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# Construct validity and diagnostic utility of the cognitive assessment system: Discriminating individuals with ADHD from random normals

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Construct Validity and Diagnostic Utility of the Cognitive Assessment System: Discriminating Individuals with ADHD from Random Normals

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BY

Allison R. Gaboury

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Abstract

This study examined the construct validity and diagnostic utility of the Cognitive Assessment System (Naglieri & Das, 1997). Distinct group differences and discriminative validity of 40 kindergarten through second grade students (20 meeting ADHD criteria on the Structured Diagnostic Interview for Parents and the Adjustment Scales for Children and Adolescents, 20 random matched control) on measures of Planning, Attention, Simultaneous, and Successive Processing were completed. The ADHD and random matched control groups differed significantly on Planning and Attention scores with large effect sizes but not on Simultaneous or Successive scores. Low Planning and Attention scores but normal Simultaneous and Successive scores were reported for the ADHD group. Direct discriminant function analysis with follow up diagnostic efficiency statistics found CAS PASS scores correctly differentiated ADHD and random matched control groups with an overall correct classification rate of 78%. Results suggested the potential utility of the CAS as a measure to assist in ADHD diagnosis.

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# Construct Validity and Diagnostic Utility of the Cognitive Assessment System: Discriminating Individuals with ADHD from Random Normals

Attention-Deficit/Hyperactivity Disorder (ADHD) is a developmental disorder observed in children and adults that impacts 5-8% of the childhood population and 4-5% of the adult population (Barkley & Murphy, 2006). Symptoms of ADHD are often manifested through inattention and/or impulsive-hyperactive behaviors that are excessive and inappropriate for an individual's age or developmental level. These individuals have difficulties regulating their behavior. Due to ADHD prevalence and impact of behaviors, the primary purpose of this study is to demonstrate the utility of the Cognitive Assessment System for ADHD diagnosis instead of solely looking at group differences.

In an attempt to understand the many factors that contribute to ADHD, several theories that address characteristics of individuals with ADHD were reviewed. Three models or theories address ADHD characteristics: (1) Gray's Learning Theory (Gray, 1975), (2) Barkley's model of behavioral disinhibition and executive functioning (Barkley, 2003; Barkley, 2006), and (3) Luria's Functional System (Luria, 1973).

## *Gray's Learning Theory*

Gray's Learning Theory involves the behavior inhibition system (BIS) and the behavior activation system (BAS), which interact to produce behavioral output (Gray, 1975). The BAS is responsible for eliciting behaviors in response to rewards or for actively avoiding punishment (Gray, 1975; Fowles, 1980). The BAS works to execute a behavior in response to an incentive. Technically, if a stimulus is presented and a behavior is exhibited, then the BAS system is producing greater input.

The BIS is the system that is responsible for stopping ongoing behaviors, particularly in a punishment based system, or preventing the elicitation of behavior. The BIS inhibits behavior when punishment is threatened, received, or during frustrative non-reward (extinction). When the BIS is activated, the ongoing behavior is stopped and attention is focused on relevant environmental cues (Quay, 1997). The decision to display a behavior is controlled by the BIS and BAS. If the BAS produces more input than the BIS, behavior will occur. If the BIS produces more input than the BAS, behavior will be inhibited. According to Gray's theory, children with ADHD appear to have more relative input in the BAS than children without ADHD due to the excessive amount of behaviors activated. This may be due to deficits in the BIS (Canivez, 1989).

*Barkley's Model of ADHD*

One of the main problems of ADHD is behavioral disinhibition. Children with ADHD respond quickly to situations without waiting for instructions and fail to consider the potential consequences in certain situations. Because of this, children with ADHD receive more punishment and criticism from adults than children without ADHD (Barkley, 2006). Due to the problems in inhibiting or stopping behaviors and taking note of cues around them, there appears to be a direct problem in the BIS. Even though there may be immediate cues in the environment that punishment will occur if the behavior is exhibited, the child may still perform the behavior. The child with ADHD may not attend to the environmental stimuli so the anxiety linked to the cue of punishment to stop the behavior is not perceived, which results in a problem with disinhibition.

The disinhibition problem (Canivez, 1989) was adapted by Barkley in his theory of ADHD. In relation to Gray, deficits in the BIS, such as an inability to prevent

behaviors from occurring, can be described as behavioral disinhibition. According to Barkley, ADHD includes a problem with behavioral inhibition and executive functioning, which leads to difficulties in motor control (Barkley, 2003; Barkley, 2006). In order for behavioral inhibition to take place, three processes must occur. They are (1) inhibiting prepotent response, (2) interrupting an ongoing response, and (3) interference control. Children with ADHD have difficulties inhibiting responses where immediate reinforcement is available. This reinforcement can be either positive or negative. Children with ADHD appear to have difficulty waiting for any type of reinforcement because they prefer instantaneous feedback. Interrupting an ongoing response is important when the current response is ineffective. If a response is not successful there needs to be knowledge of the unproductiveness of the behavior and then the individual needs to halt the current behavior to determine an alternative method. Interference control occurs with both internal and external distractions. Individuals show good interference control if they are not distracted when focusing on a task.

These three processes contribute to problems with behavioral disinhibition due to deficits in four executive functions (1) poor working memory, (2) delayed internalization of speech, (3) immature self-regulation of affect/motivation/arousal, and (4) impaired reconstitution (Barkley, 2003; Barkley, 2006). Among other things, poor working memory involves limited self-awareness. This results in difficulties holding a thought in mind, imitating complex behavior sequences, and time management. Delayed internalization of speech consists of poor self-questioning and problem solving as-well-as delayed moral reasoning. With a delay in internalized speech, it may be difficult for children with ADHD to comprehend reading because reading to oneself requires

internalized speech. Immature self-regulation of affect/motivation/arousal involves diminished self-regulation of motivation. Just as individuals with ADHD have difficulties in inhibiting a prepotent response, a problem with immediately responding to an event will not allow individuals with ADHD to modify their emotional reaction. Impaired reconstitution consists of limited analysis and synthesis of behavior. In this case, there is a setback in analyzing and breaking down behaviors.

The difficulties with behavioral inhibition and executive functioning are displayed in reduced motor control, fluency, and syntax (Barkley, 2003; Barkley, 2006). These interlocking networks in the brain are demonstrated when a child does not execute goal-directed responses or new and complex motor sequences. Children with ADHD appear not to be able to concentrate solely on the task at hand. Also, there may be problems with controlling emotions. It may be complicated for these children to control their behavior by internally represented information. Since there may be difficulties with inner speech, children with ADHD may have a hard time conducting self-talk to determine appropriate emotional responses and behavior.

*Luria's Functional System*

Self-regulation and impulse control were earlier explored by Alexander Luria (Luria, 1966). His discussion of the work of each functional unit of the brain is closely related to executive functions – with the role the units play in planning, organizing, attention, and impulse control (Korkman, 1999). This neuropsychological model is also known as Luria's Functional System. In Luria's system these difficulties all are controlled by the most advanced unit of the brain – the output planning unit.

There are three hierarchically ordered functional units that make up the brain: (1) the arousal unit, (2) sensory input unit, and (3) output planning unit (Luria, 1966; Luria, 1973). The arousal unit is the reptilian part of the brain. The brainstem, reticular formation, midbrain, pons, and medulla make up the arousal unit. The arousal unit attends to sensation, arousal, consciousness, and activation of cortical functions. This unit is the most basic unit of the brain that allows us to perform our basic functions (Luria, 1973).

