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BLACK-WHITE DIFFERENCES IN COGNITIVE PROCESSING: A STUDY OF THE PLANNING, ATTENTION, SIMULTANEOUS, AND SUCCESSIVE THEORY OF INTELLIGENCE

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Researchers have typically found a mean difference of about 15 points between Blacks and Whites on traditional measures of intelligence. Some have argued that the difference between Blacks and Whites would be smaller on measures of cognitive processing. This study examined Black (n = 298) and White (n = 1,691) children on Planning, Attention, Simultaneous, and Successive cognitive processes (PASS theory of intelligence) as operationalized by the Cognitive Assessment System (CAS). Regression analyses, controlling for key demographic variables, showed an estimated CAS Full Scale mean score difference of 4.8, which is smaller than that found with traditional IQ. Correlations between the PASS scores and achievement were similar for Blacks (median of .70) and Whites (median of .64). Moderated regression analyses showed no interaction effect for race by CAS Full Scale with achievement, suggesting that there are similar relationships between the CAS and achievement for Black (n = 298) and White (n = 1,691) groups. Nonsignificant interactions resulted when the Black and White child groups were analyzed with smaller matched samples (n = 298; n = 298). These results add to the growing body of literature supporting the validity of the PASS theory as measured by the CAS and the utility of the theory for assessment of minority students.

Matarazzo (1992) predicted that in the 21st century the field of intelligence testing would be marked by steadfast adherence to the traditional verbal, quantitative, and nonverbal IQ concepts. In addition, however, he predicted that tests that borrow "heavily from the recent knowledge explosion in cognitive psychology, information processing, and developmental psychology" (p. 1012) would be developed. Matarazzo went on to suggest that the research in cognition would yield "new forms of individually administered intelligence tests of a type never before available in tests of ability" (p. 1013), which he illustrated using the work of Das, Kirby, and Jarman (1979) and Naglieri and Das (1990). The PASS theory and the work of Kaufman and Kaufman (1983) are two important efforts to redefine intelligence according to research in cognitive psychology as described by Matarazzo (1992). Their work was ignored by Neisser et al. (1996) in their review of knowns and unknowns about intelli-

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gence, a limitation that was noted by Naglieri (1997a) and recognized as an omission by Neisser (1997).

Competing with traditional intelligence tests is not an easy task for a number of reasons. Perhaps the most important advantage the Binet and Wechsler tests have is their predictive validity combined with their technological simplicity (Deary, Austin, & Caryl, 2000) and their long-established place in psychology and education (Wasserman, 2002). These characteristics have led to continued widespread use and general acceptance that intelligence is what *these* tests measure. As predicted by Matarazzo more than 10 years ago, researchers are finding cognitively based methods to challenge the concept of intelligence represented by traditional IQ.

In the years since the publication of Matarazzo's paper, researchers have more fully developed alternatives to traditional IQ that are cognitively based and some have argued that intelligence is *better* conceptualized on the basis of basic cognitive processes (e.g., Fagan, 2000; Gardner, 1983; Kaufman & Kaufman, 1983; Naglieri, 2002; Sternberg, 1988). Ceci (2000) suggested that this is a provocative shift that could allow for early detection of disabilities that predate academic failure, could have diagnostic utility, and could provide a way to better understand children's disabilities. Similarly, Das (2002) proposed that reading disabilities and PASS processes are related and that this theory offers advantages when delineating among groups of individuals with mental retardation. Das, Naglieri, and Kirby (1994) and Naglieri (2002; 2003) further argued that a cognitive approach to intelligence can have greater instructional relevance (Naglieri & Gottling, 1995, 1997; Naglieri & Johnson, 2000) and yield smaller differences between race groups (Naglieri & Rojahn, 2001). Additionally, Das et al. (1994) and Naglieri (2003) have presented a cognitive processing approach to intelligence that can predict achievement at least as well as traditional IQ (Naglieri & Bornstein, 2003; Naglieri, De Lauder, Goldstein, & Schwebech, in press; Ramsey & Reynolds, 2004) and retain the advantages of technological simplicity and standardized methods of administration.

Fagan (2000) argued that a processing approach to intelligence may show that "Whites and Blacks, while different in average IQ, are equally intelligent" (p. 168). He went on to state that "defining intelligence as processing can make the hope for culture-fair tests of intellectual functioning a reality" (p. 168). He devised a test of selective attention to novelty to measure psychological processing and reported that although White children were significantly different from Black children in IQ they did not differ in processing on his test. These results supported Fagan's view that processing is a better way to conceptualize intelligence and that lower IQ scores earned by Blacks may be influenced by their relatively lower fund of knowledge, which leads to lower IQ scores.

