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Archives of Clinical Neuropsychology
20 (2005) 385–401

Archives of CLINICAL NEUROPSYCHOLOGY

Relationships between the WISC-III and the Cognitive Assessment System with Conners' rating scales and continuous performance tests

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Accepted 29 September 2004

Abstract

The aim of this study was to examine the relationships between intelligence, ratings of behavior, and continuous performance test scores for a sample of 117 children aged 6–16 years who were referred to a specialty clinic. The sample was comprised of children who had a primary (45%) or secondary (36%) diagnosis of ADHD. All children were given the Wechsler Intelligence Scale for Children Third Edition (WISC-III), Cognitive Assessment System (CAS), Conners' Continuous Performance Test (CPT), and Conners' Parent and Teacher Rating Scales—Revised, Long Form. Correlations between Conners' Behavior Rating Scale and Conners' Continuous Performance Test were uniformly low and non-significant (the highest correlation was .17). Correlations between the WISC-III and Conners' Parent Rating Scale were all non-significant, but Teacher Ratings showed significant correlations between most of the WISC-III factors and the Cognitive Problems/Inattention scores. Few significant correlations were found between CPT with the WISC-III and CAS. These results suggest that practitioners should expect to find a lack of consistency between the scores provided by these measures and should be conservative of their use in clinical settings.
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Keywords: Intelligence; Cognitive processing; Continuous performance tests

Over the past 50 years, Attention Deficit Hyperactivity Disorder (ADHD) (APA, 1994) has become one of the most widely researched areas in childhood and adolescence, with an increasing emphasis throughout the adult life span (Goldstein & Ellison, 2002). Problems

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doi:10.1016/j.acn.2004.09.008

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arising from the constellation of symptoms called ADHD have long constituted one of the most chronic childhood behavior disorder (Wender, 1975) and the largest single source of referrals in mental health, educational and medical settings (Barkley, 1981; Garland et al., 2001). Some suggest that children with ADHD may comprise as much as 50% of referrals to child guidance clinics (Barkley, 1981, 1990). The prevalence of referrals and complexity of the disorder places considerable demands on the task of diagnosis.

Currently, the recommended assessment for ADHD consists of the completion of (a) Parent and Teacher questionnaires reported to be sensitive and specific to ADHD, (b) an in depth, face-to-face history with parents, and (c) a clinical assessment such as an interview and/or psychological evaluation. There continues to be, however, limited consensus concerning an exact combination of methods and tests that can best identify children. Practitioners have used tests specifically designed to assess ADHD (e.g., Continuous Performance Tests) as well as measures that assess other abilities within which attention is purportedly measured (e.g., Wechsler Intelligence Scale for Children Third Edition (WISC-III); Cognitive Assessment System (CAS)).

DuPaul (1992) suggests that the diagnosis of ADHD should be guided by five basic questions. These include: Does the child exhibit a significant number of ADHD symptoms? Are the symptoms exhibited at a frequency that is greater than presented by other children? Are the symptoms cross-situational and at what age did they begin? Do they cause impairment across multiple domains as prescribed by the DSM-IV-TR? And finally, could factors such as other behavioral disorders, learning disability or emotional problems contribute to or better account for these ADHD symptoms? It is this last question that mental health professionals typically attempt to address in the course of an individual, psychological assessment.

Measures of intellect, such as the Wechsler Intelligence Scale for Children Third Edition (Wechsler, 1991) or Cognitive Assessment System (Naglieri & Das, 1997), behavioral questionnaires such as the Conners' Parent and Teacher Behavior Rating scales (Conners, 2000) and Continuous Performance Tests (CPT) such as the Conners' Continuous Performance Test (Conners, 1995), have increasingly comprised the basic clinical battery administered when children are evaluated for ADHD. The Conners' Parent and Teacher Rating Scales continue to be widely used questionnaires in the evaluation of ADHD. Though cutoff scores to determine clinical significance are debated (1.5 or a 2S.D.), this measure has been sensitive in identifying children subsequently receiving diagnoses of ADHD as well as those whose symptoms may result from other etiologies (for review see Goldstein & Goldstein, 1998).

An in depth review of the effectiveness of CPTs is provided by Riccio, Reynolds, and Lowe (2001) who found the measure to yield significant differences between children with and without ADHD. Despite research support and their popularity, approximately a third of children receiving diagnoses of ADHD may not be detected by CPTs (Maes & Calhoun, 1999). Further, children with ADHD classified as abnormal on CPTs, have been found to score below those classified as normal on other measures such as abstract and verbal reasoning, logical and non-verbal problem solving, and arithmetic skills (see Conners, 1995; Riccio et al., 2001).

Some researchers also argue there is no compelling evidence for a sustained attention deficit in ADHD (Corkum & Siegel, 1993). Many of the CPTs (in which the child must inhibit responding the majority of the time and respond only when the target appears) may have good positive predictive power but limited negative predictive power. The Conners' CPT requires

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the child to respond continuously and inhibit responding when the target appears, which is more likely to measure skills consistent with recent theories of ADHD involving problems with response inhibition, but it has yet to meet the thresholds for negative predictive power.

