CHAPTER 3

The Cognitive Assessment System

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THEORY UNDERLYING THE CAS

The *Cognitive Assessment System (CAS)* (Naglieri & Das, 1997a) is a multidimensional measure of ability based on a cognitive and neuropsychological processing theory called *Planning, Attention, Simultaneous, and Successive (PASS)* (Naglieri, 1999a, 2005). The PASS theory described by Naglieri and Das (1997b, 2005) is a reconceptualization of intelligence largely, but not solely, based on the neuropsychological work of A. R. Luria (1966, 1973, 1980, 1982). The four processes that make up the PASS theory represent a blend of cognitive and neuropsychological constructs, such as executive functioning (Planning) and selective attention (Attention), including tests that in the past were often arguably described as nonverbal/visual-spatial (Simultaneous) and sequencing/memory (Successive) (Naglieri & Das, 2002).

The PASS theory is a different approach to understanding intelligence that not only expands the idea of what "abilities" should be measured, but also stresses the significance of basic psychological or cognitive processes. Additionally, the functions of the brain that encompass the PASS processes are considered the building blocks of ability conceptualized within a cognitive processing framework. While the theory may have its roots in neuropsychology, "its branches are spread over developmental and educational psychology" (Varnhagen & Das, 1986, p. 130). Thus, with its connections to developmental and cognitive processing, the PASS theory offers an advantage in explanatory power over the notion of traditional general intelligence (Naglieri & Das, 2002).

PASS Defined

The four cognitive processes that make up the PASS theory are each associated with different brain regions, cognitive abilities, and behaviors (Naglieri, Conway, & Goldstein, 2007). The four processes of the PASS theory are described more fully below.

Planning is a mental activity that provides cognitive control, intentionality, organization, self-regulation and use of processes, knowledge, and skills. This includes self-monitoring and impulse control as well as generation, evaluation, and execution of a plan. This process may involve control over the other three processes, as well as providing the means to solve problems and to acquire knowledge and skills.

The essence of the construct of Planning and tests to measure it is that they provide a novel problem-solving situation for which one does not have a previously acquired strategy. This is also similar to how the concept of executive function has been described. O'Shanick and O'Shanick (1994) describe executive functions as including the abilities to formulate and set goals, assess strengths and weaknesses, plan and/or direct activities, initiate and/or inhibit behavior, monitor current activities, and evaluate results. This is very similar to the description provided by Hayes, Gifford, and Ruckstuhl (1996). Executive functions include abilities to formulate a goal, plan, carry out goal-directed behaviors effectively, and monitor and self-correct spontaneously and reliably (Lezak, 1995). These skills are essential for fulfilling most daily responsibilities and maintaining appropriate social behavior. This view is closely aligned with the definition of Planning provided by Goldberg (2001), particularly in that it includes self-regulation, skillful and flexible use of strategies, allocation of attention and memory, response inhibition, goal setting, and self-monitoring and self-correction (Eslinger, 1996).

Planning is a frontal lobe function. As one of the prominent capacities that differentiate humans from other primates, Planning is associated with the prefrontal cortex. The prefrontal cortex "plays a central role in forming goals and objectives and then in devising plans of action required to attain these goals. It selects the cognitive skills required to implement the plans, coordinates these skills, and applies them in a correct order. Finally, the prefrontal cortex is responsible for evaluating our actions as success or failure relative to our intentions" (Goldberg, 2001, p. 24). Planning helps to achieve goals by aiding in the development of strategies needed to accomplish tasks. Therefore, Planning is essential to all activities that require one to figure out how to solve a problem. This includes self-monitoring and impulse control as well as creation, assessment, and execution of a plan. Thus, Planning permits the generation of solutions, discriminating use of knowledge and skills, as well as control of Attention, Simultaneous, and Successive processes (Das, Kar, & Parrila, 1996).

Although a variety of assessment tools have been proposed to assess executive functions, the results often yield conflicting data given the very broad definition of these functions (e.g., for a review of this issue in the assessment of ADHD, see Barkley, 2003). Planning in the PASS theory offers a more finite description that may be characterized as executive function.

Attention is conceptualized (Naglieri & Das, 2005) as a mental function that provides focused, selective cognitive activity over time that is resistant to distraction. The base of the brain allows one to focus selective attention toward a stimulus over a period of time without the loss of attention to other, competing stimuli. The longer attention is needed, the more that activity requires vigilance. The process is linked with the orienting response, and is involved when one must demonstrate focused, selective, sustained, and effortful activity. Focused attention involves directed concentration toward a specific activity and selective attention is important for the inhibition of responses to distracting stimuli. Sustained attention refers to the variation of performance over time, which can affect the different amount of effort necessary to solve the test. Intentions and goals mandated by the Planning process control Attention, while knowledge and skills play an integral part in the process as well. This construct was conceptualized and operationalized similarly to the attention work of Schneider, Dumais, and Shiffrin (1984) and Posner and Boies (1971), particularly the selectivity aspect of attention, which relates to the deliberate discrimination between stimuli.

Simultaneous processing is a mental activity by which a person integrates stimuli into interrelated groups or a whole. Simultaneous processing tests typically have strong spatial aspects for this reason, but can involve both nonverbal and verbal content as long as the cognitive demand of the task requires the integration of information. This ability to identify patterns as interrelated elements is made possible by the parieto-occipital-temporal brain regions. The construct of Simultaneous processing is conceptually related to the examination of visual-spatial reasoning often seen in progressive matrices tests, such as those originally developed by Penrose and Raven (1936) and now included in nonverbal scales of intelligence tests such as the Wechsler Nonverbal Scale of Ability (Wechsler & Naglieri, 2006), the Naglieri Nonverbal Ability Test (Naglieri, 2008), and the Stanford-Binet Fifth Edition (Roid, 2003).

Successive processing is a mental activity by which a person processes stimuli in a specific serial order to form a chain-like progression. To require true Successive processing, the information must not be able to be grouped into a pattern (like the number 442558 organized into 44-2-55-8). Successive processing involves both the recognition of stimuli in sequence and the formation of sounds and movements in order. For this reason, Successive processing is involved with recall of information in order as well as the syntax of language and the phonological analysis, which it has been conceptually and experimentally related to (Das, Naglieri, & Kirby, 1994). The concept of Successive processing is similar to the concept of sequential processing included in the KABC-II (Kaufman & Kaufman, 2004).

DESCRIPTION OF THE CAS

The four PASS processes are assessed using the CAS (Naglieri & Das, 1997a), which was specifically structured according to the PASS theory. The CAS measures the four basic psychological processes using 12 subtests (three for each of the four scales) that are described in more detail below.

Planning Subtests

The three subtests that make up the Planning scale are Matching Numbers, Planned Codes, and Planned Connections. In the Matching Numbers subtest, the examiner introduces the child to four pages containing eight rows of numbers. The child is instructed to underline the two numbers that are the same in each row. The items were constructed so that children can use strategies such as locating the match by focusing on the last number as opposed to the first number (e.g., 318, 313, 381, 318, 813, 311) and omitting one option that does not begin with the same number that most of the others do (e.g., 813).

The Planned Codes subtest contains two pages with empty boxes sorted in seven rows and eight columns. At the top of each page is a legend that has a specific set of codes (e.g., A = XO; B = XX; C = OO). The child is instructed to write in the correct code beneath each corresponding letter. The letters are arranged on the page in a manner that gives the child the chance to use a strategy, or plan, of filling in all the codes. Planned Codes is a variation of similar coding subtests (e.g.,Yoakum & Yerkes, 1920).

The child is directed to connect numbers in sequences that appear in a quasi-random order (e.g., 1-2-3, etc.) in the Planned Connections subtest. The child connects numbers and letters in sequential order for the last two items, alternating between numbers and letters (e.g., 1-A-2-B, etc.). A child can apply various strategies to this task, such as scanning the page for the next number or letter, and looking back to the previous step to know more easily what comes next (e.g., when the child reaches B in the sequence 1-A-2-B-3-C looking back to the number 2, the next step is more easily obtained). For a complete list of the strategies used by children on all the Planning tests, see Naglieri and Das (1997b) and for further discussion of strategy use, see Winsler and Naglieri (2003).

Planned Connections is similar to the Trial Making procedure that was originally part of the Army Individual Test of General Ability (Adjutant General's Office, 1944) and used by Armitage (1946), Reitan (1955), and Spreen and Gaddes (1969). Tests similar to Planned Connections, such as the Trail Making test (Lezak, 1995), are sometimes used to evaluate frontal lobe functioning (Naglieri & Das, 1997b).

Attention Subtests

The three subtests on the CAS that measure Attention processing are Expressive Attention, Number Detection, and Receptive Attention. 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 horse was drawn to appear small, the child would respond "large"). In the Expressive Attention for children 8 years and older, the children are given three pages to finish that are similar to the well-known Stroop test (Lezak, 1995). The child reads color words (i.e., Red, Blue, Yellow, and Green) printed in black font and presented in a quasi-random order on the first page. On the second page, the child is instructed to name out loud the colors of a series of rectangles printed in the same colors that were introduced as words on the first page. On the third page, the color words are printed in different ink colors than the colors the words name (e.g., the word *Green* would appear in red ink). The child must say the color the word is printed in and resist the urge to read the name of the color.

The Number Detection subtest requires children to find the target stimuli (e.g., the numbers 1, 2, and 3 printed in an open font) among many distracters, such as the same numbers printed in a different font. This subtest is modeled after the work of Schneider, Dumais, and Shiffrin (1984) on selective attention.

The Receptive Attention subtest consists of two pages. On the first page, targets are letters that are physically the same (e.g., LL but not Ll). For the second page, targets are letters that have the same name (e.g., Ll but not Pl). This test was modeled after the attention research of Posner and Boies (1971).

Simultaneous Subtests

The Simultaneous scale on the CAS contains the Nonverbal Matrices, Verbal Spatial Relations, and Figure Memory subtests. Nonverbal Matrices is a traditional progressive matrix test that includes items that have a variety of shapes and geometric designs that are connected through spatial or logical organization. The child must appreciate the interrelationships for each question and choose the best of six possible options that completes the matrix. Progressive matrix tasks have been included in PASS research since the 1970s and have been used to measure simultaneous processing in over 30 published papers (for summaries of these studies, see Das, Kirby, & Jarman, 1979, and Das, Naglieri, & Kirby, 1994). The construction of the Nonverbal Matrices was based on items that conformed to the item types found in the Matrix Analogies Test (Naglieri, 1985).

The Verbal Spatial Relations subtest measures the comprehension of logical and grammatical descriptions of spatial relationships. For this subtest, the child is shown six drawings, arranged in a specific spatial manner, and a printed question. Then, the child is told to select one of the six drawings that best answers the question. A typical item may ask: "Which picture shows a diamond below a circle?," with six options that include these and other shapes in various spatial arrangements. This test was based on the concept that Simultaneous processing underlies the understanding of what Luria (1982) explained as logical and grammatical relationships, as measured by the Token test (Lezak, 1995).

