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INTELLIGENCE AND ACHIEVEMENT: JUST HOW CORRELATED ARE THEY?

Jack A. Naglieri
Brienan T. Bornstein
George Mason University

The purpose of this study was to summarize the correlations between individually administered tests of intelligence and achievement reported in various test manuals and published journal articles. An exhaustive review of published findings yielded data that were organized into two groups: studies involving correlations between (a) IQ and achievement test composites and (b) IQ and achievement subtests. Within these two areas, data were further divided into studies involving small ($n < 200$) and large ($n > 200$) samples. For the large studies, the ability/achievement composite correlations for the K-ABC (.74) followed by the CAS and WJ-III (both .70) were the top ranked. Results for the large-scale ability and achievement subtest studies demonstrated that the CAS (Standard and Basic Batteries, respectively) had the highest correlations with achievement subtests (.65 and.64), followed by the K-ABC (.63). Thus, the two measures of cognitive processing consistently had the highest correlations with achievement despite the fact that they do not contain achievement-like subtests found in all the other ability measures. These and other findings are discussed and contribute to the conclusion that measures of basic psychological processes offer a viable alternative to traditional IQ for the correlation with achievement.

School psychologists typically relate information about a student's intellectual or cognitive characteristics to academic successes and failures. It is, therefore, important to assess the validity of the relationships between IQ and achievement. One approach to evaluate the validity of the relationship between IQ and acquired skills is to examine the correlations between ability and achievement test scores. Regardless of whether the ability test is based on a general intelligence model (e.g., the approach used in the Wechsler Scales) or a multidimensional cognitive processing approach like the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983) or the Planning, Attention, Simultaneous, Successive (PASS) theory operationalized by the Cognitive Assessment System (CAS; Naglieri & Das, 1997), the relationship between these measures of ability and achievement is important to study. If there is a strong relationship between them, it can be concluded that the intelligence test plays an important role (in conjunction with other variables such as the curriculum, the teacher, the characteristics of the school, and so forth) in scholastic performance.

Although the examination of the relationship between ability and achieve-

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Correspondence concerning this article should be addressed to Jack A. Naglieri, Department of Psychology, MSN 2C6, George Mason University, Fairfax, VA 22030. E-mail: naglieri@gmu.edu.

ment seems straightforward, there is one critical issue that complicates the comparison. Specifically, some tests of ability have content that is very similar to the content found in achievement tests. Content overlap is found when the child's answer relies on specific information that is shared across two tests despite differences in how the answer is expressed. For example, a multiple-choice vocabulary test and a free-response vocabulary test have differences in format, but the content required for arriving at the answer (knowledge of the definition of the word), which is the essence of the question, is the same. Similarly, math word problems can be presented in written format with multiple-choice answers or orally by an examiner with pictorial cues, but what they share is the requirement that the child solve the problem using a variety of math skills. Even though the formats may differ and introduce method variance, they share the common requirement of application of math knowledge and skills.

School psychologists are very familiar with the fact that verbal and quantitative tests of "ability" found on tests like the Stanford-Binet IV (SB-IV; Thorndike, Hagen, & Sattler, 1986), WISC-III (Wechsler, 1991), Differential Ability Scales (DAS; Elliot, 1990), and Woodcock-Johnson III (WJ-III; Woodcock, McGrew, & Mather, 2001a) all contain subtests that are very similar to those found in tests of achievement. For example, these tests of ability contain subtests that require the child to know the meaning of words. Knowledge of word definitions is also found on group tests of achievement, such as the Stanford Achievement Test, Ninth Edition (SAT^9, 1995). Similarly, the WISC-III Information subtest measures general knowledge in a variety of areas, and the Peabody Individual Achievement Test-Revised (PIAT-R; Dunn & Markwardt, 1989) has a subtest called General Information that asks the same kinds of questions. Picture vocabulary tests are used on both the WJ-III Tests of Cognitive Abilities (Woodcock et al., 2001a) and WJ-III Tests of Achievement (Woodcock, McGrew, & Mather, 2001b) in the Verbal Comprehension and Picture Vocabulary portions, respectively. Additionally, arithmetic subtests that involve either oral or written word problems are also included in tests of intelligence and achievement. This overlap in content across "intelligence" and "achievement" tests has important practical as well as research implications.

