Journal of Psychoeducational Assessment

http://jpa.sagepub.com

Discriminant Validity of the Cognitive Assessment System for Students with Written Expression Disabilities

Judy A. Johnson, Achilles N. Bardos and Kandi A. Tayebi

Journal of Psychoeducational Assessment 2003; 21; 180
DOI: 10.1177/073428290302100205

Journal of Psychoeducational Assessment
2003, *21*, 180-195

DISCRIMINANT VALIDITY OF THE COGNITIVE ASSESSMENT SYSTEM FOR STUDENTS WITH WRITTEN EXPRESSION DISABILITIES

Judy A. Johnson
University of Houston - Victoria
Achilles N. Bardos
University of Northern Colorado
Kandi A. Tayebi
Sam Houston State University

This study explored the PASS cognitive processing theory in junior high students (aged 11-15 years) with and without written expression disabilities. Ninety-six students with (n = 48) and without (n = 48) written expression disabilities were administered the Das-Naglieri: Cognitive Assessment System (DN:CAS; 1997) and the writing subtests of the Wechsler Individual Achievement Test (WIAT; 1992). Discriminant analyses were utilized to identify the DN:CAS subtests and composites that contributed to group differentiation. The Planning composite was found to be the most significant contributor among the four composite scores. Subsequent efficiency of classification analyses provided strong support for the validity of the obtained discriminant functions in that the four DN:CAS composite scale scores correctly identified 83% of the students as members of their respective groups.

The role of intelligence and intelligence testing in the learning disability (LD) field continues to be debated among researchers and practitioners. Some argue that intelligence and LD have no relation, whereas others claim that new measures of intelligence are needed to clarify the issue. Siegel (1989) asserted that IQ is irrelevant when defining LD, while Naglieri and Reardon (1993) maintained that different measures of intelligence may be more sensitive to measuring intellectual differences of those with LD, thus contributing to a better diagnostic process. It is well documented in the literature that traditional intelligence tests have failed to distinguish between children with LD and their peers without LD (Berk, 1983; Mueller, Dennis, & Short, 1986; Naglieri & Haddad, 1984). Naglieri and Das (1990) argued that traditional tests have too narrow a view of intelligence and thus neglect many aspects of cognitive functioning. The Das Naglieri: Cognitive Assessment System (DN:CAS; Das &

Correspondence concerning this article should be addressed to Achilles N. Bardos, University of Northern Colorado, School Psychology Programs, Box 131, Greeley, CO 80639; e-mail: abardos@attbi.com.

Naglieri, 1997), a new test of cognitive functioning, was developed to expand the definition of intelligence. The test is based on the Planning Attention Simultaneous and Successive (PASS; Das & Naglieri, 1997) theory of cognitive functioning based on the work of Luria. Studies with the DN:CAS have shown specific Planning, Attention, Simultaneous, Successive (PASS) profiles with students with disabilities in reading and mathematics, as well as with students with attention deficit disorder and traumatic brain injuries (Naglieri, 1999; Naglieri & Das, 1997).

Writing-disability research, in general, has been neglected (Fryburg, 1997), and this is also the case with the DN:CAS and its role in the assessment of those with writing disabilities. Most of the research with the DN:CAS has been conducted with students who have reading or mathematical disabilities. The limited research that has examined the relationship between the DN:CAS scales and writing has been conducted with experimental tasks of the DN:CAS (Flanagan, 1992). The importance of planning (one of the four PASS theory areas operationalized by the DN:CAS) in writing has been addressed by writing theorists (Hayes, 1996; Hayes & Nash, 1996). Available research using other measures has shown deficits in higher-order cognitive processes and metacognition in those with writing disabilities (Wong, Butler, Ficzere, & Kuperis, 1996), as well as lower-order cognitive processes like letter automaticity (Berninger, 1999).

PASS THEORY

The PASS theory has developed through empirical and theoretical research over the past several decades. The theory was first described as an information-processing theory based on Luria's work (Das, Kirby, & Jarman, 1975), later as the Information-Integration theory (Das, Kirby, & Jarman, 1979), and most recently as the Planning-Attention-Simultaneous-Successive (PASS) theory (Das, Naglieri, & Kirby, 1994).

Naglieri (1997, p. 249) stated that "planning processes provide the individual with the means to determine and use efficient solutions to problems using attention, simultaneous, and successive processes and the individual's base of knowledge." Planning, in general, is a set of decisions or strategies that one adopts and modifies to problem solve and reach a goal (Das, 1980). In the planning process, an individual must recognize the need for a plan, as well as develop and initiate the plan. An essential part of planning is metacognition, where the individual examines the plan for its usefulness, modifies the plan, and creates another plan as needed. Planning is the process that appears to unite the information coding and attentional processes (Das, Naglieri, & Kirby, 1994).

Naglieri and Das (1997) defined attention as "a mental process by which the individual selectively focuses on particular stimuli while inhibiting responses to competing stimuli presented over time" (p. 3). Selective attention can be either focused or divided. In focused attention, one attends to one source of information and excludes the others, while in divided attention one divides time between several sources (Das et al., 1994).

