Screening measures for attention deficit hyperactivity disorder

Heather Foley

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Screening Measures for Attention Deficit Hyperactivity Disorder

Master’s Thesis

Submitted to the Faculty
Of the School Psychology Program
College of Liberal Arts
ROCHESTER INSTITUTE OF TECHNOLOGY

By
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In Partial Fulfillment of the Requirements
for the Degree of
Master of Science

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Abstract

While performance-based measures have not typically been used by school psychologists in Attention Deficit Hyperactivity Disorder (ADHD) assessment, a growing body of evidence suggests that neuropsychological measures may provide valuable diagnostic information as part of a comprehensive evaluation of the disorder. The utility of two neuropsychological measures for use as screening measures in assessing ADHD was examined in the present study. The performance of 29 children with ADHD was compared with that of 96 controls on alternate forms of Trails B and a Figure Cancellation Task. Although a developmental trend was found suggesting increased performance with age, time to complete both tasks was comparable for ADHD and control groups. However, children with ADHD obtained a lower total Figure Cancellation Task score, and more errors on Trails B. These results suggest that accuracy, rather than time, is the best predictor of attentional problems in children.
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# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title page</td>
<td>i</td>
</tr>
<tr>
<td>Abstract</td>
<td>ii</td>
</tr>
<tr>
<td>Copyright</td>
<td>iii</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>iv</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>v</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>1</td>
</tr>
<tr>
<td>Historical Overview</td>
<td>2</td>
</tr>
<tr>
<td>Traditional ADHD Assessment Techniques</td>
<td>4</td>
</tr>
<tr>
<td>Differential Diagnosis</td>
<td>7</td>
</tr>
<tr>
<td>Neuropsychological Assessment of ADHD</td>
<td>9</td>
</tr>
<tr>
<td>Method</td>
<td>13</td>
</tr>
<tr>
<td>Subjects</td>
<td>13</td>
</tr>
<tr>
<td>Procedure</td>
<td>14</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>16</td>
</tr>
<tr>
<td>Results</td>
<td>18</td>
</tr>
<tr>
<td>Descriptive Statistics</td>
<td>18</td>
</tr>
<tr>
<td>Table 1: Descriptive Statistics</td>
<td>18</td>
</tr>
<tr>
<td>Zero-order Correlation Analysis</td>
<td>19</td>
</tr>
<tr>
<td>Table 2: Zero-order Correlation Matrix</td>
<td>19</td>
</tr>
<tr>
<td>Backward Elimination Regression Analysis (Cancellation Task)</td>
<td>20</td>
</tr>
<tr>
<td>Figure 1: Cancellation Sum (ADHD vs. Controls)</td>
<td>21</td>
</tr>
</tbody>
</table>
Table 3: Backward Elimination Regression for Cancellation Task ..... 22

Backward Elimination Regression Analysis (Trails B) ........................................ 22

Figure 2: Cancellation Time (Both groups) ....................................................... 23

Table 4: Backward Elimination Regression for Trails B ................................. 24

Figure 3: Trails B Errors (ADHD vs. Controls) ............................................... 25

Figure 4: Trails B Time (Both groups) ............................................................. 26

Discussion ........................................................................................................... 24

Limitations ......................................................................................................... 30

Conclusion ......................................................................................................... 30

References .......................................................................................................... 32

Appendix A ......................................................................................................... 39

Appendix B ......................................................................................................... 41

Appendix C ......................................................................................................... 43
Introduction

Statement of the Problem

Attention Deficit Hyperactivity Disorder (ADHD) is manifested in childhood. The disorder is characterized by developmentally inappropriate degrees of attention, motor activity, and impulse control. Children with characteristics suggestive of ADHD constitute a high percentage of all referrals to childhood outpatient mental health clinics (Barkley, 1988). Although estimates vary according to the stringency of the diagnostic criteria used (Ross & Ross, 1982) and the level of agreement among those involved in the assessment process (Lambert, Sandoval, & Sassone, 1978), approximately 3% of school-age children experience this disorder (American Psychiatric Association, 1994). The prevalence of this disorder in combination with the young age of onset (before seven years of age) necessitates the involvement of school personnel, especially school psychologists, who must identify and evaluate children with attention problems.

Despite the frequency with which school personnel encounter such attention problems, standardized batteries for assessing children with ADHD have not been developed (Rosenberg & Beck, 1986). The question remains whether assessment of the disorder should entail the use of standardized instruments with adequate psychometric properties, adequate norms, and objective scoring criteria. For practitioners involved in the assessment of ADHD, the decision to use certain instruments is often based on constraints of time, money, and perhaps a tendency to maintain the status quo. As school psychologists do not generally have the resources to conduct comprehensive evaluations of attention problems, inferences must be made regarding attention, memory, and executive function. The use of psychometrically sound screening measures would be
practical and beneficial for determining which children may need further evaluation for the disorder.