Fagan (2000), like Suzuki and Valencia (1997), argued that because traditional intelligence tests have verbal and numerical questions they should be considered as measures of past learning. Others have noted that some items on traditional IQ tests measure the same information found on achievement tests and therefore these two types of tests are really not very different (Kaufman & Kaufman, 1983; Naglieri, 2002; Naglieri & Bornstein, 2003). For example, many IQ *and* achievement tests measure vocabulary, knowledge of general information, and skills at solving math word problems. Kaufman and Lichtenberger (1999) recognized this overlap in content when they wrote that verbal scales in traditional IQ tests do "measure achievement" (p. 133). Importantly, Naglieri et al. (in press) directly compared the correlations between the WISC-III and CAS with the same achievement scores. The median correlation between the WISC-III Full Scale IQ and the Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001) Broad Reading, Broad Math, Math Calculation, Academic Skills, and Academic Fluency scores was .67 ($N = 119$), and the median correlation for the CAS Full Scale with these same variables for the same children was .82. This study, in addition to others (Naglieri, 1999; Naglieri & Bornstein, 2003; Naglieri & Rojahn, 2000; Ramsey & Reynolds, 2004), suggests that verbal and quantitative tests can be eliminated from a measure of ability without loss of predictive validity. The overlap in content between ability and achievement tests has also been considered undesirable by a number of test developers (e.g., Bracken & McCallum, 1998; Kaufman & Kaufman, 1983; Naglieri, 1997b; Naglieri & Das, 1997) because academic components of traditional IQ tests place persons with limited levels of achievement and verbal knowledge at a significant disadvantage, particularly children from groups of lower socioeconomic status and those who are culturally and especially linguistically different.

Recognition of the academic content limitation in traditional IQ tests has led some to develop alternative conceptualizations of intelligence that do not include verbal and quantitative tests (e.g., Fagan, 2000; Gardner, 1983; Kaufman & Kaufman, 1983; Naglieri, 1997b; Naglieri & Das, 1997; Sternberg, 1988). Suzuki and Valencia (1997) examined alternatives to traditional IQ tests such as the theories of Gardner (1983) and Sternberg (1988) as well as methods such as the Learning Potential Assessment Device (LPAD; Feuerstein, Rand, & Hoffman, 1979) and the Cognitive Assessment System (CAS: Naglieri & Das, 1997). They concluded that the LPAD does not provide standard scores that can be used to calibrate a child's performance in relation to a national standardization sample, which diminishes its utility considerably. Similar limitations apply to Gardner's (1983) concept of multiple intelligences and Sternberg's (1988) triarchic theory, neither of which have been operationalized into a standardized, practical test format. Suzuki and Valencia (1997) suggested that the Planning, Attention, Simultaneous, and Successive (PASS) theory of intelligence (Naglieri, 1999) represents an innovative approach to traditional intelligence assessment that does not include traditional verbal and quantitative tests. Despite the omission of verbal and quantitative tests, the CAS demonstrates strong correlations with achievement in relation to other tests of ability (Naglieri & Bornstein, 2003). Suzuki and Valencia (1997) stated further that "one of the advantages of the CAS is that it assesses a broader spectrum of abilities than has been previously available in IQ testing" (p. 1111). This approach is consistent with Matarazzo's (1992) prediction that new theories and ways to measure intelligence according to these theories would be developed.

The PASS theory (Naglieri & Das, 1997) is rooted in the work of A. R. Luria

(1966, 1973, 1980) and was used by Das and Naglieri (1997) as a blueprint for defining the important components of human intelligence included in the PASS theory (Naglieri & Das, 2004). There are four basic cognitive processes, which are defined as follows:

1. *Planning* is a cognitive process that provides cognitive control, use of knowledge, intentionality, and self-regulation. Planning is critical to all activities where the person has to determine how to solve a problem, which includes self-monitoring and impulse control as well as generation, evaluation, and execution of strategies for problem solving. Planning is measured using tests that require the child to develop a plan of action, evaluate the value of the method, monitor its effectiveness, revise or reject the plan to meet the demands of the task, and control the impulse to act without careful consideration.

2. *Attention* is a cognitive process that provides focused, selective cognitive activity over time and resistance to distraction. Attention is involved when a person selectively focuses on particular stimuli and inhibits responses to competing stimuli. The process provides focused and selective attention over time. Focused attention involves directed concentration toward a particular activity, whereas selective attention is important for the inhibition of responses to distracting stimuli. An effective measure of attention presents children with competing demands on their attention and requires sustained focus.

3. *Simultaneous* processing is a cognitive process used to integrate stimuli into groups. An essential aspect of simultaneous processing is the organization of interrelated elements into a whole, which is why this process is often tested using visual spatial tasks. Simultaneous processing can, however, be used to solve tasks that are verbal as well as nonverbal. For example, Simultaneous processing underlies use and comprehension of grammatical statements because they demand understanding of word relationships, prepositions, and inflections so the person can obtain meaning based on the whole idea.

4. *Successive* processing is a cognitive process used when stimuli are arranged in a specific serial order to form a chainlike progression. This process is required when information must follow a strictly defined order where each element is only related to those that precede it and these stimuli are not interrelated. Successive processing involves both the perception of stimuli in sequence and the formation of sounds and movements in order. For this reason, successive processing is concerned with activities that involve phonological skills (Das et al., 1994) and the syntax of language.