On the Figure Memory subtest, the child is presented a two- or three-dimensional geometric figure for 5 seconds and then is presented with a response page that has the original geometric figure embedded in a larger, more complex geometric pattern. The child is then asked to identify the original design. Luria (1966) utilized both copying designs and drawing from memory as measures of simultaneous processing. Both

Figure Copying (Ilg & Ames, 1964) and the Memory-for-Designs test (Graham & Kendall, 1960) served as models for the Figure Memory test.

Successive Subtests

The Successive scale on the CAS contains the subtests Word Series, Sentence Repetition, and Sentence Questions. In Word Series, the child is read a series of words and then asked to repeat the words in the same order. This subtest uses nine single-syllable, high-frequency words. The repetition of words and digits in order was recommended by Luria (1966) and has been used since 1972 as a measure of Successive processing in the PASS theory. Summaries of these studies can be found in Das, Kirby, and Jarman (1979) and Das, Naglieri, and Kirby (1994).

Twenty sentences are read to the child for the Sentence Repetition subtest. The child is then instructed to repeat each sentence exactly as presented. The sentences are composed of color words (e.g., "The blue yellows the green"), which reduces semantic meaning from the sentences.

The same type of sentences that are used in the Sentence Repetition subtest are used on the Sentence Questions; however, in this test 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 development of both Sentence Repetition and Sentence Questions followed Luria's (1966, 1982) explanation of how Successive processing underlies a child's understanding of the syntactic organization of language.

ADMINISTRATION OF THE CAS

Appropriate Testing Conditions

The CAS, like any test, needs to be administered and scored as prescribed in the test's Administration and Scoring Manual (Naglieri & Das, 1997c). While it is the obligation of the administrator to make sure that administration procedures are consistent with applicable professional standards, it is also assumed that examiners will create an appropriate environment for the standardized test. A description of general, good testing practices will not be reviewed here; however, one can obtain such information through such resources as Aiken (1987) and Sattler (1988). Only specific issues about the administration of the CAS are addressed here.

Seating Arrangement

Proper administration of the CAS can be obtained only if the examiner is within reach of the child and can closely observe the child's actions. This is especially important for the Planning tests that involve recording the strategies used by the child (see the section later in this chapter on Strategy Assessment). Examiners would likely find sitting across from the child or across the corner of a table most appropriate for this instrument.

Administration Directions

The CAS instructions typically involve both verbal and nonverbal instructions. Examiners need to carefully observe the gestures (indicated in parenthetical statements following or preceding the text) that correspond to the oral directions.

Administration Information

There are two places that provide information about administration of the test—the Administration and Scoring Manual (Naglieri & Das, 1997c) and the Record Form. Both sources provide the same information about various administration issues in a text box at the top of their respective sections. This information includes what pages are used in the Response or Stimulus Books, whether a stopwatch or red pencil is needed, time limits, which items to give, and so on. This redundancy provides examiners ample opportunity to obtain information about how to give the subtests.

Standard and Basic Batteries

There are two versions of the CAS. The Standard Battery contains all 12 subtests, while the Basic Battery is made up of only 8 of the subtests. Each of the two batteries is composed of Planning, Attention, Simultaneous, and Successive subtests. If the Basic Battery is administered, the first two subtests in each of the four PASS Scales are given. The subtests included in the Basic Battery are clearly noted in several ways on the Record Form and in the Administration and Scoring Manual. The subtests that form the Basic Battery appear in dark blue boxes with white lettering on the front of the Record Form. Regardless of which version is administered, both yield PASS Scale and Full Scale standard scores with a mean of 100 and *SD* of 15.

Subtest Order

To retain the integrity of the test and reduce the influence of extraneous variables on the child's performance, it is necessary that the CAS subtests be administered in the prescribed order. The Planning, Simultaneous, Attention, and Successive order was determined to maximize the validity of the scales. For example, the Planning tests are administered first because they provide the fewest restrictions on how the child may complete the task. This gives children considerable flexibility to solve the subtest in any manner they choose, which is the goal of these subtests. In contrast, the Attention subtests must be completed in the prescribed manner (e.g., left to right, top to bottom). By administering the Planning subtests before the Attention subtests, the amount of constraint increases over time. If the Attention subtests were administered before the Planning ones, some children could be inhibited by the more structured instruction. It is also strongly recommended that either the 8- or 12-subtest version be used in its entirety rather than a smaller number of subtests being selected.

Age Partition

Instructions and, in some cases, sets of items differ for children aged 5–7 and 8–17 years. In addition, two of the Attention subtests have different types of materials so that the content of the test would be more appropriate for children in the two age groups. Specialized content was necessary to ensure that children aged 5–7 would easily understand the items and that older children (aged 8–17) would not view subtests as too simple.

All of the CAS subtests, except two, are given to all children regardless of age. The exceptions are Speech Rate, which is administered only at ages 5–7 years, and Sentence Questions, which is given only to children 8–17 years of age. This information appears in the Record Form and Administration and Scoring Manual (Naglieri & Das, 1997c). The items, which are to be given for children aged 5–7 or 8–17 years, are also indicated in the way the Record Form is graphically constructed. The form includes boxes that are arranged so that they are filled in only when the test is given to the appropriate age group.

Start and Discontinue Rules

Children aged 5–7 always begin with the first item, but children aged 8–17 typically begin with a more advanced item. The exception to this rule is for Planned Codes (all children get the same items) and Speech Rate (all items are given to children aged 5–7 years). A discontinue rule of four consecutively numbered item failures is applied to all Simultaneous subtests and all Successive subtests except Speech Rate.

Time Limits

The time limits for items vary and for that reason they are provided in the Administration

Directions Manual and in the Record Form. These limits are provided in total seconds (e.g., 150") as well as minutes and seconds (e.g., 2:30) to accommodate professionals who use digital or analog stopwatches. The point at which to begin timing is clearly indicated in the Administration and Scoring Manual (Naglieri & Das, 1997c). In those instances where time limits are not provided (e.g., Nonverbal Matrices), examiners should exercise good judgment when encouraging the child to attempt the next item.

Rates of Presentation

There are six subtests that require stimuli be presented at a specific rate or for an exact period of time. There is one successive subtest that requires administration at the rate of one word per second (Word Series), and two that are presented at the rate of two words per second (Sentence Repetition and Sentence Questions). Figure Memory involves stimuli that are presented for exactly five seconds, and there is a 30-second exposure time limit for each item in the Verbal-Spatial Relations subtest. These time limits must be followed exactly to ensure comparison to the normative sample.

Strategy Assessment

All the CAS Planning subtests include an observational phase called *Strategy Assessment*. This means that the examiner observes whether the child used strategies to complete the items. Strategy Assessment was developed to obtain information about how the child completed the items and is used to help describe the standard scores that were obtained (see the later section on interpretation). This information allows the examiner to go beyond the score and understand the methods the child used during planning. The specific strategy used is then interpreted in relation to the standard score and the percentage of children who used that strategy in the standardization sample. This can help explain a particularly high or low Planning score and be integrated into the overall pool of data that comprises the entire evaluation.

Strategy Assessment includes two parts: Observed Strategies and Reported Strategies. Observed Strategies are those seen by the examiner through nonobtrusive means when the child completed the items. Examiners often evaluate how children complete test items through careful observation during testing. Reported Strategies are obtained following completion of the item(s) of each Planning subtest. The examiner obtains this information by saying, "Tell me how you did these," "How did you find what you were looking for?," or a similar statement or question. The strategies can be communicated by the child by either verbal or nonverbal (gesturing) means.

To facilitate recording of strategies that were both "Observed" and "Reported," a Strategy Assessment Checklist is included in the Record Form. Examiners indicate which strategy or strategies were used by placing a checkmark in the appropriate location(s) during the observation and reporting stages. Unique strategies can be recorded in a blank space provided.

Provide Help Guidelines

One of the unique features of the CAS is the opportunity to provide help. The instructions for administration of the CAS have been written to ensure that the child will understand the demands of every subtest. Several methods have been used to ensure that the child understands what is being requested. This includes sample and demonstration items as well as opportunities for the examiner to clarify the requirements of the task. For example, after the first sample in Expressive Attention, the child is asked whether he or she is ready to begin. If the child does not seem ready or appears in any way confused or uncertain, the examiner is instructed to "provide a brief explanation if necessary." This instruction is intended to give the examiner the freedom to explain what the child must do in whatever terms are considered necessary so as to ensure that the child understands the task. This interaction can be in any form, including gestures, verbal statement, or communication in any language. The intent of this instruction is to give the examiner full decision making in clarifying the demands of the subtest and to allow the examiner to be certain that the child was well informed about what to do. This instruction, however, is not intended to teach the child how to do the test, but rather to tell the child what is required.

Bilingual or Hearing-Impaired Children

The CAS instructions for administration were designed to give the examiner flexibility to interact with the child to assure that good data are obtained. It is assumed that the child has an adequate working knowledge of English so that he or she will benefit from the samples and demonstrations provided. It is, as discussed above, possible to augment the English instructions when the statement "provide additional help when needed" is given. That is, during initial introductory portions of the subtests, examiners who have the knowledge to interact with the child in his or her native language or through another means such as sign language may do so when instructed to provide assistance. The child's need for information in another language or method can become obvious when the child asks for help using another language, or if it is apparent that the child is hearing impaired, or the child does not respond to the instruction. In such instances, it is the responsibility of the examiner to decide when to use another method of communication. It is also the responsibility of the examiner to determine whether, because he or she does not know the child's other language, another examiner should evaluate the child.

Spoiled Subtests

It is possible that one of the three regularly administered subtests in the Standard Battery is spoiled. There are two options in such an instance. First, the sum of three subtests can be estimated using a Prorating table found in Naglieri (1999a). Second, examiners could use the remaining two subtests and compute the PASS Scale using the Basic Battery norms. Because the Full Scale requires either 8 or 12 subtests, the calculation of the Full Scale would have to be computed on the basis of the Basic, not Standard, Battery. If one of the Basic Battery subtests is spoiled during administration, practitioners should give the last subtest on the scale. That subtest scaled score could be used as one of the two scores needed to obtain a Basic Battery sum of scaled scores and the Full Scale. This practice should be limited to those rare instances where limitations demand variation from the normally prescribed method of calculating scores for the Basic Battery.

Scoring the CAS

There are two methods for scoring the CAS. First, the *CAS Rapid Score* (Naglieri, 2002) software can be used to convert all raw scores to standard scores, make comparisons among the PASS scores, compare PASS and Full Scale scores to achievement, and obtain a written description of the results. Alternatively, the CAS can be manually scored. Essentially, the sequence of events follows the pattern: Subtest raw scores are obtained, and then raw scores are converted to subtest scaled scores. After that, the PASS Scale standard scores are obtained from the sum of the respective subtest scaled scores, and, finally, the CAS Full Scale is obtained from the sum of all subtest scaled scores.