The second unit, the sensory input unit, is located in the lateral regions of the neocortex and consists of the parietal, temporal, and occipital lobes (Luria, 1973). These all deal with perception, including vision, sound, and general sensory information. In these lobes are primary, secondary, and tertiary zones. The primary zone receives, sorts, and records information. The secondary zone organizes and codes information. The tertiary zone merges, synthesizes, and forms the basis of complex behavior. All of these zones are necessary to properly perceive incoming information.

The final unit, the output planning unit, organizes and directs behavior. The prefrontal cortex receives impulses and organizes impulses from lower structures in the brain. The frontal lobes are described by Luria (1973) as "superstructures about all other parts of the cerebral cortex, so that they perform a far more universal function of general regulation" (p. 89). Such universal functions of general regulation include the center of higher order processing and the locus of intelligent behavior. If there is destruction of the prefrontal cortex, individuals have severe problems performing complex behaviors, tuning out extraneous stimuli, and determining and correcting errors. Lesions seen in the frontal lobes have resulted in patients demonstrating an inability to make plans and

control distractions. Luria observed individuals responding impulsively to what a picture means instead of looking carefully and picking out details. These individuals failed to properly verify their hypothesis to the original information, which prevented them from correcting their impulsive mistakes (Luria, 1973). This inability to plan and respond adequately is solely controlled by the output planning unit.

Each functional unit is necessary to perform conscious activities. Whether it includes maintaining consciousness, perceiving information, or organizing and directing behavior, each unit performs a specific function. However, individuals with ADHD show deficits in the output planning unit (Carte, Nigg, & Hinshaw, 1996). These individuals have difficulties regulating their behavior, inhibiting impulses, and restraining movements. These are all complex behaviors which are controlled by the prefrontal cortex.

*PASS Cognitive Theory*

The PASS Theory (Das, Naglieri, & Kirby, 1994) is based on Luria's Functional System (and subsequently related to the aforementioned theories of Barkley and Gray) and can be used to explain where deficits are in children with ADHD. PASS stands for Planning, Attention, Simultaneous, and Successive (Das, Naglieri, & Kirby, 1994; Naglieri & Das, 1997). Each process in the PASS Theory falls within one of Luria's three functional units.

The first functional unit, the arousal unit, is responsible for Attention (Naglieri, 1998). Problems with attention lead to difficulties in resisting distraction or sustaining focus on tasks. The mental process incorporated with attention requires a child to focus

on specific stimuli while ignoring alternative, less important, stimuli. Good attention requires an individual to be selective and persistent.

The second functional unit, the sensory input unit, is in charge of Simultaneous and Successive Processing. This functional unit receives, processes, and retains information. Simultaneous and Successive Processing represent the two ways to handle this information (Naglieri, 1998). Simultaneous Processing is a mental process that requires integration of several stimuli into a coherent whole. This type of processing requires an individual to make links between various stimuli to create a conceptual whole.

Successive Processing requires the individual to sequentially process incoming stimuli in a specific order. This involves remembering information in a strict, defined order. The main difference between the two types of processes is that Successive Processing requires stimuli to be taken in and reproduced back in a particular systematic sequence while Simultaneous processing demands the recognition of how multiple stimuli are interconnected.

The third functional unit, the output planning unit, corresponds to Planning Processing (Naglieri, 1998). Planning Processing is a mental process where the individual makes decisions, selects strategies and uses them, and evaluates solutions for problems. The Planning process is important in solving all problems one encounters. Through Planning Processing, an individual can apply the processes of attention, simultaneous, and successive processing to create and carry out a plan and then evaluate the success of the plan. Each of the four processes can be used to illustrate cognitive

strengths and weaknesses within the individual and in relation to others based upon what each process measures (Naglieri & Das, 1997).

The Das-Naglieri Cognitive Assessment System (CAS; Naglieri & Das, 1997) was created as an alternative measure of cognitive ability using the PASS Theory. The CAS measures the four dimensions of the PASS theory. There are 13 total subtests of the CAS which fit into this model. In the Basic Battery, 8 subtests are administered and 12 subtests are included in the Standard Battery. Speech Rate is administered only to children 5 to 7 years old, while Sentence Questions is reserved for children 8 to 17 years of age.

The Planning scale includes subtests requiring the individual to create an approach to solve a specific task in an efficient manner. The individual must determine a means to solve the task, select which means to use, apply the means, and then evaluate the solution of the task and modify as needed. There are three subtests included in the Planning Scale. Matching Numbers requires an individual to determine which two numbers in a row of numbers are the same. Some rows include numbers with similar strings of digits varying in similarity to each other in the beginning or end of the sequence. Planned Codes requires filling in corresponding codes in empty boxes based upon a key. Each letter refers to a specific code. There are two trials with letters first corresponding vertically while the second trial has letters configured in a diagonal pattern. Planned Connections involves connecting either numbers in a sequential order or numbers and letters in a sequential order in an alternating manner without crossing lines. Within all of these subtests, examiners notice the plan in which the individual completed the task.

Attention Scale subtests require individuals to focus on one part of the task while ignoring less relevant stimuli, even if the alternate stimuli are difficult to disregard. When individuals are focused in their attention, they demonstrate concentration on a specific task. Sustaining attention is also expressed by varying performance over time based upon the amount of effort necessary to solve a problem (Naglieri & Das, 1997). The three subtests that measure Attention are: (1) Expressive Attention, (2) Number Detection, and (3) Receptive Attention. Expressive Attention measures selectivity and the ability to shift attention by either having individuals identify whether an animal shown on paper is big or small in real life, or by having children over eight-years-old identify, given a list of colors, the color the word is printed in, not what color the word spells. The application of this task for children above eight-years is the Stroop Color Word task. Number Detection requires young children to underline 1, 2, and 3 or 4, 5, and 6 when given a page of numbers. Older children are given the task to underline 1, 2, and 3 that are printed in an outlined typeface on the first task and to underline 1, 2, and 3 in regular typeface and 4, 5, and 6 in an outline typeface on the second task. Receptive Attention requires children to underline either pairs of drawings that are identical (i.e., A A not A a) or underline pairs of pictures that have the same name (i.e., A A or A a).

Subtests in the Simultaneous scale involve interrelating parts of a particular item to arrive at a correct answer. Successful simultaneous processing requires strong spatial and logical-grammatical components (Naglieri & Das, 1997). The Nonverbal Matrices subtest requires children to determine the relationships among parts of shapes and geometric patterns and decide which of six options best fit the pattern. The Verbal-Spatial Relations subtest includes six drawings and a printed question for each item. The

child must determine which drawing best matches the listed phrase. The Figure Memory subtest requires a child to identify a two- or three-dimension geometric figure that is displayed for five seconds which is embedded in a larger, more complex geometric figure.

The Successive scale includes subtests in which the individual must reproduce a particular sequence of stimuli or answer questions that require knowledge of the linearity of events. Successive processing involves perceiving stimuli in a sequence, comprehending the organized order of the stimuli, and providing output in the same sequence. The four subtests that correspond with Successive processing are: (1) Word Series, (2) Sentence Repetition, (3) Speech Rate, and (4) Sentence Questions. In Word Series, the child is given a string of words and is asked to repeat the words back in the same order. Sentence Repetition includes nonsense sentences composed of color words. The child must repeat the sentence exactly as it was presented. Speech Rate is for children five to seven years old. Children are timed while they repeat a three-word series ten times. Sentence Questions is for children eight to seventeen years old. Children are given a color word sentence and then are required to answer a question about the sentence.