Whereas the attention and planning systems can either assist or interfere with processing, the coding system combines and transforms information. Coding occurs when new or incoming information is "interpreted in terms of what we already know" (Das et al., 1994, p. 52). In the PASS theory, coding is operationalized through two processes, namely simultaneous processing and successive processing. Simultaneous processing requires a person to see how different stimuli interrelate to form the perception of a whole of a construct. For example, simultaneous processing is required in order to comprehend and derive meaning from a reading passage, by integrating the various information components of the passage. Successive processing, on the other hand, requires that stimuli are organized in a serial temporal order where one stimulus relates only to the stimulus that precedes it and they are not interrelated.

According to the theory, the four PASS processes are not unrelated and/or function in isolation. This is consistent with Luria's position that each cognitive activity requires the inner workings of all brain units. Various tasks might demand the differential contribution of a particular process (Planning, Attention, Simultaneous, or Successive) depending on the demand of the task and a person's knowledge base.

THE PASS THEORY AND WRITTEN EXPRESSION ACHIEVEMENT

Few studies have examined the relationship between the PASS processes and writing achievement, and most of them took place at early stages of the development of the PASS theory with exploratory tasks. For example, Ashman (1978) found that planned composition loaded highly on a factor with other planning tasks, forming the initial hypothesis that planning (as described in the PASS theory) is important to writing. Later, Flanagan (1992) found that planning tasks were the best predictor of punctuation, capitalization, and written composition achievement in 78 elementary-aged children referred for learning problems. Wachs and Harris (1986) found a significant relationship between written composition and successive processing in college students, but they did not use any planning processing tasks.

Three studies are mentioned in the DN:CAS Interpretive Handbook that involve writing. In the first study (Naglieri & Das, 1997), 1,600 youth were administered the DN:CAS and the Dictation and Proofing subtests of the Woodcock-Johnson-Revised Tests of Achievement (WJ-R; Woodcock & Johnson, 1989). Significant correlations were found between the WJ-R achievement measures and the DN:CAS, with analyses demonstrating that weaknesses on the Planning scale were related to scores on the Dictation and Basic Writing subscales. In the second study, 80 students identified and placed in special education classes for LD were administered the DN:CAS, WJ-R Tests of Achievement, and another cognitive measure (Naglieri & Das, 1997). The students were classified with LD prior to the study and ranged in age from 6 to 16 years. The highest correlation (with the exception of the Full Scale) was with the Planning scale, and all correlations were significant at the .05 level. When compared with their scores on other achievement subtests of the WJ-R, those with LD achieved their lowest scores on the Basic Writing Skills composite. In the third study, the DN:CAS was administered to 105 regular education students in Grade 6 (n = 45) and Grade 8 (n = 60) (Naglieri & Das, 1997). In addition, each student wrote a story about a picture. The students were instructed to write a story that had a purpose, a starting point, an action, and an ending. The resulting stories were scored on a seven-point scale in Expression (ability to express ideas and thought given to the topic); Organization (logical sequence of plan and underlying plan); Wording (imaginative and correct use of words); Mechanics (spelling, punctuation, and sentence structure); and Individuality (creative approach to the material). The DN:CAS Planning scale correlated significantly with the Planned Composition Total and each rating category.

The results of these studies suggest that when children have the basic writing skills, their Planning scale standard scores and individual Planning subtest scores were significantly correlated with their written compositions (Naglieri & Das, 1997). The studies, although limited in number and with experimental tasks of the DN:CAS, have shown that a relationship exists between the Planning scale of the DN:CAS and writing in both students with and without learning difficulties.

The purpose of this study was to (a) examine the performance of a sample of junior high students identified with disabilities in writing, and (b) investigate the discriminant validity of the published version of the DN:CAS by exploring the differential contribution of its scale scores (composite and subtest) and the classification efficiency for a group of students with and without writing disabilities.

METHOD

Participants and Procedures

Participants were selected on a voluntary basis from two junior high schools in Texas. In the two schools, 72.3% and 48.8% of the students are identified as low income. The ethnicity of the students placed in special education in the district includes Anglo (43.6%), Hispanic (31.1%), African American (24.3%), Asian (0.7%), and of other ethnic backgrounds (0.3%). Parental consent as well as assent was obtained by each participant. All assessments were completed by a licensed school psychologist during nonacademic class periods at each student's school. The average testing time was 2 hours, and each student received a small incentive for participation in the study. Junior high–aged students were selected because it is an age at which students are asked to demonstrate much of their learning through written products (Hooper et al., 1993). In addition, Johnson and Myklebust (1967) stated that, by this age, students should possess most of the neurodevelopmental abilities to perform the tasks necessary in the writing process. Further, Hooper et al. (1993, p. 612) stated, "Although the amount and quality of writing instruction likely varies significantly from school district to school district, the middle school years also represent a time when nearly all students have been exposed to some kind of instruction devoted to writing."