The PASS theory posits that the four basic psychological processes interact with a person's fund of knowledge. "Cognitive processes rely on (and influence) the base of knowledge, which may be temporary (as in immediate memory) or more long term (that is, knowledge that is well learned)" (Naglieri & Das, 1997, p. 145). Further, knowledge and processes are influenced by membership in particular social and cultural milieus (Das & Abbott, 1995). Knowledge, therefore, interacts with processes but is separate and should be measured distinctly from the four cognitive processes included in the PASS theory. This makes the PASS theory markedly different from traditional concepts of intelligence, which have been comprised of verbal, nonverbal, and quantitative tests since the early 1900s (see Yoakum & Yerkes, 1920) and is why PASS was cited by Matarazzo (1992) as a very different approach to intelligence.

Despite the potential of the PASS theory, Suzuki and Valencia (1997) emphasized the need for more research on such "innovative modifications of traditional intelligence assessment procedures and new instruments … [especially] given concerns confronting practitioners in assessing a growing diversity in clientele" (p. 1111). The purpose of this study was to expand our understanding of the PASS theory by examining one specific topic: how Black and White groups compare. We aimed to test Fagan's suggestion that measuring intelligence as processing could reduce the difference between Black and White groups and address Suzuki and Valencia's (1997) calls for research on the PASS theory. To achieve these goals we examined two dimensions of construct validity for samples of Black and White children—mean score differences between the race groups and the similarity of correlations between PASS and achievement for samples of Black and White children.

METHOD

Participants

The present sample of 1,989 children and adolescents aged 5 to 17 years included 1,691 Whites and 298 Blacks who were from the nationally representative sample of 2,200 students used to compute normative values for the CAS. Each participant was individually administered the CAS by trained examiners, and a subset of the sample was also administered tests of achievement (n = 1,211) as part of the standardization and validation process. The standardization sample was stratified to represent the U.S. population by the following variables: gender; race (Black, White, Hispanic origin, Asian, Native American, Other); region (Northcentral, Northeast, South, West); community setting (urban/suburban, rural); classroom placement (full-time regular classroom, part-time special education resource, full-time self-contained special education); and parents' education (high school graduate, some college or technical school, 4 or more years of college). The sample characteristics are summarized by race in Table 1, which also includes the characteristics of the U.S. population on some key variables. These data illustrate that the Black and White samples closely match the characteristics of these groups in the U.S. population.

Measures

Cognitive Assessment System (CAS). The CAS (Naglieri & Das, 1997) was developed according to the Planning, Attention, Simultaneous, Successive (PASS) theory. Tests were developed that required the appropriate mental processing (see Naglieri & Das, 1997, for more details) without requiring the retrieval of facts and particularly without demanding that the child utilize past knowledge such as vocabulary, arithmetic, and general information. Following standardization, differential item functioning was examined using the Mantel-Haenszel procedure and prediction to achievement methods (Naglieri & Das, 1997). No significant differences in regression slopes were found, and less than 5% of the CAS items showed differential performance (about half the time this was in the direction favoring the referent group). The small number of items that were found to be significant were excluded (Naglieri & Das, 1997).

Table 1
Demographic Characteristics of the U.S. and Black and White Samples by Race

	Black (*n* = 298)		US Pop.	White (*n* = 1,691)		US Pop.
	n	%		*n*	%	
Gender						
Female	143	51		855	48	
Male	155	49		836	52	
Parental education						
< High school	93	31	30	271	16	16
High school graduate	95	32	31	491	29	29
Some college	81	27	28	505	30	30
4+ years of college	29	10	10	424	25	25
Region						
Northcentral	60	20	20	470	28	28
Northeast	44	15	17	335	20	20
South	165	55	54	560	33	32
West	29	10	9	326	19	21
Community setting						
Rural	70	24		471	28	
Urban and suburban	227	76		1,220	72	
Classroom placement						
Full-time regular ed.	258	87		1,587	93	
Full-time special ed.	18	6		24	2	
Part-time special ed.	22	7		79	5	
Other	0	0		1	0.1	
Educational classification						
Nonspecified	250	85		1,456	87	
Gifted	2	0.7		83	5	
ADHD	3	1		12	0.7	
Learning disability	22	7		82	5	
Mental retardation	14	5		13	0.8	
Neurological	1	0.3		9	0.5	
Speech and language	1	0.3		21	1	
Social/emotional disorder	4	1		13	0.8	

The CAS provides a standard score for each PASS process as well as a Full Scale standard score. The average internal reliability coefficients across all ages for the PASS scales are Planning = .88; Attention = .88; Simultaneous = .93; Successive = .93; and Full Scale = .96. The standard battery includes 12 subtests (3 for each PASS scale). The scales are described below (for further explanation, see Naglieri, 1999).

The Planning scale includes *matching numbers*, *planned codes*, and *planned connections*. In the matching numbers subtest, children are presented with four pages containing eight rows of numbers. For each row, the child is instructed to underline the two numbers that are the same. The time and number correct for each page is recorded, and the subtest score is calculated by combining both time and number correct. The planned codes subtest contains two pages, each with a distinct set of codes arranged in seven rows and eight columns. At the top of each page is a legend, which indicates how letters relate to simple codes (e.g., A = OX; B = XX; C = OO). The child is instructed to fill in the correct code beneath each corresponding letter in any manner he or she chooses. The subtest score is calculated by combining both the time and number correct for each page. In the planned connections subtest the child is instructed to connect numbers in sequence that appear in a quasi-random order (e.g., 1-2-3, etc.). For the last two items, the child connects numbers and letters in sequential order, alternating between numbers and letters (e.g., 1-A-2-B, etc.). Any errors made by the child are corrected as he or she progresses through the task. The subtest score is based on the total amount of time used to complete the task.