CPTs are not without limitations. Low correlations have been found between CPT scores and direct observation of ADHD symptoms in the classroom. Omission scores appear to correlate modestly with behavioral categories on standardized questionnaires (Gordon, 1988). CPT performance has not been found to be reliably sensitive to stimulant medication (DuPaul, Barkley, & McMurray, 1991) and well-controlled studies have not consistently found that children passing CPTs do not have ADHD. McGee, Clark, and Symons (2000) suggest that children with ADHD who fail CPTs tend to be rated as more hyperactive than those with ADHD who pass CPTs.

Perhaps no other single laboratory instrument secondary to CPTs, has been considered to be as effective in facilitating the diagnosis of ADHD as the WISC-III (Wechsler, 1991). Research data suggests diagnostic differences within subtypes of ADHD, Combined Type versus Inattentive Type, these differences were found in intellectual performance, with the Combined Type demonstrating lower Verbal IQ scores (Carlson, Lahey, & Neeper, 1986). Although subtests of the last two versions of the WISC (Revised and III) have been suggested as measures of vigilance and concentration (Gardner, 1979), divided attention (Van Zomeren, 1981), and attention (using the Freedom from Distractibility factor (Kaufman, 1979), recent research casts doubt on the test's ability to identify children with ADHD. In fact, Kaufman and Lichtenberger (2000) state that "studies using the WISC-III (Wechsler, 1991) with samples of ADHD children show WISC-III scores provide useful information about these children's intellectual abilities and cognitive strengths and weaknesses but the research findings do *not* [emphasis added] indicate that the WISC-III can be used as a diagnostic test for ADHD" (p. 205). Additionally, the Freedom from Distractibility factor on the Wechsler has not been found to correlate well with observation or parent and teacher reports of ADHD (Cohen, Becker, & Campbell, 1990). Nonetheless, some authors continue to advocate that the Wechsler may be sensitive to discriminating children with ADHD from those with other disorders as well as controls (Bowers et al., 1992).

Researchers have also examined the CAS (Naglieri & Das, 1997) as an assessment tool for ADHD and related conditions. Several studies examining the performance of children with ADHD using the PASS theory as measured by the CAS have been reported. Paolitto (1999) found matched samples of ADHD and normal children earned significantly lower scores on the Planning scale of the CAS (Naglieri & Das, 1997). He concluded that these results supported Barkley views (1997, 1998) that ADHD involves problems with behavioral inhibition and self-control, which is associated with poor executive control (e.g., planning from PASS). Paolitto also concluded "the CAS was able to successfully identify about three of every four children having ADHD" (p. 4). Similarly, Dehn (2000) and Naglieri, Goldstein, Iseman, and Schwebach (2002) found that groups of children who met diagnostic criteria for ADHD earned significantly lower mean scores on measures of planning. Importantly, Naglieri, Salter, and Edwards (2004) found that children with anxiety disorders had a different PASS profile than those with ADHD and specific reading difficulties. These results suggest that the PASS theory may have utility as part of the diagnostic process and that research of its relationship to other procedures is warranted.

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Measures of IQ, academic achievement, Teacher behavioral ratings and memory scores have not consistently been found to vary significantly between groups of children with and without ADHD (Aylward, Brager, & Harper, 2001). It is not uncommon for children to score in the clinical range on one measure but not another, to be reported as inattentive, hyperactive and impulsive by parents and teachers, but perform successfully on the CPT or fail to demonstrate the suggested pattern of weakness on achievement and intellectual measures. Further, tests designed to measure similar constructs do not always agree. For example, the Tests of Variables of Attention (TOVA) (Greenberg, 1991) has not been found to correlate with measures of intelligence (Weyandt, Mitzlaff, & Thomas, 2002). These authors found that neither the Full Scale IQ nor any of the three factor scores that constituted the revised Wechsler correlated significantly with the four variables measured on the TOVA. This is in contrast to findings of others, suggesting a relationship between CPT performance and intelligence but only between the ability to detect the target (errors of omission) and the intellectual measures that reportedly measure attention (Aylward, Gordon, & Verhulst, 1997; Klee & Garfinkel, 1983; Lovejoy & Rasmussen, 1990; Seidel & Joschko, 1991). Some neuropsychological tests have been found to show low diagnostic sensitivity and limited ability to discriminate between males with ADHD from controls. Although it has been found that impaired neuropsychological test performance can be associated with a diagnosis of ADHD, unimpaired test performance does not rule out the diagnosis (Doyle, Biederman, Seidman, Weber, & Faraone, 2000). Questionnaire data and CPT performance has also not been found to correlate particularly well (Hathaway, Dooling-Litfin, & Ash, 1998). Some researchers have suggested that the inconsistency among the various measures, in and of themselves, may hold diagnostic utility (Gordon, 1990).