Subtest Raw Scores

The CAS subtest raw scores are calculated using four different methods based on which aspects of the child's performance are being measured. These methods include one or more of the following dimensions: (1) the number correct; (2) time to completion; (3) and number of false detections. These methods of evaluating a child's performance are used either in isolation or in combination based on the goals of the subtest. Some subtest raw scores, therefore, are based on: (1) number correct, (2) total time, (3) number correct and total time, and (4) number correct, total time, and number of false detections.

Converting Raw Scores to Subtest Scaled Scores

The CAS subtest scaled scores (mean of 10 and *SD* of 3) are obtained using age-based tables included in Appendix A.1 (pp. 99–177) of the Administration and Scoring Manual (Naglieri & Das, 1997c). The Appendix is divided according to the child's chronological age in years, months, and days. Locate the appropriate conversion table (the first page of the subtest norms section includes an index showing which pages in the manual to apply to each age group).

PASS Scale Standard Scores

Each of the four PASS Scales is derived from the sum of the subtest scaled scores. For the Standard Battery, sum all three subtest scaled scores within each PASS Scale. For the Basic Battery, sum only the first two subtests within each PASS Scale. The Full Scale is obtained from the sum of scaled scores for both the Standard and Basic Batteries and is calculated by summing the four "Sum of Subtest Scaled Scores" values found on the front page of the Record Form. The PASS Scales (mean of 100 and *SD* of 15) are derived from the sum of subtest scaled scores using Appendix B (pp. 179–191) of the Administration and Scoring Manual (Naglieri & Das, 1997c). Each PASS Scale has its own table. The table provides the standard score, percentile, and estimated true-score-based confidence intervals (90% and 95%).

Obtaining Full Scale Standard Scores

The CAS Full Scale (mean of 100 and *SD* of 15) is obtained from the sum of the scaled scores used to obtain the four PASS Scales using Appendix B (pp. 179–191) of the Administration and Scoring Manual (Naglieri & Das, 1997c). The Full Scale is computed from the sum of 8 or 12 subtests if the Basic and Standard Batteries, respectively, are given. The sum of the subtest scaled scores, which appears on the front of the Record Form, is used to obtain the standard score. Like the PASS conversion system, this table provides the standard score, percentile, and estimated true-score-based confidence intervals (90% and 95%) for all possible raw scores.

CAS Rapid Score Software

The CAS Rapid Score (Naglieri, 2002) software is uniquely designed around the CAS Record Form and functions as a portal for data entry that is graphically configured to mimic the child's responses that were recorded during administration. For example, Figure 3.1 provides the CAS Rapid Score window for entry of data for the Planned Connections and Nonverbal Matrices subtests. The configuration of the computer image is nearly identical to the configuration in the CAS Record Form. Examiners simply insert the time scores for Planned Connections and the child's response or the score for each Matrices item. The appropriate subtest raw score is automatically calculated and transferred to the front of the Record Form. Once all subtest raw scores or all raw scores are entered on the electronic version of the front of the CAS Record Form (see Figure 3.2), then the standard scores, percentile ranks, and confidence intervals are provided. These findings can be printed and attached to the original CAS Record Form.

Analysis of the differences among the four PASS Scales, subtest analysis, and comparisons of each PASS Scale and the Full Scale with a variety of achievement tests is also provided (see Figure 3.3). Finally, a narrative report of the CAS results can be obtained (see Figure 3.4) and copied and pasted into a word processing program, printed, or converted to a text file.

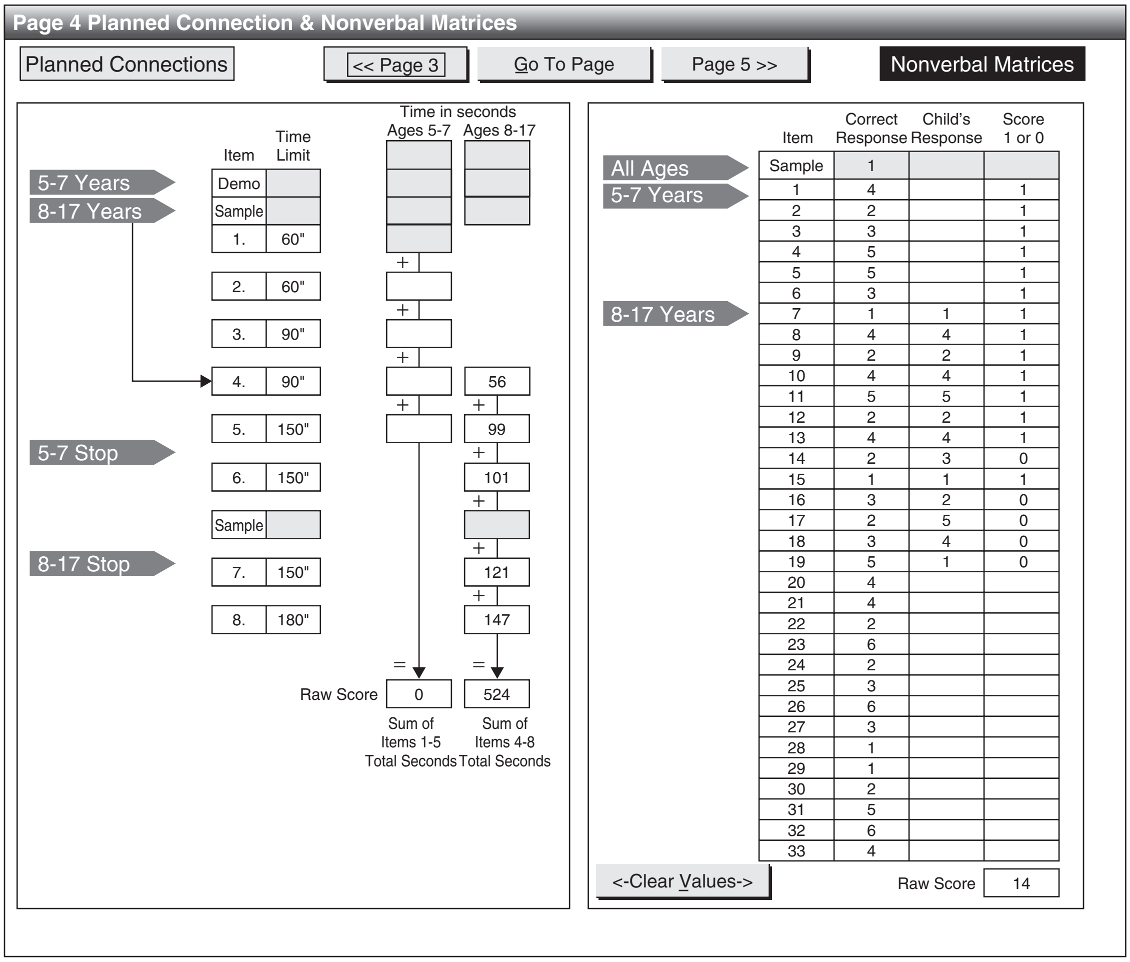


FIGURE 3.1

CAS Rapid Score Subtest Data Entry Screen

STANDARDIZATION, NORMS, AND PSYCHOMETRICS OF THE CAS

Standardization

The CAS was standardized on a sample of 2,200 children aged 5–17 years who were representative of the U.S. population on a number of important demographic variables. The sample is a nationally representative, stratified sample based on gender, race, ethnicity, region, community setting, classroom placement, and parental education (see Naglieri & Das, 1997b, for more details).

Reliability

The CAS Full Scale has a high internal reliability ranging from .95 to .97 for the different age groups. The average reliability coefficients for

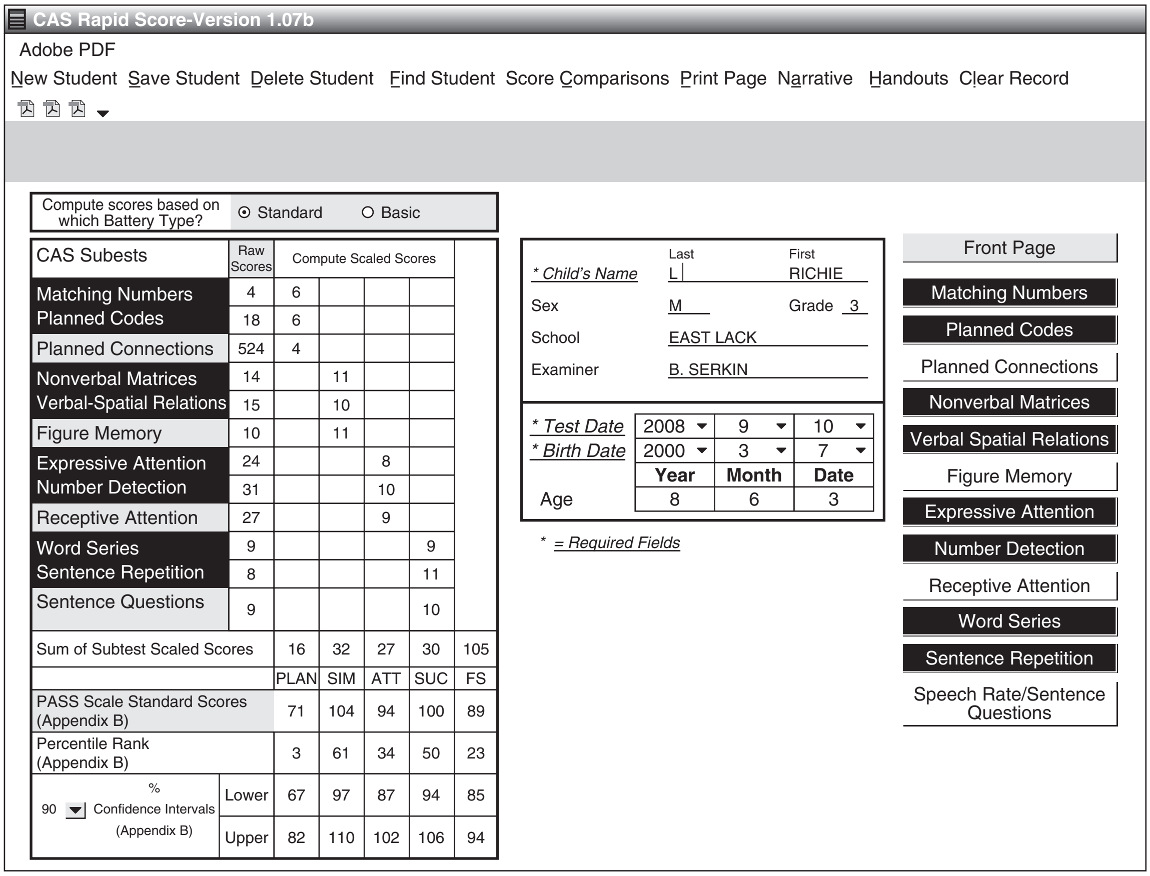


FIGURE 3.2

CAS Rapid Score Summary Page

the scales are .88 (Planning), .88 (Attention), .93 (Simultaneous processing), and .93 (Successive processing).