The participants in this study were 96 junior high school students, 56 females (58%) and 40 males (42%) who were enrolled in Grades 6 (25%), 7

(49%), and 8 (26%). The students ranged in age from 11 years 3 months to 15 years 2 months, with a mean age of 13.14 years (*SD* = 10 months). Thirty-two were African American (34%), 31 were Anglo (32%), 29 were Hispanic (30%), 3 were Asian (3%) and 1 was Native American (1%). Forty-eight of the participants attended regular education classes and served as the control group, whereas the remaining 48 were already identified with learning disabilities in written expression (LD) using criteria established by the Texas Education Agency.

Students labeled "with LD" and assigned in this group for the purpose of this study met the following criteria:

1. Each student met the Texas Education Agency's criteria for eligibility as a student with LD. This eligibility (method one) requires a discrepancy of more than one standard deviation between measured intelligence and achievement using norm-referenced measures. Low achievement in spelling alone does not qualify as a written expression disability.

2. Measured intelligence must be above the range for mental retardation (IQ 71 or higher). The WISC-III (Wechsler, 1991) and in some cases the Woodcock-Johnson Cognitive (WJ-R; Woodcock & Johnson, 1989) was used in the initial determination of a disability. Recognizing the limitations of the discrepancy formula, this study placed an additional criterion for selection in this group over and above the state eligibility criteria. For example, although some of the students with LD in writing also had low achievement scores in reading (21%), math (8%), and both reading and math (62%) on their last evaluation, in order to be included in the group with writing disabilities, they had to achieve a score below 85 on the Written Expression subtest of the WIAT. Students who had additional classifications of traumatic brain injury, emotional disturbance, autism, hearing impairment, or visual impairment were ruled out.

3. To be included in the study, a student had to have English selected as the dominant language on a survey of the language spoken in the home completed by the parents.

To be considered for the control, "without LD" group, the students had to be junior high (Grades 6-8) with a grade of "B" or better in their language arts class. This criterion was to ensure that the student did not have an undiagnosed learning disability. Berninger (1999) stated that many students who perform poorly on state-designed assessments of writing may have undiagnosed writing problems. The students also scored 85 or higher on the WIAT Written Expression subtest to be included in the study. In addition, the student was not receiving special education services in any disability classification and had to have English selected as the dominant language.

Materials

All participants were administered the standard battery of the Das-Naglieri: Cognitive Assessment System (DN:CAS; Das & Naglieri, 1997), an individually administered intelligence test. In addition, the Spelling and Written Expression subtests of the Wechsler Individual Achievement Test (WIAT;

Wechsler, 1992) were administered in small groups. The two subtests combine to yield a Writing Composite score as described in the WIAT administration manual. The Written Expression subtest was chosen because it is a standardized measure that has the student write on a topic for 15 minutes. Unlike many writing assessments, for example, the Woodcock-Johnson Tests of Achievement–Revised Writing Samples subtest (Woodcock & Johnson, 1989, 1990) and the Oral and Written Language Scales (Carrow-Woolfolk, 1996), it allows the student to write for a more extended period of time, rather than writing a few sentences describing a picture. The WIAT Written Expression subtest provided more data on a student's ability to plan and organize an essay. The DN:CAS and WIAT are reviewed in more detail below:

Das-Naglieri: Cognitive Assessment System

The Das-Naglieri Cognitive Assessment System (DN:CAS) was published in 1997 to "integrate theoretical and applied areas of psychological knowledge using a theory of cognitive processing and tests designed to measure those processes" (Naglieri & Das, 1997, p. 1). The DN:CAS is based on the PASS theory of cognitive processing and is designed for children aged 5 through 17 years. Its standardization sample, which was based on the 1990 U.S. Census data, included 2,200 children, as well as 872 additional students in the reliability and validity studies. The DN:CAS includes 12 subtest scores, which yield four cognitive processing scales (Planning, Attention, Simultaneous, Successive) and a Full Scale score. Both the Full Scale score and the cognitive processing scales have a mean of 100 and a standard deviation of 15. The subtest scores have a mean of 10 and a standard deviation of 3.

Reliability for the DN:CAS was determined using several methods (Naglieri & Das, 1997). Subtest reliabilities (the average for all ages) ranged from .75 to .89, whereas the composite reliabilities ranged from .88 to .96. Validity of the DN:CAS was established using a variety of methods. Naglieri and Das (1997, p. 50) stated that "the subtests and items on the DN:CAS were developed using the combination of task analysis and experimental examination so they would efficiently reflect the processes described in the PASS theory." In regard to construct validity, the DN:CAS scaled scores are developmentally sensitive. Further, Naglieri and Das (1997) have noted that each subtest of the DN:CAS is assigned to the cognitive processing scale for which it has the highest correlation. Naglieri and Das (1997) reported confirmatory and exploratory factor analyses to examine the underlying structure of the DN:CAS. Support for both a three-factor solution and a four-factor solution was found through factor analyses. However, the four-factor solution was chosen because it is more consistent with empirical, theoretical, and clinical information (Naglieri, 1999). Although there has been a debate in the literature (Keith, Kranzler, & Flanagan, 2001; Kranzler, Keith, & Flanagan 2000) regarding the factor structure of the DN:CAS, and in particular whether the planning and attention scales should be separated or combined, we have adopted the authors' position of a four-factor solution, which is consistent with the PASS theory and how the test is used in the field.