To further examine these questions, this study examined the relationships between intelligence, ratings of behavior, and continuous performance test scores, for a group of clinic-referred children. Based upon the available research literature, it was hypothesized that whereas global scores on measures of CPT, Behavior Rating Scales, WISC-III, and CAS would be minimally correlated, specific scales would be strongly correlated. For example, we anticipated that Conners' CPT Attentiveness Scale would correlate with Conners' Cognitive Problems/Inattention Rating Scale. We also expected that the Conners' CPT would be related to the CAS Attention and Planning scales. However, given the past research we generally expected that the relationships among these various measures would be modest.

1. Method

1.1. Participants

The sample was comprised of 117 children and adolescents (83 males and 34 females) aged 6–16 years 11 months who lived in suburban/urban (82.9%) and rural (17.1%) community settings in the western region of the United States. Each child was referred to a neuropsychological clinic for evaluation and treatment primarily by physicians, educators and/or community mental health providers. Following referral, each child received a comprehensive evaluation including assessment of intellect, cognitive processes, behavior, attention, achievement, emotional functioning, learning and an in-depth history following DSM-IV. The WISC-III, CAS,

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Table 1
Primary and secondary DSM-IV diagnoses for the sample ($n = 117$)

Diagnosis	Primary		Secondary	
	Frequency	%	Frequency	%
ADHD Combined Type	36	30.8	8	16.7
ADHD/NOS	13	11.1	2	4.2
ADHD Inattentive Type	4	3.4	7	14.6
Oppositional Defiant Disorder	3	2.6	12	25.0
Anxiety/NOS	16	13.7	4	8.3
Generalized Anxiety Disorder	10	8.5	2	4.2
Adjustment Disorders	11	9.4	3	6.3
Mood Disorders	11	9.4	9	18.8
Developmental Disorders	6	5.1	0	.0
Learning Disorders	2	1.7	1	2.1
Personality Disorders	1	.9	0	.0
Axis Deferred	2	1.7	0	.0
No diagnosis	2	1.7	0	.0
Total	117	100.0	48	100.0

CPT, Conners' Parent and Teacher Behavior Rating Scales were not used in making the diagnosis of ADHD, or any other mental disorder.

Diagnostic characteristics of the sample are provided in Table 1. Ninety-eight percent of children were Caucasian whose parents were well educated. Among the children's fathers, 61% were college graduates, 17% had some college, and 22% graduated from high school. Similarly, 50% of the children's mothers were college graduates, 30% had some college, and 20% were high school graduates. DSM-IV, Axis I diagnoses were made based on data obtained during the course of a structured history session with each child's parents by the second author or by one of three post-doctoral, neuropsychological residents supervised by the second author. A sizable proportion of the sample had a primary (45%) or secondary (36%) diagnosis of ADHD. Adjustment and Mood disorders accounted for an additional 18% of the primary diagnoses of the sample. The most typical secondary diagnoses after ADHD were Oppositional Defiant Disorder (25%) and Mood Disorder (19%). See Table 1 for a complete list of DSM-IV Diagnoses. Eighty-five percent of children within this sample were in a regular public education setting, 14% were in a part-time special education program, and 1% were educated in a full-time special education placement.

1.2. Instruments

1.2.1. Wechsler scales

The WISC-III (Wechsler, 1991) is a widely used measure of general intelligence for children aged 6–16 years. The WISC-III is organized into three IQ scores (Verbal, Performance, and Full Scale) and further divided into four factorially derived index scores including the Verbal Comprehension, Perceptual Organization, Freedom from Distractibility, and Processing Speed (Kaufman & Lichtenberger, 2000). Each of the IQ scores and factor indexes yield standard

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scores with a mean of 100 and a S.D. of 15. The WISC-III is well standardized on a sample of 2200 children who ranged in age from 6 to 16 and match the 1988 U.S. Census on a number of key demographic variables. The average split-half reliability coefficients for individual subtests across different age groups range from .69 to .87. The average split-half reliability coefficients for IQ and Index measures are as follows: Verbal IQ (.95), Performance IQ (.91), Full Scale IQ (.96), Verbal Comprehension Index (.94), Perceptual Organization Index (.90), Freedom from Distractibility Index (.87), and Processing Speed Index (.85) (Kaufman & Lichtenberger, 2000).

1.2.2. Cognitive Assessment System

The CAS (Naglieri & Das, 1997) is an individually administered test for children aged 5–17 years designed to measure four basic psychological processes. The CAS is organized according to the PASS theory and comprised of four scales: Planning, Attention, Simultaneous, and Successive, each set at a mean of 100 and S.D. of 15. The eight-subtest Basic Battery was used in this study. The CAS was standardized on a sample of 2200 children aged 5–17 years who were selected to reflect the demographics of the United States. The average Basic Battery reliability coefficients are as follows: Full Scale (.87), Planning (.85), Attention (.84), Simultaneous (.90), and Successive (.90). The CAS Planning Scale requires the child to consider how to solve each item, develop a plan of action, apply the plan, modify the plan as needed, and control the impulse to act without careful consideration. Planning subtests also require the use of strategies for efficient performance (Naglieri & Das, 1997). The CAS Attention Scale requires the child to focus cognitive activity, detect particular stimuli, and inhibit responses to competing stimuli. The Simultaneous Scale requires the child to synthesize separate stimuli into an interrelated group involving spatial and logical content. The CAS Successive Scale requires the child to integrate material into a specific serial order in which each element is related to those that precede and follow it, and involves the repetition or comprehension of the serial organization of events. The CAS Full Scale score is an overall measure of cognitive processes that is the equally weighted composite of all subtests included in the Planning, Attention, Simultaneous, and Successive scales.

