FACTOR STRUCTURE OF THE WECHSLER INTELLIGENCE SCALE FOR CHILDREN–THIRD EDITION AMONG GIFTED STUDENTS

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Factor analysis was applied to the Wechsler Intelligence Scale for Children–Third Edition (WISC-III) scores of 505 gifted students to evaluate the construct validity of the WISC-III with this population. Multiple criteria were used to determine the number of factors to retain for principal axis extraction. A two-factor solution that roughly mirrored the verbal comprehension and perceptual organization factors of the WISC-III normative sample appeared to be most supportable. Arithmetic, Picture Arrangement, and Coding subtests failed to contribute to this solution. These results are consistent with the hypothesis that subtests that emphasize speed of responding are not valid for gifted children and suggest that an alternative WISC-III composite score, the General Ability Index, may be a better summary of ability for gifted students.

Although giftedness may be defined in many ways (Stanley, 1997), students are often identified as gifted if they perform at superior levels on an individual intelligence test (Winner, 2000). In fact, IQ cutoff score requirements are often embedded in state education rules and regulations for identification of gifted students (i.e., State Board of Education, 2000).

Of the many available intelligence tests, the Wechsler Intelligence Scale for Children–Third Edition (WISC-III) (Wechsler, 1991) is the most popular

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for the assessment of gifted children (Sparrow & Gurland, 1998). The WISC-III is based on Wechsler's (1991) notion of intelligence as "an aggregate and global entity" (p. 1) and was not derived from a specific theoretical structure (Macmann & Barnett, 1992, 1994).

Whereas traditional theories focus on a general intelligence (*g*), more contemporary theories (e.g. P. Cattell's [1963] Gf-Gc; Sternberg's [1986] triarchic; Das, Kirby, & Jarman's [1975] simultaneous and successive processing; Gardner's [1983] multiple intelligences) postulate that intelligence is a broad construct that goes beyond *g*. Although the WISC-III has an atheoretical foundation, several contemporary theories have been applied to this widely used test (Flanagan, McGrew, & Ortiz, 2000). Whether the WISC-III measures *g* or multiple abilities in addition to a general factor, however, remains a point of contention (Daniel, 1997; Kush, 1996).

Regardless of its theoretical foundation, Kaufman (1992) opined that the WISC-III is a "carefully constructed, technically superior instrument, with attractive materials, sensitive items (by gender and ethnicity), exceptional standardization, strong construct validity, reliable and stable IQ scores, and intelligently written manuals that facilitate test interpretation" (p. 158). Although generally positive, Kaufman also acknowledged that "many more validity studies are needed to help delineate the role of the . . . WISC-III for use with gifted or potentially gifted children" (p. 158).

Factor analysis constitutes one major source of statistical evidence regarding the construct validity of a test. Construct validity comprises the evidence supporting the appropriateness of inferences and actions taken on the basis of test scores (Messick, 1995). Factor analysis of the Wechsler Intelligence Scale for Chidren–Revised (WISC-R) (Wechsler, 1974) among students in regular and special education programs suggested a robust two-factor structure with mixed support for a third factor (Sattler, 1992). Although not uniform, studies of the WISC-R factor structure among gifted students also produced evidence of two factors and inconsistent evidence for a third factor (Brown, Hwang, Baron, & Yakimowski, 1991; Brown & Yakimowski, 1987; Karnes & Brown, 1980; Macmann, Plasket, Barnett, & Siler, 1991; Masten, Morse, & Wenglar, 1995).

However, there are many differences between the WISC-R and the WISC-III (Sparrow & Gurland, 1998), and results from the older test cannot be uncritically assumed to generalize to the newer instrument. Kaufman (1992), in his review of the WISC-III, expressly called for a replication of WISC-R factor analytic studies among gifted students. Although Wechsler (1991) reported that the WISC-III was composed of four factors for children of high ability, methodological details were sparse. No other factor analysis of WISC-III scores among gifted students has been reported. Consequently, the present study applied factor analysis to the WISC-III scores of gifted students to better evaluate the construct validity of the WISC-III with this population.