In addition to studies with special populations reported in the manual, a number of studies demonstrating the ability of the DN:CAS to guide the development of remedial programs has been reported (Naglieri & Das, 1997; Naglieri & Johnson, 2000). Because the DN:CAS is a relatively new instrument, the DN:CAS subtests are reviewed in more detail below.

Planning Subtests

The DN:CAS planning tasks were developed "to require the child to create a plan of action, apply the plan, verify that an action taken conforms with the original goal, and modify the plan as needed" (Naglieri & Das, 1997, p. 14). The planning subtests include Planned Codes, Matching Numbers, and Planned Connections. Each Planning subtest also has a strategy assessment checklist that is marked on each subject tested. The examiner marks the strategies used by the student in completing the planning tasks. Planned Codes provides a client with codes (XX, OO, XO, OX) that correspond to specific letters, and he or she then fills in the corresponding codes in the empty boxes. This subtest is a variation of other coding subtests that have been used to measure planning (Yoakum & Yerkes, 1920). In Matching Numbers, the client identifies and underlines two numbers in a row that are the same. Matching Numbers has been found to be related to other measures of planning in PASS research (Naglieri & Das, 1988; Naglieri, Prewett, & Bardos, 1989). Planned Connections requires the client to connect sequential stimuli that appear on a page in an apparent random manner. For example, the easier items require a child to connect a series of numbers in order, whereas the more difficult items have him or her connect numbers and letters alternately (A to 1, B to 2, etc.). Tasks similar to Planned Connections have been found to correlate with other planning tests and have been used to evaluate the functioning of the frontal lobe (Ashman & Das, 1980; Naglieri et al., 1989).

Attention Subtests

The Attention subtests of the DN:CAS "require the focus of cognitive activity, detection of a particular stimulus, and inhibition of responses to irrelevant competing stimuli" (Naglieri & Das, 1997, p. 17). Subtests of attention in the DN:CAS are measures of selective attention and include Number Detection, Receptive Attention, and Expressive Attention. Number Detection requires subjects to underline specific numbers that occur at the top of the page, whereas Receptive Attention has them underline pairs of pictures (younger students) or letters (older students) that are identical in appearance and then identify those with the same name. The Expressive Attention subtest varies by age, but for older subjects (8-17) the client reads words, identifies colored shapes, and then must read the color of the word rather than pronouncing the word. For example, the word "blue" may be printed in red ink, and the client would say "red."

Simultaneous Processing Subtests

Simultaneous processing subtests of the DN:CAS "require the synthesis of separate elements into an interrelated group using both verbal and nonverbal content" (Naglieri & Das, 1997, p. 21). Measures of simultaneous processing in the DN:CAS include Verbal Spatial Relations, Nonverbal Matrices, and Figure Memory. Verbal Spatial Relations requires examinees to identify the picture that correctly answers the question read by the examiner, whereas Nonverbal Matrices requires them to examine an abstract pattern and solve the item by choosing the best option to complete the matrix. Figure Memory requires the examinee to look at a figure (for example, a square) for 5 seconds and then identify (by tracing) the initial figure, which is embedded in a more complex design.

Successive Processing Subtests

The Successive processing subtests included in the DN:CAS were developed to deal with a serial organization of events. All the successive subtests require the individual to work cognitively with information that is presented in a specific order and for which the order is most important (Naglieri & Das, 1997). The Successive processing subtests include Word Series, Sentence Repetition, Sentence Questions (ages 8-17), and Speech Rate (ages 5-7). Word Series requires the examinee to repeat words in the same order as read by the examiner (from two to nine words). Sentence repetition has subjects repeat each sentence (which has color words in place of nouns and verbs) exactly as it was presented, and Sentence Questions has them answer questions about the sentence. Speech Rate involves the repeated pronunciation of words in order. For example, the time it took the examinee to say three words in order 10 times would be recorded.

Wechsler Individual Achievement Test (WIAT)

The Wechsler Individual Achievement Test (WIAT) was published in 1992 as an individually administered achievement test for ages 5 to 19 and yields standard scores with a mean of 100 and a standard deviation of 15. The test yields eight subtest scores (Basic Reading, Reading Comprehension, Numerical Operations, Mathematics Reasoning, Listening Comprehension, Oral Expression, Spelling, and Written Expression). Four composites (Reading Composite, Mathematics Composite, Language Composite, and Writing Composite) are created by combining several of the subtests. In this study, only the Written Expression and Spelling subtests were administered.

The WIAT was standardized on 4,252 children ranging in age from 5 through 19 years. Average reliability coefficients (age-based) of the WIAT writing subtests were .90 for the Spelling subtest, .81 for the Written Expression subtest, and .90 for the Writing Composite using the Fisher's z transformation (WIAT manual, 1992). Evidence of content, construct, and criterion related validity is detailed in the test manual (WIAT manual, 1992).