The Attention scale includes the *expressive attention*, *number detection*, and *receptive attention* subtests. For expressive attention, children 7 years and younger are presented pictures of animals arranged in rows. Animals that are typically small are drawn to appear large, and large animals are drawn to appear small. The child is instructed to indicate the *real* size of the animal (e.g., if a butterfly was drawn to appear large, the child would respond "small"). Children 8 years and older are given three pages to complete. For the first page, the child reads color words (i.e., blue, yellow, green, and red). The words are presented in a quasi-random order. On the second page, the child is instructed to name the colors of a series of rectangles printed in aforementioned colors. On the third page, the color words are printed in a different ink color than the color the words name (e.g., the word "red" would appear in blue ink). The subtest score is calculated using time and number correct. The number detection subtest asks children to find the target stimuli (e.g., the numbers 1, 2, and 3 printed in an open font) among many distractors (e.g., the same numbers printed in a different font). The subtest score is a ratio of accuracy (total number correct minus the number of false detections) to total time taken to complete all items. The receptive attention subtest contains two pages: for the first page, targets are letters that are physically the same (e.g., BB but not Bb), and for the second page, targets are letters that have the same name (e.g., Bb but not Ab). Again, the subtest score is a ratio of accuracy to total time.

The Simultaneous scale has *nonverbal matrices*, *verbal spatial relations*, and *figure memory*. Nonverbal matrices items present a variety of shapes and geometric designs that are interrelated through spatial or logical organization. For each item, the child is required to decode the relationships and choose the best of six possible answers to complete the gird. The subtest score is the total number correct. The verbal spatial relations subtest measures the comprehension of logical and grammatical descriptions of spatial relationships. In this subtest, the child is presented with six drawings, arranged in a specific spatial manner, and a printed question. The child is instructed to choose one of the six drawings that best answers the question within the 30-second time limit. The subtest score is calculated by adding up the total number of items answered correctly. For figure memory, the child is first presented a two- or three-dimensional geometric figure for 5 seconds and then a response page, with the original geometric figure embedded in a larger, more complex geometric pattern, and is asked to identify the original design. The subtest score is the total number of items correctly identified.

The Successive scale has *word series*, *sentence repetition*, and *sentence questions*. In word series, the examiner reads a series of words and then asks the child to repeat the words in the same order. This subtest uses the following nine single-syllable, high-frequency words: *book, car, cow, dog, girl, key, man, shoe,* and *wall*. The presentation rate is one word per second. The subtest score is the total number of word series correctly repeated. For sentence repetition, the child is read 20 sentences aloud and is asked to repeat each sentence exactly as presented. The sentences are composed of color words (e.g., "The blue yellows the green"), which reduces the influence of simultaneous processing and removes semantic meaning for the sentences. The subtest score is the total number of sentences repeated correctly. The sentence questions subtest uses the same type of sentences that are used in the sentence repetition subtest, however, now the child is read a sentence and asked a question about it. For example, the examiner reads "The blue yellows the green" and asks the child "Who yellows the green?" The correct answer is "the blue." The subtest score is the total number of questions answered correctly.

Woodcock-Johnson Tests of Achievement-Revised (WJ-R). The WJ-R (Woodcock & Johnson, 1989) is an individually administered test of academic achievement. The test contains nine subtests that assess the basic skills of reading, writing, mathematics, and knowledge. Each subtest will be briefly described.

Letter-Word Identification. The first 5 items of this subtest involve symbolic learning, or the ability to match a pictorial representation of a word with an actual picture of the object. The remaining 52 items (total = 57) assess the child's reading skills in identifying isolated letters and words. The items are arranged in order of difficulty, with the easiest items presented first and the most difficult items last. The median reliability for the WJ-R standardization sample is .94.

Passage Comprehension. For this subtest, the participant is first presented with a picture to identify, followed by a picture and sentence with a word omitted. The participant uses syntactic and semantic clues to decide which word best answers the question. The median reliability for the WJ-R standardization sample is .90.

Calculation. This subtest measures the child's skill in performing mathematical calculations such as addition, subtraction, multiplication, and division. The items are arranged in order of difficulty, with the easiest items presented first and the most difficult items presented last. There are a total of 58 items in the Calculation subtest. The median reliability for the WJ-R standardization sample is .93.

Applied Problems. Problems on this subtest range from basic counting to long word problems with no pictorial stimuli. The median reliability for the WJ-R standardization sample is .92.

Dictation. This subtest measures basic writing skills, punctuation, capitalization, spelling, and usage. Responses are given in writing. The median reliability for the WJ-R standardization sample is .91.

Word Attack. This subtest requires the child to pronounce nonsense words that are phonically regular. All words follow patterns of regular English but are novel to the participant. The median reliability for the WJ-R standardization sample is .91.

Reading Vocabulary. In this subtest, which tests children's knowledge of synonyms and antonyms, the child is asked to read the printed word and provide either a word with a similar meaning or a word with the opposite meaning. The median reliability for the WJ-R standardization sample is .93.