1.2.3. Conners' Continuous Performance Test

The Conners' Continuous Performance Test (CPT) is a computer delivered test designed to measure attention difficulties in children aged 6 to adult. This test requires the child to press the space bar immediately following the presentation of a target letter (any letter other than X) while refraining from pushing the button when non-target letters are presented (the letter X). These stimuli (target and non-target letters) are presented to the child in variable time intervals (i.e., presentation rate changes over the course of the test). Raw scores provided by the CPT are converted to *T*-scores (mean of 50 and a S.D. of 10). Percentile scores, provided by the CPT program were converted to *T*-scores for the purposes of the study. The CPT computer program calculates five scores which include Attentiveness, Risk-taking, Hits, Omissions, and Commissions. The Attentiveness score provides an index of how well the child discriminated target letters (Hits) from non-target letters (Commissions). The Hits score is representative of the number of targets with which the child correctly responded. The Risk-taking score provides information about a child's response tendency, high scores indicating cautious and

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a low response rate, and low scores indicating a more impulsive response tendency. The Omissions score represents the number of target letters to which the child did not respond. The Commissions score is representative of the number of times the person incorrectly responded to a non-target letter ("X"). For a detailed explanation of how these scores are calculated see *Conners' Continuous Performance Test Manual* (Conners, 1995).

Reliability coefficients for the CPT measures were not available in the CPT manual, details about the validity can be found in the *Conners' Continuous Performance Test Manual* (Conners, 1995). Normative data for Conners' CPT are based on 758 subjects, in a general population ($n = 520$) and a clinical population ($n = 238$) from six states around the U.S. The sample included children and adults aged 4–70 years. There were 74 individuals in the 18–70 age group and 446 in the school aged sample. Both males (51.2%) and females were included but no information is provided about other important demographic variables such as parental education, geographic region, race/ethnicity, etc. The absence of information about the standardization sample does not allow a comparison to the population in which the instrument is used and is a serious limitation of the CPT.

1.2.4. Conners' Parent and Teacher Rating Scales (CPRS-R:L, CTRS-R:L)

The Conners' Parent (80 items) and Teacher (59 items) Rating Scales-Revised Long Forms (*CPRS-R:L*, *CTRS-R:L*) (Conners, 2000) are norm-based behavior rating scales used to assess childhood behaviors for children aged 3–17. The Conners' Parent and Teacher Rating Scales assess areas of attention, conduct, cognition, family, social problems, academics, perfectionism, emotion, anger control, and anxiety (Conners, 2000). The parent or teacher answers the given questions on a Likert-type scale ranging from 0 (not true at all) to 3 (very much true). Conners' Parent and Teacher Rating Scale raw scores are converted to *T*-scores (mean of 50 and a S.D. of 10). Both Parent and Teacher rating scales have identical subscales with the exception of the Psychosomatic subscale which appears only on the Parent version. In this study, the following subscale variables were used: Oppositional, Cognitive Problems/Inattention, Anxious/Shy, Global Index Total, and DSM-IV Total (Conners, 2000).

The Conners' Oppositional subscale (10 items Parent, 6 items Teacher) includes questions that target rule breaking, problems with authority, irritability, and anger. The Cognitive problems/inattention subscale (12 and 7 items on the Parent and Teacher forms, respectively) involves questions related to difficulties in the area of completion of schoolwork, concentration on tasks that require sustained mental effort, and inattentiveness. The Anxious/Shy (eight and six items on the Parent and Teacher forms, respectively) subscales include questions about whether a child may have more worries, fears, sensitivity to criticism, anxiousness in new or unfamiliar situations, shyness, and withdrawn behavior, or may behave more emotionally for children of their age.

The Global Index Total (10 items on Parent and Teacher forms) is a multi-dimensional measure that includes the subcomponents of both the Restless–Impulsive (hyperactivity and inattentiveness) and Emotional Lability (tendency for pronounced emotional reaction, such as crying, getting angry often, or having mood swings) scales.

The DSM-IV Total component of the rating scales target and match *The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV; APA, 1994) symptoms for ADHD, Hyperactive–Impulsive and Inattentive type (eight items each for both Parent and

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Teacher scales). This scale examines the severity of an attention problem and indicates that a child may meet diagnostic criteria for Attention Deficit Hyperactivity Disorder (Conners, 2000).