The Spelling subtest of the WIAT is designed to assess "the ability to write dictated letters of the alphabet and the ability to encode dictated sounds" (WIAT manual, 1992, p. 45). The test is administered orally to each subject, who receives one point for each correct response. In the Written Expression subtest, the child writes for 15 minutes on the topic described in the writing prompt. The child views the writing prompt throughout the entire subtest and is reminded of the time remaining at scheduled intervals. The essay is then scored using an analytic or holistic rating system; only the analytic system will be described because it was the one used in this study. Using the analytic scoring system, the essay is rated on six elements and element groups using a 1 (*poor*) to 4 (*excellent*) scale. The analytic rating system addresses the following areas: Ideas and Development; Organization, Unity, and Coherence; Vocabulary; Sentence Structure and Variety; Grammar and Usage; and Capitalization and Punctuation (WIAT manual, 1992). Although the reliability coefficients reported in the WIAT technical manual are adequate, to increase the accuracy of the writing scores, the study employed three trained raters. The raters were blind to group membership and rated every essay. An average score for each student was recorded.

Table 1
Means and Standard Deviations of the DN:CAS and WIAT Subtests and Composites for the Samples with and without Learning Disabilities

	With LD		Without LD	
DN:CAS subtests	*M*	*SD*	*M*	*SD*
Matching Numbers	7.42	2.50	11.17	2.59
Planned Codes	8.15	1.87	11.23	2.40
Planned Connections	7.54	2.38	10.90	3.10
Nonverbal Matrices	8.71	2.29	9.96	2.45
Verbal-Spatial Relations	9.04	2.16	11.02	2.79
Figure Memory	8.73	2.35	11.27	2.55
Expressive Attention	8.60	1.85	11.21	2.48
Number Detection	9.58	2.18	11.98	3.36
Receptive Attention	8.46	2.13	11.35	2.65
Word Series	8.83	2.16	9.29	2.58
Sentence Repetition	8.92	2.08	10.60	1.71
Sentence Questions	8.35	2.07	9.94	2.01
DN:CAS composite scores				
Planning Composite	85.56	11.30	106.79	13.78
Simultaneous Composite	92.88	10.15	104.50	10.74
Attention Composite	93.23	9.96	109.5	14.25
Successive Composite	91.98	10.28	99.56	9.25
WIAT				
Written Expression (WE) Subtest	72.19	6.24	109.48	9.83
Spelling Subtest	74.13	9.36	104.35	11.11
Writing Composite	68.98	8.55	106.75	10.57
WE words written	80.90	49.52	147.35	42.19
WE time (in seconds)	454.33	234.96	657.10	124.28

RESULTS

The scaled score means and standard deviations of the 12 DN:CAS subtest and the four DN:CAS composite scores for the two groups with and without LD are reported in Table 1. Although the DN:CAS also offers a Full Scale score with a mean of 100 ($SD = 15$), this score was not calculated due to a statistically significant discrepancy that existed between the four composite scores (in about 80% of the cases in the group with LD), rendering its interpretation meaningless. The group with LD scored lower than the group without LD on all subtests and composite scores. In fact, the regular education group scored in the average range on all DN:CAS subtests, whereas most of the subtest scores of the group with LD fell in the low-average range. Similarly, all composites for the group without LD fell in the average range; the group with LD fell in the low-average range on the Planning composite but scored in the average range on the Attention, Simultaneous, and Successive composites. The group with LD scored lower than the control on all PASS composites.

Table 1 also describes the performance of the two samples on the WIAT Written Expression and Spelling subtests. The Written Expression scores ranged from 90 to 131 for the regular education group and from 60 to 84 for the group with LD. Consistent with the literature (Mather & Roberts, 1995), students with LD wrote fewer words and wrote for fewer minutes than did their peers without LD. On average, the group with LD wrote 66 fewer words and wrote for 3 minutes less than the group without LD on the Written Expression subtest.

Two multivariate analyses of variance (MANOVA) were conducted to examine the difference in performances of the groups with and without LD with respect to the DN:CAS subtests and composites. First, the differences between the two groups on the 12 DN:CAS subtests were examined and found to be significant ($F = 11.508$, $p < .000$). The second MANOVA examined the group differences on the DN:CAS Composites. Once again, overall differences between the groups were found to be significant ($F = 21.480$, $p < .000$).

Following the significant differences revealed by the MANOVA, post-hoc analyses were performed to determine the variables that contributed to the differentiation between the groups. Table 2 presents the results of univariate F tests. Eleven of the DN:CAS subtests were found to be significant when comparing the two groups with and without LD. The Word Series ($F = .893$, $p < .34$) subtest was not significant and showed marginal differentiation between the groups. All univariate F tests for the DN:CAS composites were found to be significant ($p < .000$) when comparing the groups with and without LD. The univariate F tests alone do not reflect the discriminating power that the variables may share. For this reason, a discriminant analysis was conducted to gain additional information.