*PASS and CAS Implications for ADHD*

Naglieri and Das (1997) sampled 66 children who met the DSM-IV criteria for ADHD. These children received the lowest score in Planning ($M$ = 88.4) and a somewhat low score in Attention ($M$ = 92.1). Average Simultaneous and Successive scores were reported ($M$ = 99.6 and $M$ = 100.5, respectively). It was not noted if

Planning and Attention scores were significantly lower for ADHD children than normals. The majority of subsequent research that has been completed also followed this pattern.

Paolitto (1999) compared 63 individuals with ADHD to a demographically matched sample. ADHD students had previous diagnosis of ADHD according to the DSM-IV criteria. Using the standard battery, ADHD children received Planning scores of 88.95, Attention scores of 92.38, Simultaneous scores of 100.60, Successive scores of 101.13, and Full Scale scores of 94.06. Matched standardization sample students received the following scores: Planning 102.17, Attention 101.60, Simultaneous 108.06, Successive 106.78, and Full Scale 105.83. Statistical significant differences were found on three of the four PASS scales (Planning, Attention, and Simultaneous processing scales) with large effect sizes for Planning ($d = 1.0$), medium to large effect sizes for Attention ($d = .7$), and small to medium for Simultaneous ($d = .5$). A statistically significant difference was also found between the ADHD group and matched group on the Full Scale scores with a large effect size ($d = .8$).

Crawford (2002) studied students with a learning disability in reading, students with ADHD, students with mental retardation, and students not in special education. The ADHD group had a PASS composite profile pattern of lower performance on Planning and Attention scales and stronger scores on Simultaneous and Successive scales. It was not noted if these Planning and Attention scales differences were statistically significant. In the children with the hyperactive subtype of ADHD, significant difficulties were found on the Planning scale and depressed scores on the Attention scale. This difference was not observed in the non-special education group. All but one study found evidence for

lower Planning scores in ADHD groups (Paolitto, 1999; Pottinger, 2002; Naglieri, Goldstein, Iseman, & Schwebach, 2003; Van Luit, Kroesbergen, & Naglieri, 2005).

Naglieri, Goldstein, Iseman, and Schwebach (2003) studied differences between children diagnosed with ADHD, matched children diagnosed with anxiety/depression, and the CAS normative standardization sample. Children were diagnosed with ADHD using the DSM-IV or DSM-IV-TR based upon an in-depth history session with parents, completion of parent and teacher behavioral questionnaires, and a face-to-face assessment. Children with ADHD had lower Planning scores than children with anxiety/depression (6.5 points; $d = .6$), and the standardization sample (12.7 points; $d = .9$). Students who met diagnostic criteria for ADHD earned statistically significant lower mean scores on the Planning scale of the CAS. There was a small effect size between the ADHD group and the standardization sample ($d = .3$) on the Attention scale. No statistically significant differences were found between these groups on the WISC-III Full Scale, Verbal Comprehension, Perceptual Organization, Freedom from Distractibility, and Processing Speed. However, a small effect was noted between the ADHD group and standardization sample on Processing Speed ($d = .3$).

Naglieri, Salter, and Edwards (2004) studied the differences between 48 ADHD referred children, 23 reading disabled children, and 48 regular education children. Children in the ADHD group were consecutive referrals to an ADHD specialty clinic and whose parents and/or teachers identified them with significant problems with hyperactivity, impulsivity, or inattention. Naglieri et al. found the ADHD group had significantly lower Planning scores ($M = 90.3$) than the regular education group ($M = 98.6$) ($p < .01$, $d = .61$). A non-significant difference, but small effect size was found

between the ADHD group ($M$ = 99.3) and the regular education group ($M$ = 103.6) on Simultaneous processing scores ($d$ = .36). No significant differences were found between the ADHD group and regular education group on Attention ($M$ = 97.4, $M$ = 99.3, respectively) or Successive processing ($M$ = 104.0, $M$ = 102.2, respectively).

Van Luit, Kroesbergen, and Naglieri (2005) studied a random sample of Dutch children with ADHD ($n$ = 20) and found the same profile observed in American children. Children were considered as ADHD if they were diagnosed based upon DSM-IV criteria by a psychiatrist who was not involved with the research project. The Planning scores for the Dutch children with ADHD ($M$ = 81.8) significantly differed from the control group ($M$ = 95.6) ($p$ = .003). There was also a statistically significant difference between the ADHD group ($M$ = 87.3) and the control group ($M$ = 102.2) on the Attention scale ($p$ < .003). The PASS theory of intelligence, as measured by the CAS, therefore was reported to offer a viable alternative to traditional IQ assessments. The PASS profiles demonstrated results showing distinct group differences, especially among those with attention difficulties and learning disabilities. The CAS is an excellent predictor of achievement; is more culturally sensitive as it does not contain verbal based tests; and is relevant to intervention and instructional planning.

Only one CAS study found inconsistent results. Palencia (2003) studied 32 clinically referred ADHD children with no psychiatric comorbid diagnoses and 39 regular education children with no disorders. No significant differences or significant group effects ($p$ < .05) on the Planning and Attention scales were found between these two groups. However, this could be the result of only part of the CAS being administered. Simultaneous and Successive scales were *not* administered, which in turn

may not provide an accurate representation of the CAS and its ability to show distinct group differences as assessments are the most valid when given in entirety.

*Significance of this Study*

There are three areas of difficulty that are most commonly observed in those with ADHD: (1) impaired response inhibition, (2) excessive task-irrelevant activity, and (3) poor sustained attention (Barkley & Murphy, 2006). Some examples of impaired response inhibition in children can include an inability to stop and think before performing a particular behavior and an inability to resist distractions while working. Excessive task-irrelevant activity can be manifested as excessive movement of the feet and legs. When observed, this difficulty is typically described as "always on the go". Problems with sustained attention can be witnessed when an individual cannot stay on task during independent work and when he or she loses concentration and skips from one incomplete task to another activity.

These behaviors associated with ADHD are not situation specific. ADHD behaviors appear not only in schools, but in many contexts of the child's life, especially when diligence in work-related tasks is required or where behavior restraint is necessary. Both parents and teachers who deal with children with ADHD complain that the child cannot listen, concentrate, stay on task, and finish assignments (Barkley, 1998).

ADHD has extensive biological contributions to its occurrence. This may explain why 30% to 60% of children diagnosed with ADHD continue to show significant symptoms of the disorder into adulthood (Gingerich et al., 1998). Factors associated with genetics may account for 80% of the differences among those with ADHD (Barkley & Murphy, 2006).

The current study provides important information to add to previous research on the CAS and students with ADHD. No previous study has included children prior to an ADHD diagnosis. New information obtained from this data will allow for a more accurate picture on utilizing the CAS for ADHD diagnosis instead of solely looking at group differences.

*Hypotheses*

The PASS profile for children with ADHD incorporates lowest Planning scores, depressed Attention scores, and normal Simultaneous and Successive scores (Crawford, 2002; Naglieri, 2004; Naglieri & Das, 1997; Naglieri, Goldstein, Iseman, & Schwebach, 2003; Paolitto, 1999; Pottinger, 2002; Van Luit, Kroesbergen, & Naglieri, 2005). Based on these studies it was hypothesized that significant distinct group differences would be observed on the CAS Planning and Attention scales. It was secondly hypothesized that the ADHD group would show a pattern of low Planning and Attention scale scores, but normal Simultaneous and Successive scale scores. Third, it was hypothesized that the CAS would correctly discriminate and differentiate the ADHD group from the Random Matched Control (RMC) group. If the CAS is to be useful in assisting in diagnosing ADHD, it must also accurately differentiate children with ADHD with low false positive and false negative rates. Psychologists have previously utilized less accurate neuropsychological tests to determine ADHD eligibility (Pfeiffer et al., 2000). Popular tests such as the Wechsler intelligence scales showed minimal group differences between children with ADHD and matched random normals while the CAS demonstrated differences on the Planning scale, suggesting the CAS may be sensitive to the processing difficulties experienced by children with ADHD (Naglieri et al, 2003).