Quantitative Concepts. This subtest measures knowledge of basic math terms, signs, shapes, and facts. Most items involve basic math knowledge and some require computations. The median reliability of the WJ-R standardization sample is .87.

Proofing. This subtest requires the child to find and correct the written statements that have punctuation, spelling, capitalization, and usage errors. The median reliability for the WJ-R standardization sample is .91.

Table 2
Hierarchical Regression Analysis for Race Predicting CAS Scores (N = 1,831)

Predictors	$R^2\Delta$	$F\Delta$	Sig $F\Delta$	B	β	Sig
Full Scale						
Block 1	.28	41.77	.000			
Block 2	.01	29.25	.000	4.798	.111	.000
Planning						
Block 1	.18	23.88	.000			
Block 2	.00	8.57	.003	2.740	.063	.003
Attention						
Block 1	.17	22.65	.000			
Block 2	.00	7.72	.006	2.596	.060	.006
Simultaneous						
Block 1	.21	30.76	.000			
Block 2	.03	65.66	.000	7.055	.167	.000
Successive						
Block 1	.18	25.15	.000			
Block 2	.00	9.21	.002	2.721	.065	.002

Note.—Block 1: Gender, Region, Community Setting, Parental Education, Classroom Placement, Student Services.
Block 2: Race. *B* values are interpreted as the differences between the race groups in original standard score metric (M = 100 and SD = 15).

Eight WJ-R Achievement cluster scores are calculated by combining the subtests listed above in a variety of combinations: Broad Reading (Letter-Word Identification and Passage Comprehension); Basic Reading (Letter-Word Identification and Word Attack); Reading Comprehension (Passage Comprehension and Reading Vocabulary); Broad Math (Applied Problems and Calculation); Basic Math (Calculation and Quantitative Concepts); Math Reasoning (Applied Problems); Basic Writing Skills (Diction and Proofing);

and Skills (Letter-Work Identification and Passage Comprehension and Diction). Reported internal reliability coefficients for the clusters range in the mid .90s.

RESULTS

Five separate regression analyses were performed for each set of CAS scores, with the six demographic variables (gender, region, community setting, parental education, classroom placement, and student services) entered in Block 1 in that order and race entered on the first step of Block 2. Results show that the incremental R^2 change is close to zero across all five sets of CAS scores, indicating that race offers almost no additional predictive ability in explaining variation in CAS scores above and beyond the democratic variables (see Table 2). The unstandardized (ß) and standardized (ß) regression coefficients give the effect size for race. ß values are interpreted as the differences between the race groups in original standard score metric (M = 100 and SD = 15). As the unstandardized regression coefficients show, Black-White differences range from 2.6 to 7.1 across the set of CAS scores, with the Full Scale CAS showing a 4.8 point difference between Blacks and Whites.

Table 3
Means and SDs for Achievement Variables, Correlations between CAS Full Scale Scores and WJ-R Achievement Scores by Race, and Moderated Regression Analyses

	Blacks				Whites				Difference		
	M	*SD*	*n*	*r*	*M*	*SD*	*n*	*r*	*z*	$R^2 \Delta$	$F \Delta$
Broad Reading	92.8	15.8	153	.71	104.2	17.1	1,053	.63	1.61	.002	4.139
Basic Reading Skills	90.6	16.2	152	.70	102.3	17.0	1,044	.60	1.79	.001	3.034
Reading Comprehension	94.0	15.4	149	.68	105.3	16.6	1,045	.60	1.49	.002	3.576
Broad Mathematics	91.7	20.8	155	.66	103.7	18.0	1,055	.65	0.25	.0001	0.814
Basic Mathematic Skills	91.8	18.9	154	.69	102.3	18.0	1,056	.65	0.75	.001	2.051
Mathematics Reasoning	91.7	18.9	155	.60	106.1	17.2	1,056	.64	-0.69	.001	2.463
Basic Writing Skills	89.2	17.7	138	.74	97.1	16.0	1,035	.64	2.04	.0001	0.045
Skills	89.4	17.1	138	.74	101.1	16.3	1,053	.69	1.00	.001	2.339
Median	91.7	17.4	153	.70	103	17.1	1,053	.64	1.14	-	-

Achievement standard score means, *SD*s, and Pearson correlations with the CAS Full Scale scores are provided in Table 3 by race group. Correlations between CAS and achievement by race were similar across groups. Overall, the correlations were high and ranged from .60 to .74. The median correlations for Blacks and Whites on the Achievement clusters were .70 and .64, respectively. The difference in correlations between Blacks and Whites was compared with a z test for the difference between independent correlations (Guilford & Fruchter, 1978). Twelve z tests were computed to compare the CAS Full Scale and separate PASS correlations with achievement between Black and White samples, using an experimentwise error rate of .01, and none of the differences were found to be statistically significant. The z values are also presented in Table 3, along with moderated regression analyses used to test whether a significant interaction effect was found (Aguinis, 2004; Jaccard, Turrisi, & Wan, 1990). These results suggest that there were no significant slope differences between CAS Full Scale and achievement subscales for Black versus White children as seen from the negligible and nonsignificant ($p > .01$) R^2 change associated with the interaction effect for each of these analyses.