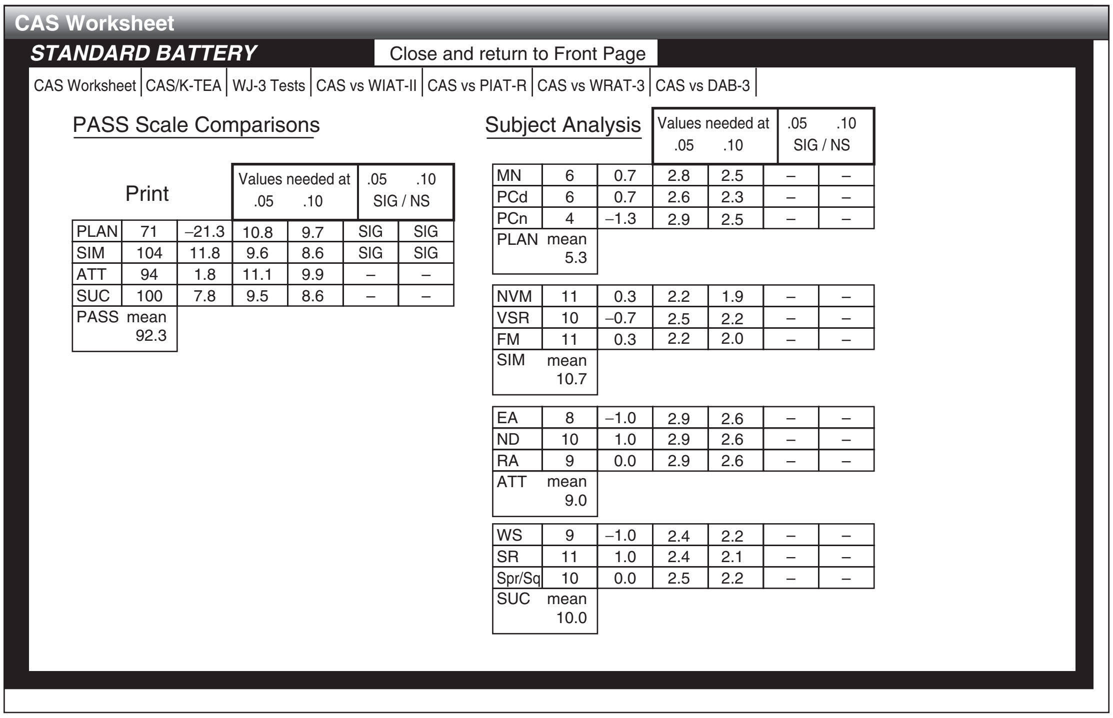
USE OF THE CAS

Interpretation Methods

The goal of interpreting a child's CAS is to integrate PASS scores with all other information so that a comprehensive view of the child is achieved and a thorough plan for treatment, if appropriate, can be developed, implemented, and evaluated. The CAS interpretative methods discussed below should be applied flexibly and within the context of all available information about the child.

Steps for Interpreting CAS Results

Interpretation of CAS scores first involves examination of the PASS Scale (and secondarily subtest) variability and comparison of these results with other tests (measures of achievement, rating scales, etc.). A five-step interpretation procedure will be discussed.



CAS Worksheet

STANDARD BATTERY   Close and return to Front Page

CAS Worksheet | CAS/K-TEA | WJ-3 Tests | CAS vs WIAT-II | CAS vs PIAT-R | CAS vs WRAT-3 | CAS vs DAB-3

PASS Scale Comparisons

Print			Values needed at .05	.10	.05 SIG / NS	.10 SIG / NS
PLAN	71	–21.3	10.8	9.7	SIG	SIG
SIM	104	11.8	9.6	8.6	SIG	SIG
ATT	94	1.8	11.1	9.9	–	–
SUC	100	7.8	9.5	8.6	–	–
PASS mean 92.3						

Subject Analysis

			Values needed at .05	.10	.05 SIG / NS	.10 SIG / NS
MN	6	0.7	2.8	2.5	–	–
PCd	6	0.7	2.6	2.3	–	–
PCn	4	–1.3	2.9	2.5	–	–
PLAN mean 5.3						
NVM	11	0.3	2.2	1.9	–	–
VSR	10	–0.7	2.5	2.2	–	–
FM	11	0.3	2.2	2.0	–	–
SIM mean 10.7						
EA	8	–1.0	2.9	2.6	–	–
ND	10	1.0	2.9	2.6	–	–
RA	9	0.0	2.9	2.6	–	–
ATT mean 9.0						
WS	9	–1.0	2.4	2.2	–	–
SR	11	1.0	2.4	2.1	–	–
Spr/Sq	10	0.0	2.5	2.2	–	–
SUC mean 10.0						

FIGURE 3.3
CAS Rapid Score Comparison of CAS Scores Screen

Step 1—CAS Full Scale and PASS Scale Standard Scores

The first step in interpreting the CAS is to describe the PASS and Full Scale standard scores using descriptive categories that can be found in Appendix C in the Administration and Scoring Manual (Naglieri & Das, 1997c). These categories qualitatively summarize the child's scores but are not intended to be diagnostic. Further description of the scores includes the confidence intervals and percentile ranks that are provided in the sum of scaled score to raw score conversion tables. The Full Scale score should be considered as a good general description of a child's cognitive processing when the four PASS Scale scores are similar. However, when there is significant variability among the PASS Scale standard scores, emphasis on the Full Scale may obscure important relative strengths and weaknesses. When this happens, then the Full Scale score should be clarified (as a midpoint between extreme scores) and deemphasized.

The PASS and Full Scale standard scores that are associated with normal curve percentile ranks are provided in the respective norms conversion tables in Appendix B in the Administration and Scoring Manual (Naglieri & Das, 1997c). These scores can be interpreted as a ranking of a child's performance relative to those of comparable age in the standardization group.

Confidence intervals provide a way to estimate the precision of test scores and a range of values in which the child's true score is likely to fall. Estimated true-score-based confidence intervals are provided in the PASS and Full Scale standard score conversion tables (Appendix B of

CAS Rapid Score-Version 1.07b [Narrative]

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Cognitive Assessment System Rapid Score
Jack A. Naglieri

Confidential

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NAME:	RICHIE L.
AGE:	Y8 M6 D3
DATE OF BIRTH:	3/7/2000
COMPUTER ASSIGNED ID:	7
GENDER:	M
GRADE:	3
SCHOOL:	EAST LACK
EXAMINER:	B. SERKIN
SIGNIFICANCE:	10

Richie earned a Cognitive Assessment System (CAS) Full Scale score of 89, which is within the Low Average classification and is ranked at the 23rd percentile. This means that his performance is equal to or greater than 23% of these obtained by children his age in the standardization group. There is a 90% probability that Richie's true Full Scale score is within the range of 85-94. The CAS Full Scale score is made up of separate scales called Planning, Attention, Simultaneous, and Successive cognitive processing. Because there was significat variation among these scales, the Full Scale will sometimes be higher and other times lower than the separate PASS scales on the CAS. The Planning scale was found to be a significant cognitive weakness. This means that Richie performed especially poorly on tests that required him to make decisions about how best to complete the Planning tests. Richie's poor performance in Planning is especially important because it is a weakness both in relation to his overall PASS score and in relation to his peers. This cognitive weakness has important implications for diagnosis/eligibility determination and educational programming. The Simultaneous scale was found to be a significant strength in relation to his average PASS score.

Richie's Planning processing scale was significantly lower than his average PASS score and well below the Average range. This indicates that Richie performed especially poorly on tests that required strategies for problem solving. He had trouble with development and use of good strategies, control of behavior, self-monitoring and self-correction when completing the planning tests, Richie earned a CAS Planning scale standard score of 71 which is within the Below Average classification and is ranked at the 3rd percentile, which means Richie did as well as or better than 3% of the scores obtained by children his age in the standardization group. There is a 90% probability that Richie's true Planning score is within the range of 67-82. There was no significant variation among the three subtests on this scale.

Page 1 of 3

Page: 1

FIGURE 3.4

Narrative Report Text File

the Administration and Scoring Manual), making calculation unnecessary (Naglieri & Das, 1997c).

Step 2—Compare the Four PASS Standard Scores

One of the main purposes of the CAS is to examine the variability across PASS scores to determine whether the child has cognitive strengths or weaknesses. There are two factors to consider when PASS variation is examined. First is the statistical significance of the profile of scores, and second is the percentages of children in the standardization sample with such differences. The statistical significance of the variation in PASS scores, that is, the profile, is evaluated using an intraindividual or ipsative (Kaufman, 1994) method. These procedures help distinguish among differences that are related to error associated with reliability of the scales and when the PASS variation can be interpreted within the context of the theory, related to strategy use, and evaluated in relation to achievement tests.

PASS cognitive processing strengths (scores that are significantly greater than the child's mean score) or weaknesses (scores that are significantly lower than the child's mean score) are found if a score is significantly high or low relative to the child's own level of performance. Because the PASS scores are compared to the individual child's average (and not the normative mean of 100), this tells us about "relative" strengths or weaknesses. This approach has been used in intelligence testing (see Kaufman, 1994; Naglieri, 1993; Sattler, 1988) for some time.

The steps needed to determine whether a child's PASS profile is significant are listed below. The values needed at different levels of significance and for the Standard and Basic Batteries are shown in Figure 3.3 and the CAS Interpretive Handbook (Naglieri & Das, 1997b).

1. Calculate the average of the four PASS standard scores.
2. Subtract the mean from each of the PASS standard scores to obtain the intraindividual difference scores.
3. Compare the intraindividual difference scores (ignore the sign) to the values needed for significance. Differences equal to or greater than the tabled values are significantly different from the child's average PASS Scale standard score.
4. Label any significant score that is above the mean as a strength and those below the mean as weaknesses.
5. Any variation from the mean that is not significant should be considered chance fluctuation.

When a significant weakness in the PASS Scale profile is found, it is also important to consider the level of performance in relation to the standardization sample. For example, if a child has a significant intraindividual difference score that also falls below a score of 90 (in the low-average range or lower), then it should be labeled a cognitive weakness. In contrast, a child could have a significant weakness that still falls in the average range (90–110); this score should be viewed as relative weakness because it is low in relation to the child's mean but still in the average range of normative expectations. In this case, the finding is important for different reasons (it could explain uneven high performance for a child who typically functions very well), but it is not the same as a cognitive weakness. A cognitive weakness is a more serious finding because it represents poor performance relative to peers as well as in comparison to the child's own level.

The frequency of occurrence of PASS profiles can be determined through use of actuarial tables in Appendix D of the CAS Administration and Scoring Manual (Naglieri & Das, 1997c). These tables tell the frequency of occurrence of all possible intraindividual difference scores in the standardization sample. This can help determine how common or rare the PASS profile is and whether a pattern is typical or unusual.