**Historical Overview**

When problems with attention and levels of motor activity were first recognized in children in the late 1800s and early 1900s, implicit biological impairments rather than environmental causes were implicated (Barkley, 1981). In the 1940s, some researchers maintained that all children who displayed impulsive and overactive behavior had minor brain damage, whether or not there was any medical evidence for such a determination (Fletcher, Shaywitz, & Shaywitz, 1994). In 1962, the National Institute of Neurological Diseases defined *Minimal Brain Dysfunction* (MBD) as a disorder of learning and behavior in children with average intelligence and no obvious explanation for the disorder (Fletcher et al. 1994). However, as early studies were unable to support findings of consistent neurological dysfunction in hyperactive children, the term MBD fell out of favor. MBD was replaced by terms that underscored what was thought to be the principal characteristic of the disorder: elevated levels of motor activity (Stewart, Pitts, Craig & Dieruf, 1966). Children with these characteristics were deemed to have “Hyperactive Child Syndrome,” or “Hyperkinetic Reaction of Childhood” (Stewart et al. 1966). Primary deficits in attention as opposed to hyperactivity, were forwarded in 1971, particularly emphasizing this as a disorder of cognition (Fletcher et al., 1994). In 1980, the classification system in the third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III) identified deficits in attentional processes according to two subtypes: Attention Deficit Disorder with Hyperactivity, and Attention Deficit Disorder Without Hyperactivity. The latter referred to children who demonstrated significant
problems with inattention, but lacked the overactivity component. When the DSM-III was revised in 1987 (DSM-III-R), it maintained the separate classification for ADHD, but eliminated the distinction among the three dimensions employed in the DSM-III. According to the DSM-III-R definition, eight or more of 14 symptoms reflecting difficulties in attention, impulsivity, or hyperactivity, with onset before the age of seven, was sufficient for a diagnosis of ADHD.

In 1994, a number of changes were made to the DSM-IV diagnostic criteria for ADHD (American Psychiatric Association, 1994). Because several studies subjecting the DSM-III-R symptom list to a principal components analysis found that there are indeed two separate factors, the DSM-IV definition of ADHD provides two separate symptom lists for children with attentional problems presenting with or without hyperactivity. According to the criteria, a child diagnosed with ADHD, predominantly Inattentive Type, must exhibit at least six of nine symptoms of inattention, with no more than three symptoms associated with hyperactive and impulsive behaviors; and for ADHD, predominantly Hyperactive/Impulsive Type to be diagnosed, six or more symptoms of hyperactivity-impulsivity, but fewer than six symptoms of inattention must exist. In addition, ADHD - Combined Type is diagnosed when a child displays six or more symptoms pertaining to inattention, and six or more symptoms pertaining to hyperactivity and impulsivity. In addition, to be diagnosed with any of the subtypes, the symptoms must have originated before seven years of age, have persisted for at least a six month period, be present in two or more situations (e.g., home, school), have resulted in significant impairment in social, academic, or occupational functioning, and must not be due to any other mental disorder (American Psychiatric Association, 1994).
Considering the changing conceptualization of ADHD over the past decades and the recent changes in definition, it is not surprising that confusion exists among professionals as to the proper assessment and diagnostic procedures for determining whether or not a child manifests ADHD (Barkley, 1990). The vast majority of research argues for a comprehensive clinical assessment of children with attention problems, relying on several informants, across multiple settings, and using a variety of instruments (Barkley, 1991). Although most practitioners do indeed rely on a battery approach (Rosenberg & Beck, 1986), many techniques typically used in the assessment of ADHD have limited utility in the diagnostic evaluation of the disorder (Dupaul & Stoner, 1994).

**Traditional ADHD Assessment**

Due to the emphasis on elevated levels of activity, diagnosis of ADHD has relied heavily upon behavior rating scales and observations of the child’s behavior at home or in school (Welton, 1990). In addition, because rating scales have the advantage of being easy and inexpensive to use, they are often the instrument of choice among practitioners (Barkley, 1991). Although research suggests that more than half of practitioners use behavior rating scales to assess hyperactivity in children, less than 25% of clinical psychologists and 20% of school psychologists sampled indicated a belief that rating scales are the best predictors of childhood hyperactivity (Rosenberg & Beck, 1986). Furthermore, though rating scales on their own cannot diagnose or rule out attentional problems (Blondis, Accardo, & Snow, 1989), this practice is not uncommon. Behavior rating scales do not directly measure a child’s performance, but rather indirectly measure the informant’s *appraisal* of the child’s performance (Blondis et al., 1989). It is therefore necessary that the informant be able to clearly read and understand the questions being
asked. However, as 30% of adults in the United States read at or below a fifth grade level, parental reading ability is an important factor that may be overlooked when rating scales are used in assessment. (Martin, Hooper, & Snow, 1986).

Self-report questionnaires of attention problems must be interpreted with caution. As children with disruptive behavior disorders are typically poor reporters of their own behavior, the reliability and validity of results are questionable (Landau, Milich, & Widiger, 1991). In addition, because many self-report measures do not have separate factors or subscales specific to ADHD symptoms, the utility of the information is quite limited (DuPaul & Stoner, 1994).

Barkley (1981) outlined several requirements for accurate behavior rating scales, and maintained that many do not meet these requirements. Most behavior rating scales lack construct validity, as they have not been adequately correlated with other objective measures of hyperactivity, and many lack adequate normative data and interrater reliability as well (Barkley, 1990). An additional concern with rating scales lies in their susceptibility to rater bias (Halperin, 1991), whereby a child is viewed by the rater in either a wholly positive or negative light. Children who are disruptive in class tend to be rated as inattentive and overactive by teachers, even if they are not (Schachar, Sandberg, Rutter & 1986). Rating scales tend to produce an overall assessment of disturbance, but are not effective in the assessment of a specific symptom, such as inattention (Halperin, 1991). However, when used as part of a comprehensive, multimethod, multimodal assessment procedure, behavior rating scales can be useful in screening for problems related to ADHD, and for obtaining standardized teacher impressions for initial assessment and treatment evaluation (Atkins & Pelham, 1991). The Child Attention Profile (Barkley,
Screening Measures for ADHD

1990) is a psychometrically sound rating scale (Barkley, 1990) found to be a convenient means of assessing the presence or degree of inattention and overactivity in children.