Method

Participants

The participants in this study were 505 students (266 male and 239 female) enrolled in gifted education programs in Pennsylvania. They were predominately of elementary school age (median age = 8 years, median grade = 3). Ethnic background was reported to be 82.6% White, 3.4% Black, and 3.8% other, with 10.3% of unknown ethnicity.

Instrument

The WISC-III is an individually administered test of intellectual ability for children aged 6-0 to 16-11 years. The standardization sample consisted of 2,200 children selected so as to represent a random sample of U.S. children stratified by age, gender, race/ethnicity, geographic region, and parent education. The WISC-III contains 10 mandatory and 3 optional subtests ($M = 10$, $SD = 3$). The 10 mandatory subtests combine to yield verbal (VIQ), performance (PIQ), and full-scale (FSIQ) scores ($M = 100$, $SD = 15$).

Of the 3 optional subtests, the Mazes subtest does not contribute to IQ or index scores and is only employed when a mandatory subtest has been spoiled by administration error. Consequently, it is almost never used in practice. Factor analytic studies of the WISC-III normative sample reported four factors when 12 subtests were analyzed (Wechsler, 1991). This purported four-factor, first-order solution of the WISC-III consisted of (a) verbal comprehension (VC) composed of Information, Similarities, Vocabulary, and Comprehension subtests; (b) perceptual organization (PO) composed of Picture Completion, Picture Arrangement, Block Design, and Object Assembly subtests; (c) freedom from distractibility composed of Arithmetic and Digit Span subtests; and (d) processing speed composed of Coding and Symbol Search subtests. A factor analysis of only the 10 mandatory subtests among the WISC-III standardization sample was not reported.

Procedure

All 373 regular members of the Association of School Psychologists of Pennsylvania during 1997-1998 and 1998-1999 were asked via letter to participate in this study by contributing WISC-III scores from anonymous students enrolled in gifted programs in their schools. Thirty-seven responded with data on 533 students. Congruent with previous surveys of school psychologists (Canivez & Watkins, 1998), the 3 optional WISC-III subtests were rarely administered. Consequently, only cases with scores on the 10 mandatory WISC-III subtests were included. This resulted in complete WISC-III data on 505 gifted students. Because responses were anonymous, there were no demographic data about the contributing school psychologists.

Gifted eligibility in Pennsylvania requires an “IQ or 130 or higher . . . [but] a person with an IQ score lower than 130 may be admitted to gifted programs when other educational criteria in the profile of the person strongly indicate gifted ability” (State Board of Education, 2000, pp. 6335). Some gifted students in the present sample attained FSIQ scores below 130, but multidisciplinary evaluation teams determined that they exhibited superior performance on other WISC-III (i.e., VIQ, PIQ, FSIQ, VC, PO, etc.) or educational metrics. Following Pennsylvania regulations, they were therefore determined to be eligible for special educational programming and were consequently retained for analysis in the present study.

Results

As illustrated in Table 1, mean WISC-III IQ and subtest scores for this sample of gifted students were considerably above the normative mean. It is also apparent that this gifted sample demonstrated less variation than the normative sample. Because factor analysis is based on correlation matrices, range restriction in variables can result in smaller correlation coefficients and thereby perturb factor analytic results (Hunter & Schmidt, 1990; Woodward & Hunter, 1999). Consequently, the correlation matrix was corrected for restriction of range using a formula presented by Alexander, Carson, Alliger, and Carr (1987). Consistent with previous research with gifted students (Detterman & Daniel, 1989), the average corrected intercorrelation between subtests (see Table 2) was smaller than the WISC-III standardization sample (i.e., .05 vs. .50).