Step 3—Compare Subtest Scores within Each Scale

Variation in CAS subtests, set at a mean of 10 and *SD* of 3, can be examined using the same method used for studying the PASS profile. The subtest scaled scores are compared to the child's mean subtest score and the presence of significant differences determined. In addition, the frequency of occurrence of subtest differences is compared to that found for the normal standardization sample. These variations should also be interpreted within the context of the theory, consideration of strategy use, and other relevant variables. Additionally, although this fine-grain analysis has the advantage of allowing for a more specific examination of the child's performance, it has the disadvantage of involving scores with lower reliability than the PASS Scales.

Step 4—Compare the PASS and Full Scale with Achievement Standard Scores

The CAS scores can be used to help determine whether a child's achievement is below expectations, to assist when interventions are being planned, and when eligibility for special education services is being considered. The exploration of these differences is intended to fit within a theoretical framework designed to discover whether the child has a PASS cognitive weakness and an associated academic weakness. Values for comparing PASS and Full Scale standard scores to various achievement tests are provided in the *CAS Rapid Score* program, the *CAS Interpretive Handbook* (Naglieri & Das, 1997b), and *Essentials of CAS Assessment* (Naglieri, 1999a).

The examination of differences between PASS and achievement can be used to determine whether an ability achievement discrepancy is present. Traditionally, the ability achievement discrepancy has provided information that the child's actual level of achievement is inconsistent with the level predicted by the IQ score. Such a finding, however, does not allow us to know whether there may be a cognitive explanation for the poor academic performance. Assuming that the academic weakness is not due to sensory limitations, lack of educational opportunity, and so forth, we have typically identified a child as disabled partially on the basis of not finding any cognitive problem.

The CAS allows practitioners to detect whether there may be a cognitive explanation for an academic problem. When a child's Full Scale or separate PASS Scale standard scores are significantly higher than achievement, then the discrepancy is found. However, because a child's weakness in a specific area of achievement (e.g., reading decoding) could be related to a specific weakness in a PASS area (e.g., Successive processing), the *consistency* between these two scores (Successive and reading decoding) as well as a *discrepancy* between other CAS Scales and achievement scores can be found. The consistency between successive processing and reading decoding is indicated by a nonsignificant difference between these scores. This evidence contributes to the interpretation that for an individual child Successive processing and reading decoding were related, as suggested by Kirby and Williams (1991), and such a suggestion has intervention implications.

Step 5—Compare CAS Scores over Time

It is sometimes important to administer a test of cognitive functioning on two occasions to monitor recovery or deterioration associated with neurological conditions, or to evaluate cognitive functioning that may have changed over the course of medical treatments. This may be especially important to evaluate the recovery of children who have experienced traumatic brain injury. The statistical significance of the differences between first and second Full Scale and PASS standard scores can be determined using a method described by Atkinson (1991). This involves the comparison of the first test score with a range of scores that represents the variability expected by both regression to the mean and test reliability. The method can be applied when sufficient time has elapsed, for example, 6–12 months, so that minimal practice effects are anticipated.

The ranges of scores that are used to determine when significant change has occurred were calculated for the PASS and Full Scale standard scores for the Standard and Basic Batteries separately. The values appear in Appendix G in the CAS Administration and Scoring Manual (Naglieri & Das, 1997c).

CASE EXAMPLE

This case illustration involves a young boy named Gary who attends a school for children with learning disabilities. This is a real child—one of the subjects who participated in a math intervention study summarized by Naglieri (2008). His name has been changed to protect his identity. Both CAS and actual results of the classroom intervention will be provided to illustrate how the results could be described. Additional test results that might normally accompany the CAS and K-TEA scores are not included in this example. Thus, this example is not intended to provide a complete case study with all other test data that typically would accompany a full evaluation. Instead, the goal is to show how the PASS and Full Scale results might be described and then used to identify an appropriate instructional approach, and finally how the effectiveness of the intervention is determined.

Test Results and Interpretation

Gary earned a Cognitive Assessment System (CAS) Full Scale score of 87, which falls within the Low Average classification. His Full Scale score is ranked at the 19th percentile, which is equal to or greater than 19% of the scores obtained by the children his age who were included in the standardization group. There is a 90% probability that Gary's true Full Scale score falls within the range of 83–92; however, there was significant variation among the separate scales of the CAS. This means that sometimes the Full Scale will be higher and other times lower than the separate scales in the test. For example, his Planning score is classified as Below Average and his Simultaneous scale is Low Average but his Attention and Successive standard scores are within the Average range. Thus, the Full Scale score is inconsistent with some of these scores. Importantly, Gary's Planning scale score is significantly lower than the mean of the four PASS Scales, indicating that an important weakness has been detected.

Gary earned a significantly low score on measures of Planning processing, which indicates that he has a cognitive weakness in this important area. Gary's score on the Planning scale of 75 (90% confidence interval is 71–85) reflects the difficulty he had using efficient and effective strategies for problem solving. He had trouble making good decisions about how to complete several tests and failed to monitor the quality of his work. This resulted in poor completion of tasks due to inadequate and inefficient methods for solving them.

Gary's poor performance in Planning is especially important because it is a weakness both in relation to his overall PASS score and in relation to his peers. The low Planning score suggests that Gary has an important cognitive weakness and suggests he will have difficulty in activities that demand development and/or use of strategies to solve problems, making decisions about how to do things, general control of behavior, and self-monitoring and self-correction.

Gary earned a K-TEA Mathematics Computation score that is as low as his cognitive weakness in Planning. In fact, there is no significant difference between these scores. While his Mathematics Computation score of 76 (5th percentile) is similar to his Planning score (75, 5th percentile), it is significantly lower than his Mathematics Applications score of 91 (27th percentile). Additionally, the Mathematics Computation score is significantly lower than his Simultaneous, Attention, and Successive scores (therefore, an ability achievement discrepancy has been found). In addition, the consistency between his low scores in mathematics computation and Planning processing is likely related (which can be assessed via examination of his responsiveness to intervention that will be described later in this illustration).

Gary's Attention was measured by subtests that required him to focus on specific features of test material and resist reacting to distracting parts of the tests. He was able to focus concentration and resist distractions well enough to earn a score of 102 on the CAS Attention scale, which ranks at the 55th percentile and falls within the Average classification (90% range is 94–109). Gary's score in Attention indicates that he demonstrated typical performance in both identifying targets and avoiding responses to distracting stimuli.

On the Simultaneous processing scale, Gary earned a score of 89. This ranks him at the 23rd percentile and falls at the juncture of Average and Low Average classifications. These tests involving Simultaneous processes required that he work with spatial relationships, relate parts as a group or whole, and understand relationships among words and diagrams. Gary's score on the Simultaneous scale illustrates that he can solve problems that demand integration of information into groups at a level that is close to the average range.

Gary also earned an Average score of 96 on the Successive processing scale, which ranks at the 39th percentile (90% true score interval is 90–103). His Successive processing was measured by tests that required Gary to work with information in a specific linear order. For example, these tests required him to remember the order of words spoken by the examiner and answer questions that are based on ordering of words.

Overall, Gary had important variation among the four PASS Scales. While he earned scores that ranged from 89 to 102 on the Simultaneous, Successive, and Attention scales, he earned a cognitive weakness in Planning (75). This cognitive weakness in Planning is accompanied by a similar score on the K-TEA Math Computation subtest, because both measures demand careful control of activity, selection of appropriate strategies to complete the problems, and self-monitoring (checking one's work). These results indicate that interventions that address both the academic and Planning processing demands of these tasks should be considered.

Intervention Design

In order to address the Planning component of Gary's math computation problems, an intervention described by Naglieri and Pickering (2003) from the book *Helping Children Learn* was applied. This text will be discussed more extensively in the intervention section of this chapter. The regular teacher, using math worksheets consistent with the teacher's instructional objectives and curriculum, gave the intervention to the entire class. The teacher taught in half-hour segments following the format of 10 minutes of math worksheet activity, 10 minutes of discussion, and 10 minutes of math worksheets. During the 10-minute discussion period, the teacher facilitated an interaction designed to encourage the children to consider how they completed the work and how they would go about completing the pages in the future. The teacher did not attempt to reinforce or otherwise encourage the children to complete the math in any particular manner. For example, if a child reported using a particular strategy, the teacher did not say something like "Good job" but instead encouraged the children to think about how they did the work and what methods were effective.

In general, the teacher encouraged Gary's class to describe how they did the worksheets and discuss their ideas and methods (this facilitates planning). In addition, the children were asked to explain why some methods work better. The goal was to teach the children to be self-reflective and self-evaluative when they think about what they are doing. The teacher's job in this intervention was to facilitate self-awareness and self-reflection through class interaction and not specifically instruct the children to use strategies.

Response to Intervention

Gary reported that he developed and used several methods for completing the math pages. First, Gary informed his teacher that it was very difficult to concentrate because he was sitting next to someone who was disturbing him. He moved to a quieter part of the room so he could do his work and not be distracted by this person. Second, he noticed that he needed to review his basic math facts. Gary found that making flashcards and working with one of his friends at his teacher's suggestion was an enjoyable way to review this information. Third, Gary reported that in the past he rushed through his math problems without checking his work. His work was often written in a sloppy and messy manner. This caused errors, for example, when he subtracted columns that were not aligned properly. These observations illustrate how the cognitively based intervention encouraged Gary to be self-reflective, evaluate his approach to completing the work, and make modifications to improve accuracy.

Gary's performance in math was evaluated in two different ways. First, the number of math problems he got correct on each worksheet during baseline and the intervention phases were recorded and provided in Figure 3.5. The results showed that Gary appeared to improve from baseline to intervention, more than doubling the number of problems correct per worksheet. Additional analysis was conducted to determine the magnitude of change using Gorsuch's detrended analysis method, described by Glutting and Watkins (2007). These authors describe this method (Gorsuch, 1983) as a fairly simple approach to examine change for a single subject. The procedure is similar to an analysis of covariance and yields a result expressed as Cohen's *d* statistic, which is the difference between the means during baseline and intervention phases divided by the averaged standard deviations. The result is a *d* ratio that is interpreted as follows: .20–.49 as small, .5–.79 as medium, and .80 and above as large.

Gary's response to intervention suggested that improvement was made with a cognitively based instructional method, but the longer term effectiveness of continued treatment like that described above as well as more academically focused interventions should also be determined. The effects of treatment could be further evaluated using the pre/post method described by Naglieri (1999a) and his Table 4.14. This method provides a way to test the significance of the differences between pre- and post-treatment standard scores on a standardized test. In this case, the initial K-TEA score of 76 is compared to a range of test scores that would be expected on the basis of regression to the mean and reliability. Gary's initial Math Computation score (assuming a reliability of .93) of 76 has a range of scores of 69 to 87 that are expected on the basis of psychometric issues. To obtain this value from Naglieri's (1999a) Table 4.14, enter the column labeled .93 (the reliability of the Math Computation score) and then read down the row that corresponds to the first test score and find where 76 is located. Reading across the table, the range of 69–87 is found. If Gary's score on Math Computation after academic instruction is less than 87, then no significant improvement has been made. If, however, Gary's post-intervention score is above 87, then significant improvement has been found and the intervention can be viewed as being effective.