The clinical interview is another diagnostic procedure widely used by both physicians and practitioners, and can easily be conducted with parents, teachers, and the children themselves. According to Rosenberg and Beck (1986), practitioners clearly indicate interviews as their preferred method of assessment. Primary care physicians have traditionally used information supplied by the parents and/or teachers as their principal sources of information as well, even though there is general agreement that parents may not always be the best informants regarding the symptoms of ADHD (Copeland, Wolraich, Lindgren, Milich, & Woolson, 1987). Despite the widespread use of these measures, interviews rarely include normative information, standardized procedures, and generally have low interdiagnostic agreement (Schaughency & Rothlind, 1991). Even structured interviews, which permit diagnostic assessment in accordance with systematic, specific criteria for disorders and standardized methods for obtaining information (Schaughency & Rothlind, 1991), show low to moderate test-retest reliabilities (Velhurst & Van der Ende, 1991).

Because of the relatively high incidence of learning disabilities among children with ADHD (Frick & Lahey, 1991), a comprehensive evaluation will likely include well-standardized measures of intelligence and academic achievement. The Wechsler Intelligence Scale for Children - III (WISC-III; Wechsler, 1990), is one of the most widely used measures of children's intellectual abilities (Searight, Nahlik & Campbell, 1995). Before the WISC-III edition, the WISC-R was composed of 12 specific tasks, with the Arithmetic, Digit Span, and Coding subtests termed *Freedom from Distractibility*. This
factor has been used as a measure of distractibility (Sattler, 1992), because increased focused attention and enhanced memory and arithmetic performance results form stimulant treatment (Kaufman, 1980). Although the FD factor correlates poorly with other tests of attention or teacher ratings of inattention, Hale, Rosenberg, Hoeppner, Gaither, and Kavanagh (1997) found FD to be predictive of teacher reported attention problems, accounting for 19% of the variance in scores. Because the WISC-R FD factor may assess other neuropsychological functions, such as short term memory, facility with numbers, perceptual-motor speed, visual-spatial skills, and arithmetic calculation (Barkley, 1994), its ability to predict ADHD may be limited. However, the WISC-III FD and Processing Speed factors (Coding and the new Symbol Search subtest) may effectively discriminate children with attention problems from controls (Kaufman, 1994).

Differential Diagnosis

Practitioners must also consider whether the primary symptoms of inattention and hyperactivity are specific to ADHD. Not every child who is easily distracted, frequently calls out in class, or has difficulties in memory and organization, has ADHD. For example, symptoms of inattention are common in children with low intellectual functioning. Children who are seemingly impulsive may be demonstrating oppositional behaviors suggestive of a Conduct Disorder (CD) (American Psychological Association, 1994). Further, attentional problems are often evident in other psychiatric diagnoses, such as anxiety disorders, depression, and Tourette’s syndrome, and medical conditions, such as fragile X syndrome (Barkley, 1991). Because many studies have failed to distinguish between the primary symptoms of ADHD and co-occurring problems, some of the problems once thought to be accounted for by ADHD are actually more related to the co-
occurring problems (Hinshaw, 1987). Because children with ADHD often have other problems in addition to their primary symptoms, differential diagnosis becomes a complicated, but nonetheless crucial component in the assessment of ADHD.

One of the associated problems common in children with ADHD is poor school performance (Barkley, 1991; Frick & Lahey, 1991), suggesting the presence of possible learning disabilities (Grodzinsky & DuPaul, 1992). Although estimates vary, most children with ADHD do not achieve to the level predicted by their age and general intelligence (Frick & Lahey, 1991). While it is often unclear whether it is the symptoms of ADHD that interfere with learning, whether learning problems result in more inattentive and distractible behavior, or whether a biological factor could account for both (Frick & Lahey, 1991), assessment practices must discriminate between the disorders for intervention to be successful.

In addition to problems of academic performance, children with ADHD tend to experience considerable difficulties in their social relationships (Frick & Lahey, 1991). These difficulties are often related to inattentive, disruptive, and impulsive behaviors, including inappropriate attempts to join peer activities (e.g., interrupting games in progress), poor conversational behaviors (e.g., frequent interruptions), and use of aggression to solve interpersonal conflicts (Guevremont, 1990). Aggression, including defiance or noncompliance with authority figures, poor temper control, argumentativeness, and verbal hostility (Loney & Milich, 1982), is common in children with ADHD (Frick & Lahey, 1991), and may be indicative of Oppositional Defiant Disorder (ODD) or Conduct Disorder (American Psychiatric Association, 1994). Children with ADHD only, CD only, and ADHD + CD differ significantly from controls on many measures, but not from each
other (Schaughency & Rothlind, 1991). The presence of conduct problems increases the likelihood that a child with another disorder might be incorrectly diagnosed with ADHD (Schaughency & Rothlind, 1991). Furthermore, because many of the questions found on behavior rating scales contain items which overlap with symptoms of other disorders (e.g. noncompliance and aggression items on a hyperactivity scale), these scales may not result in accurate assessment of ADHD. It is clear that the primary symptoms of ADHD are not specific to the disorder, and may occur in conjunction with numerous other disorders.