Because relationships among latent variables were of concern, common factor analysis was conducted on the corrected correlation matrix (Gorsuch, 1990). Principal axis extraction, with squared multiple correlations providing initial communality estimates, was applied due to its lack of assumption about the distribution of the variables (Cudeck, 2000; Fabrigar, Wegener, MacCallum, & Strahan, 1999). Multiple criteria were used to determine the number of factors to retain for rotation: parallel analysis (PA) (Horn, 1965), the minimum average partial (MAP) (Velicer, 1976), and the scree test (R. B. Cattell, 1966). A simulation study by Zwick and Velicer (1986) found that PA and MAP procedures were highly accurate and the scree test was a useful adjunct. The MAP procedure indicated that only one factor was necessary, but both the scree test and the PA criteria suggested two factors should be retained. Following the recommendation of Wood, Tataryn, and Gorsuch (1996) that overextraction is preferable to underextraction, one-, two-, and three-factor solutions were retained so that theoretical convergence could also be considered (Ford, MacCallum, & Tait, 1986).

Table 1
Wechsler Intelligence Scale for Children–Third Edition Descriptive Statistics Among 505 Gifted Students

	M	*SD*	Minimum	Maximum
Verbal IQ	131.2	7.25	111	151
Verbal Comprehension	130.9	7.99	108	149
Performance IQ	127.2	9.27	95	150
Perceptual Organization	125.8	9.16	99	150
Full-Scale IQ	131.8	5.65	116	148
Picture Completion	13.5	2.21	5	19
Information	15.1	1.95	9	19
Coding	13.5	2.82	5	19
Similarities	15.8	1.87	10	19
Picture Arrangement	14.2	3.06	6	19
Arithmetic	14.6	2.52	7	19
Block Design	15.7	2.78	8	19
Vocabulary	15.5	2.22	8	19
Object Assembly	13.4	2.47	7	19
Comprehension	15.4	2.34	8	19

Table 2
Correlations Among 10 Wechsler Intelligence Scale for Children–Third Edition Subtests for 505 Gifted Students, Corrected for Restriction of Range

	PC	IN	CD	SM	PA	AR	BD	VO	OA	CM
PC	1	–.07	.05	.02	.11	–.03	.19	.01	.26	–.03
IN		1	–.25	.71	–.14	.14	–.01	.53	–.11	.23
CD			1	–.25	.08	–.03	.07	–.24	.04	–.15
SM				1	–.15	–.07	.05	.55	–.17	.38
PA					1	–.03	.05	–.17	.05	–.07
AR						1	.17	.04	.13	.14
BD							1	–.12	.36	–.24
VO								1	–.12	.37
OA									1	–.12

Note. PC = Picture Completion; IN = Information; CD = Coding; SM = Similarities; PA = Picture Arrangement; AR = Arithmetic; BD = Block Design; VO = Vocabulary; OA = Object Assembly; CM = Comprehension.

To maintain consistency with WISC-III standardization sample analyses (Wechsler, 1991), varimax rotation was applied. Salience of pattern/structure coefficients was set at $|.30|$ given the statistical significance produced by the size of this sample (Hair, Anderson, Tatham, & Black, 1998). To be eligible for interpretation, rotated factors were required to be loaded by at least two salient pattern/structure coefficients (Nunnally & Bernstein, 1994).

Table 3
Initial Communities and Structure/Pattern Coefficients for One-, Two-, and Three-Factor Orthogonal Solutions for Wechsler Intelligence Scale for Children–Third Edition Among 505 Gifted Students

	One Factor	Two Factors		Three Factors			
Subtest	I	I	II	I	II	III	Initial Communality
Information	*.76*	*.78*	.10	*.76*	.02	.07	.594
Similarities	*.83*	*.86*	.10	*.93*	.11	–.22	.657
Vocabulary	*.70*	*.69*	–.05	*.67*	–.11	.03	.399
Comprehension	*.44*	*.43*	–.17	*.42*	–.24	.13	.302
Picture Completion	–.08	–.05	*.31*	–.03	*.33*	–.06	.115
Picture Arrangement	–.20	–.20	.06	–.19	.09	–.05	.050
Block Design	–.13	–.09	*.74*	–.04	*.73*	.11	.286
Object Assembly	–.21	–.19	*.51*	–.16	*.49*	.15	.217
Coding	*–.32*	*–.32*	.04	*–.31*	.07	–.04	.091
Arithmetic	.05	.06	.17	.08	.10	*.73*	.187

Note. Italicized loadings are salient for that factor.