Two direct discriminant analyses were executed separately using the 12 DN:CAS subtests and the 4 composite scores as the criterion variables. A ratio of 20 to 1 (subject to criterion variable) is suggested for discriminant analysis (Stevens, 1992). For this reason, analyses utilizing the DN:CAS composite scores should be more reliable than those analyses examining the DN:CAS subtest scores. In addition, the composite scores are the scores that operationalize the PASS theory and are used in the diagnostic decision-making process. However, because this is the first study reported in the literature with these samples the findings of all analyses are reported. The discriminant functions derived from the analyses were significant. To analyze the group differences further, canonical discriminant function coefficients for the 12 DN:CAS subtests and the DN:CAS composites were obtained (see Table 2). When examining the DN:CAS composites, the Planning and Simultaneous composites account for the majority of differences between the groups with and without LD. In regard to the 12 DN:CAS subtests, the highest weights were on the Figure Memory, Planned Codes, and Receptive Attention subtests. Structure coefficients are also reported in Table 2 because they have greater stability when small or medium-sized samples are used (Stevens, 1992). This is especially true if there are moderate to high correlations among the variables. The above characteristics describe the data in this study. The structure coefficients also describe which variables are most closely related with the trait that the discriminant function represents (Stevens, 1992). The structure coefficients for the 12 DN:CAS subtests indicate that Matching Numbers, Planned Codes, Planned Connections, and Receptive Attention were most predictive of group differentiation between the groups with and without LD. The first three subtests comprise the Planning composite. An examination of the structure coefficients for the DN:CAS composites reveals that, of the four composites, Planning followed by Attention is most predictive of group differentiation. However, in both examinations, the Planning composite was most predictive of group differentiation.

Table 2
Univariate F Tests, Structure Coefficients, and Standardized Canonical Discriminant Function Coefficients for the DN:CAS Subtests and Composite Scores

	F Test	*p*	Structure Coefficients	Discriminant Function
Matching Numbers	52.151	.000	.577	.309
Planned Codes	49.366	.000	.562	.478
Planned Connections	35.330	.000	.475	-.008
Nonverbal Matrices	6.678	.011	.207	-.155
Verbal-Spatial Relations	15.109	.000	.311	-.020
Figure Memory	25.796	.000	.406	.601
Expressive Attention	34.045	.000	.467	.269
Number Detection	17.160	.000	.331	-.380
Receptive Attention	34.719	.000	.471	.437
Word Series	.893	.347	.076	-.168
Sentence Repetition	18.832	.000	.347	.166
Sentence Questions	14.435	.000	.304	.332
Planning Composite	68.128	.000	.876	.627
Attention Composite	29.700	.000	.688	.169
Simultaneous Composite	42.047	.000	.578	.416
Successive Composite	14.436	.000	.403	.234

The efficiency of classification examines the ability to accurately classify subjects into their groups using the discriminant functions. A form of bias is created when the cases classified are based on the same cases that were used in the development of the classification equation. The jackknife procedure eliminates this bias when all data are used in the analysis. Using the jackknife procedure, each case is classified using equations created from all data except the case being classified (Stevens, 1992). Thus, the results of the classification can be seen as a more genuine estimate of the ability of the predictors to distinguish among groups (Tabachnick & Fidell, 1983).

Table 3 presents the efficiency of classification analyses. Using the DN:CAS subtests, 91.7% of the students without LD and 87.5% of the students with LD were correctly classified. Overall, using the DN:CAS subtests, 89.6% of the original cases were classified correctly. With the use of the jackknife technique, 85.4% of the cross-validated groups were classified correctly.

When the classification efficiency of the four DN:CAS composites was examined (Table 3), 83.3% of the students without LD and 87.5% of the students with LD were classified correctly. Both the DN:CAS subtests and composites identified the same percentage of students with LD. Of the original cases, 85.4% of all cases were classified correctly. Using the jackknife procedure, 83.3% of the cross-validated cases were classified correctly.

Table 3
Classification Accuracy Based on DN:CAS Subtests and Composite Scores

Original Group Membership		Predicted Group	
DN:CAS Subtests	*N*	With LD	Without LD
With LD	48	42 (87.5%)	6 (12.5%)
Without LD	48	4 (8.3%)	44 (91.7%)
Cross-Validated			
With LD	48	41 (85.4%)	7 (14.6%)
Without LD	48	7 (14.6%)	41 (85.4%)
DN:CAS Composites			
With LD	48	42 (87.5%)	6 (12.5%)
Without LD	48	8 (16.7%)	40 (83.3%)
Cross-Validated			
With LD	48	40 (83.3%)	8 (16.7%)
Without LD	48	8 (16.7%)	40 (83.3%)

DISCUSSION

It has been proposed that "IQ is better described as PASS cognitive processes" (Naglieri & Johnson, 2000, p. 591). In fact, studies with the DN:CAS have shown specific PASS profiles with those who have reading and mathematics disabilities (Naglieri & Das, 1997). This study contributed additional data to the research that states that students who have writing disabilities have depressed scores on the Planning composite. This finding may mean that difficulties in some aspects of writing may be due to poor planning processes.