The correlations between each PASS scale and WJ-R Skills subtest were also obtained by race. For Whites and Blacks, respectively, the correlations are: Planning (r = .52 and .63); Simultaneous (r = .62 and .58); Attention (r = .47 and .57); and Successive (r = .53 and .60). None of these correlations differed significantly by race. A second set of moderated regression analyses was conducted to compare the correlations by race for each of the four PASS scales with WJ Skills subtest scores; no significant differences were found: Planning R^2 = .0001, F change = .723 (p =.395); Simultaneous R^2 = .0001, F change = .104 (p = .747); Attention R^2 = .0001, F change = .387 (p =.534); and Successive R^2 = .0001, F change = .832 (p = .362). Finally, a third set of moderated regression analyses was conducted on a subset of the database that consisted of racial groups of equal size and controlling for the same set of demographic variables. A random selection of 298 White children was compared to the sample of Black children (n = 298). Similar results were found, with the product-term R^2 change ranging from .0001 to .003, indicating negligible change in explained variance and no moderating effect for race.

DISCUSSION

The two main aims of this study were to examine the performance of Black and White children on PASS cognitive processes measured using the CAS and to assess the relationships between PASS and achievement for samples of Black and White children. Both of these goals help evaluate the validity of the PASS theory as operationalized by the CAS. The results support Fagan's (2000) expectation that whereas Blacks and Whites differ considerably on traditional IQ tests there are small differences when ability is measured using tests of basic psychological processing. Importantly, the smaller difference does not come at the cost of reduced validity (e.g., lower correlations to achievement); in fact, the correlations between the PASS constructs and achievement for Blacks and Whites are substantial.

The 4.8 estimated mean score difference of the CAS Full Scale score between Blacks and Whites when controlling for demographic differences between the samples is in contrast to differences found between these groups on traditional IQ tests that require knowledge. For example, a 12-point mean score difference between matched samples of Blacks and Whites was reported by Wasserman and Becker (2000) for the Woodcock-Johnson Tests of Cognitive Ability (Woodcock & Johnson, 1989), a test that has considerable achievement-like content (Naglieri & Bornstein, 2003). In addition, Wasserman and Becker (2000) found that the largest differences on the WJ-R were for the most achievement-like clusters (e.g., Comprehension-Knowledge cluster, which measures breadth and depth of knowledge and experience, and Quantitative Ability, which measures quantitative concepts and relationships and manipulation of numerical symbols). Similarly, Wasserman and Becker (2000) found that the Verbal Reasoning and Quantitative Reasoning scales of the Stanford-Binet-IV also yielded large Black-White differences. Their findings further support Fagan's (2000) argument that measuring intelligence using tests with a strong achievement component is undesirable. Even if these tests are considered measures of crystallized intelligence (Carroll, 1993) rather than achievement, measurement of this "ability" is at least confounded by the child's fund of knowledge and, therefore, assessment of any person with limited educational success becomes difficult. The present results, and those presented by Fagan (2000), suggest that tests of processing that do not rely on accumulated knowledge offer a viable alternative to traditional IQ. Similarly, Naglieri (1986), Naglieri and Ronning (2000), and Naglieri and Ford (2003) have found small differences between minority and White children on the Kaufman Assessment Battery for Children (Kaufman & Kaufman, 1983) and the Naglieri Nonverbal Ability Test (Naglieri, 1997b), illustrating the advantage of measuring ability apart from knowledge.

The use of a theory of intelligence based on processing and the resulting smaller differences between Black and White groups found in this study and others cited above has important implications for special education. For example, a processing approach could result in fewer Black children being identified as mentally retarded, thereby addressing the problem of over-representation of minorities in special education (Oswald, Coutinho, Best, & Singh, 1999). Naglieri and Rojahn (2001) found evidence that the PASS processing approach would classify a smaller portion of Black children as having mental retardation than a traditional IQ test (the WISC-III—a test that measures intelligence through the use of verbal and arithmetic subtests). They found that if PASS, as measured by the CAS, was used for determination of mental retardation and eligibility in special education, the number of children identified would have been reduced by about 30%. Naglieri and Rojahn (2001) attributed the different classification rates to the verbal and academic content included in the WISC-III because the Black children in their sample earned lower Verbal than Performance scores and lower Verbal scores than the White sample of children with mental retardation. Their data, in conjunction with the present results, suggest that the theory of intelligence selected drives the content of the tests, which appears to be related to the smaller mean score differences as suggested by Fagan (2000) and Suzuki and Valencia (1997). A smaller mean score difference, however, did not come at the cost of reduced predictive validity.

The correlations and moderated regression analyses between the PASS constructs and achievement reported in this study illustrate the similarities of the relationships for both Black (median of .70) and White (median of .64) samples and support the validity of the theory for prediction to achievement. These correlations are consistent with, and actually somewhat higher than, the correlations found between traditional IQ tests and achievement (Naglieri, 1999; Naglieri & Bornstein, 2003; Naglieri et al., in press; Ramsey & Reynolds, 2004). These results suggest that the CAS correlations with achievement were at least as high as those found for the WISC-III even though the CAS does not include verbal tests. The results of all these studies support the view that the PASS processes are important for academic performance—an especially important aspect of validity for measures that are used within the educational context.