Identification of Special Populations and the CAS

The CAS can be used in identification of special populations (Naglieri & Kaufman, 2008). Research on specific populations suggests that specific PASS profiles that are consistent with an understanding of the nature of the cognitive deficits have been found. For example, children with ADHD *hyperactive/impulsive* type earned

Gorsuch's Detrended Analysis

Sessions	Sessions Code	Time	Score	Predict	Residual
Baseline 1	0	1	14	16.2	–2.2
Baseline 2	0	2	13	16.6	–3.6
Baseline 3	0	3	17	17.0	0.0
Baseline 4	0	4	15	17.4	–2.4
Baseline 5	0	5	16	17.8	–1.8
Baseline 6	0	6	14	18.2	–4.2
Baseline 7	0	7	17	18.7	–1.7
Intervention 1	1	8	19	19.1	–0.1
Intervention 2	1	9	24	19.5	4.5
Intervention 3	1	10	20	19.9	0.1
Intervention 4	1	11	23	20.3	2.7
Intervention 5	1	12	27	20.8	6.2
Intervention 6	1	13	28	21.2	6.8
Intervention 7	1	14	23	21.6	1.4
Intervention 8	1	15	22	22.0	0.0
Intervention 9	1	16	24	22.4	1.6
Intervention 10	1	17	22	22.8	–0.8
Intervention 11	1	18	26	23.3	2.7
Intervention 12	1	19	19	23.7	–4.7
Intervention 13	1	20	25	24.1	0.9
Intervention 14	1	21	29	24.5	4.5
Intervention 15	1	22	28	24.9	3.1
Intervention 16	1	23	29	25.4	3.6
Intervention 17	1	24	20	25.8	–5.8
Intervention 18	1	25	24	26.2	–2.2
Intervention 19	1	26	22	26.6	–4.6
Intervention 20	1	27	23	27.0	–4.0

Preliminary Statistics

Slope	Intercept	r	r-square
0.418	15.738	0.393	0.155

Detrended Regression Result

d = 0.856

Note: Interpret d values of .2 - .49 as small, .5 - .79 as medium, and .80 above as large.

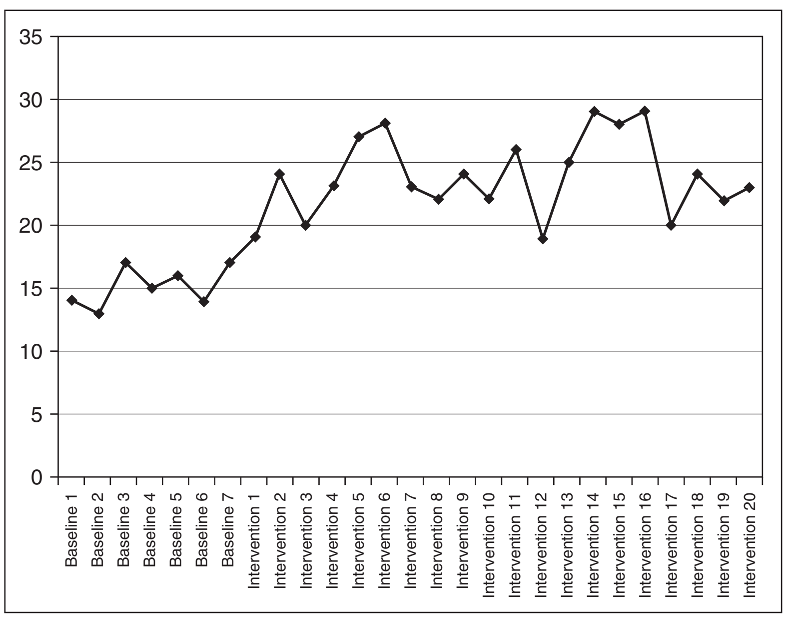

FIGURE 3.5
Example of Using Gorsuch's Detrended Analysis Method for an Individual Student

average scores except in Planning, but those with reading decoding problems show poor performance on Successive processing. As a group, these findings suggest that the PASS processing scores have utility for differential diagnosis and intervention, as well as response to intervention (Naglieri, 2003, 2005).

The profiles of the PASS scores obtained from populations of children with ADHD, mental retardation, and reading disabilities have been examined in several studies (Naglieri, 1999a, 2005). The significant finding among the various studies is that predictable and discriminating differences between the groups have emerged. That is, children with mental retardation earned low and similar PASS scores (Naglieri & Das, 1997b), while children diagnosed with ADHD earned average scores except in Planning (Dehn, 2000; Naglieri, Goldstein, Iseman, & Schwebach, 2003; Naglieri, Salter, & Edwards, 2004; Paolitto, 1999). In contrast, children with evidence of reading disabilities obtained average scores except for low Successive scores (Naglieri, 1999a). As a group, these studies provided evidence that measuring cognitive processes can give important information and suggest that the PASS processing scores have utility for differential diagnosis and intervention, as well as predicting children's response to instruction (Naglieri, 2003, 2005).

Correspondence with IDEA 2004

The PASS cognitive processing scores obtained from the CAS fit well with the movement away from ability/achievement discrepancy analysis for significant learning disability (SLD) eligibility and toward a system that better aligns the definition and the methods used. Naglieri (1999a) first argued that a model based on a discrepancy *and* a consistency would be more informative than the traditional ability/achievement discrepancy approach. He argued that intraindividual variability should be determined using the statistical method originally proposed by Davis (1959) and modified by Silverstein (1982, 1993). Sometimes referred to as an *ipsative approach*, the method can be used to determine when variability within a child is greater than what would be expected on the basis of unreliability of the scores. This technique has been applied to a number of tests, including, for example, the CAS (Naglieri & Das, 1997a) and SB 5 (Roid, 2003). Determining whether a child has significant variability relative to his or her own average score is a useful way to determine relative strengths and weaknesses. However, Naglieri (1999a) cautioned that in order to ensure that a child has "a disorder in one or more of the basic psychological processes" necessary for SLD identification, the child's PASS profile should show significant variability (using the ipsative method) *and* the lowest score must also fall at a level that could be defended as substantially below normal. When this occurs, evidence for a disorder in one or more of the basic psychological processes, also referred to as a *cognitive weakness*, is obtained. Naglieri (1999a) further suggested that finding a cognitive weakness *and* an academic weakness would provide evidence that contributes to the diagnosis of SLD, especially if other appropriate conditions are also met.

The Consistency/Discrepancy approach (shown in Figure 3.6) is consistent with the widely held view that specific learning disabilities are defined by a dysfunction in cognitive, or neuropsychological, processes and that this processing disorder is seen as the primary causal factor. This view is apparent in the definition of SLD that appeared in IDEA 2004:

> Specific learning disability *means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations. Such term includes such conditions as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. Such term does not include a learning problem that is primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional*

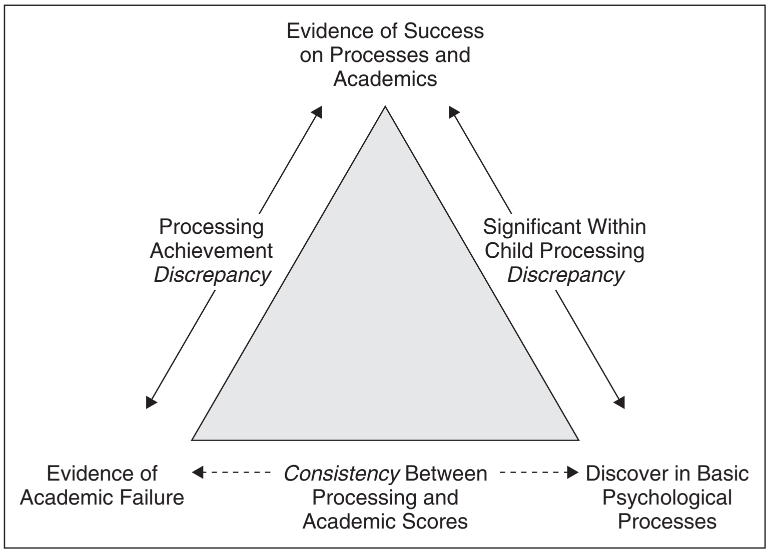

FIGURE 3.6
Illustration of Naglieri's Consistency/Discrepancy Model

disturbance, or of environmental, cultural, or economic disadvantage.

There is wide consensus, as evidenced by the 10 professional organizations that comprised the Learning Disabilities Roundtable (2002), that the "identification of a core cognitive deficit, or a disorder in one or more psychological processes, that is predictive of an imperfect ability to learn, is a marker for a specific learning disability." Documentation of the cognitive and academic status of the child is essential (Hale, Kaufman, Naglieri, & Kavale, 2006). It is logical, therefore, that assessment of "basic psychological processes" as stipulated in IDEA 2004 be a part of any comprehensive assessment designed to determine whether a child has a specific learning disability.

Naglieri (2000) tested the Consistency/Discrepancy model and found that children with a weakness in one or more of the basic PASS cognitive processes earned lower scores on achievement and were more like to have been deemed eligible for special educational services. Importantly, the more pronounced the cognitive weakness, the lower the achievement scores. Naglieri's (2000) findings support the view that a PASS cognitive processing disorder accompanied by academic failure could be used for the purpose of eligibility determination. Even though a cognitive approach makes sense because IDEA 2004 defines SLD as a disorder in processing, it also requires the use of a variety of assessment tools that are technically sound and nondiscriminatory to gather functional, developmental, and academic information when special education eligibility is being determined. It is always important that cognitive processing information be intergraded with other important findings about the child to ensure that a comprehensive evaluation is obtained.

VALIDITY OF THE CAS

There is considerable evidence that the CAS can be used to gain an understanding of how well the child thinks and learns (Naglieri & Rojahn, 2004); can be used to discover strengths and needs of children that can then be used for effective differential diagnosis (Naglieri, 2003, 2005); is particularly appropriate for assessment of minority children (Naglieri, Otero, DeLauder, & Matto, 2007; Naglieri, Rojahn, & Matto, 2007; Naglieri, Rojahn, Matto, & Aquilino, 2005); and can be used to select or design appropriate interventions (Naglieri, 2003, 2005; Naglieri & Pickering, 2003). More details about the validity evidence for each of these topics will be summarized below.