Neuropsychological Assessment of ADHD

As the name of the disorder indicates, a primary characteristic of ADHD is a disturbance of attention, and most of the brain is involved in the attention processes (Colby, 1991; Mirsky, 1994). Although there seems to be general agreement that the primary symptoms of ADHD include inattention, hyperactivity, and excessive motor activity, the underlying neuroanatomical structures and neurophysiological mechanisms responsible for these disturbances remain unclear (Trites & Laprade, 1983). Following Mattes’ (1980) observations regarding the similarities between children with ADHD and adults with frontal lobe abnormalities, research increasingly began to focus on the role that frontal lobe dysfunction plays in the disorder (Hoeppner, Hale, Bradley, Byrns, Coury, & Trommer, 1997). As mechanisms in the prefrontal regions of the frontal lobes are responsible for regulating motor output and the organization of behavior (Hynd, Hern, Voeller, & Marshall, 1991), damage in these areas results in disturbances in the regulation of goal-directed activity and an increase in impulsive behavior (Luria, 1973). Thus, as research implicating the frontal lobes as the cause of ADHD grew, so did the interest in neuropsychological assessment of the disorder.
As neuropsychological studies have shown children with ADHD to manifest frontal lobe abnormalities (Hynd et al. 1991), the neuropsychological assessment of the disorder has focused on the use of tests designed specifically to measure the primary functions of the frontal lobes, including mental tracking, self-regulation, motor performance (Johnston, 1986), and sustained attention (Kratchowill, 1982). Although no standard battery of neuropsychological tests exists specifically for the identification of ADHD, a review of the literature suggests there are a number of instruments which demonstrate utility in this approach to assessing the disorder.

Continuous Performance Tests (CPT) are the most widely used instruments for assessing sustained attention (Barkley, 1991). Although CPTs vary in format, most require responding to target stimuli while inhibiting responses to non-targets. Although CPTs are expensive and time consuming, Barkley and Grodzinsky (1994) evaluated the adequacy of CPTs for discriminating children with ADHD from normal controls and children with learning disabilities, and found these measures to be among the most reliable and predictive of group membership. These findings provided further support for previous results (Barkley, 1991; Grodzinsky & Diamond, 1994). Apart from the CPT, the Wisconsin Card Sort Test (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993) has been one of the most commonly used neuropsychological measures for research on ADHD (Barkley & Grodzinsky, 1994). This instrument measures cognitive flexibility, the ability to benefit from feedback, shift attention, and shift mental sets, abilities found to be deficient in children with ADHD. The WCST consists of 128 cards containing sets of geometric designs that vary according to color, shape, form, and number. The participant is given four cards and is asked to sort the remaining deck of cards using feedback provided
by the examiner. Numerous studies (Boucugnani & Jones, 1989; Chelune et al. 1986; Gorenstein, Mammato, & Sandy, 1989) have found that children with ADHD differ from normal controls on one or more of the WCST dependent measures: perseverative responses, perseverative errors, and the number of categories correctly achieved. In fact, Chelune et al. (1986) found that these variables were able to correctly classify 85.4% of the children, and thus suggest that children with ADHD may have frontal lobe dysfunction resulting in disregulation of attention and executive function.

Another common method for assessing attention is The Stroop Color-Word Interference Test (Stroop, 1978). Described as a task of cognitive flexibility, selective attention, and inhibition, the Stroop first requires the participant to read a list of color names in black ink as quickly as possible, then to name colored Xs of ink as quickly as possible, and finally to name the color of ink in which a word is printed, as rapidly as possible. The latter is termed the “interference” test because the words are color names printed in ink of a different color, and thus requires an ability to adapt to a novel, conflicting stimulus, while inhibiting the automatic response of reading the word (Barkley, 1990). In a review of studies of children with ADHD, Barkley, Grodzinsky, and DuPaul, (1992) reported that five out of six studies found children with ADHD to be more impaired on this test, particularly the interference portion, relative to control children.

The Trail Making Test Part B (Trails B) of the Halstead-Reitan Neuropsychological Test Battery (HRNTB), has been regarded as one of the best measures of general brain functions (Reitan & Wolfson, 1985). In the children’s version, the measure consists of eight circles numbered one to eight and seven circles with the letters A-G, and requires the child to connect the circles as quickly as possible, alternating
between numbers and letters. Thus, this test requires visual scanning, attention and concentration, mental flexibility, and graphomotor speed. Both Trails A and B have been used in several studies of children with ADHD, with several reporting one or both of the tests to be sensitive measures of ADHD deficits (Gorenstein, Mammato, & Sandy, 1989; Grodzinsky & Diamond, 1992; Homatidis & Konstantareous, 1981; Welton, 1990); yet negative results have also been reported (Barkley et al. 1992).

Cancellation tasks typically consist of rows of symbols, such as letters or geometric shapes, and require the participant to scan the rows searching for the correct target symbol, which he or she crosses out, or “cancels,” with a pencil. These tasks measure visual scanning, graphomotor speed, and selective attention, as the participant must select the target stimulus while ignoring all other stimuli. Support for the use of this instrument comes primarily from the frontal lobe literature. Patients with frontal lobe lesions make more errors and perform more slowly on cancellation tasks than controls (Richer, Decary, Lapierre, & Roulou, 1993). Additional support for these measures can be derived from the assumption that successful performance requires many abilities thought to be deficient in children with ADHD. Aman and Turbott (1986) found that a cancellation task discriminated between hyperactive and control participants; and using a letter cancellation task, Voeller and Heilman (1988) found that boys with attention disorders made more errors of omission than a group of controls.

As research regarding the assessment of ADHD has suggested, there is no standard practice for the comprehensive evaluation of the disorder. It seems likely that this may be due to a combination of factors, including time constraints of clinicians and school psychologists, contradictory claims regarding the best assessment approach,
unfamiliarity with performance-based assessment tools for the disorder, and perhaps a fear of accepting neuropsychological explanations of academic or behavioral difficulties due to an implication that a problem with its roots in biology may reduce the likelihood of intervention (Welton, 1990). In fact, should further research support the use of the Trails B and cancellation tasks in distinguishing ADHD and control populations, these measures would serve as a convenient and economical addition to an ADHD assessment battery. In order to advance our understanding of the disorder and allow for more accurate and convenient assessment of ADHD, the present study examined the utility of alternate forms of the Trails B and Figure Cancellation Test for use in ADHD screening and assessment. It was hypothesized that performance of children with ADHD on these measures relative to the performance of normal controls, would not predict the number correct on the Figure Cancellation Task and the number of errors on Trails B. Rejection of this null hypothesis would provide further support for the inclusion of these cognitive measures in a comprehensive battery approach for the assessment of ADHD. For time to complete the tasks, it was predicted that performance would not increase with age (e.g. decreased time).