## Method

### *Participants*

Forty kindergarten, first, and second grade students from schools in suburban Pierce County, Washington, met study criteria for inclusion in this study. Groups consisted of referred students with symptoms related to ADHD and a group of random and matched control (RMC) students. Thirteen students met qualifications for the ADHD group on the structured diagnostic interview, but *did not* meet criteria of an ASCA Attention Deficit-Hyperactive core syndrome *T* score of 65 or above and, therefore, were not included in the study.

Matching ADHD and control group children was attempted on gender, age, race, and special education classification; however, only 11 ADHD students were accurately and randomly matched from the same classroom. Five first grade students were used as matches for kindergarten students while one second grade student was utilized when a kindergarten or first grade student was not available. Table 1 presents demographic characteristics of the sample. To examine differences in ages, an independent *t*-test for differences between means was conducted. Results showed that children who were assigned to the ADHD group had significantly lower ages ($M = 6.60$, $SD = 1.14$) than those in the RMC group ($M = 7.45$, $SD = .51$), $t(38) = -3.04$, $p = .004$ (two-tailed), $d = .96$).

Table 1

*Demographic Characteristics*

| | ADHD | RMC |
|---|---|---|
| Gender | | |
| Male | 16 | 14 |
| Female | 4 | 6 |
| Grade | | |
| Kindergarten | 6 | 0 |
| First Grade | 7 | 11 |
| Second Grade | 7 | 9 |
| Race | | |
| Caucasian | 14 | 17 |
| Multi | 3 | 3 |
| Hispanic | 1 | 0 |
| No Answer | 2 | 0 |
| Special Education Classification | | |
| No SDI | 17 | 20 |
| Receives SDI | 3 | 0 |

*Note.* ADHD = Attention Deficit Hyperactivity Disorder, RMC = Random and Matched Control, SDI = Specially Designed Instruction.

*Instruments*

*Cognitive Assessment System.* The Cognitive Assessment System (CAS) is a test designed to determine cognitive processing abilities based upon the PASS Theory that was normed on 2,200 children ages 5- to 17-years-old (Naglieri & Das, 1997). The four

components of the PASS model include: (1) planning by using strategies for efficient performance, (2) competing demands on attention which require sustained focus, (3) perception of parts into a single gestalt for simultaneous processing, and (4) perceiving and reproducing the serial nature of stimuli for successive processing.

The CAS is organized into the Full Scale, the PASS Scales, and the subtests. The Full Scale provides an overall measure of cognitive functioning. The PASS scales are used to identify strengths and weaknesses in cognitive processing. The subtests are combined into the Full Scale and Pass Scale scores and involve the Basic Battery of eight subtests or the Standard Battery of 12 subtests (Naglieri & Das, 1997). The Full Scale internal reliability coefficients by age ranged from .95 to .97 (Thompson, 2001). The average internal reliability coefficients by age for the PASS scales are .88 (Planning), .88 (Attention), .93 (Simultaneous), and .93 (Successive) (Naglieri & Das, 1997; Van Luit, Kroesbergen, & Naglieri, 2005).

The CAS is recommended for use to diagnose learning strengths and weaknesses, classification (learning disabilities, attention deficit, mental retardation, giftedness), eligibility decision (meeting state or federal criteria), and consideration of the appropriateness of treatment, instruction, or remedial programs (Naglieri & Das, 1997). Overall, the CAS is reportedly useful for testing special populations (Thompson, 2001).

*Adjustment Scales for Children and Adolescents.* The Adjustment Scales for Children and Adolescents (ASCA; McDermott, Marston, & Stott, 1993) is nationally normed on 1,400 children. It is a behavior rating scale completed by classroom teachers and designed to assess psychopathology in youth aged 5 to 17 (McDermott, 1993; McDermott, 1994; McDermott, 1995). It contains 97 problem and 26 positive behavior

indicators that are presented in situations involving authority, peers, smaller/weaker children, play, learning, or confrontation (McDermott, 1996). Items are scored 1 if applicable or 0 if not applicable (e.g. items include "does not stand up for herself," "loses her temper if she cannot get her own way," "attacks other students viciously if provoked," "stands up for herself when she has to," and "often used as a 'scapegoat' or object of ridicule by others") (McDermott & Spencer, 1997).

Six core syndromes were found to have high internal consistency, unique and reliable variance, and convergent, divergent, and discriminant validity (McDermott, 1996). These core syndromes are: (1) attention-deficit hyperactive (ADH), (2) solitary aggressive (provocative) (SAP), (3) solitary aggressive (impulsive) (SAI), (4) oppositional defiant (OPD), (5) diffident (DIF), and (6) avoidant (AVO). Internal consistency ranged from .67 to .86 for the six core syndromes (Canivez, 2001; McDermott, 1993). Test-retest reliability over 30 school days ranged from .66 to .91, and inter-observer reliability ranged from .65 to .85 (Canivez, 2001; McDermott, 1993).

Canivez and Sprouls (2005) studied the ASCA's ability to discriminate between individuals with ADHD and a random and matched control sample. The ASCA was very accurate in correctly differentiating those with DSM-IV criteria for ADHD from those in the random and matched control group with sensitivity of .98 (true positive rate), specificity of .95 (true negative rate), positive predictive power of .94, negative predictive power of .98, and an overall correct classification rate of .96. These results indicated that in distinguishing between individuals with and without ADHD, the ASCA has very few false positive and false negative classifications. The ASCA was utilized as one of two

criteria to determine qualification for student inclusion in the ADHD group, and thus was a vital measure in helping determine the diagnostic utility of the CAS.

*Learning Behaviors Scale.* The LBS is a 29-item rating scale completed by a classroom teacher following a minimum of 50 contact days with the student. Items are rated on a 3-point Likert Scale (*Most often applies, Sometimes applies,* or *Doesn't apply*) rating the behavior during the past 2 months (McDermott, 1999; Schaefer & McDermott, 1999). Items are variably worded positively and negatively to control for integrity (e.g., items include "Says task is too hard without making much effort to attempt it," "Accepts new tasks without fear or resistance," "Responds without taking sufficient time to look at the problem or work out a solution") (Yen, Konold, & McDermott, 2004).

The Learning Behaviors Scale (LBS; McDermott, Green, Francis, & Stott, 1999) was normed on a sample of 5-17-year-olds ($N$ = 1500) stratified according to the 1992 U.S. Census by age, gender, academic level, ethnicity, family structure, disabling condition, national region, community sized, and parent education. There are four factors or subscales and a total score from 25 of 29 items (4 items are not scored) on which teachers rate students' positive and negative learning behaviors (McDermott, 1999; Worrell, Vandiver, & Watkins, 2001). The four factors are: (1) Competence Motivation (CM), (2) Attitude Toward Learning (AL), (3) Attention/Persistence (AP), and (4) Strategy/Flexibility (SF). Canivez, Willenborg, and Kearney (2006) tested the model and found coefficients of congruence for the four-factor model to be higher than a three-factor model. The LBS was found to have internal consistency estimates from .69 to .93 (*Mdn* = .88) across the five demographic subgroups analyzed (Grade 1-3, Grade 4-7, Male, Female, Total Sample) (Canivez, Willenborg, & Kearney, 2006). In the

standardization data, internal consistency estimates ranged from .75 to .85 with an average of .82 (McDermott, 1999). The LBS was used to obtain additional information in ADHD classification.