Content overlap in tests of cognitive abilities and tests of achievement complicate the study of the validity of intelligence tests because the similarity inflates the correlation between these two types of tests. The recognition that this overlap in content was undesirable for both research and practical reasons influenced the structure of tests such as the K-ABC (Kaufman & Kaufman, 1983) and the CAS (Naglieri & Das, 1997). These authors have suggested that a test of ability can be effective without this criterion contamination. The purpose of this study, therefore, was to evaluate this assertion and conduct a thorough and up-to-date examination of the relationships between major tests of ability and achievement and to answer two main questions: First, how strongly do ability and achievement correlate and, second, do all tests of ability correlate similarly with achievement?

METHOD

Research investigations that examined the relationships between individually administered tests of intelligence and achievement were included in this study if (a) Pearson correlations were reported between ability and achievement; (b) the study included normal, school-aged children; (c) the study had an adequate sample size ($N \geq 20$); and (d) the study was published and written in English (excluding doctoral dissertations). Examination of these studies involved three phases. During the first phase, correlations, sample means, standard deviations, and the number of participants within the validity studies from the following test manuals were entered into a database: Cognitive Assessment System (CAS; Naglieri & Das, 1997), Differential Ability Scales (DAS; Elliot, 1990), Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983), Stanford-Binet Intelligence Scale-4th Edition (SB-IV; Thorndike et al., 1986), Wechsler Individual Achievement Test (WIAT; Wechsler, 1992), Wechsler Intelligence Scale for Children-Third Edition (WISC-III; Wechsler, 1991), Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R; Wechsler, 1989), Wide Range Achievement Test-Third Edition (WRAT-3; Wilkinson, 1993), and the Woodcock Johnson-Third Edition (Woodcock et al., 2001b).

In the second phase, published journal articles were identified using a computerized literature search (PsycInfo and ERIC databases). The search included studies through November 2001 using specific test names as search terms. The sample size, mean test scores, standard deviations, and Pearson correlations were recorded.

Finally, the third phase involved data compilation and evaluation. The data were organized into several sets to arrive at the most presentable format. The set based on the Full Scale scores of each cognitive test was chosen and partitioned into four tables. Table 1 includes the Full Scale measures correlated with achievement composites. The specific composites included for each achievement test, as well as their means and standard deviations, were organized into Appendix A by study number. Table 2 includes the correlations between each test's Full Scale measure and achievement subtest scores. Finally, Appendix B includes the means and standard deviations of each achievement subtest that contributed to the correlation, also organized by study number. To reduce the number of values to report, intelligence-achievement test correlations were averaged by intelligence test using Fisher z transformations for the achievement subtests or composites. In cases where there was only one achievement subtest or composite value to correlate with the Full Scale intelligence test, the Pearson correlation was reported. The data were organized into groups of similar sample size; small sample sizes included studies with samples less than 200 participants, and large sample sizes included studies with samples more than 200 participants. Within these groups, the correlations were rank ordered.

Table 1

Intelligence Test Full Scale Means, SDs, Ns, and Correlations with Achievement Composite Standard Scores

	Cognitive Test	Variable	*M*	*SD*	*n*	Achievement Test	*n*	Pearson	Average *r*
Small *N* Studies									
1	SB-IV	COMP	112.7	21.6	175	K-ABC ACH	175	.89	
2	DAS	GCA	102.8	11.1	27	K-ABC ACH	18	.78	
3	WPPSI-R	FSIQ	95.2	11.7	50	K-ABC ACH	50	.70	
4	K-ABC	MPC	101.1	12.3	78	KeyMath DAT	78	.69	
5	WJ-III	GIA-EXT	NG	NG	NG	WJ-III ACH	147-150		.65
6	WJ-III	GIA-STD	NG	NG	NG	WJ-III ACH	147-150		.64
7	K-ABC	MPC	115.1	17.6	31	WJ	31		.62
8	WISC-III	FS	NG	NG	46	WJ-R	46		.61
9	CAS	FS	NG	NG	46	WJ-R	46		.58
10	WPPSI-R	FSIQ	NG	NG	28	GORT	28	.58	
11	WPPSI-R	FSIQ	113.6	11	50	CTP-II ACH	50		.56
12	K-ABC	MPC	101.9	12.1	63	Stanford Reading	63	.55	
13	WISC-III	FSIQ	NG	NG	NG	WJ-III ACH	147-150		.53
14	K-ABC	MPC	108.1	10.6	29	PIAT	29	.52	
15	K-ABC	MPC	118.1	13.23	41	K-ABC ACH	41	.33	
Large *N* Studies									
16	K-ABC	MPC	NG	NG	1500	K-ABC ACH	1500		.74
17	WJ-III	GIA-EXT	NG	NG	555-1102	WJ-III ACH	202-1,940		.70
18	CAS STD	FS	100.0	14.7	1600	WJ-R ACH	1600		.70
19	CAS BAS	FS	99.9	14.7	1600	WJ-R ACH	1600		.69
20	WJ-III	GIA-STD	NG	NG	643-1547	WJ-III ACH	202-1,940		.68
21	WISC-III	FSIQ	NG	NG	1284	WIAT	1,284		.63