Method

Subjects

The present study included 125 students from two school districts outside of a medium-sized city in the Northeast United States. Sixty-five students from a rural district of approximately 1200 students, and 60 students from a suburban district of approximately 1200 students participated in the study. Subjects included an approximately equal number of male \( (n = 57) \) and female students \( (n = 68) \) from the first through sixth grades, who
ranged in age from 6 years, four months to 12 years, seven months ($M = 110.6$ months; $SD = 22.2$; approximately nine years, three months old). The population of both districts was homogeneous and consisted of predominantly Caucasian, lower to middle class children. Subjects were drawn from regular education programs, and were classified into two groups on the basis of a previous medical diagnosis of an attentional disorder, and scores on the Child Attention Profile (CAP; Appendix A), a rating scale found to reliably discriminate children with ADHD, predominantly Inattentive Type and ADHD predominantly Impulsive/Hyperactive Type (Barkley, 1991). Those children with a previous ADHD medical diagnosis and those found to be within the clinical range ($T > 93\%$) on the CAP comprised the ADHD sample, though children with ADHD and a comorbid disability were excluded from the sample. The remainder comprised the normative group. The ADHD sample consisted of a fairly equal number of males ($n = 19$) and females ($n = 10$). The study required a quasi-experimental design, which is typical of social science research. Recruitment of subjects could not include a random sampling of all available students in participant schools. Only those students whose classroom teachers agreed to participate in the study were given informed consent forms, and only those subjects with verified informed consent were included in the study.

Procedure

A cover letter explaining the research project and an IRB-approved informed consent form were given to all children in the classrooms of teachers who agreed to participate in the study. Following the distribution and return of informed consent forms from parents, a population list was generated by alphabetical order within each class. For each subject included in the sample, a graduate student contacted the classroom teacher to
schedule testing. When subjects were picked up at their classrooms for testing, the
classroom teacher was given a CAP form with instructions to complete it at his or her
earliest convenience, and return it directly to the examiner. Subjects were tested in a quiet
room for approximately 15 minutes by one of several graduate students. All examiners had
been trained and supervised by the First Thesis Reader.

Upon meeting with the subject, the examiner spent a few minutes establishing
rapport. Subjects were asked several questions designed to assess personal orientation and
academic achievement status. The last question assessed whether the children were on
medication, and if this was the case, when they took their last dose. This information was
corroborated in the informed consent form.

To control for order effects, counterbalancing was utilized; the first task
administered was alternate form #1 or #4 of the Figure Cancellation Task. Upon
completion of the first Cancellation Task trial, the alternate form of the first Trails B task
was administered (Trial #1 or #4). For each of the Trails B tasks, the participant first
completed a sample to ensure understanding of the task. If the participant completed the
sample correctly, Part B was then administered. If a mistake was made, it was pointed
out, and the participant proceeded from the point of error. The sample was administered
until success was achieved. The four alternate forms of each measure were administered
alternately, until all eight forms had been completed. Upon completion of the testing, the
participant was asked to select a free toy (approximately $1 value) as a reward for his/her
effort. Following study results, parents were offered a brief report of their child’s
performance, including recommendations for further evaluation and/or classroom
accommodations.
Instrumentation

Four alternate forms of Trails B of the Halstead-Reitan Neuropsychological Test Battery For Children (HRNTB) (Reitan & Wolfson, 1985; Hale & Vreeland, 1996; Appendix B) and the Figure Cancellation Task (Hale & Vreeland, 1996; Appendix C) were administered to all subjects. Teachers completed the CAP rating scale for each subject based on his or her behavior over the past week.

*Trails B.* (Reitan & Wolfson, 1985) is a test that requires visual scanning, attention and concentration, mental flexibility, shifting of cognitive sets, and graphomotor speed. Subjects are required to draw pencil lines to connect 15 randomly arranged encircled numbers and letters in alternating order (i.e., 1-A, 2-B). To reduce the possibility of practice effects with use over repeated trials, Hale & Vreeland (1996) developed alternate forms of Trails B for use in medication trials. The alternate forms consist of a mirror form of the original, a new form systematically constructed, and its mirror. Normative data on the original form are offered by age level from ages 6-15 (Spreen & Strauss, 1991). Spreen and Strauss (1991) reviewed reliability data for the adult version of Trails B, and reported median correlation coefficients to be \( r = .67 \). As comparable studies have yet to be conducted with children, conclusions about Trails B reliability are based on the range/standard deviation ratios. From these ratios, it appears that Trails B may be less reliable for younger children, especially below the age of eight, probably due to poor letter and number automaticity. The adult version of Trails B (Reitan & Wolfson, 1985) also has adequate test-retest reliability (.87) and is more widely researched than the children’s version.
The Figure Cancellation Task. (Hale & Vreeland, 1996) is a task designed to assess sustained attention, visual scanning, visual presentation of abstract stimuli, and graphomotor speed. It requires participants to use a pencil to cross out target symbols embedded within a group of symbols. For use in medication trials, Hale and Vreeland (1996) developed The Figure Cancellation Task and its alternate forms as adaptations and extensions of the Cancellation of Rapidly Reoccurring Target Figures Test (Rudel, Denckla, & Broman, 1978) to overcome the measure's suggested ceiling effect in older children. Unlike the original form, the alternate forms of the Figure Cancellation Task have 30 instead of 14 target stimuli, which results in increased sample space and thus greater diagnostic and treatment sensitivity.