*Structured Diagnostic Interview for Parents.* A diagnostic interview utilizing criteria from the DSM-IV-TR was used with the parent to independently categorize students with ADHD or rule out ADHD categorization. Currently there are no commonly employed diagnostic interviews for ADHD; therefore, an interview following DSM-IV-TR symptoms for ADHD and related disorders was utilized (Fischer et al., 2005). The Structured Diagnostic Interview for Parents (SDIP; Barkley & Murphy, 2006) was used and covers the following disorders: (1) Oppositional Defiant Disorder, (2) Conduct Disorder, (3) Attention-Deficit/Hyperactivity Disorder, (4) Specific Phobia, (5) Social Phobia, (6) Separation Anxiety Disorder, (7) Generalized Anxiety Disorder, (8) Dysthymic Disorder, (9) Major Depressive Disorder, (10) Bipolar 1 Disorder, (11) Obsessive-Compulsive Disorder, (12) Tourette's Disorder, and (13) Psychotic Disorders. Based upon review of literature, this appears to be the first study to use this interview based upon the DSM-IV. Most previous research utilized either the Diagnostic Interview for Children and Adolescents (DICA; Reich, 2000) or the Diagnostic Interview Schedule for children (DISC; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000), both of which were much more in depth than required for this study.

*Procedure*

Permission to complete research in the schools was granted to the researcher by the district prior to acquiring participants. In order to obtain participants, teacher referrals across two school years were solicited for 78 students suspected of behavior problems

that might relate to ADHD. Upon referral, a semi-structured teacher interview concentrating on significant problem behaviors, onset and duration of behaviors, and intensity of behaviors was conducted. Twenty-six students were excluded at this point due to either not demonstrating ADHD symptoms, they presented ADHD *and* multiple other problematic symptoms, or their school principal would not allow research at her school.

For the referred children demonstrating ADHD symptoms based on teacher interview ($n = 52$), a meeting was scheduled with the parent/guardian of each student to obtain informed consent. During each parent meeting, the Structured Diagnostic Interview for Parents (Barkley & Murphy, 2006) was conducted. ADHD consideration required a minimum of six inattention and/or six hyperactive-impulsive symptoms. The majority of symptoms were required to be manifested under the hyperactive-impulsive type. These symptoms were required to be inappropriate for the child's age, to have lasted at least the past 6 months, and to have caused some impairment prior to age 7 years. Further, symptoms were presently causing impairment in home and school, producing clear evidence of clinically significant impairment in social or academic functioning, *and not* occurring only during a Pervasive Developmental Disorder or Psychotic Disorder or better accounted for by another mental disorder. The teacher was not provided the results of this interview and was blind to diagnosis prior to completing both the ASCA and LBS. Nineteen parents of students who met the teacher referral criteria refused to meet for an interview or decided during the interview they did not want their child included in the research study and were thus excluded.

Teachers completed the ASCA and the LBS on randomly selected and matched students and referred students whose parents provided informed consent and who met the inclusion criteria for ADHD based upon the SDIP ($n$ = 33). While the ASCA was utilized to determine final inclusion in the ADHD group, the LBS was administered to provide additional information on classroom learning behaviors. These measures are important because including parent interviews and rating scales increases the probability of a correct ongoing diagnosis to 66% from 5-6% when the DSM and self-reports are used alone (Barkley et al., 2002). It is also best practice to use interviews, behavior rating scales, observations, and other assessment tools (Canivez, Watkins, & Schaefer, 2002). Children were classified and included in the ADHD group if they were referred by their classroom teacher with ADHD symptoms, qualified with the SDIP, and obtained an ASCA ADH $T$ score of 65 or greater. Thirteen students *did not* meet the ADHD classification according to the ASCA; they received an ADH $T$ score lower than 65. These students were referred and had parent structured diagnostic interviews indicating significant ADHD symptoms. Children with an ADH $T$ score of 65 or higher on the ASCA ($n$ = 20) were administered the CAS.

Matched random controls were recruited from the same classrooms (unless where noted), and informed consent forms were obtained in the same manner as referred children. Parents of students in the RMC group were not interviewed using the structured diagnostic interview. After receiving informed consent, teachers of students in the RMC group completed the ASCA and LBS. Children in the RMC group were then administered the CAS.

*Data Analysis*

Descriptive statistics were utilized to report characteristics of individuals in the sample. MANOVA and ANOVA for distinct group differences were used to analyze the differences on the ASCA, LBS, and CAS PASS scale scores. An independent *t*-test for differences between means was included to determine differences on the CAS Full Scale score. To examine the diagnostic accuracy of the CAS, direct discriminant function analysis (Tabachnick & Fidell, 2001) with subsequent diagnostic efficiency statistics (Canivez & Watkins, 1996; Kessel & Zimmerman, 1993) were used. Diagnostic efficiency statistics estimated specificity, sensitivity, positive predictive power, negative predictive power, false positive rate, false negative rate, and the overall correct classification rate (Canivez & Watkins, 1996; Kessel & Zimmerman, 1993). Analyses were conducted with SPSS version 16.0 for Macintosh and the Automated Calculation of Diagnostic Efficiency Statistics (Canivez, 1994).

## Results

Table 2 and Figure 1 present the differences between the ADHD and RMC groups on the ASCA. Statistically significant differences with large effect sizes were observed between the groups on the ASCA ADH, SAP, SAI, and OPD core syndromes.

Table 2

*Descriptive Statistics and Effect Size Estimates for Differences between the RMC and ADHD Groups on the ASCA*

| | ADHD | | RMC | | | |
|---|---|---|---|---|---|---|
| Core Syndrome | *M* | *SD* | *M* | *SD* | *p* | *d* |
| ADH | 72.00 | 4.37 | 45.30 | 8.22 | .000 | 4.06 |
| SAP | 66.95 | 9.93 | 47.20 | 6.77 | .000 | 2.32 |
| SAI | 64.10 | 11.85 | 47.00 | 0.00 | .000 | 2.04 |
| OPD | 61.25 | 11.85 | 45.00 | 6.29 | .000 | 1.71 |
| DIF | 45.10 | 7.18 | 46.10 | 8.77 | .695 | .13 |
| AVO | 50.55 | 9.92 | 46.60 | 9.59 | .208 | .41 |

*Note.* MANOVA for ASCA Core Syndromes: Wilks' $\wedge = .17$, $F(6, 33) = 27.92$, $p < .000$, Multivariate Effect Size = .835, Power = 1.000. Statistical comparisons based on univariate ANOVA following statistically significant MANOVA. ADHD = Attention Deficit Hyperactivity Disorder, RMC = Random and Matched Control. *d* = Cohen's d, ADH = Attention-Deficit Hyperactive, SAP = Solitary Aggressive (Provocative), SAI = Solitary Aggressive (Impulsive), OPD = Oppositional Defiant, DIF = Diffident, AVO = Avoidant.