This study has limitations that should be considered. First, the inclusion of only two groups does not allow for greater understanding of how PASS processes may differ between samples of Whites and other race and ethnic groups as well as bilingual children. Studies involving children with limited English language skills are particularly important given the increasing numbers of Hispanic children in the general U.S. population (Bracken & Naglieri, 2003). A second possible limitation is that the PASS theory yields smaller differences between Blacks and Whites at the cost of a failure to measure the construct of crystallized ability. This argument is, however, flawed for two reasons. First, the concept of crystallized ability as a component of intelligence is confounded by measures that involve knowledge (e.g., achievement), which advocates of the processing approach to intelligence (Fagan, 2000; Naglieri & Das, 2004) have deemed undesirable in a measure and theory of intelligence. Second, the data presented here and by others (Naglieri, 1999; Naglieri & Bornstein, 2003; Ramsey & Reynolds, 2004) have shown that a measure of processing that does not include tests like vocabulary and arithmetic can have reduced Black-White differences and demonstrate good predictive validity—questioning the need, as well as desirability, of measuring ability from a crystallized perspective. The undesirability of crystallized ability as measured by the WISC-III Verbal scale was demonstrated by Naglieri and Rojahn (2001) when they compared measures of processing and traditional IQ tests given to children with mental retardation. Their research, however, warrants replication with larger samples and a variety of minority groups.

Despite the limitations, the present results suggest that redefining intelligence in terms of PASS cognitive processes may reduce the differences between Black and White groups. The findings also suggest that traditional IQ tests with academic content can be eliminated from a test of ability without the loss of predictive validity and the result may be a more equitable system for evaluating diverse populations of children. Thus, the great success of traditional IQ measures based on predictive validity and standardized methods of administration (Deary et al., 2000) may be achieved using a processing approach to intelligence as suggested by Fagan (2000) and Naglieri (1999) with the added advantage of reduced racial differences. Matarazzo (1992) was correct when he wrote that the field of intelligence testing would feel the effect of the knowledge explosion in cognitive psychology. Now it is up to us to recognize the value of traditional models developed in the early 1900s and processing approaches of the 21^{st} century.

REFERENCES

Aguinis, H. (2004). *Regression analysis for categorical moderators.* New York: Guilford.

Bracken, B. A., & McCallum, R. S. (1998). *Universal Nonverbal Intelligence Test.* Itasca, IL: Riverside.

Bracken, B. A., & Naglieri, J. A. (2003). Assessing diverse populations with nonverbal tests of general intelligence. In C. R. Reynolds & R. W. Kamphaus (Eds.), *Handbook of psychological and educational assessment of children* (2nd ed., pp. 243-273). New York: Guilford.

Carroll, J. B. (1993). *Human cognitive abilities.* New York: Cambridge.

Ceci, S. J. (2000). So near and yet so far: Lingering questions about the use of measures of general intelligence for college admission and employment screening. *Psychology, Public Policy, and Law, 6*, 233-252.

Das, J. P. (2002). Theories of intelligence: Issues and applications. In G. Goldstein and S. R. Beers (Eds.), *Comprehensive handbook of psychological assessment* (pp. 5-24). New York: Wiley.

Das, J. P., & Abbott, J. (1995). PASS: An alternative approach to intelligence. *Psychology and Developing Societies, 7*, 155-184.

Das, J. P., Kirby, J. R., & Jarman, R. F. (1979). *Simultaneous and successive cognitive processes.* New York: Academic Press.

Das, J. P., Naglieri, J. A., & Kirby, J. R. (1994). *Assessment of cognitive processes: The PASS theory of intelligence.* Boston: Allyn & Bacon.

Deary, I. J., Austin, E. J., & Caryl, P. G. (2000). Testing versus understanding human intelligence. *Psychology, Public Policy, and Law, 6*, 180-190.

Fagan, J. R. (2000). A theory of intelligence as processing: Implications for society. *Psychology, Public Policy, and Law, 6*, 168-179.

Feuerstein, R., Rand, Y., & Hoffman, M. (1979). *The dynamic assessment of retarded performers: The Learning Potential Assessment Device* (LPAD). Baltimore, MD: University Park Press.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences.* New York: Basic Books.

Guildford, J. P., & Fruchter, B. (1978). *Fundamental statistics in psychology and education.* New York: McGraw Hill.

Jaccard, J., Turrisi, R., & Wan, C. K. (1990). *Interaction effects in multiple regression.* Newbury Park, CA: Sage.

Kaufman, A. S., & Kaufman, N. L. (1983). *Kaufman Assessment Battery for Children.* Circle Pines, MN: American Guidance Service.

Kaufman, A. S., & Lichtenberger, E. O. (1999). *Essentials of WAIS-III assessment.* New York: Wiley.

Luria, A. R. (1966). *Human brain and psychological processes.* New York: Harper and Row.

Luria, A. R. (1973). *The working brain.* New York: Basic Books.

Luria, A. R. (1980). *Higher cortical functions in man* (2nd ed.). New York: Basic Books.

Matarazzo, J. (1992). Psychological testing and assessment in the 21st century. *American Psychologist, 47*, 1007-1018.