The Conners' Parent and Teacher Behavior Rating Scale Long Forms were both normed on separate samples of children from the U.S. and Canada. The Parent form was standardized on 2482 and the Teacher form on 1973 children and adolescents further divided into male and female norms. These samples are poorly described in the test manual and characteristics that are provided suggest that the samples are different from the U.S. population on important characteristics such as race and ethnicity.

Internal consistency reliability coefficients for Conners' Parent Rating Scale range from .67 to .95 on the subscale level, the total internal reliability coefficients for the subscales range from .73 to .94. On the Teacher Rating Scale the internal reliability coefficients for the subscales range from .55 to .99, and for the subscale total internal reliability coefficients range from .77 to .96.

1.3. Procedure

All of the participants were administered the entire Wechsler Intelligence Scale for Children Third Edition (Wechsler, 1991), the Basic Battery (eight subtest) of the Cognitive Assessment System (Naglieri & Das, 1997), and the Conners' Continuous Performance Test (CPT; Conners, 1995) by trained examiners. In addition, the children's parents and teachers completed the Conners' Parent and Teacher Behavior Rating Scales (CPRS-R:L, CTRS-R:L; Conners, 2000). Parent and Teacher rating scales were completed prior to the initial intake appointment in which history was obtained from parents. The WISC-III, CAS and CPT were administered as part of a comprehensive neuropsychological battery, given in two sessions, with a lunchtime break. The WISC-III was administered as the first test in the morning session, the CPT at the close of the 2-h morning session, and the CAS as the first test in the afternoon session.

1.4. Statistical analyses

Results were analyzed utilizing SPSS version 10.0, standard scores (mean of 100, S.D. of 15) were used for the WISC-III and CAS, *T*-scores (mean of 50, S.D. of 10) were used with the Conners' Parent and Teacher Rating Scales, and Conners' Continuous Performance Test (CPT). Conners' CPT Hits and Omissions percentile scores were converted into *T*-scores based upon their normal curve equivalent values. Standard scores were used to compute Pearson correlations. Pearson correlations were corrected for range instability apparent by standard deviations that were either lower or higher that would be expected in the normal population (15 for standard scores and 10 for *T*-scores) using the formula provided by Guilford and Fruchter (1978).

2. Results

Means and standard deviations are presented in Table 2 for the WISC-III and PASS standard scores illustrate that the sample earned mean scores that fall in the average range (90–109)

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Table 2
Means and S.D.s for WISC-III, CAS, Conners' Rating Scale, and Conners' CPT ($n = 117$)

	Mean	S.D.
Wechsler Intelligence Scale for Children (WISC-III)		
Verbal IQ	108.8	14.5
Performance IQ	101.7	13.7
Full Scale IQ	105.1	15.9
Verbal Comprehension Index	110.1	14.8
Perceptual Organization Index	102.7	14.4
Freedom from Distractibility Index	100.6	14.1
Perceptual Organizational Index	98.7	14.3
Cognitive Assessment System (CAS)		
Planning	92.4	11.9
Simultaneous	104.3	11.8
Attention	96.5	12.6
Successive	100.4	13.3
Full Scale	97.7	12.2
Conners' Parent Rating Scale (CPRS-R:L)		
Oppositional	59.7	13.5
Inattentive/Cognitive Problems	71.3	11.4
Anxious/Shy	57.5	14.7
Global Index Total	65.6	11.8
DSM-IV Total	69.6	12.3
Conners' Teacher Rating Scale (CTRS-R:L)		
Oppositional	54.5	11.7
Inattentive/Cognitive problems	67.2	12.3
Anxious/Shy	57.1	11.4
Global Index Total	65.9	12.7
DSM-IV Total	66.1	13.7
Conners' Continuous Performance Scale (CPT)		
Attentiveness	59.6	9.1
Risk-taking	68.6	20.6
Hits	58.5	10.5
Omissions	59.8	10.4
Commissions	56.4	8.8

Note: WISC-III and CAS values are standard scores (mean of 100, S.D. of 15) all others are *T*-scores (mean of 50, S.D. of 10).

on all of the variables. Most of the WISC-III and CAS standard deviations were smaller than would be expected in an unrestricted sample. Conners' Rating Scale *T*-score means provided in Table 2 were typically above the average (50) with several of the variables in the upper 60s or low 70s (Global Index Total, DSM-IV Total, and Inattention/Cognitive Problems), which is +1 and +2S.D.s, respectively. Conners' Continuous Performance Test *T*-score means were also generally high (all 56 or higher) with a maximum of 68.6 on the Risk-taking scale. These data suggest that the sample had average or higher intelligence and behavior problems as noted by parents and teachers as well as difficulty with the CPT.