RESULTS

Table 1 provides correlations between the Full Scale scores on the ability tests and the standard scores for composites or clusters from various achievement tests for both small (n = 13) and large studies (n = 6). For the small studies, sample sizes ranged from 27 to 175. Single correlations are included in the table under the Pearson column; when more than one achievement test composite was provided, an averaged correlation is given under the Average correlation column. The minimum correlation was .33 (between the K-ABC MPC and achievement) and the maximum was .89 (between the SB-IV and the K-ABC Total Achievement). The median of these correlations was .61. It is important to note that the results for the highest correlation found (.89) in study 1 (Table 1) should be considered an overestimate because the standard deviation of the SB-IV was considerably larger (21.6) than the normative standard deviation (16.0). Additionally, the varying magnitude of the correlations in this group of studies is related to the different sample sizes, which are strongly related to the standard error of measurement of the correlation coefficient (Guilford & Fruchter, 1978).

Also provided in Table 1 are the results for the six large-scale studies (sample sizes ranged from 1,284 to 1,940 participants). The minimum ability/achievement correlation for this group of studies was .63 (between the WISC-III and the WIAT), and the maximum correlation was .74 (between the K-ABC Mental Processing Composite and K-ABC achievement composites). These studies produced a narrower range of correlations (range = .11) and an overall median correlation of .70. The K-ABC correlation was the highest, followed by correlations of .70 for the CAS Standard Battery and WJ-III Extended Battery, and a correlation of .69 for the CAS Basic Battery.

Table 2 provides correlations between the Full Scale scores on the cognitive tests and the achievement subtests. The investigations (n = 16) with small sample sizes ranged from 23 to 198 participants, whereas large-scale studies (n = 7) had sample sizes that ranged from 544 to 2,400 participants. The minimum correlation within the small group was .36 (K-ABC and PIAT) and the maximum correlation was .64 (also between the K-ABC and PIAT achievement). This demonstrates the instability that may be produced with studies of such small sample sizes. The range between these two correlations was quite large (.28). The median correlation was .54. In contrast, the minimum correlation among the seven large studies was .47 (K-ABC and the Written Computation subtest of the Key Math Diagnostic Arithmetic Test) and the maximum correlation (Standard Battery for the Cognitive Assessment System and the WJ-III achievement subtests) was .65, producing a range of .18. The median correlation among this group of large studies was .63. The highest correlation found was for the CAS Standard Battery (.65), followed by the CAS Basic Battery (.64) and then the K-ABC (.63).

In summary, the ability and achievement composite results for small studies (Table 1) indicated that the SB-IV (.89) yielded the highest correlation, followed by the DAS (.78) and WPPSI-R (.70). For the large studies of ability with achievement composites, the K-ABC (.74) was followed by the CAS and WJ-III (both .70). As demonstrated in Table 2, the ability and achievement subtest

Table 2

Intelligence Test Full Scale Means, SDs, N, and Correlations with Achievement Test Subtest Standard Scores