Research concerning the Planning composite has shown that planning processes do not occur before the age of 4 or 5 (Das et al., 1994). Pelletier (1996) found evidence that planning skills are present in children aged 6 to 8. However, at that age, planning was not found to be the major contributor that differentiated between the groups with and without LD. Using older students (aged 11-15 years), the present study found that the Planning composite was a major factor contributing to the discrimination of students with and without LD in writing.

The findings of this study suggest that the use of the DN:CAS with an assessment battery will yield information that contributes to the differential diagnosis of a student suspected of having a learning disability in writing. A direct measure of planning processes is not contained in traditional IQ tests or tests that measure general ability. The literature has consistently shown that general ability tests (e.g., Wechsler Scales) have failed to provide evidence of differential diagnosis for students with learning disabilities, including students with writing disabilities. This study suggests that the DN:CAS appears to be sensitive to the cognitive differences of students with LD in writing as shown by the high percentages of classification efficiency (83%). Once the findings of this study are replicated, discovering that a learning disability exists in a specific area is only the beginning. It is hoped that assessment data can be linked to effective intervention. Assessment is more useful when it leads to "remediation of the cognitive deficit revealed in testing an individual" (Das et al., 1994, p. xvii). An important goal of the DN:CAS is to use the cognitive processing information to make decisions about instructional programming (Naglieri & Das, 1997).

Recent research has studied how to link the DN:CAS data to intervention planning with students who experience difficulties in math and reading. Studies have examined whether instruction to facilitate planning would be impacted by specific PASS cognitive profiles of the subjects (Hald, 2000; Naglieri & Johnson, 2000). These studies found that children with cognitive weaknesses in Planning gained the most benefit from the instruction that focused on planning facilitation. Although these studies were completed with students who had difficulties in mathematics, the same concept could be applied to those with writing disabilities. If further studies replicate the findings in the present study, similar interventions that address deficiencies in students' planning and organization skills may be warranted for students with written expression disabilities.

The idea that planning is important to writing is not new. The Hayes and Flower (1986) theory of writing highlighted planning as an important aspect of writing. De La Paz (1997, p. 245) stated that "a large literature now exists in which the advantages of teaching students with and without learning disabilities strategies to plan (setting process and content goals, using text structure to generate writing content) before composing are well known." The planning interventions discussed above include Self-Regulated Strategy Development (SRSD). The SRSD approach was influenced by many researchers, including Meichenbaum, Vygotsky, Sokolov, and Luria (Graham & Harris, 1993). The

PASS theory was influenced by the work of Luria. However, proponents of the SDRD approach recognizing the complex nature of writing have stated that "no single instructional approach can affect all aspects of writing nor fully address the complex nature of a learning problem" (Graham & Harris, 1993, p. 174). The DN:CAS and its assessment of the cognitive processes appears to be a natural extension of this theoretical work, and intervention studies are needed to test such hypotheses. This study provided initial and strong support for the use of the DN:CAS in the evaluation and differential discrimination of students with writing disabilities. The data highlight the potential role of Planning and its contribution to the differential diagnosis process of learning disabilities in writing.

In view of the promising work linking assessment to intervention for students with mathematics and reading difficulties, this study's findings provide the springboard for the design and implementation of intervention studies with the DN:CAS and the SRSD approach.

REFERENCES

Ashman, A. (1978). *The relationship between planning and simultaneous and successive synthesis.* Unpublished doctoral dissertation, University of Alberta, Edmonton.

Ashman, A., & Das, J. P. (1980). Relation between planning and simultaneous-successive processing. *Perceptual and Motor Skills, 51,* 371-382.

Berk, R. A. (1983). The value of WISC-R profile analysis for the differential diagnosis of learning disabled children. *Journal of Clinical Psychology, 39,* 133-136.

Berninger, V. (1999, April). *Planning, implementing, and evaluating writing interventions.* Paper presented at the meeting of the National Association of School Psychologists, Las Vegas, NV.

Carrow-Woolfolk, E. (1996). *Oral and Written Language Scales.* Circle Pines, MN: American Guidance Service.

Das, J. P. (1980). Planning: Theoretical considerations and empirical evidence. *Psychological Research, 41,* 141-151.

Das, J. P., Kirby, J. R., & Jarman, R. F. (1975). Simultaneous and successive synthesis: An alternative model. *Psychological Bulletin, 82,* 87-103.

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. (1997). *Das-Naglieri: Cognitive Assessment System.* Chicago: Riverside.

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

De La Paz, S. (1997). Strategy instruction in planning: Teaching students with learning and writing disabilities to compose persuasive and expository essays. *Learning Disability Quarterly, 20,* 227-248.

Flanagan, D. P. (1992). *The planning, attention, simultaneous, and successive (PASS) model of cognitive processing and its relationship to academic achievement.* Unpublished doctoral dissertation, Ohio State University, Columbus, Ohio.