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Table 3
Obtained and corrected Pearson correlations between Conners' Behavior Rating Scales and Conners' Continuous Performance Test ($n = 117$)

	Conners' Continuous Performance Test (CPT)									
	Attentiveness		Hits		Risk-taking		Omissions		Commissions	
	O	C	O	C	O	C	O	C	O	C
Conners' Parent Rating Scale										
Oppositional	.07	.06	.13	.05	.03	.02	.03	.02	.00	.00
Cognitive Problems/Inattention	.16	.15	.15	.06	.16	.14	.16	.14	.08	.08
Anxious/Shy	.10	.08	.03	.01	.02	.01	.02	.01	.15	.12
Global Index Total	.12	.12	.11	.05	.07	.04	.05	.04	.10	.10
DSM-IV Total	.17	.15	.16	.06	.12	.09	.12	.09	.13	.12
Conners' Teacher Rating Scale										
Oppositional	−.04	−.03	−.03	−.01	.03	.02	.03	.02	−.09	−.09
Cognitive problems/Inattention	.01	.01	−.02	−.01	.03	.02	.03	.02	−.01	−.01
Anxious/Shy	−.07	−.06	−.03	−.01	−.12	−.10	−.12	−.10	.04	.04
Global Index Total	.12	.10	.02	.01	.01	.01	.01	.01	.17	.15
DSM-IV Total	.10	.08	.00	.00	.00	.00	.00	.00	.17	.14

Note: Correlations were corrected for sample variation that was not consistent with normative values (S.D. of 10). See text for more explanation. O, obtained correlations; C, corrected correlations. None of the values are significant at $P < .01$.

Obtained correlations between Conners' Behavior Rating Scales and Conners' Continuous Performance Test were uniformly low as were those corrected for range instability (Table 3). The correlations ranged from a low of .00 to a high of .17 and none of the obtained or corrected correlations were significant. Remarkably, the correlations between variable pairs such as Attentiveness on the CPT and Cognitive Problems/Inattention on Conners' Rating Scale showed little to no correlation ($r = .01$). This suggests that practitioners should not expect these two measures to yield consistent results.

Corrected correlations between the WISC-III, Conners' Rating and CPT scales are provided in Table 4. The WISC-III Scores did not correlate significantly with any of the Conners' Parent Rating Scale *T*-scores. The WISC-III only correlated significantly with the Cognitive Problems/Inattention scores from Conners' Teacher Rating Scale, although low (all less than .36). The relationships between the Conners' CPT with the WISC-III were also quite weak and few of the values (14%) were significant. The only significant correlations found between CPT and the WISC-III were for the CPT Attentiveness scores with WISC-III Freedom from Distractibility Scale ($r = -.25$); the WISC-III PIQ with Hits ($r = -.25$) and Omissions ($r = -.25$); and the WISC-III Processing Speed with Hits ($r = -.24$) and Omissions ($r = -.24$).

Corrected correlations between the CAS, Conners' Rating, and CPT scales are also provided in Table 4. The CAS scores, like the WISC-III, did not correlate significantly with any of the Conners' Parent Rating Scale *T*-scores. Only the Cognitive Problems/Inattention scores from Conners' Teacher Rating Scale correlated significantly with the CAS Simultaneous, Successive, and Full Scales although the relationships were weak (all less than .34). The

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Table 4
Corrected Pearson correlations between Conners' Behavior Rating Scales and measures of intelligence ($n = 117$)

	WISC-III							CAS				
	VIQ	PIQ	VC	PO	FD	PS	FSIQ	PL	SIM	ATT	SUC	FS
Conners' Parent Rating Scale												
Oppositional	−.04	.02	−.01	.01	−.06	.02	−.04	.11	.00	.11	.08	.09
Cognitive problems/Inattention	.14	−.11	−.06	−.12	−.21	−.07	−.15	−.04	−.24	−.03	−.03	−.13
Anxious/Shy	−.03	−.02	−.01	.01	−.01	−.13	−.03	−.09	.02	−.06	−.01	−.06
Global Index Total	−.11	−.09	−.06	−.12	−.09	.04	−.14	.15	−.09	.13	.05	.06
DSM-IV Total	−.09	−.07	−.04	−.11	−.12	.03	−.11	.12	−.10	.09	.03	.03
Conners' Teacher Rating Scale												
Oppositional	.01	−.08	.05	−.05	−.16	−.03	−.02	−.12	.00	−.06	.02	−.07
Cognitive problems/Inattention	**−.31**	−.23	**−.29**	−.23	**−.35**	−.19	**−.31**	−.22	**−.26**	−.23	**−.26**	**−.34**
Anxious/Shy	−.01	−.01	−.04	.02	−.01	−.17	−.02	.03	.21	−.19	−.03	−.02
Global Index Total	−.10	−.10	−.09	−.10	−.22	−.01	−.16	.01	.00	−.04	−.15	−.09
DSM-IV Total	−.15	−.13	−.15	−.13	−.18	−.02	−.20	.03	−.13	.05	−.06	−.01
Conners' CPT												
Attentiveness	−.04	−.14	−.01	−.11	**−.25**	−.19	−.10	**−.26**	−.23	−.18	−.18	**−.33**
Risk-taking	−.03	−.10	−.01	−.07	−.07	−.15	−.05	−.16	−.10	−.08	−.04	.14
Hits	−.05	**−.25**	−.01	−.21	−.18	**−.24**	−.13	−.28	**−.28**	−.20	−.10	**−.31**
Omissions	−.05	**−.25**	−.01	−.21	−.18	**−.24**	−.13	−.28	−.28	−.20	−.10	**−.31**
Commissions	.07	.02	.06	.02	−.11	−.04	.01	−.01	−.07	−.06	−.13	−.13