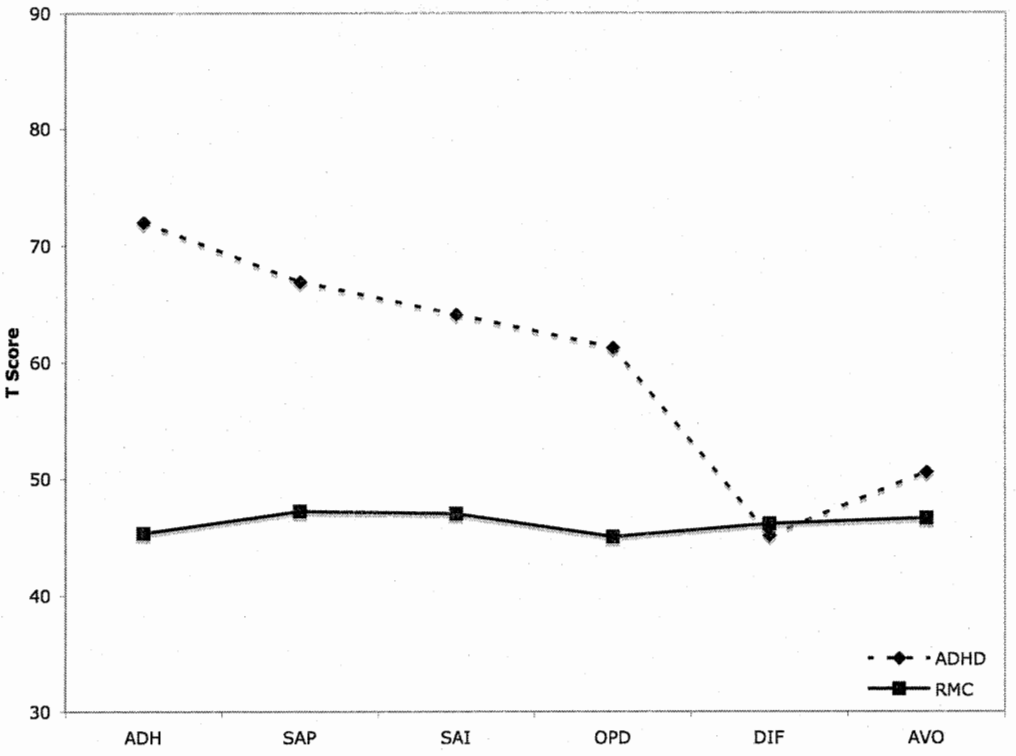


*Figure 1*. Mean *T* scores of core syndrome scales for the ADHD and RMC groups on the ASCA.

Differences between the ADHD group and RMC group on the core syndrome scores of the LBS are presented in Table 3 and Figure 2. Statistically significant differences with large effect sizes were observed between the groups on the LBS AL, AP, and SF scales.

Table 3

*Descriptive Statistics and Effect Size Estimates for Differences between the RMC and ADHD Groups on the LBS*

| | ADHD | | RMC | | | |
|---|---|---|---|---|---|---|
| Core Syndrome | *M* | *SD* | *M* | *SD* | *p* | *d* |
| CM | 43.90 | 7.22 | 48.15 | 15.28 | .268 | .36 |
| AL | 40.60 | 5.25 | 51.90 | 14.40 | .002 | 1.04 |
| AP | 30.05 | 13.98 | 50.50 | 10.30 | .000 | 1.67 |
| SF | 27.60 | 14.20 | 53.15 | 8.83 | .000 | 2.16 |

*Note.* MANOVA for LBS Core Syndromes: Wilks' $\wedge = .38$, $F(4, 35) = 14.61$, $p < .000$, Multivariate Effect Size = .625, Power = 1.000. Statistical comparisons based on univariate ANOVA following statistically significant MANOVA. ADHD = Attention Deficit Hyperactivity Disorder, RMC = Random and Matched Control. *d* = Cohen's d, CM = Competence/Motivation, AL = Attitude Toward Learning, AP = Attention/Persistence, SF = Strategy/Flexibility.

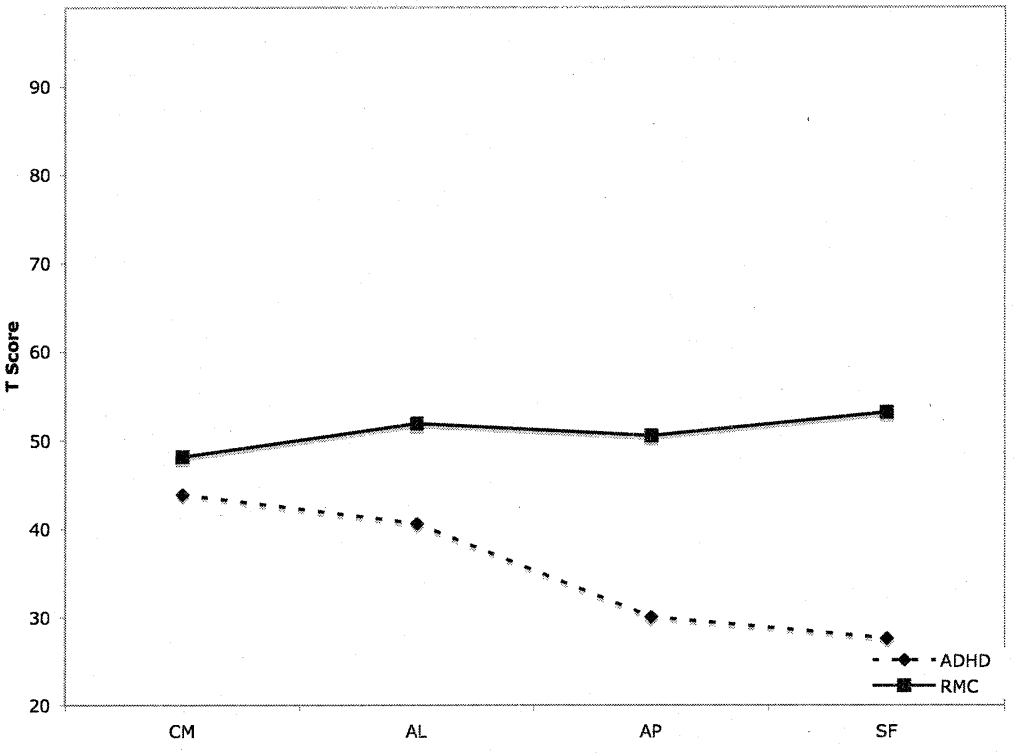


*Figure 2*. Mean *T* scores of core syndrome scales for the ADHD and RMC groups on the LBS.

*CAS Distinct Group Differences*

A one-way multivariate analysis of variance (MANOVA) and univariate ANOVAs were conducted to examine distinct group differences between the ADHD and RMC group on the CAS PASS scores. Statistically significant differences were found among the two groups on the PASS scores, Wilks's $\wedge = .70$, $F(4, 35) = 3.83$, $p = .011$. The observed power was .849. Table 4 presents the results of the univariate ANOVAs and Table 5 presents the PASS means and the standard deviations for the two groups. Subsequent one-way univariate ANOVAs were statistically significant for the Planning and Attention scales. The ADHD group obtained significantly lower scores than the

random matched control group on the CAS Planning (medium effect size) and Attention (large effect size) scales.

An independent *t*-test for differences between means was conducted for the CAS Full Scale scores. Results showed that children who were in the RMC group had significantly higher Full Scale IQ scores ($M = 107.05$, $SD = 14.52$) than the ADHD group ($M = 93.75$, $SD = 17.17$), $t\,(38) = -2.65$, $p = .012$ (two-tailed), $d = .84$. This was considered a large effect (Cohen, 1988).