Naglieri, J. A. (1986). WISC-R and K-ABC comparison for matched samples of Black and White children. *Journal of School Psychology, 24*, 81-88.

Naglieri, J. A. (1997a). Intelligence knowns and unknowns: Hits and misses. *American Psychologist, 25*, 75-76.

Naglieri, J. A. (1997b). *Naglieri Nonverbal Ability Test.* San Antonio: The Psychological Corporation.

Naglieri, J. A. (1999). *Essentials of CAS assessment.* New York: Wiley.

Naglieri, J. A. (2002). Best practices in interventions for school psychologists: A cognitive approach to problem solving. In A. Thomas & J. Grimes (Eds.), *Best practices in school psychology* (4th ed., pp. 1373-1392). Bethesda, MD: NASP.

Naglieri, J. A. (2003). Current advances in assessment and intervention for children with learning disabilities. In T. E. Scruggs & M. A. Mastropieri (Eds.), *Advances in learning and behavioral disabilities Volume 16: Identification and assessment* (pp. 163-190). New York: JAI.

Naglieri, J. A., & Bornstein, B. T. (2003). Intelligence and achievement: Just how correlated are they? *Journal of Psychoeducational Assessment, 21,* 244-260.

Naglieri, J. A., & Das, J. P. (1990). Planning, Attention, Simultaneous, and Successive cognitive processes as a model for intelligence. *Journal of Psychoeducational Assessment, 8*, 303-337.

Naglieri, J. A., & Das, J. P. (1997). *Cognitive Assessment System.* Itasca, IL: Riverside.

Naglieri, J. A., & Das, J. P. (2004). The PASS theory. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary intellectual assessment* (2nd ed., pp. 120-135).

Naglieri, J. A., De Lauder, B. Y., Goldstein, S., & Schwebech, A. (in press). WISC-III and CAS: Which correlates higher with achievement for a clinical sample? *School Psychology Quarterly.*

Naglieri, J., & Ford, D. Y. (2003). Addressing under-representation of gifted minority children using the Naglieri Nonverbal Ability Test (NNAT). *Gifted Child Quarterly, 47*, 155-160.

Naglieri, J. A., & Gottling, S. H. (1995). A cognitive education approach to math instruction for the learning disabled: An individual study. *Psychological Reports, 76*, 1343-1354.

Naglieri, J. A., & Gottling, S. H. (1997). Mathematics instruction and PASS cognitive processes: An intervention study. *Journal of Learning Disabilities, 30,* 513-520.

Naglieri, J. A., & Johnson, D. (2000). Effectiveness of a cognitive strategy intervention to improve math calculation based on the PASS theory. *Journal of Learning Disabilities, 33*, 591-597.

Naglieri, J. A., & Rojahn, J. (2001). Evaluation of African-American and White children in special education programs for children with mental retardation using the WISC-III and Cognitive Assessment System. *American Journal of Mental Retardation, 106*, 359-367.

Naglieri, J. A., & Ronning, M. E. (2000). Comparison of White, African-American, Hispanic, and Asian children on the Naglieri Nonverbal Ability Test. *Psychological Assessment, 12*, 328-334.

Neisser, U. (1997). Never a dull moment. *American Psychologist, 52*, 79-81.

Neisser, U., Boodoo, G., Bouchard, R. J., Boykin, A. W., Brody, N., Ceci, S. J., et al. (1996). Intelligence: Knowns and unknowns. *American Psychologist, 51*, 77-101.

Oswald, D. P., Coutinho, M. J., Best, A. M., & Singh, N. N. (1999). Ethnic representation in special education: The influence of school-related economic and demographic variables. *Journal of Special Education, 32*, 194-206.

Ramsey, M. C., & Reynolds, C. R. (2004). Relations between intelligence and achievement tests. In G. Goldstein and S. Beers (Eds.), Comprehensive handbook of psychological assessment (pp. 25-50). New York: Wiley.

Sternberg, R. J. (1988). *The triarchic mind: A new theory of human intelligence.* New York: Viking.

Suzuki, L. A., & Valencia, R. R. (1997). Race-ethnicity and measured intelligence. *American Psychologist, 52*, 1103-1114.

Wasserman, J. D. (2002). Assessment of intellectual functioning. In J. R. Graham & J. A. Naglieri (Eds.) *Handbook of psychology: Volume 10 assessment psychology,* pp. 417-442. New York: Wiley.

Wasserman, J. D., & Becker, K. A. (2000, August). Racial and ethnic group mean score differences on intelligence tests. In J. A. Naglieri (Chair), *Making assessment more fair: Taking verbal and achievement out of ability tests.* Symposium at the annual meeting of the American Psychological Association, Washington, DC.

Woodcock, R. W., & Johnson, M. B. (1989). *Woodcock-Johnson Psychoeducational Battery-Revised: Standard and supplemental batteries.* Itasca, IL: Riverside.

Woodcock, R. W., Mc Grew, K. S., & Mather, N. (2001). *Woodcock-Johnson III Tests of Achievement.* Itasca, IL: Riverside.

Yoakum, C. S., & Yerkes, R. M. (1920). *Army mental tests.* New York: Henry Holt.