Note: Bolded values: $P < .01$. VIQ, Verbal IQ score; PIQ, Performance IQ score; VC, Verbal Comprehension Index score; PO, Perceptual Organizational Index score; FD, Freedom from Distractibility score; PS, Processing Speed score; FSIQ, Full Scale IQ score; PL, Planning score; SIM, Simultaneous score; ATT, Attention score; SUC, Successive Score; FS, Full Scale score.

relationships between the Conners' CPT with the CAS were negative, weak and only about a third of the values were significant. Significant correlations were found between the CPT Attentiveness scores with the CAS Full Scale ($r = -.33$) and Planning Scale ($r = -.26$); the CPT Hits scores with CAS Planning ($r = -.28$), CAS Simultaneous Scales ($r = -.28$), and CAS Full Scale ($r = -.31$); and the CPT Omissions scores with CAS Planning ($r = -.28$), CAS Simultaneous Scales ($r = -.28$), and CAS Full Scale ($r = -.31$). About two times as many significant correlations were found between the CAS and the Conners' CPT than the WISC-III and Conners' CPT.

3. Discussion

The purpose of this study was to examine the relationships among tests of ability, attention, and behavior for a sample of children with attention, emotional and behavioral problems. The tests included are those often used to evaluate levels of functioning of children with learning problems, but particularly those with ADHD. Surprisingly, there were few significant relationships detected for this sample. Correlations from Conners' Behavior Rating Scales and Conners' Continuous Performance Test were uniformly low. Importantly, while it is reasonable to anticipate that measures of Cognitive Problems/Inattention (Conners' Behavior Rating Scales) and Attentiveness on the Conners' Continuous Performance Test should be related, the

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correlations were very small. These results suggest that the rating scale information and CPT results are likely to be inconsistent and therefore pose particular difficulties for practitioners striving to make an accurate diagnosis based on a convergence of data from tests that would be expected to yield similar results.

Although it could be anticipated that Index scores from the WISC-III might show some correspondence to Conners' Rating Scales, only low correlations were found. Surprisingly, none of the WISC-III standard scores correlated significantly with any of the Conners' Parent Rating Scales. With the exception of the modest correlations between the Cognitive Problems/Inattention Scale of the Conners' Teacher Rating Scale, the WISC-III correlations with this rating scale again were very small. Similar results were found for the CAS, suggesting that practitioners should not expect consistent findings across these instruments. Although some relationships were found, they were uniformly low even if statistically significant. These results beg the question why these measures are so poorly related, particularly Conners' CPT and Conners' Parent and Teacher Rating Scales. Although these tests are often used as part of a battery of tests to assess and diagnose children with attention problems, few similarities in scores were found. If CPT and rating scales produced by the same author (Conners) do not correspond to one another what is the practitioner to do? Similarly, although some might expect the Attention scale on the CAS to be related to the CPT, none of the Attention scale correlations were significant. Additionally, even though the Planning (and Simultaneous) scores were significantly correlated with most of the CPT variables the magnitude of the correlation was not high.

The larger question raised by the results of this study is "How should practitioners decipher all this conflicting information?" Should they follow Mealer, Morgan, and Luscomb (1996) who suggest that these measures should not be used for the diagnosis of ADHD but rather as a supplement to diagnosis? If so, how would inconsistent data supplement a diagnosis? These data suggest that it is wise to heed the advice offered by Anastopoulos, Spisto, and Maher (1993) that practitioners do not rely on WISC-III factors in ruling in or out the diagnosis of ADHD. Does that statement apply the CPT, CAS, and Conners' Rating Scales also? How do we make sense of all this inconsistent information?

These findings provide additional data, making apparent the need for more research on how ADHD should be measured *and* conceptualized (Rucklidge & Tannock, 2002). The DSM-III-R, -IV and -IV-TR have and are used as the gold standard for the definition and diagnosis of ADHD, yet they have limitations (August & Garfinkel, 1993; Baumgaertel, Wolraich, & Dietrich, 1995; Cantwell & Baker, 1988). Further, the diagnosis of ADHD is behaviorally anchored yet most researchers describe ADHD as a failure of self-regulation that leads to the behaviors noted in DSM-IV. While behavioral operationalization is important, assessment should include both the behavioral symptoms and examination of the possibility of an underlying cognitive deficit.

We suggest that researchers begin to look more closely at ADHD symptoms and accompanying cognitive impairment consistent with a theoretical definition of a failure in self-regulation as suggested by Barkley (1997) and Goldstein and Goldstein (1998). Studies have supported a cognitive pattern of weaknesses in executive and related functions in ADHD (Adams & Snowling, 2001; Barkley, Grodzinsky, & DuPaul, 1992; Lawrence et al., 2002; Naglieri et al., 2002; Pennington & Ozonoff, 1996; Pitcher, Piek & Hay, 2003).