	Cognitive Test	Variable	*M*	*SD*	*n*	Achievement Test	*n*	Pearson	Average *r*
Small *N* Studies									
1	K-ABC	MPC	NG	NG	51	PIAT	51		.64
2	WISC-III	FSIQ	98.5	20.2	100	WRAT-3	100		.63
3	SB-IV	COMP	109.8	12.8	55	DAS ACH	55		.61
4	WPPSI-R	FSIQ	95.2	11.7	50	K-ABC ACH	50		.61
5	K-ABC	MPC	101.1	12.3	78	KeyMath DAT	78		.60
6	DAS	GCA	102	13.6	157-198	BASIS	157-198		.57
7	K-ABC	MPC	112.0	14.3	40	K-ABC ACH	40		.55
8	WISC-III	FSIQ	105.5	11.2	27	DAS ACH	27		.54
9	WAIS-R	FSIQ	102.7	14.5	40	WRAT-3	40		.54
10	K-ABC	MPC	100.1	15.6	45	WRAT	45		.53
11	K-ABC	MPC	111.9	12.5	18-27	DAS ACH	18-27		.53
12	WPPSI-R	FSIQ	NG	NG	60	WRAT	210		.51
13	K-ABC	MPC	112.03	14.3	40	WRAT	40		.51
14	K-ABC	MPC	101.9	12.1	63	Stanford Diag. Read.	63		.50
15	WISC-III	FSIQ	105.6	13.6	23	WRAT-R	23		.47
16	K-ABC	MPC	108.1	10.6	29	PIAT	29		.36
Large *N* Studies									
17	CAS STD	FS	100.0	14.7	1600	WJ-R ACH	1600		.65
18	CAS BAS	FS	99.9	14.7	1600	WJ-R ACH	1600		.64
19	K-ABC	MPC	NG	NG	1500	K-ABC ACH	1500		.63
20	K-ABC	MPC	100.6	14.4	592	WRMT	592	.63	
21	WISC-III	FSIQ	NG	NG	1284	WIAT	NG		.58
22	DAS	GCA	NG	NG	2400	DAS ACH	2400		.57
23	K-ABC	MPC	101.4	13.8	544	KeyMath DAT	544	.47	

results for the small studies indicate that the K-ABC has the highest correlation with achievement subtests (.64), closely followed by the WISC-III (.63), and the results for the large-scale ability and achievement subtest studies demonstrate that the CAS had the highest correlations with achievement subtests (.65 and .64), followed by the K-ABC (.63). Thus, the two measures of cognitive processing consistently had the highest correlations with achievement despite the fact that they do not contain achievement-like subtests.

DISCUSSION

Examination of the relationships between the various tests of ability and achievement studied here is limited by a number of important factors. First, some of the results were based on tests given to the same children during standardization from which standard scores were also derived (K-ABC, WJ-III, and DAS), and others were based on scores from overlapping samples (WISC-III and WIAT). In contrast, some results were based on ability and achievement tests that were separately normed (e.g., CAS and SB-IV with achievement). When the same children are included in the standardization samples of both the achievement and ability tests and they are tested at similar points in time, it can be inferred that the amount of subject variance is reduced. A second confounding factor is that some of the correlations were based on samples that were not normally distributed (that is, the obtained standard deviations were not the same as the value set by the authors). This makes the comparison of results across studies difficult because when sample SDs are larger than intended by the author, the increased variability serves to increase the size of the correlation. Unfortunately, in some cases (WJ-III) standard deviations for the variables were not reported, severely limiting the interpretation of the obtained correlations. The application of a correction for restriction in range formula was, therefore, not applied because it could not be applied in all instances. Third, different achievement tests were used across the various studies, which may introduce variability due to item content. Fourth, some of the samples, particularly the small-scale studies, were different on a number of demographic variables, sample sizes, or sample composition. Fifth, subtests and composite score data were not provided in each study (e.g., the WJ-III authors provided correlations only between the cognitive portion of that test and achievement cluster scores but not achievement subtest scores, presumably because the correlations with subtests were lower due to reliability limitations). Sixth, significance testing of the differences between the correlations across ability tests could not be conducted, for example, between the WJ-III and CAS, because the numbers of subjects included in the WJ-III cognitive and achievement intercorrelation table varied considerably (from 202 to 1,940) due to the sampling method utilized by the authors. Seventh, and most important, some tests of ability were very similar to tests of achievement (e.g., WJ-III), artificially inflating the correlation between these measures. In light of these limitations, however, some important conclusions can be drawn.

First, the K-ABC and CAS correlated surprisingly well with achievement subtest scores (.63 and .65, respectively) and composite scores (.74 and .70, respectively). The ability/achievement correlations for these two tests of cognitive processing were strong and similar to the correlations found for the general

intelligence model used by the WISC-III and DAS tests. These findings imply that tests of general intelligence built on methods and models developed at the end of the 1800s and early 1900s (Wasserman, 2003) do not correlate higher with achievement than do tests of cognitive processing published in the last 20 years. These findings provide a good rationale for practitioners to move beyond traditionally formatted tests to those that are based on cognitive processing views of intelligence. The correlations between tests of cognitive processing with achievement are especially noteworthy because the two-dimensional K-ABC and the four CAS scales were strongly correlated with achievement despite the fact that the tests of ability do not contain achievement-like subtests.