Relationships to Achievement

One of the functions of an ability test is to use a child's cognitive functioning scores to anticipate current and latter academic performance. Some researchers have argued that the relationship between a test of ability and achievement is one of the most important aspects of validity (Brody, 1992; Naglieri & Bornstein, 2003; Ramsey & Reynolds, 2003). Therefore, the capacity of a cognitive processing ability test to predict (typically evaluated on the basis of correlational prediction rather than prediction over time) a child's level of school performance is an important indication of validity (Brody, 1992; Ramsey, & Reynolds, 2003).

Comparing the correlations between a test of cognitive processing and a test of achievement in comparison to correlating a traditional IQ test with achievement is more complex than might initially be considered. The complication is that traditional IQ tests contain questions that are often very similar to those included on achievement tests. In contrast, tests of cognitive processing do not contain questions that are as similar to those found in achievement tests. The reason is that verbal and quantitative test questions on some traditional IQ tests are indistinguishable from questions found on tests of achievement. For example, it is not unusual to have a test of word knowledge or math word problems on an IQ test as well as an achievement test. Traditional IQ tests also typically have some type of quantitative reasoning or arithmetic subtest. These test questions are very similar to those that appear on tests of achievement (see Naglieri, 2008b, and Naglieri & Bornstein, 2003). The similarity in content inflates the correlation between traditional IQ and school achievement tests. It should be expected, therefore, that traditional IQ tests have a content-based advantage when they are correlated with tests of achievement that tests of basic psychological processes do not (Naglieri & Ford, 2005; Suzuki & Valencia, 1997). The predication of school achievement from tests of cognitive processing that do not include achievement-like questions has the advantage of predicting concurrent, and future, performance without the interference of content overlap. Just how well does the CAS relate to academic performance?

Naglieri and Rojahn (2004) studied the relationship between the PASS processing scores from the CAS and the Woodcock-Johnson Revised (WJ-R) Tests of Achievement (Woodcock & Johnson, 1989) for a sample of 1,559 students aged 5–17 years. The sample closely represented the U.S. population on a number of demographic characteristics including gender, race, parental education, and geographic region. The CAS Full Scale correlation with the WJ-R Tests of Achievement was .71 for the Standard (all 12 subtests) and .70 for the Basic Battery score (8 subtests). In comparison to the conventional correlation between ability and traditional intelligence of .55 to .60, these findings demonstrate that the CAS correlated with achievement at least as well as tests of general intelligence (Brody, 1992; Naglieri, 1999a). The findings also provide evidence for the construct validity of the CAS, and suggest that basic psychological processes are strongly correlated with academic performance as measured by the WJ-R. Importantly, Naglieri and Rojahn (2004) also found that prediction to achievement was slightly higher for the four PASS Scales than the CAS Full Scale. These findings suggested that the four PASS Scales individually and collectively correlate higher with achievement than the four scales aggregated into the one Full Scale score. Additionally, the predictive power of the combination of the four PASS Scales was weakened when any one of the PASS Scales was excluded in the prediction equation (Naglieri & Rojahn, 2004). This suggests that each of the PASS Scales has additive value in predicting achievement.

A direct comparison of the Wechsler Intelligence Scale for Children—Third Edition (WISC-III) and CAS correlations with the Woodcock-Johnson III (WJ-III) Test of Achievement was reported by Naglieri, Goldstein, DeLauder, and Schwebach (2006). Their sample included children aged 6 to 16 who were referred for evaluation because of learning problems. The correlation of the WJ-III achievement scores with the WISC-III Full Scale IQ scores was .63; and .83 with the CAS Full Scale. The results indicate that when the same children took the two ability tests and those scores were correlated with the same achievement scores, both showed a strong relationship between ability and achievement. However, the CAS Full Scale scores correlations were significantly higher (Naglieri et al., 2006).

Naglieri, Rojahn, Matto, and Aquillino (2005) reported correlations between the CAS and achievement for samples of black children and white children from the CAS standardization sample; and Naglieri, Rojahn, and Matto (2007) examined the correlations between the CAS and achievement for samples of Hispanic children and non-Hispanic children. The correlations between the CAS scores and WJ-R Tests of Achievement were significant and similar for blacks (.70; $n = 298$) and whites (.64; $n = 1{,}691$) (Naglieri et al., 2005). Similarly, the median correlations between achievement and the CAS scores were significant and did not differ significantly between the Hispanic (.51; $n = 159$) and non-Hispanic (.65; $n = 1{,}285$) samples (Naglieri et al., 2006).

The evidence based on the research summarized here demonstrates that there is a strong correlation between the PASS processes and academic achievement without similarity in test context. This point is especially important for children who come from culturally and linguistically diverse populations, especially those who live in poverty, and those who have had a history of academic failure, and therefore could be disadvantaged on traditional intelligence tests that contain verbal and quantitative questions (Naglieri & Ford, 2005; Suzuki & Valencia, 1997).

Race, Ethnicity, and Fairness

The need for fair assessment of children has become increasingly important, as the demographics of the U.S. population continue to change. Federal law mandates that assessments must be selected and administered so as not to be discriminatory on a racial or cultural basis. One way to ensure appropriate and fair assessment of diverse populations is to decrease the amount of knowledge required to correctly answer the questions on intelligence tests. Suzuki and Valencia (1997) and Fagan (2000) have suggested that intelligence be conceptualized on the basis of psychological processes, such as the PASS theory as operationalized by the CAS, and that this approach has utility for the assessment of children from culturally and linguistically diverse populations because verbal and quantitative skills are not included. Of the assorted processing options, Suzuki and Valencia (1997) characterized the PASS theory of intelligence and the CAS used to measure that theory as "an innovative approach to traditional intelligence assessment that assesses a broader spectrum of abilities than has been previously available in IQ testing" (p. 1111).

Messick (1995) argued that the validity of a test is related to the consequences of the test scores. This is especially true if test characteristics contribute to issues such as overrepresentation of minorities in classes for children with mental retardation and underrepresentation of minorities in programs for the gifted, where the validity of the instruments should be questioned. One way to assess the impact of test scores by race is to examine mean score differences. Naglieri et al. (2005) compared CAS scores of 298 black and 1,691 white children and found that when controlling for key demographic variables, regression analyses showed an estimated CAS Full Scale mean score difference of 4.8. This difference is considerably smaller than the difference between blacks and whites of about one standardization (about 15 points) typically found on traditional IQ tests (Jensen, 1980; Fagan, 2000). Similarly, Naglieri et al. (2006) examined CAS scores for 244 Hispanic and 1,956 non-Hispanic children. They found that the two groups differed by 6.1 points when the samples were unmatched samples, 5.1 with samples matched on basic demographic variables, and 4.8 points when demographics differences were statistically controlled.

Irrelevant variance due to ethnic or cultural difference can also be a concern when examining the differences in scores on different-language versions of the same test. Naglieri, Otero, DeLauder, and Matto (2007) compared the English and Spanish versions of the CAS for bilingual Hispanic children. The children in this study earned similar Full Scale scores and deficits in Successive processing were found on both versions of the test. Importantly, 90% of children who had a cognitive weakness on one version of the CAS also had the *same* cognitive weakness on the other version of the CAS. These results suggest that the PASS scores from both the English and Spanish version of the CAS could be used as part of a comprehensive evaluation to identify a disorder in one or more of the basic psychological processes as described by current IDEA legislation for a specific learning disability (see Hale, Kaufman, Naglieri, & Kavale, 2006), and that the results would very likely be the same regardless of the language in which the CAS was administered.

Fairness and Gender

Many studies and an extensive body of literature have focused on gender differences in ability and achievement (e.g., Deaux, 1984; Fennema & Sherman, 1977; Geary, 1989, 1994, 1996; Halpern, 1997; Linn & Peterson, 1985; Maccoby & Jacklin, 1974; Voyer, Voyer, & Bryden, 1995). Some researchers have conceptualized the results of their findings within the context of verbal, quantitative, and visual-spatial abilities (Geary, 1996; Maccoby & Jacklin, 1974; Voyer et al., 1995). Halpern (1997) rejected the verbal, visual-spatial, and quantitative taxonomy domains and suggested an approach based "on underlying cognitive processes [which] offers a more fine-grained analysis of how information is retrieved from memory and what participants are doing when they are working on a cognitive task" (p. 1092). McHough, Koeske, and Frieze (1986) argued that gender differences cannot be understood adequately unless girls and boys are compared according to a theoretical model of cognitive functioning. Geary (1989) further emphasized that conceptual models of cognitive differences between the genders should provide an integration of the neurological and sociocultural components that influence the development of cognitive processes. Similarly, Fagan (2000), Sternberg (1988), and Naglieri (1999a) stressed the importance of using a theoretical approach to define and measure intelligence, which is especially important when group differences are examined, such as when genders are compared.

Naglieri and Rojahn (2004) examined gender differences in PASS scores for 1,100 boys and 1,100 girls who matched the U.S. population. They found that girls outperformed boys between the ages of 5 and 17 years on measures of Planning (d-ratio = .33), which is consistent with initial suggestions reported by Bardos, Naglieri, and Prewett (1992) and Warrick and Naglieri (1993), and on measures of Attention (d-ratio = .35), as suggested by Warrick and Naglieri (1993). A significant, formerly undetected, yet much smaller difference to the advantage of girls was also found in Successive processing. Gender differences were also found on the Woodcock-Johnson Revised Tests of Achievement Proofing, Dictation, Passage Comprehension, and Letter-Word Identification achievement subtests (especially for the 11–17-year age group). These academic tasks have strong Planning and Attention demands (Naglieri & Das, 1997a). The findings that girls and boys differed in basic PASS cognitive processes are especially important because the data were obtained using a national representative sample of school-aged children, and, therefore, generalization to the wider population is appropriate.

Empirical Support for the Test Structure

Factor structure of the CAS was first examined by Naglieri and Das (1997b) using both exploratory and confirmatory factor-analytic methods. They provided evidence that the PASS four-factor solution was the best solution based on the convergence of both factor-analytic results, clinical utility of the four separate scores, evidence of strategy use, and theoretical interpretation of the subtests. Keith and Kranzler (1999) challenged this assertion and argued that there was not sufficient support for the PASS structure. Naglieri (1999b) responded with considerable evidence and rational arguments in defense of the structure of the test and the validity of the theory. However, like many factor-analytic arguments, the outcome seemed equivocal. Factor-analytic methods are, in fact, far from decisive, and are inadequate as the sole method for establishing or discrediting the validity of any instrument. At best, the method of analyzing intercorrelations provides one piece of evidence that must be part of a balanced examination of validity. Other issues such as relationships to achievement, diagnostic utility, issues of fair assessment, and relevance to instructional interventions must be considered. This is particularly true with a neuropsychologically derived theory such as PASS, with its rich validity evidence from neuropsychology as well as cognitive and educational psychology.