The Child Attention Profile. (Barkley, 1991) is a brief measure used to screen for attentional problems in school-aged children. It is a 12-item questionnaire derived from items of the Child behavior Checklist Teacher Report Form (CBCL-TRF; Achenbach & Edelbrock, 1986) Inattention and Nervous-Overactive scales. Seven attention items and five overactivity items were extracted from the Teacher Report Form to produce a two-factor rating scale. These items were selected for having the highest loadings on their respective scale, while correlating to a low degree with other scales. Normative data was derived from the same sample used to construct the norms for the CBCL-TRF. Barkley (1990) and Barkley et al. (1990) report that the scale has excellent psychometric properties. In this study, the excellent psychometric properties of the CAP reported in the literature (Barkley, 1990; Barkley et al. 1990) were confirmed, supporting claims of its utility in the assessment of attention problems. For reliability, Cronbach's coefficient alpha for the CAP Total Scale was .91. Even though the Inattentive and Overactivity
subscales have few items, their coefficient alphas were surprisingly high (.88 and .89 respectively).

Results

The descriptive statistics for the Figure Cancellation and Trails B tasks and the Child Attention Profile teacher ratings are reported for the entire sample in Table 1. Results are collapsed across age and group, and thus represent the combined performance of all children ages 6-0 through 12-11, including those in the control and ADHD groups.

Table 1

Descriptive Statistics for Measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancellation Sum</td>
<td>125</td>
<td>25.94</td>
<td>4.13</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Cancellation Time</td>
<td>125</td>
<td>119.51</td>
<td>47.52</td>
<td>56</td>
<td>401</td>
</tr>
<tr>
<td>Trails Errors</td>
<td>125</td>
<td>.90</td>
<td>1.62</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Trails Time</td>
<td>125</td>
<td>60.20</td>
<td>59.33</td>
<td>15</td>
<td>580</td>
</tr>
<tr>
<td>CAP Total</td>
<td>125</td>
<td>6.16</td>
<td>6.27</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>CAP ADD</td>
<td>125</td>
<td>3.67</td>
<td>3.93</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>CAP HYP</td>
<td>125</td>
<td>2.49</td>
<td>3.12</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

Note. CAP = Child Attention Profile; ADD = Inattention scale; HYP = Overactivity scale.
Table 2 presents the zero-order correlations for the Cancellation Task and Trails B dependent variables, as well as the CAP total and subscale scores. An examination of the data revealed significant positive relationships between the time to complete Trails B and the number of Trails B errors, suggesting that as errors increase, so does the time to complete the task. As time to complete one task increased, the time to complete the other task increased as well, as suggested by the positive relationship between Cancellation Task and Trails B time. Results also revealed positive correlations between Trails B Time and Trails B Errors. In addition, Trails B Time was inversely related to Cancellation Sum. These results suggest that poorer performance on Trails B, as indicated by increased time and errors, will likely be associated with poorer accuracy on the Cancellation Task as well.

Table 2

Two-Tailed, Zero-Order Correlation for Measures

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cancellation Sum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Cancellation Time</td>
<td>.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Trails Errors</td>
<td>-.26**</td>
<td>.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Trails Time</td>
<td>-.16*</td>
<td>.30**</td>
<td>.67**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. CAP Total</td>
<td>-.10</td>
<td>.03</td>
<td>.26**</td>
<td>.18*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. CAP ADD</td>
<td>-.16</td>
<td>.06</td>
<td>.28**</td>
<td>.23**</td>
<td>.91**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. CAP HYP</td>
<td>.00</td>
<td>-.01</td>
<td>.16*</td>
<td>.07</td>
<td>.85**</td>
<td>.55**</td>
<td></td>
</tr>
</tbody>
</table>

*Note. CAP = Child Attention Profile; ADD = Inattention scale; HYP = Overactivity scale.

*p < .05. **p < .01.
Of particular interest are the correlations between performance on the tasks and the scores on the Child Attention Profile. Results indicate positive relationships between the CAP Total and ADD scores and Trails B Time and Errors. Trails B Errors was also positively related to the CAP Overactivity subscale scores, suggesting that Trails B errors might reflect impulsivity. Further, those who received higher scores on the CAP Overactivity subscale also tended to receive greater scores on the ADD subscale, suggesting the commonality of inattention, impulsivity, and hyperactivity. However, these conclusions should be interpreted with caution because of the likelihood of a Type I error.

To determine if Group membership and Age predicted dependent measure scores, backward elimination multiple regression analyses were performed. The groups were dummy coded and the interaction of Group and Age was also calculated. Results of the backward elimination regression analyses for Cancellation Task Sum and Time scores are presented in Table 3. For Cancellation Sum, a main effect for Group, as well as an Age by Group interaction was found. For the Cancellation Time variable, an Age main effect was revealed, indicating a developmental trend whereby time decreases as children get older. Age accounted for 39% of the variance in Cancellation Time, suggesting a strong relationship between these variables.

To better understand the slope of the relationship between Cancellation Task scores and predictor variables, mean scores were used to plot the data. Figure 1 depicts the performance of ADHD subjects versus controls for Cancellation Task Sum. Although the control group consistently obtained a mean correct score of approximately 26 across all ages, the ADHD group's performance showed greater developmental variability. As children with ADHD increased in age, they obtained a greater mean number correct, so
Figure 1. Performance of ADHD and Control groups on Figure Cancellation Task.
that by ages 11 and 12, children with ADHD obtained a score comparable to control children.