The problem of overlapping content in the study of the relationship between ability and achievement is most obviously confounded in the WJ-III. For example, the WJ-III Cognitive subtest 1A Verbal Comprehension that involves synonyms has a sample item that states, "Tell me another word for *big*," and test 17A Reading Vocabulary Synonyms has the sample item "Tell me another word for *large*." Similarly, Item 3 on test 17A is "Tell me another word for (examiner points to the word small)," and in the Cognitive test 1B Item 2 the examiner says, "Tell me another word for *small*." Additionally, on the Cognitive test 1A Verbal Comprehension subtest there are 23 Picture Vocabulary items and on the WJ-III Achievement Test 14 there are 44 Picture Vocabulary items. Item 2 on Test 14 is a ball, and on test 1A the item is a ball. Item stimuli are the same for item 21 on the Cognitive Verbal Comprehension Picture Vocabulary Test 1A and Achievement Test 14 Picture Vocabulary item 39, which contributes to the Oral Expression and Oral Language Scores. This degree of item overlap and subtest similarity across tests that purport to measure cognitive ability and achievement is inappropriate and inflates the correlation between measures of ability and achievement. For this reason, the correlations between the WJ-III and achievement should be considered overestimates of the true relationships between ability and achievement and the authors should justify why such similar test items are used across supposedly different constructs. Importantly, however, despite the similarity in item content, this test, and others with similar although not as significant overlap (WISC-III, SB-IV, DAS), did not give the WJ-III an advantage in so far as correlating with achievement is concerned. In fact, given that the K-ABC and CAS have fewer factors and subtests, the strong correlation between these measures of cognitive processing and achievement questions the need for so many factors as found in the WJ-III.

The present study challenges strong statements by McGrew, Flanagan, Keith, and Vanderwood (1997) that the theory upon which the WJ-III is based represents the "most useful framework for understanding cognitive functioning" (p. 1994). Instead, these data raise the question, why are so many WJ-III scales needed if two on the K-ABC (Sequential and Simultaneous) and four from CAS (PASS) are just as effective for prediction of achievement. Moreover, given that Kaufman (2000) noted that there is no empirical evidence that [the *GfGc*] approach "yields profiles for exceptional children, [is] relevant to diagnosis, or [has] relevance to eligibility decisions, intervention, or instructional planning" (p. 27), and based on the present findings, it is unclear that the extra effort of administration of so many constructs as found in the WJ-III is beneficial.

Additionally, the limitations cited above cause considerable doubt on the utility of the Cross-Battery Assessment approach advocated by Flanagan and Ortiz (2001), especially given the limited validity of such a method.

The results reported in this study also raise an important question about the number of scales needed to effectively predict academic performance. There was no apparent relationship between the number of scales and the strength of the correlations found. For example, the analysis of the ability/achievement correlations for large-scale studies involving composite achievement scores showed that the correlations for the K-ABC (two scales; 10 subtests) and the CAS (four scales; 12 subtests) were similar to the WJ-III Extended, which contains seven scales and 20 subtests. Apparently, the cognitive model on which the WJ-III is based requires so many more subtests and scales to correlate with achievement at a similar level as the K-ABC and CAS.

In conclusion, despite the limitations of the present investigation, three findings were uncovered. First, it appears that tests without achievement-like subtests are at least as related to achievement as general intelligence tests that do have achievement-like content. Second, the two measures of ability based on a cognitive-processing approach to redefining intelligence (CAS and K-ABC) without achievement-like subtests consistently correlated the highest with achievement test scores. Third, tests with the most factors (WJ-III) did not show stronger correlations to achievement than did tests with fewer numbers of factors (e.g., CAS or K-ABC). These findings should serve to assure professionals that an approach to intelligence that measures basic psychological processes like the CAS or K-ABC has considerable validity for prediction of achievement.