The factor structure of the CAS was most recently examined using an alternative method of factor analysis that is considered more objective than the statistical approaches previously used (Blaha, 2003). This method is less subjective than the statistical approaches used in the previous studies. Blaha (2003) used an exploratory hierarchical factor-analytic method described by Blaha and Wallbrown (1996) to examine the CAS subtest assignment to the PASS Scales. It follows the data more closely, allowing for the most probable factor-analytic model (Carroll, 1993). A general factor equated to the CAS Full Scale was found and interpreted as a general intelligence factor. Two factors emerged after removal of the variance caused by the general factor. The first was comprised of the Simultaneous and Successive and the second included the Planning and Attention subtests. At the third level, four primary factors were found that consisted of each of the four PASS Scales. Blaha (2003) concluded that the results "provide support for maintaining the Full Scale as well as the Planning, Attention, Simultaneous, and Successive standard scores of the CAS" (p. 1).

Intervention Relevance

There are several resources for applying the PASS theory to academic remediation and instruction. The PASS Remedial Program (PREP; 1999) developed by J. P. Das and the Planning Strategy Instruction, also known as the Planning Facilitation Method, described by Naglieri and Pickering (2003), are two options. Other resources include Kirby and Williams's 1991 book, *Learning Problems: A Cognitive Approach*, as well as Naglieri and Pickering's (2003) book, *Helping Children Learn: Intervention Handouts for Use in School and Home*. The first two methods are based on empirical studies, while the two books contain several reasonable approaches to academic interventions. The instructional methods in the books use structured and directed instructions based on PREP, as well as minimally structured instructions based on Planning Strategy Instruction. The books vary from more general (Kirby & Williams, 1991) to more applied (Naglieri & Pickering, 2003). Based on the fact that the two books utilize the concepts of both PREP and

Planning Strategy Instruction, only PREP and Planning Strategy Instruction will be discussed in further detail.

PREP Remedial Program

PREP is a cognitive remedial program that is based on the PASS theory of cognitive functioning (Das, Naglieri, & Kirby, 1994) and is supported by a line of research beginning with Brailsford, Snart, and Das (1984), D. Kaufman and P. Kaufman (1979), and Krywaniuk and Das (1976). These researchers demonstrated that students could be trained to use Successive and Simultaneous processes more efficiently, which resulted in an improvement in "their performance on that process and some transfer to specific reading tasks also occurred (Ashman & Conway, 1997, p. 169)." PREP assumes that the information processing strategies recognized as Simultaneous and Successive processing underlie reading ability and aims to improve these two processes. At the same time, the direct teaching of word reading skills such as phoneme segmentation or blending is avoided. The tasks in the program teach children to focus their attention on the sequential nature of many tasks, including reading. This helps the children better utilize Successive processing, which is a cognitive process necessary for reading decoding. The premise that the transfer of principles is best facilitated through inductive, rather than deductive, inference is also at the foundation of PREP (Das, 2001). The program is accordingly structured so that tacitly acquired strategies are likely to be used in appropriate ways.

Support for PREP has been established by studies that examine the effectiveness of the instructional method for children with reading decoding problems. In a study by Carlson and Das (1997), children who received PREP (n = 22) were compared to those in a regular reading program (control $n = 15$). The samples were tested before and after intervention using the reading subtests Word Attack and Word Identification from the Woodcock Reading Mastery Test—Revised (WRMT-R; Woodcock, 1987). The intervention was conducted in two 50-minute sessions each week for 12 weeks. Another study by Das, Mishra, and Pool (1995) involved 51 reading-disabled children who were divided into PREP ($n = 31$) and control ($n = 20$) groups. There were 15 PREP sessions given to small groups of four children. Word Attack and Word Identification tests were administered pre- and post-treatment. PREP groups outperformed the control groups in both studies.

In a study conducted by Boden and Kirby (1995), a group of learning-disabled children were randomly assigned to PREP training and compared to a control group that received regular instruction. As in previous studies, the results showed significant differences between the two groups in reading decoding of real and pseudowords. Similar results were found in a study by Das, Parrila, and Papadopoulos (2000), where children who were taught using PREP ($n = 23$) improved significantly more in pseudoword reading than did a control group ($n = 17$).

Another study by Parrila, Das, Kendrick, Papadopoulos, and Kirby (1999) was an extension of the above experiments except for three important changes. The first change was that the control condition was a competing program given to a carefully matched group of children. Second, the participants (N = 58) were beginning readers in Grade 1, which was younger than the participants in the previous studies. Finally, the training was shorter in duration than in most of the previous studies (Parrila et al., 1999). The purpose of this study was to examine the possible efficacy of PREP in comparison to a meaning-based reading program received by the control group. All of the participants were experiencing reading difficulties and were divided into two matched remediation groups of either PREP or the control condition. Results showed a significant improvement of reading (Word Identification and Word Attack) for the PREP group. Specifically, the gain in reading was greater than it was for the meaning-based control group (Parrila et al., 1999). Particular relevance to the children's CAS profiles was also demonstrated by the fact that those children with a higher level of Successive processing at the beginning of the program benefited the most from the PREP instruction but those with the most improvement in the meaning-based program were characterized by a higher level of Planning (Parrila et al., 1999).

Planning Facilitation

The research that has examined the relationship between strategy instruction and CAS Planning scores has illustrated a significant connection between Planning and intervention. These intervention studies focused on the concept that children can be encouraged to be more planful when they complete academic tasks and that the facilitation of plans positively impacts academic performance. The studies have involved both math and reading achievement scores. The initial concept for Planning Strategy Instruction was based on the work of Cormier, Carlson, and Das (1990) and Kar, Dash, Das, and Carlson (1992). These authors taught children to discover the value of strategy use without being specifically instructed to do so. This was done by encouraging the children to examine the demands of the task in a strategic and organized manner. They demonstrated that students differentially benefited from the technique that facilitated Planning. The children who demonstrated significantly greater gains were the children who performed poorly on the CAS measures of Planning. The children with higher Planning scores did not demonstrate as pronounced gains. These initial results indicated that a relationship between PASS and instruction might be possible.

Naglieri and Gottling (1995, 1997) found that Planning Strategy Instruction was shown to improve children's performance in math calculation. All children in these studies attended a special school for those with learning disabilities. In these studies, students completed mathematics worksheets in sessions over about a two-month period. The method designed to indirectly teach Planning was applied in individual one-on-one tutoring sessions (Naglieri & Gottling, 1995) or in the classroom by the teacher (Naglieri & Gottling, 1997) about two to three times per week in half-hour blocks of time. During the intervention periods, students were encouraged to recognize the need to plan and use strategies when completing mathematic problems. The teachers provided probes that facilitated discussion and encouraged the children to consider various ways to be more successful. More details about the method can be found in Naglieri and Gottling (1995, 1997) and Naglieri and Pickering (2003).

The relationship between the PASS profiles for children with learning disabilities and mild mental impairments and Planning Strategy Instruction was studied by Naglieri and Johnson (2000). The purpose of this study was to determine whether children with cognitive weaknesses in each of the four PASS processes and children with no cognitive weaknesses showed different rates of improvement in math when given the same group Planning Strategy Instruction. The children with a cognitive weakness in Planning were shown to improve considerably over baseline rates, while those with no cognitive weakness improved only marginally. Similarly, there were substantially lower rates of Simultaneous, Successive, and Attention. The importance of this study was that the five groups of children responded very differently to the same intervention. In other words, the PASS processing scores were predictive of the children's response to this math intervention (Naglieri & Johnson, 2000).

Haddad, Garcia, Naglieri, Grimditch, McAndrews, and Eubanks (2003) conducted another study that examined the effects of Planning Strategy Instruction. An instruction designed to facilitate Planning was assessed in this study to see whether it would have differential benefit on reading comprehension, and whether improvement was related to the PASS processing scores of each child. The researchers used a sample of general-education children sorted into three groups based on each of the PASS Scale profiles from the CAS. Even though the groups did not differ by CAS Full Scale scores or pretest reading comprehension scores, children with a Planning weakness benefited substantially more from the instruction designed to facilitate Planning. In contrast, children with no PASS weakness or a Successive weakness did not benefit as much. These results further support previous research suggesting that the PASS profiles are relevant to instruction.

Planning Strategy Instruction in children with learning disabilities and ADHD was examined by Iseman (2005). Students in the experimental group engaged in Planning Strategy Instruction designed to encourage effective strategies in mathematics. Additional math instruction by the regular teacher was given to a comparison group. An analysis examined students with and students without a cognitive weakness in Planning on the CAS after the intervention. Students with a Planning cognitive weakness in the experimental group improved considerably on math worksheets. In contrast, students with a Planning cognitive weakness in the comparison group did not improve. Students with ADHD in the experimental group with a weakness in Planning improved considerably on the worksheets. In contrast, students with ADHD in the comparison group without a cognitive weakness in Planning did not improve. The results of this study showed that individuals with cognitive weaknesses in Planning, with and without ADHD, benefited more from Planning Strategy Instruction than normal instruction (Iseman, 2005).

The results of these Planning Strategy Instruction studies using academic tasks suggest that changing the way aptitude is conceptualized (e.g., as the PASS rather than traditional IQ) and measured (using the CAS) increases the probability that an aptitude-by-treatment interaction (ATI) is detected. Past ATI research suffered from inadequate conceptualizations of aptitudes based on the general intelligence model. That model and approach is very different from the basic psychological processing view represented by the PASS theory and measured by the CAS. The summary of studies provided here is particularly different from previous ATI research, which found that students with low general ability improve little, whereas those with high general ability improve a lot to instruction. In contrast, children with a weakness in one of the PASS processes (Planning) benefited more from instruction compared to children who had no weakness or a weakness in a different PASS process. The results of these studies also indicate that the PASS profiles can help predict which children will benefit from academic instruction and which will not. As suggested by Naglieri and Pickering (2003), this offers an important opportunity for researchers and practitioners interested in the design of instruction.

SUMMARY

The CAS holds a unique position in the field of ability assessment. It is the only test explicitly constructed on a specific cognitive processing conceptualization of intelligence. The PASS theory provided the framework for the instrument and the test provided a means to evaluate the strength of the theory. The result is a well-articulated theory with a strong empirical base that supports both the PASS theory and its operationalization in the CAS (see Das, Kirby, & Jarman, 1979; Das, Naglieri, & Kirby, 1994; Naglieri, 1999b, 2003, 2005, 2008a; Naglieri & Das, 1997b, 2005). The theory is easily accessed through the well-standardized PASS measures, which are easy to administer and score and can be used for calibration of basic psychological processes. The PASS scores can also be used within the context of IDEA for specific learning disability eligibility determination and the PASS profile aids in understanding the cognitive processing deficit found in many children with ADHD. Importantly, the CAS has been shown to yield small differences between samples of whites and African Americans as well as Hispanics and non-Hispanics, yet it has very strong correlations with academic achievement.

Additionally, much research has demonstrated that PASS is relevant to academic interventions and selection of specific instructional methods. The research summarized in this chapter illustrates that the PASS theory, as operationalized by the CAS, provides a viable option to today's practitioners who are most concerned about (1) equitable assessment; (2) intervention design; and (3) detecting specific variations in ability that are related to success and failure.

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