Table 3

*Backward Elimination Regression for Cancellation Task, Age, Group*

<table>
<thead>
<tr>
<th>Dependent</th>
<th>Predictor</th>
<th>Beta</th>
<th>SE Beta</th>
<th>$r_{xy}$</th>
<th>$pr_{xy}$</th>
<th>$F$</th>
<th>$P$</th>
<th>$r^{2}_{eq}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum</td>
<td>Group</td>
<td>.86</td>
<td>.43</td>
<td>-.02</td>
<td>-.18</td>
<td>4.03</td>
<td>.047</td>
<td>.032</td>
</tr>
<tr>
<td></td>
<td>Age*Group</td>
<td>.86</td>
<td>.43</td>
<td>.01</td>
<td>-.18</td>
<td>3.98</td>
<td>.047</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Age*Month</td>
<td>-.63</td>
<td>.07</td>
<td>-.63</td>
<td>-.63</td>
<td>79.11</td>
<td>&lt;.001</td>
<td>.39</td>
</tr>
</tbody>
</table>

*Note.* POUT = .10.

The developmental trend for Cancellation Task Time is presented in Figure 2.

Because there was no interaction between Cancellation Task Time and Group membership, the Group means were collapsed. The negative relationships between Cancellation Task Time and Age are readily apparent and consistent across age groups, suggesting that older children perform this task more quickly and efficiently, regardless of group membership.

The results of the backward elimination regression analyses for Trails B Errors and Time scores are presented in Table 4. Similar to the Cancellation Task Sum results, an Age and Group interaction was revealed for Trails B errors. These effects accounted for 12% of the variance, indicating Group membership and Age adequately predict performance on this task. As was found for Cancellation Task Time, an Age effect was revealed for Trails B Time, again indicating a developmental trend whereby regardless of group membership, as a child gets older, the time to complete the task decreases. Fifteen
Figure 2. Performance of collapsed groups on Figure cancellation task.
percent of the variance was accounted for by this relationship.

Table 4

**Backward Elimination Regression for Trails I, Age, Group**

<table>
<thead>
<tr>
<th>Dependent</th>
<th>Predictor</th>
<th>Beta</th>
<th>SE Beta</th>
<th>$r_{xy}$</th>
<th>$pr_{xy}$</th>
<th>$F$</th>
<th>P</th>
<th>$r^2_{eq}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Errors</td>
<td>Group</td>
<td>1.24</td>
<td>.41</td>
<td>.28</td>
<td>.26</td>
<td>9.22</td>
<td>.003</td>
<td>.12</td>
</tr>
<tr>
<td></td>
<td>Age*Group</td>
<td>-.99</td>
<td>.41</td>
<td>.23</td>
<td>-.20</td>
<td>5.79</td>
<td>.018</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Age*Month</td>
<td>-.38</td>
<td>.08</td>
<td>-.38</td>
<td>.38</td>
<td>20.94</td>
<td>&lt;.001</td>
<td>.15</td>
</tr>
</tbody>
</table>

*Note. POUT = .10.*

A representation of the mean Trails B Errors for the ADHD and control groups can be found in Figure 3. Results suggest that the youngest children with ADHD make the most errors, but as age increases, the number of errors decreases. Trails B performance was consistently better for the control group than the ADHD group, with few errors made across age groups.

Figure 4 depicts the developmental trend for Trails B Time. Again, because there was no Time and Group interaction effect, the Group means were collapsed. The negative correlation between task Time and Age once again reflects quicker performance for older children, regardless of group membership.

**Discussion**

Performance based measures have not typically been used by school psychologists in ADHD assessment. However, a growing body of evidence suggests that neuropsychological measures may provide valuable diagnostic information as part of a comprehensive evaluation of ADHD. Although disruptive behaviors are common in
Figure 3. Performance of ADHD and control groups on Trails B
Figure 4. Performance of collapsed groups on Trails B.
ADHD, and often require the immediate attention and intervention of practitioners, cognitive deficits are equally prevalent and problematic for children with this disorder (Fletcher et al. 1994). Cognitive deficits may directly affect a child's ability to maintain attention, complete tasks, and delay impulsive responding, thereby affecting academic achievement in the classroom (Barkley, 1991).

The present study results suggest that the performance of children with ADHD differs from normal controls on Trials B and the Figure Cancellation Task for accuracy, but not speed of performance. The mean time to complete the tasks was relatively equal for both groups, with ADHD and control children showing a negative relationship between age and task time. Regardless of whether a child has ADHD, the time to complete the tasks decreases as age increases. It is plausible that developmental trends in attention, concentration, and mental flexibility could account for increased performance with age. However, because psychomotor speed is a significant factor on these measures, it cannot be determined with certainty whether advances in visual spatial skills or psychomotor speed are responsible for increased performance in older children.

Younger children with ADHD identified fewer Cancellation Task targets than their same-age peers. These results suggest that limited sustained visual attention, proficient scanning, and graphomotor speed could adversely affect academic performance in young children with ADHD. This would limit academic achievement in the areas of reading decoding and fluency, mathematics computation, and written language proficiency. The number of correctly canceled figures of the two groups revealed an unexpected trend. Although control children performed consistently across age ranges, children with ADHD
improved with age, such that by age 11, their performance was comparable to controls. It is possible that this improved performance in older children with ADHD is the result of strategies they have developed to compensate for areas of difficulty. It should be emphasized however, that results suggesting better performance of children with ADHD may be an artifact of the small ADHD sample size at this age, and not a reflection of actual differences between children with ADHD and controls at this age level. Despite this possibility, the Figure Cancellation Task would appear to have limited utility in the differential diagnosis of older children with attention problems. Future research using a larger sample of children with ADHD may reveal additional information regarding the sensitivity of this measure.