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APPENDIX A

Achievement Test Composite Standard Score Means and SDs

Study #	Citation	Test	Variable	*M*	*SD*
1	Thorndike, Hagen, & Sattler, 1986, p. 68	KABC	Total Ach	107.4	19.9
2	Elliot, 1990, p. 234	KABC	Total Ach	110.5	7.4
3	Lassiter & Bardos, 1995	KABC	Total Ach	94.5	11.6
4	Kaufman & Kaufman, 1983, p. 128	KeyMath DAT	Total Ach	121.7	47.5
5,6, 11	Woodcock, 2001, p. 90	WJ-III	Total Ach	103.6	13.1
			Broad Reading	97.2	11.5
			Basic Reading Skills	94.6	11.2
			Reading Comprehension	103.9	11.5
			Broad Mathematics	106.9	11.6
			Math Calculation Skills	105.7	11.5
			Math Reasoning	104.9	12.4
			Broad Written Language	113.7	11.9
			Basic Writing Skills	104.4	11.5
			Written Expression	119.7	13.5
			Phoneme/Grapheme Knowledge	102.5	11.1
			Academic Skills	97.6	10.5
			Academic Fluency	109.8	12.7
			Academic Applications	106.3	10.7
			Academic Knowledge	104.4	11.8
			Oral Expression	105.0	13.3
7	Kaufman & Kaufman, 1983, p. 121	WJ	Preschool Cluster	457.5	14.4
			Knowledge Cluster	455.8	15.9
8,9	Naglieri & Das, 1997, p.	WJ-R	Broad Reading	111.9	13.7
			Basic Reading Skills	110.0	16.1
			Reading Comprehension	113.8	17.7
			Broad Mathematics	111.1	15.9
			Basic Mathematics Skills	108.9	16.1
			Mathematics Reasoning	110.8	14.3
			Basic Writing Skills	99.2	14.3
			Skills	107.1	14.4
10	Wechsler, 1989, p. 146	GORT	Reading	NG	NG

APPENDIX A (continued)

Achievement Test Composite Standard Score Means and SDs

Study #	Citation	Test	Variable	*M*	*SD*
11	Kaplan, 1993	CTP-II	Reading	308.5	11.1
			Word Analysis	308.7	7.8
12	Kaufman & Kaufman, 1983, p. 128	Stanford Reading	Total Composite	103.3	13.1
13	Woodcock, 2001, p. 90	WJ-III	Total Achievement	103.6	13.1
			Broad Reading	97.2	11.5
			Basic Reading Skills	94.6	11.2
			Reading Comprehension	103.9	11.5
			Broad Mathematics	106.9	11.6
			Math Calculation Skills	105.7	11.5
			Math Reasoning	104.9	12.4
			Broad Written Language	113.7	11.9
			Basic Writing Skills	104.4	11.5
			Written Expression	119.7	13.5
			Phoneme/Grapheme Knowledge	102.5	11.1
			Academic Skills	97.6	10.5
			Academic Fluency	109.8	12.7
			Academic Applications	106.3	10.7
			Academic Knowledge	104.4	11.8
			Oral Expression	105.0	13.3
14	Kaufman & Kaufman, 1983, p. 121	PIAT	Total test	108.0	8.9
15	Klanderman, Mollner, & Devine, 1985	KABC	Achievement	115.6	12.7
16	Kaufman & Kaufman, 1983, p. 313	KABC	Achievement	NG	NG
17,20	Woodcock, 2001, p. 175	WJ-III	Total Achievement	NG	NG
			Oral Language-Std	NG	NG
			Broad Reading	NG	NG
			Broad Math	NG	NG
			Broad Written Language	NG	NG
			Academic Skills	NG	NG
			Academic Fluency	NG	NG
			Academic Applications	NG	NG
			Oral Language-Ext	NG	NG

(APPENDIX A continues)

APPENDIX A (continued)
Achievement Test Composite Standard Score Means and SDs

Study #	Citation	Test	Variable	*M*	*SD*
			Oral Expression	NG	NG
			Listening Comprehension	NG	NG
			Basic Reading Skills	NG	NG
			Reading Comprehension	NG	NG
			Math Calculation Skills	NG	NG
			Math Reasoning	NG	NG
			Basic Writing Skills	NG	NG
			Written Expression	NG	NG
			Phoneme/Grapheme Knowledge	NG	NG
18, 19	Naglieri & Das, 1997, p. 62	WJ-R	Broad Reading	103.0	17.0
			Basic Reading Skills	101.3	16.9
			Reading Comprehension	104.1	16.7
			Broad Mathematics	103.2	18.7
			Basic Mathematics Skills	101.8	18.1
			Mathematics Reasoning	104.8	17.4
			Basic Writing Skills	96.4	16.4
			Skills	100.0	16.3
21	Wechsler, 1992, p. 346	WIAT	Reading composite	NG	NG
			Mathematics composite	NG	NG
			Language composite	NG	NG
			Writing composite	NG	NG

Note.—All variables are set at mean of 100 and *SD* of 15, except the Key Math DAT.
NG = Not given, Ach = Achievement, Comp = Comprehension, Ext = Extended, Std = Standard.