Table 4

*Multivariate Analysis of Variance for PASS Scales*

| Source | *SS* | *SS* Error | *MS* | *MS* Error | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Planning | 1562.50 | 10037.90 | 1562.50 | 264.16 | 5.92 | .020 | .135 |
| Attention | 2907.03 | 7135.95 | 2907.03 | 187.79 | 15.48 | .000 | .289 |
| Simultaneous | 819.03 | 10189.95 | 819.03 | 268.16 | 3.05 | .089 | .074 |
| Successive | 32.40 | 6356.00 | 32.40 | 167.26 | .19 | .662 | .005 |

*Note.* MANOVA for Cognitive Assessment System PASS Scales: Wilks' $\wedge = .70$, $F(4, 35) = 3.83$, $p = .011$, Multivariate Effect Size = .304, Power = .849. On all significant effects, students with ADHD obtained lower CAS scores than students in the control group. $\eta^2$ = Partial Eta Squared.

Table 5

*Descriptive Statistics, F, and Effect Size Estimates for Differences between the RMC and ADHD Groups on the CAS*

| | ADHD | | RMC | | | | |
|---|---|---|---|---|---|---|---|
| Core Syndrome | *M* | *SD* | *M* | *SD* | *F* | *p* | *d* |
| Planning | 91.55 | 16.57 | 104.05 | 15.93 | 5.92 | .020 | .77 |
| Attention | 90.45 | 12.81 | 107.50 | 14.54 | 15.48 | .000 | 1.24 |
| Simultaneous | 102.50 | 17.55 | 111.55 | 15.11 | 3.05 | .089 | .55 |
| Successive | 97.30 | 13.69 | 99.10 | 12.14 | .19 | .662 | .14 |

*Note*. ADHD = Attention Deficit Hyperactivity Disorder, RMC = Random and Matched Control, *d* = Cohen's *d*.

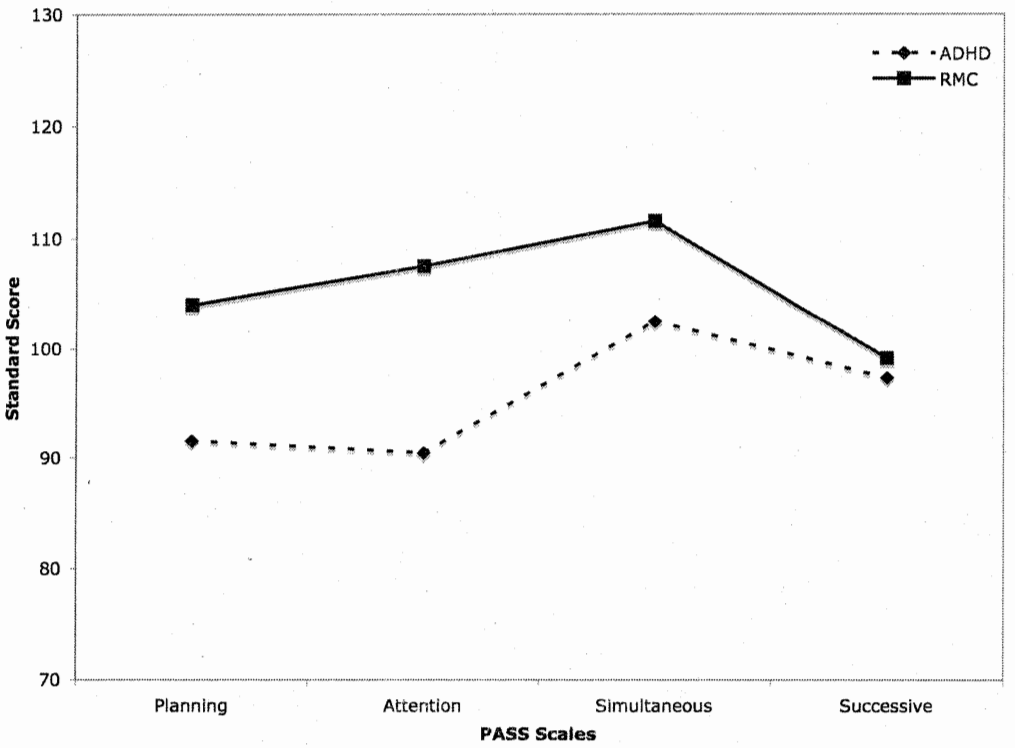


*Figure 3*. Mean standard scores of Planning, Attention, Simultaneous, and Successive scales for the ADHD and RMC groups.

*CAS Discriminative Validity*

The direct discriminant function analysis was statistically significant; Wilks's $\wedge$ = .70, $F(4, 35) = 3.83$, $p = .011$. Diagnostic efficiency statistics based on the discriminant function analysis of the PASS scales are presented in Figure 4. The overall correct classification of 78% illustrated the average degree of diagnostic accuracy for utilizing the PASS theory of the CAS for ADHD diagnosis. This resulted in a kappa coefficient of .55 ($z = 3.48$, $p < .001$). False positive, false negative, sensitivity, specificity, positive predictive power, and negative predictive power are also included. The false positive is also known as a Type I error, in which the CAS scores suggested an individual as ADHD but in actuality the child did not meet ADHD inclusion criteria. The false negative (Type II error), is where the CAS scores suggested an individual as non-ADHD but the child met the inclusion criteria for ADHD. Kessel and Zimmerman (1993) described sensitivity, specificity, positive predictive power, and negative predictive power. In the case of this study, sensitivity is the CAS ability to correctly identify individuals with ADHD. Specificity relates to the CAS ability to identify non-ADHD individuals correctly. Positive predictive power refers to the percent of individuals classified by the CAS as ADHD who are truly ADHD (based upon inclusion criteria). Negative predictive power is the percent of individuals classified as not ADHD by the CAS who are truly not ADHD.

*Diagnostic Efficiency Table*

| | | Diagnosis | | |
|---|---|---|---|---|
| | | Present | Absent | Total |
| Test | Positive | 16 | 5 | 21 |
| | Negative | 4 | 15 | 19 |
| | Total | 20 | 20 | 40 |

*Results*

| | |
|---|---|
| Sensitivity (True Positive Rate) = | 0.8 |
| Specificity (True Negative Rate) = | 0.75 |
| Positive Predictive Power = | 0.7619 |
| Negative Predictive Power = | 0.79 |
| False Positive Rate = | 0.25 |
| False Negative Rate = | 0.2 |
| Overall Correct Classification (Hit) Rate = | 0.775 |
| Observed Agreement Po = | 0.775 |
| Chance Agreement Pc = | 0.5 |
| Kappa = | 0.55 |
| Standard Error of Kappa = | 0.15791612 |
| Significance Test for Kappa Ho: k = 0 Z = | 3.48286173 |
| p < | 0.00049608 two-tail test |
| p < | 0.00024804 one-tail test |

*Figure 4*. Diagnostic efficiency table for the CAS PASS discriminant function analysis classifications © 1994 by Gary L. Canivez, Ph.D. All rights reserved.

## Discussion

All previous CAS studies with students with ADHD examined students already with ADHD diagnoses and focused on group differences. Previous studies involving ADHD and the CAS also found a general pattern of low Planning and Attention scale scores and normal Simultaneous and Successive scale scores. Since children in the present study did not have an ADHD diagnosis, students were included if the SDIP

resulted in 6 or more reported symptoms and an ADH *T* score of 65 or higher was earned on the ASCA. In order to test the hypotheses, the present study examined 40 kindergarten thru second grade students (20 ADHD, 20 RMC), and obtained results for the Cognitive Assessment System, Adjustment Scales for Children and Adolescents, Learning Behaviors Scale, and Structured Diagnostic Interview for Parents. Data analysis to examine hypotheses included descriptive statistics, MANOVA, ANOVA, independent *t*-test, direct discriminant function analyses, and diagnostic efficiency statistics. The hypotheses of the present study included: (1) significant distinct group differences between ADHD and RMC groups on Planning and Attention scales, (2) low Planning and Attention scale scores and normal Simultaneous and Successive scores for the ADHD group, and (3) the CAS would correctly differentiate between the ADHD and RMC groups. As the CAS presented these hypothesized results, as well as good positive predictive power and negative predictive power and low false positive and false negative classifications, the utility of the CAS as a diagnostic measure for ADHD was supported.