Unlike the limited results of the Figure Cancellation Task, rather robust differences between groups were found for Trails B Errors. On this measure, control children made fewer errors than children with ADHD across all ages, though the gap in performance began to close somewhat for older children. For children at the younger ages however, this measure revealed significant differences in performance between children with ADHD and controls, suggesting that it would prove useful as a screening measure for children with attentional difficulties. Although further research will be necessary to examine the utility of this measure in screening for attention deficits, these findings suggest that children with ADHD have persistent difficulties with attention, concentration, and especially mental flexibility, as measured by Trails B. However, one plausible cause of the greater number of errors in the ADHD group may be related to impulsivity in responding. Further support for this hypothesis can be found in the zero order correlations, which suggest Trails B Errors are related to CAP Overactivity (which also measures impulsivity),
but not CAP Inattention scores. It may be that limited mental flexibility and impulsivity are deficient in children with the Impulsive/Hyperactive subtype of the disorder, which results in the characteristic organizational problems, poor self-monitoring, and difficulties with transitions. Additional research exploring ADHD Inattentive and Impulsive/Hyperactive subtypes may reveal that the former identifies fewer targets on the Figure Cancellation Task (e.g. poorer sustained attention), while the latter makes more impulsive errors on Trails B. Differentiation of subtypes could subsequently lead to identification of unique academic and behavioral profiles, which could have direct implications for educational intervention.

Based on these results, it would seem that Trails B Errors and Figure Cancellation Task Sum provide additional information necessary for identifying children in need of further evaluation of attentional problems, and that time to complete the tasks is not a good predictor for either measure. Consistent with other findings (Sargeant & van der Meere, 1989), these results suggest that accuracy, rather than time, discriminates children with attention problems from normal controls.

One of this study’s most significant findings was incidental. The CAP was selected as an instrument to screen for attentional problems among the subjects and to discriminate children with ADHD from controls. As has been reported in the literature (Barkley, 1990), this 12 - item rating scale, based on the most sensitive items of the Child Behavior Checklist - Teacher Report Form, demonstrated excellent technical quality in this study. Not only were the subscales related to each other and the Total score, but the Trails B dependent variables were related to the CAP scores as well. With such outstanding reliability and apparent construct validity, and considering its brevity, this teacher rating
scale would be a valuable addition to any screening of attention problems or comprehensive ADHD assessment battery.

The study results must be viewed in the context of several methodological limitations. First, the relatively small number of children with ADHD reduced the power of this study’s ability to determine group differences on both measures. It could be argued that the magnitude of the differences found for the Figure Cancellation and Trails B tasks would be amplified if a larger sample of children with ADHD was used. The ADHD group in this study met stringent inclusion criteria regardless of gender; however, future research could explore possible gender differences in performance on these tasks. Another limitation of the study concerned collapsing the Inattentive and Overactive CAP subtypes into the ADHD group. Research suggests that because the they may represent qualitatively different disorders (Barkley, DuPaul & McMurray, 1990), it will be important for future research to address whether the results of this study are applicable to Inattentive and Impulsive/Hyperactive subtypes. A major limitation was that children with ADHD were treated with medication at the time of the study. Because the study attempted to work around the childrens’ regular school schedule, some of the younger subjects may have been tested only two and a half to three hours after taking their morning medication dose, rather than the preferred four hour delay between dosing and administration of the instruments. This may have reduced the strength of the results because the children may have been tested when their cognitive deficits were ameliorated by the medication.

Conclusion

With these limitations in mind, the study results suggest that the accuracy of performance on the Figure Cancellation Task and Trails B is an adequate predictor of
attentional problems in children. In addition, findings of exceptional reliability and apparent validity of the CAP suggest that this instrument is a powerful screening tool for discriminating children with attention problems. Furthermore, this tool may be used in subsequent research to discriminate children with the Inattentive subtype from those with the Impulsive/Hyperactive subtype of the disorder. Taken together, the results support inclusion of the Figure Cancellation Task, Trails B, and the Child Attention Profile as screening measures of attention problems and in a comprehensive assessment ADHD battery. This may provide the practitioner with the additional diagnostic information necessary to develop more effective educational interventions.
References


Hale, J.B., & Vreeland, J.S. (1996). *Figure Cancellation Task* (Unpublished instrument).


Appendix A

Child Attention Profile
CHILD ATTENTION PROFILE

<table>
<thead>
<tr>
<th>Child’s Name</th>
<th>Child’s Age</th>
<th>Child’s Sex [ ] M [ ] F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Directions: Below is a list of items that describe pupils. For each item that describes the pupil now or within the past week, check whether the item is Not True, Somewhat or Sometimes True, or Very or Often True. Please check all items as well as you can, even if some do not seem to apply to this pupil.

<table>
<thead>
<tr>
<th></th>
<th>Not true</th>
<th>Somewhat or sometimes true</th>
<th>Very or often true</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fails to finish things he/she starts</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>2. Can’t concentrate, can’t pay attention for long</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>3. Can’t sit still, restless, or hyperactive</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>4. Fidgets</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>5. Daydreams or gets lost in his/her thoughts</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>6. Impulsive or acts without thinking</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>7. Difficulty following directions</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>8. Talks out of turn</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>9. Messy work</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>10. Inattentive, easily distracted</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>11. Talks too much</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>12. Fails to carry out assigned tasks</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

Please feel free to write any comments about the pupil’s work or behavior in the last week.

---

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Appendix B

Trails B Test
TRAIL MAKING

Part B

SAMPLE

Begin 1

End D

4

A

B

2

C

3
Appendix C

Figure Cancellation Task