Fryburg, E. (1997). *Reading and learning disability: A neuropsychological approach to evaluation and instruction.* Springfield, IL: Charles C. Thomas.

Graham, S., & Harris, K. (1993). Self-regulated strategy development: Helping students with learning problems develop as writers. *The Elementary School Journal, 94* (2), 169-181.

Hald, M. E. (2000). *A PASS cognitive processes intervention study in mathematics.* Unpublished doctoral dissertation, University of Northern Colorado, Greely.

Hayes, J. R. (1996). A new framework for understanding cognition and affect in writing. In M. Levy & S. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 1-27). Mahwah, NJ: Erlbaum.

Hayes, J. R., & Flower, L. (1986). Writing research and the writer. *American Psychologist, 41,* 1106-1113.

Hayes, J. R., & Nash, J. (1996). On the nature of planning in writing. In M. Levy and S. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 29-55). Mahwah, NJ: Erlbaum.

Hooper, S., Swartz, C., Montgomery, J., Reed, M., Brown, T., Wasileski, T., & Levine, M. (1993). Prevalence of writing problems across three middle school samples. *School Psychology Review, 22* (4), 610-621.

Johnson, D., & Myklebust, H. (1967). *Learning disabilities: Educational principles and practices.* New York: Grune and Stratton.

Keith, T., Kranzler, J., & Flanagan, D. (2001). What does the Cognitive Assessment System (CAS) measure? Joint confirmatory factor analysis of the CAS and the Woodcock-Johnson Test of Cognitive Ability (3rd ability). *School Psychology Review, 30,* 89-119.

Kranzler, J. Keith, T., & Flanagan, D. (2000). Independent examination of the factor structure of the Cognitive Assessment System (CAS): Further evidence challenging the construct validity of the CAS. *Journal of Psychoeducational Assessment, 18,* 143-159.

Mather, N., & Roberts, R. (1995). *Informal assessment and instruction in written language: A practitioner's guide for students with learning disabilities.* New York: Wiley.

Mueller, H., Dennis, S., & Short, R. H. (1986). A meta-exploration of WISC-R factor score profiles as a function of diagnosis and intellectual level. *Canadian Journal of School Psychology, 2,* 21-43.

Naglieri, J. A. (1997). Planning, attention, simultaneous, successive theory and the Cognitive Assessment System: A new theory-based measure of intelligence. In D. P. Flanagan, J. L. Genshaft, & P. L. Harrison (Eds.), *Contemporary intellectual assessment* (pp. 247-265). New York: Guilford.

Naglieri, J. A. (1999). How valid is the PASS theory and CAS? *School Psychology Review, 28* (1), 145-162.

Naglieri, J. A., & Das, J. P. (1988). Planning-arousal-simultaneous-successive (PASS): A model for assessment. *Journal of School Psychology, 26,* 35-48.

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

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

Naglieri, J. A., & Haddad, F. A. (1984). Learning disabled children's performance on the Kaufman Assessment Battery for Children: A concurrent validity study. *Journal of Psychoeducational Assessment, 2,* 49-56.

Naglieri, J. A., & Johnson, D. (2000). Effectiveness of a cognitive strategy intervention in improving arithmetic computation based on the PASS theory. *Journal of Learning Disabilities, 33,* 591-597.

Naglieri, J. A., Prewett, P., & Bardos, A. N. (1989). An exploratory study of planning, attention, simultaneous, and successive cognitive processes. *Journal of School Psychology, 27,* 347-364.

Naglieri, J. A., & Reardon, S. M. (1993). Traditional IQ is irrelevant to learning disabilities–intelligence is not. *Journal of Learning Disabilities, 26* (2), 127-133.

Pelletier, S. (1996). A validation study of the Planning-Attention-Simultaneous-Successive model of cognitive processing in children with and without learning disabilities (Doctoral dissertation, University of Northern Colorado, 1996). *Dissertation Abstracts International, 57/08,* 3397.

Siegel, L. S. (1989). IQ is irrelevant to the definition of learning disabilities. *Journal of Learning Disabilities, 8,* 469-478.

Stevens, J. (1992). *Applied multivariate statistics for the social sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Tabachnick, B. , & Fidell, L. (1983). *Using multivariate statistics.* New York: Harper & Row.

Wachs, M. C., & Harris, M. (1986). Simultaneous and successive processing in university students: Contribution to academic performance. *Journal of Psychoeducational Assessment, 4,* 103-112.

Wechsler, D. (1991). *Wechsler Intelligence Scale for Children–Third Edition.* San Antonio, TX: The Psychoeducational Corporation.

Wechsler Individual Achievement Test. (1992). San Antonio, TX: The Psychological Corporation.

Wong, B., Butler, D., Ficzere, S., & Kuperis, S. (1996). Teaching low achievers and students with learning disabilities to plan, write, and revise opinion essays. *Journal of Learning Disabilities, 29* (2), 197-212.

Woodcock, R., & Johnson, M. (1989, 1990). *Woodcock-Johnson Psycho-Educational Battery–Revised.* Itasca, IL: Riverside.

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