Appendix B
Achievement Subtest Standard Score Means and SDs

Citation	Test	Variable	*M*	*SD*
1 Cooley & Ayers, 1985	PIAT	Reading Recognition	NG	NG
	PIAT	Reading Comprehension	NG	NG
2 Wilkinson, 1993, p. 179	Wide Range Achievement Test-3	Reading Combined	97.5	14.9
	Wide Range Achievement Test-3	Spelling Combined	96.0	17.9
	Wide Range Achievement Test-3	Arithmetic combined	97.5	15.3
3 Elliot, 1990, p. 230	DAS Achievement	Basic Number Skills	NG	NG
	DAS Achievement	Spelling	NG	NG
	DAS Achievement	Word Reading	NG	NG
4 Lassiter & Bardos, 1995	K-ABC Achievement	Faces and Places	95.8	10.8
	K-ABC Achievement	arithmetic	96.8	13.6
	K-ABC Achievement	Riddles	98.8	12.4
	K-ABC Achievement	Reading Decoding	91.5	14.9
5 Kaufman & Kaufman, 1983, p. 128	KeyMath DAT	Concepts	35.0	10.9
	KeyMath DAT	Operations	42.1	19.0
	KeyMath DAT	Applications	44.6	18.9
6 Elliot, 1990, p. 245	BASIS	Mathematics	103.6	16.4
	BASIS	Spelling	102.7	12.6
	BASIS	Reading	99.2	13.4
	BASIS	Mathematics	106.6	16.0
	BASIS	Spelling	102.6	15.0
	BASIS	Reading	102.3	15.4
7 Zins & Barnett, 1983	K-ABC Achievement	Faces and Places	108.6	12.8
	K-ABC Achievement	arithmetic	110.4	16.1
	K-ABC Achievement	Riddles	113.2	15.8
	K-ABC Achievement	Reading Decoding	110.3	13.9
	K-ABC Achievement	Reading Understanding	112.1	14.2
8 Wechsler, 1991, p. 204	Differential Ability Scales	Basic Number Skills	104.8	11.5
	Differential Ability Scales	Spelling	108.4	14.2
	Differential Ability Scales	Word Reading	107.8	13.0
9 Wilkinson, 1993, p. 180	Wide Range Achievement Test-3	Reading Combined	95.4	11.6

(Appendix B continues)

Appendix B (continued)
Achievement Subtest Standard Score Means and SDs

Citation	Test	Variable	*M*	*SD*
	Wide Range Achievement Test-3	Spelling Combined	95.8	13.2
	Wide Range Achievement Test-3	Arithmetic combined	94.9	13.5
10 Kaufman & Kaufman, 1983, p. 128	WRAT	Reading	110.1	15.5
	WRAT	Arithmetic	100.0	12.2
	WRAT	Spelling	107.5	16.0
11 Elliot, 1990, p. 234	DAS Achievement	Basic Number Skills	NG	NG
	DAS Achievement	Spelling	NG	NG
	DAS Achievement	Word Reading	NG	NG
12 Wechsler, 1989, p. 146	Wide Range Achievement Test	Spelling	NG	NG
	Wide Range Achievement Test	Arithmetic	NG	NG
13 Zins & Barnett, 1983	WRAT	Reading	116.1	15.3
	WRAT	spelling	107.0	14.4
	WRAT	arithmetic	100.3	15.0
14 Kaufman & Kaufman, 1983, p. 128	Stanford Diagnostic Reading Test	Phonetic Analysis	106.3	12.1
	Stanford Diagnostic Reading Test	Auditory Vocabulary	107.0	12.1
	Stanford Diagnostic Reading Test	Literal Comprehension	103.9	12.9
	Stanford Diagnostic Reading Test	Inferential Comprehension	103.8	15.0
15 Wechsler, 1991, p. 206-207	Wide Range Achievement Test-R	Reading	94.3	13.4
	Wide Range Achievement Test-R	Spelling	91.0	15.0
	Wide Range Achievement Test-R	Arithmetic	86.8	15.1
15 Kaufman & Kaufman, 1983, p. 121	PIAT	Mathematics	107.2	11.8
	PIAT	Reading Cognition	109.3	9.0
	PIAT	Reading Comprehension	107.0	10.4
	PIAT	Spelling	103.3	10.0
	PIAT	General Information	108.9	10.9
17 Naglieri & Das, 1997, p. 62	WJ-R	Letter-Word Identification	102.1	16.8
	WJ-R	Passage Comprehension	104.5	16.6
	WJ-R	Calculation	102.9	17.9
	WJ-R	Applied Problems	104.8	17.4

