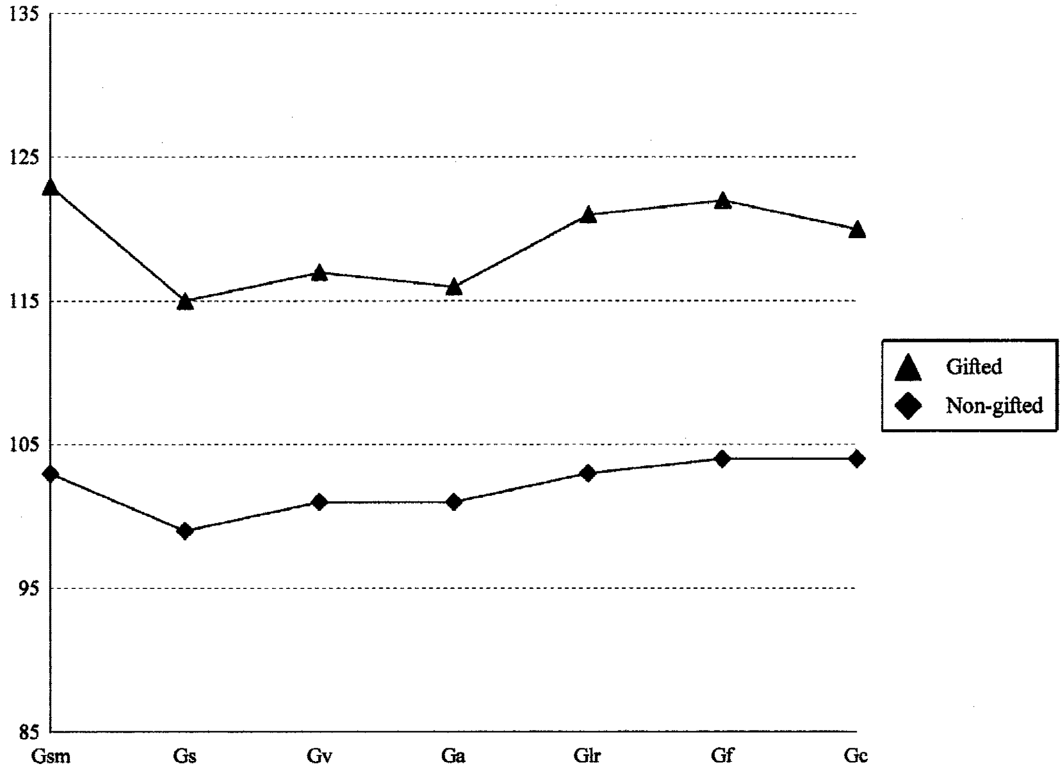

FIGURE 1. Mean CHC factor scores for the gifted and nongifted groups.
Note. Gsm = Short-Term Memory, Gs = Processing Speed, Gv = Visual-Spatial Thinking, Ga = Auditory Processing, Glr = Long-Term Retrieval, Gf = Fluid Reasoning, Gc = Comprehension-Knowledge.

(Gf; Mean = 113.29) and the Comprehension-Knowledge (Gc; Mean = 112.17) factors, $t(101) = -3.919$, $p = .003$ and $t(101) = -3.450$, $p = .02$, respectively. A significant difference was also found between the Auditory Processing (Ga; Mean = 108.35) and the Fluid Reasoning (Mean = 113.29) factors, $t(101) = -3.148$, $p =$;.05. T-tests for dependent samples were also computed comparing the mean CHC cluster scores for the gifted and nongifted groups separately. There were no significant differences found between the CHC factor scores for the gifted and nongifted groups.

Discussion

The Cattell-Horn-Carroll (CHC) factor clusters of the Woodcock-Johnson III Tests of Cognitive Abilities (WJ III COG) were studied with a group of gifted and nongifted students. Specifically, a profile analysis was conducted using the seven CHC factors identified by the WJ III COG authors (Woodcock, McGrew, & Mather, 2001). The results of the profile analysis found gifted and nongifted students display similar patterns of performance across the CHC factor clusters. This is in contrast to prior research by Rizza, Gridley, and Kipfer (1998) who found a group of gifted students displayed intracognitive discrepancies among the WJR-TCA tests. Specifically, in that study, the gifted sample displayed lower scores on the Auditory Processing (Ga) and Visual Processing (Gv) tests. The differing results found between the Rizza, Gridley, and Kipfer and the present study are most likely due to sampling differences and criteria used to identify the gifted students. For example, the present study used the WJ III COG General Intellectual Ability Extended (GIAE) score of 125 or higher as the primary criteria for giftedness, while the Rizza, Gridley, and Kipfer study used a WISC-III Full Scale IQ score of 125 and higher as the primary criteria for giftedness. Differences in performance on the WISC-III and the WJR-TCA would not have been surprising due to issues related to regression to the mean, standard error of measurement, and differences in scores found among individual IQ tests when assessing gifted students (McCallum, Karnes, & Edwards, 1984; Sattler, 1992). The present study also controlled for age, gender, ethnicity, and parent level of education, which is rarely conducted in gifted research. By controlling these variables, a higher level of confidence can be attributed to the present statistical results and corresponding interpretations.