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Given the inconsistency in the definition, diagnosis, and methods used to assess ADHD, we propose that researchers should examine the utility of defining the disability on the basis of two dimensions. First, behavioral manifestations as described by the DSM-IV and second, evidence of some cognitive deficit that underlie the failure of self-regulation prototypical of ADHD. For example, researchers should examine if the child with the Combined Type of ADHD possessing all the behavioral characteristics *and* a cognitive failure related to self-regulation is different from the child who has all the behavioral characteristics but does *not* have a cognitive failure related to self-regulation. We suggest that the cognitive component of self-regulation must be measured using well-standardized, reliable, and valid tests that are administered directly to the child, including the assessment of a range of issues. Differences between cognitive and behavioral dimensions may hold diagnostic and treatment utility as Gordon (1990) hypothesized.

The constellation of symptoms that define ADHD revolve around a basic failure to self regulate and the resulting problems with inhibition and delay of gratification. This regulation failure leads to impulsive responding and with impulsivity, minimal consideration of alternative solutions to a problem. The child does not evaluate the possible options and choose the best response to achieve the goal, but instead, responds quickly with little reflection or consideration of the implications of his or her choices. Moreover, if the goal is not attained the child with ADHD finds it difficult to change the response even when confronted with new information. This type of self-control problem fits into at least one theory of cognitive processing.

A failure of self-regulation or self-control has all the ingredients of the cognitive process of Planning as described by Ashman and Conway (1997), Das, Naglieri, and Kirby (1994), Goldberg (2001), and Naglieri (1999). These authors take a view of cognitive processing based on the neuropsychological work of Luria (1966, 1973, 1980) and they include these behaviors under the broad category of Planning. Planning, a frontal lobe function, involves initiation of behavior, formulation of a goal, development of a strategy or plan, execution of the plan, determination if the goal has been accomplished, and revision of the plan as needed (Goldberg, 2001). Similarly, Naglieri (1999) states: "Planning processes provide cognitive control, utilization of processes and knowledge, internationality, and self-regulation to achieve a desired goal" (p. 11). Thus, there is convergence of the theoretical conceptualization of Planning provided above with the definition of ADHD as a failure of self-regulation (Barkley, 1997) as well as the behaviors included in the DSM-IV. It is logical, therefore, to suggest that researchers should continue to evaluate how assessment of ADHD could include assessment of the *cognitive* attributes associated with ADHD as well as the behaviors typical of the disorder (for review see Goldstein & Goldstein, 1998). The current study did not provide an opportunity to test this suggestion because such an investigation would require carefully matched groups and extensive evaluation of instrument differentiation of children with ADHD, non-disabled, and children with other exceptionalities (e.g., Anxiety Disorders, Conduct Disorders, etc.). This is a prime area for future research.

Researchers should also examine if groups of children who have both the behavioral and cognitive dimensions of ADHD differ from those who only have the behavioral manifestations and in particular, their differential response to intervention. It will be important to determine if there are specific interventions that are best for children with cognitively versus behav-

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iorally based self-regulation problems characteristic of ADHD. This distinction could make a difference in educational planning.

There is also evidence to suggest that children with self-regulation problems differ in their response to academic interventions designed to teach them to be more self-controlled. Naglieri and Gottling (1995, 1997), Naglieri and Johnson (2000), and Haddad et al. (2003) found that children with and without planning deficits responded differently to the same academic instruction. Those with low Planning scores on the CAS benefited considerably more than children with adequate Planning scores when given an instruction that helped them learn to be more self-regulated. Researchers should study if children who have behavioral and cognitive evidence of ADHD would likely benefit differently when taught to be more strategic than those who have the behavioral manifestations of ADHD without the cognitive deficit in planning.

Researchers should also study the Inattentive Type of ADHD to determine if these children are especially low in Attention without the Planning (self-regulation) problems discussed above. It will be especially important to determine if children with a cognitive deficit in Attention will benefit from an intervention suggested by Kirby and Williams (1991) and described by Naglieri and Pickering (2003). This program is designed to help a child become aware of the impact of the attention problem and provide compensatory strategies for overcoming the problems they experience. Additionally, the differences between children with an attention versus planning deficits should be examined further.

The findings presented here should be viewed in relation to the limitations of this investigation. For example, the sample is restricted on the basis of socioeconomic status and geographic region and the extent to which these children represent a larger body of those referred for ADHD evaluations is not determined. Despite these limitations, the results of this study raise many cautions about the current state of the art of assessment of children with ADHD and a number of important research questions that must be addressed. We urge practitioners to be knowledgeable that current methods of assessment for ADHD will involve information from different sources that are likely to be inconsistent. In such a situation, a conservative approach to making the diagnosis should be adopted. Erring on the side of sensitivity or diagnosis will likely lead to over identification and potential failure to appropriately treat those most in need.

Acknowledgment

Preparation of this manuscript was supported in part by Grant R215K010121 from the U.S. Department of Education.

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