Appendix B (continued)
Achievement Subtest Standard Score Means and SDs

Citation	Test	Variable	*M*	*SD*
	WJ-R	Dictation	94.6	14.6
	WJ-R	Word Attack	100.4	17.4
	WJ-R	Reading Vocabulary	103.3	16.6
	WJ-R	Quantitative Concepts	101.7	17.2
	WJ-R	Proofing	99.4	15.9
18 Naglieri & Das, 1997, p. 62	WJ-R	Letter-Word Identification	102.1	16.8
	WJ-R	Passage Comprehension	104.5	16.6
	WJ-R	Calculation	102.9	17.9
	WJ-R	Applied Problems	104.8	17.4
	WJ-R	Dictation	94.6	14.6
	WJ-R	Word Attack	100.4	17.4
	WJ-R	Reading Vocabulary	103.3	16.6
	WJ-R	Quantitative Concepts	101.7	17.2
	WJ-R	Proofing	99.4	15.9
19 Kaufman & Kaufman, 1983, p. 313	K-ABC	Faces and Places	NG	NG
	K-ABC	Arithmetic	NG	NG
	K-ABC	Riddles	NG	NG
	K-ABC	Reading/Decoding	NG	NG
	K-ABC	Faces and Places	NG	NG
	K-ABC	Arithmetic	NG	NG
	K-ABC	Riddles	NG	NG
	K-ABC	Reading/Decoding	NG	NG
	K-ABC	Faces and Places	NG	NG
	K-ABC	Arithmetic	NG	NG
	K-ABC	Riddles	NG	NG
	K-ABC	Reading/Decoding	NG	NG
	K-ABC	Faces and Places	NG	NG
	K-ABC	Arithmetic	NG	NG
	K-ABC	Riddles	NG	NG

(Appendix B continues)

Appendix B (continued)
Achievement Subtest Standard Score Means and SDs

Citation	Test	Variable	*M*	*SD*
	K-ABC	Reading/Decoding	NG	NG
	K-ABC	Faces and Places	NG	NG
	K-ABC	Arithmetic	NG	NG
	K-ABC	Riddles	NG	NG
	K-ABC	Reading/Decoding	NG	NG
	K-ABC	Faces and Places	NG	NG
	K-ABC	Arithmetic	NG	NG
	K-ABC	Riddles	NG	NG
	K-ABC	Reading/Decoding	NG	NG
	K-ABC	Faces and Places	NG	NG
	K-ABC	Arithmetic	NG	NG
	K-ABC	Riddles	NG	NG
	K-ABC	Reading/Decoding	NG	NG
	K-ABC	Faces and Places	NG	NG
	K-ABC	Arithmetic	NG	NG
	K-ABC	Riddles	NG	NG
	K-ABC	Reading/Decoding	NG	NG
20 Kaufman & Kaufman, 1983, p. 124	Woodcock Reading Mastery Tests	Passage Comprehension Raw Score	37.2	18.2
21 Wechsler, 1992, p. 346	WIAT	Basic Reading	NG	NG
	WIAT	Mathematics Reasoning	NG	NG
	WIAT	Spelling Combined	NG	NG
	WIAT	Reading Comprehension	NG	NG
	WIAT	Numerical Operations	NG	NG
	WIAT	Listening Comprehension	NG	NG
	WIAT	Oral Exp.	NG	NG
	WIAT	Written Exp.	NG	NG
23 Elliot, 1990, p. 242	DAS Achievement	Basic Number Skills	NG	NG
	DAS Achievement	Spelling	NG	NG
	DAS Achievement	Word Reading	NG	NG
24 Kaufman & Kaufman, 1983, p. 125	KeyMath Diagnostic Arithmetic Test	Written Computation Raw Score	18.1	10.2