As expected, the results of the present study found gifted students performed significantly higher across the CHC factor clusters compared to the nongifted group. This is not an unexpected result because gifted students, by nature of their advanced abilities, generally score higher on cognitive measures (Coleman & Cross, 2001; Sparrow & Gurland, 1998). The important consideration of this finding, however, is that the WJ III COG appears to be a good measure when assessing high ability children and adolescents. The clinical usefulness of the outcome may be seen when assessing high functioning students with possible learning problems (G/LD). For example, gifted students in general display consistent levels of performance across the CHC factor clusters; therefore, any differences found on specific factors would indicate the need for further evaluation. However, it should be noted that the current study did not intentionally include G/LD students. Additional research is needed to determine if G/LD students display a different pattern of performance across CHC factor clusters.

Although the gifted group performed consistently higher across the CHC factors compared to the nongifted group, some discussion is warranted regarding the use of group data to make inferences about individual students. For example, the intracognitive differences for an individual is averaged out when combined with other students to form group data. Therefore, it is important to be cognizant of the fact that many of the gifted students used in the present study most likely display intracognitive discrepancies among the CHC factor clusters. One approach to discovering the extent that intracognitive discrepancies played among gifted students on the WJ III COG could be to explore the occurrence and types of discrepancies for each individual, then pool this data to determine if the occurrence and types of CHC factor discrepancies are similar to nongifted students. Although time consuming, this would indeed provide a better understanding of the cognitive abilities of gifted students on the WJ III COG. Future researchers are encouraged to attempt this task.

The criteria used to identify students as gifted will also influence the statistical results. With the present sample, a WJ III COG General Intellectual Ability Extended (GIAE) score of 125 or higher was used. However, when reviewing the range of scores for the CHC factor clusters for the gifted and nongifted groups, it becomes evident that students within the nongifted group attained scores of 125 or higher on several of the CHC factor clusters. Consideration of performance across the CHC factor clusters when identifying giftedness would have indeed changed the nature of the results. Therefore, it is recommended that a more pragmatic approach to identifying giftedness be utilized when identifying giftedness with the WJ III COG. Specifically, consideration of performance on each of the CHC factor clusters could be considered as opposed to using a single score for identifying giftedness. This is consistent with current trends in the field, which recommends that students be identified using a matrix approach that takes into account a variety of strengths and abilities (Davis & Rimm, 1994; Renzulli & Reis, 1997).

The results of this study also provide a view of what is expected when assessing gifted students using the WJ III COG. A practical overview of the WJ III COG tests and administrations procedures suggest that the same issues of ceiling effects and penalties for time, as seen in evaluations using other cognitive measures like the WISC-III (Fishkin, & Kampsnider, 1996; Kaufman, 1992) are not present. One of the main strengths of the WJ III COG is that it was normed on a large sample that included a broad spectrum of individuals from diverse backgrounds and ages (Woodcock & McGrew, 2001). The items do span a wider range of ability than other measures, thus reducing the possibility of ceiling effects. Again, closer examination of specific WJ III COG test performance would give more information about this issue, but the consistency of the profile pattern does lend support of the WJ III COG for use with gifted populations. Another strength of the WJ III COG is that it provides several approaches (e.g., Performance Model and Information Processing Model; Mather & Woodcock, 2001) to better understanding the individual strengths and weaknesses of gifted students. Mather and Woodcock also note that the WJ III COG can assist in the development of individual treatments and program planning.

The present study examined the scores of a specific group of students who may not be representative of an entire gifted population. The current data, for example, only included students from Asian-American and Caucasian families. Interestingly, none of the African-American students within the subset of WJ III COG data met criteria for inclusion within our study. Therefore, the generalizability of the present study is limited to only Caucasian and Asian-American students. Additional research is warranted to fully understand the lack of representation of African-Americans scoring $\geq$125 on the WJ III COG. In addition, this study did not explore the differences at the individual test level. Future research may wish to investigate if differences are found at that level which may provide further understanding of the cognitive abilities of gifted students.

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