Results for the one-, two-, and three-factor solutions for the participating gifted students are presented in Table 3. These results were robust to extraction and rotation method. Maximum likelihood extraction as well as oblique rotation resulted in similar pattern/structure coefficients for both two- and three-factor solutions.

Discussion and Conclusions

Common factor analysis was applied to the WISC-III scores of 505 students enrolled in gifted programs in Pennsylvania. The one-factor solution was composed of four verbal subtests, with the Coding subtest exhibiting a salient negative loading. An examination of the residual correlations found many ≥ |.10|, indicating that there could be other factors to consider in the data (Cudeck, 2000). When three factors were retained and rotated, the Arithmetic subtest alone comprised the third factor. The two-factor solution appeared to be most supportable in that its first factor had four salient pattern/structure coefficients, its second factor was composed of three salient pattern/structure coefficients, only two residual correlations exceeded |.10|, and the two factors accounted for 31.8% of the total variance. In this solution, Picture Arrangement and Arithmetic did not load on any factor and Coding exhibited a negative pattern/structure coefficient on the verbal factor.

This two-factor solution for the WISC-III among gifted students is similar to the results reported by Macmann et al. (1991) for their factor analysis of the WISC-R for 829 children with FSIQs ≥ 120. This solution also generally corresponds to the first two factors found by Karnes and Brown (1980) in their factor analysis of 946 gifted students' WISC-R scores. It also roughly mirrors the verbal comprehension and perceptual organization factors found in the WISC-III normative sample (Wechsler, 1991). Consequently, confidence in the present results is increased by this consistency across tests and populations.

Researchers recommended that WISC-R Arithmetic and Coding subtest scores not be used to determine eligibility for gifted programming due to their reliance on speed of responding (Bireley, Languis, & Williamson, 1992; Reams, Chamrad, & Robinson, 1990). As noted by Kaufman (1992), the WISC-III places more emphasis on speed of responding than does the WISC-R, with bonus points for speed being emphasized for the Arithmetic and Picture Arrangement subtests. Of course, the Coding subtest has always been highly speeded. This speed component might account for the failure of the Arithmetic, Picture Arrangement, and Coding subtests to contribute in the current factor analysis. To this end, Kaufman (1992) suggested that "it is well known that gifted children, as a group, don't excel quite as much in sheer speed" (p. 157). These speculations are congruent with the conclusions of other researchers (Fishkin, Kampsnider, & Pack, 1996; Sparrow & Gurland, 1998).

Prifitera, Weiss, and Saklofske (1998) suggested that the traditional FSIQ might not be the best way to summarize overall ability under certain conditions because "it can be unduly influenced by certain working memory and speed-of-information processing subtests" (p. 22). Consequently, it may be reasonable to use an alternative summary of ability with gifted students because the failure of Arithmetic, Picture Arrangement, and Coding to contribute variance to the factor analysis makes their unit-weighted summation in the traditional FSIQ suspect.

Prifitera et al. (1998) proposed an alternative composite score called the General Ability Index (GAI), which excludes Arithmetic and Coding. By removing the speed influence of the Coding and Arithmetic subtests, the eight-subtest GAI "may represent the best summary of the student's overall intelligence" (Prifitera et al., 1998, p. 19). Although Picture Arrangement is included in the GAI, it constitutes only one of eight (12.5%) subtests, whereas the FSIQ contains three (30%) noncontributing subtests. Because the GAI can be computed from a norms table that was derived from the WISC-III standardization sample of 2,200 children, it can be used with greater confidence than any composite score created by extrapolation. Thus, we recommend that the GAI be used to determine eligibility for gifted services and placement decisions instead of the traditional FSIQ.

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