Results of the distinct group differences analyses were as expected. The MANOVA and ANOVA produced statistically significant differences on the CAS Planning scale ($p = .020$) between the ADHD group ($M = 91.55$) and the RMC group ($M = 104.5$) and on the Attention scale ($p < .001$) between the ADHD group ($M = 90.45$) and the RMC group ($M = 107.50$). No significant differences were found on the CAS Simultaneous and Successive scales between the ADHD and RMC group. While Planning scores were generally lower than Attention scores in previous studies, there were no reports of there being statistically significant differences. Naglieri and Das (1997) reported with 66 ADHD participants a mean Planning score of 88.4, Attention

mean of 92.1, Simultaneous mean of 99.6, and Successive mean of 100.5. Naglieri, Delauder, Goldsteng, and Schuebach (2006) discovered a mean Planning score of 93.7, Attention of 96.4, Simultaneous of 102.6, and Successive of 99.1 based upon 119 ADHD participants. Two studies focusing on Planning differences also reported significant differences between ADHD groups and RMC groups (Pottinger, 2002; Naglieri, et al., 2003). When Van Luit et al. (2005) compared students with ADHD to a RMC group they found significant differences between groups on both the Planning scale ($p = .003$) and Attention scale ($p < .003$). ADHD group means included a Planning score of 81.8, an Attention score of 87.3, a Simultaneous score of 95.3, a Successive score of 93.5, and a Full Scale IQ mean of 85.7. The RMC group resulted in group means of 95.6 on the Planning scale, 102.2 on the Attention scale, 101.2 on the Simultaneous scale, 103.0 on the Successive scale, and 100.4 on the Full Scale IQ score. These Dutch CAS subtest score means did not differ from US norms and along with the current study enhances the validity of the CAS in showing differences between ADHD and RMC groups. While differences between groups provide important information, diagnostic efficiency statistics, such as positive predictive power, negative predictive power, sensitivity, specificity, and overall correct classification, were imperative to provide diagnostic utility and use of the CAS in ADHD. The current study is unique to testing the discriminative validity of the CAS by incorporating students before an ADHD diagnosis.

Current results indicated an overall correct classification rate of 78% of the individuals in the present study. Students in the ADHD group were correctly classified as ADHD 80% of the time and were correctly classified as Non-ADHD 75% of the time. Twenty-five percent of individuals were falsely categorized as ADHD without meeting

the ADHD criteria on the ADHD inclusion criteria while 20% of the participants were falsely categorized as non-ADHD when they met the ADHD criteria on the ADHD inclusion criteria. Results indicated high positive predictive power with 76% of the individuals classified by the CAS as ADHD who were truly ADHD. Strong negative predictive power indicated 79% of the participants classified as Non-ADHD by the CAS who were truly Non-ADHD based on the ASCA.

Milich, Widiger, and Landau (1987) argued the utility of positive predictive power and negative predictive power before diagnosis. Positive predictive power examines the utility of the symptom as inclusion criteria and determines the probability of an individual having the disorder given the symptom. Negative predictive power does the opposite, in which it indicates the value of a symptom as exclusion criteria and examines the probability of not having a disorder given the absence of the symptom. The present CAS results were not as strong as the ASCA in differentiating individuals meeting the *NIMH Diagnostic Interview Schedule for Children – Version IV* and *Diagnostic and Statistical Manual of the American Psychiatric Association* criteria from those in a RMC group in the Canivez and Sprouls (2005) study. The positive predictive power of the ASCA was 94%, negative predictive power 98%, sensitivity 98%, and specificity 95%. This resulted in larger differences between ADHD and RMC groups and more accurate classification.

The findings that the PASS scales were accurate in differentiating between the ADHD group and control group, and that the ADHD group showed significantly lower Planning and Attention scores and similar Simultaneous and Successive scores supported the construct validity and diagnostic utility of the CAS and PASS scales. The present

findings also suggested the CAS had strong positive predictive power, strong negative predictive power, and therefore could be a helpful tool utilized in diagnostic evaluations of ADHD. The CAS correctly identified and discriminated ADHD children from RMC children. At the same time, the CAS should be considered as one tool in diagnosis but not the sole measure.

*Limitations*

The present study had limitations that need to be recognized and should be considered when considering present results and when designing similar future research studies. First, the ADHD group ended up with a significantly lower mean age ($M = 6.60$, $SD = 1.14$) than those in the control group ($M = 7.45$, $SD = .51$) due to difficulties in obtaining matched students from the same classroom. In order to be a truly matched control group there should not be a significant difference between ages of students in each group. The age differences between groups may have had an effect on ASCA and LBS scores. Older children demonstrate greater impulse control and attention than younger children, thus the younger children would be expected to be somewhat less controlled and have somewhat poorer attention. Any differences in obtained scores should not reflect differences in samples on the CAS due to standard score utilization. Previous research included similar PASS results to the current study (Naglieri & Das, 1997; Paolitto, 2000; Van Luit, Kroesbergen, & Naglieri, 2005). While attempts were made over a two-year period to obtain children of similar ages from the same classrooms, it was not always possible and students in other classrooms were required to be included in the RMC group. Due to required permission from parents, cooperation from teachers, and cooperation of students, six students in the control group were not from the same

class as their comparison peers. Control group students were not available for kindergarten students. One second-grade student was used when a first grade student was not available for the control group. Four of the control group students' parents did not return phone calls or did not sign the informed consent form. One teacher failed to provide the comparison students from her classroom after multiple attempts. Another teacher vacated her position for the remainder of the school year due to maternity leave.

In order to obtain true diagnostic efficiency statistics the groups must represent the general population. This study examined equal numbers in the two groups. The population base rate of ADHD is around 5-8% for children as opposed to the base rate of 50% in this study (Barkley & Murphy, 2006). Future studies should investigate the diagnostic utility of the CAS with a sample that reflects the population at large.

Another limitation was obtaining parent permission for inclusion in this complex study. While some students appeared to be strong candidates, either teachers or parents refused to participate. This resulted in students whose teachers had already discussed attention difficulties with the students' parents and whose parents more often than not wanted additional information on their student. Future researchers should take into consideration the difficulties of finding valid subjects interested in being included in research while working in schools. Researchers should also attempt to exude vigilance in obtaining control subjects, as it is often difficult to find students who match on gender, age, grade, race, and special education status to students in the ADHD group.

*Conclusion*

The PASS theory of the CAS is reported to provide specific PASS profiles for students with Reading Disabilities, Attention Deficit Hyperactivity Disorder, Mental

Retardation, Traumatic Brain Injury, Serious Emotional Disturbance, and Gifted (Naglieri & Das, 1997). Continued research differentiating special populations from control groups will expand on the utility of the CAS.

The current results supported the construct validity and diagnostic utility of the CAS. The CAS continued to show validity in differentiating between special population groups (such as ADHD) from random matched control groups. Should the CAS provide increased sensitivity, specificity, and positive predictive power then it could become a very useful tool for doctors and other qualified professionals in the diagnosis of ADHD while providing much more information than observations and behavior rating scales alone.

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