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An Evaluation Of Parent And Teacher Rating Scales As Predictors Of The T.O.V.A. Measures Of Inattention, Impulsivity, Response Time And Variability

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AN EVALUATION OF PARENT AND TEACHER RATING SCALES AS PREDICTORS OF THE T.O.V.A MEASURES OF INATTENTION, IMPULSIVITY, RESPONSE TIME AND VARIABILITY

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Nancy C. Kiger

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ABSTRACT

This study evaluated the relationship of six parent and eight teacher rating scales to the T.O.V.A. measures of Inattention, Impulsivity, Response Time and Variability. Subjects consisted of 88 children 6 through 14 years of age, referred by teachers and parents to a school psychologist in a small midwestern community for evaluation of ADHD symptomatology. These students attended school at four public elementary schools and three private religious elementary schools. Sixty-eight subjects were males and twenty subjects were females. Each child was administered the T.O.V.A. by a school psychologist. Parents filled out the BASC:PRS, CPRS-48, and the ADHD Rating Scale. Teachers completed the BASC:TRS, CTRS-28, the ADHD Rating Scale and the APRS. Results from correlational analyses of parent rating scales, teacher rating scales and the four T.O.V.A. variables are presented and discussed. Multiple regression analyses were used to evaluate sets of parent and teacher rating scales as predictors of the four T.O.V.A. variables. On the basis of the study it was concluded that the combination of the sets of parent and teacher rating scales accounted for approximately one-sixth of the variance of the T.O.V.A. Impulsivity measure. The combination of the sets of parent and teacher rating scales did not explain an important part of the variance of the T.O.V.A. Inattention, Response Time or Variability measures.

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INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD), one of the most intensely studied psychiatric disorders, has chronic and debilitating social, emotional, and academic effects on children (Alessandri and Schramm, 1991). Estimates of childhood prevalence of ADHD vary from 1% to 20%, although the consensus estimate is 3-5% with males outnumbering females three to one (Barkley, 1990; Szatmari, Offord, & Doyle, 1989). In the United States alone, approximately 2,000,000 children have been diagnosed with ADHD making it one of the most prevalent childhood disorders (Christie, 1996). Inattention, impulsivity, and hyperactivity are the diagnostic features of ADHD used in the Diagnostic and Statistical Manual (DSM) fourth edition (American Psychiatric Association, 1994). The role and importance of these core features continues to change our understanding of this disorder. Differential diagnosis of ADHD has remained challenging for the clinician.

Still, a British physician, initially focused medical attention on children with characteristics of inattentiveness, impulsvity and hyperactivity in 1902. In a series of lectures to the Royal College of Physicians, he described patients with additional symptoms of aggression, disinihibition, and defiance as afflicted with a "defect in moral control" (Barkley, 1990; Fowler, 1992). This theory was short-lived and interest soon shifted to central nervous system dysfunction as the cause of ADHD type behaviors in children. Children with this disorder were said to have "minimal brain damage" or later

"minimal brain dysfunction." Although this concept established a neurologic basis for ADHD which remains accepted today, practitioners did not find it useful in actual clinical practice due to the broad spectrum of symptoms encompassed and the difficulty establishing treatment plans (Fowler, 1992).

Subjective methods were used to diagnoses ADHD throughout much of the early history of the disorder. In an attempt to measure brain damage and its effects on sustained attention, Rosvold, Mirsky, Sarason, Bransom, and Beck (1956) developed the Continuous Performance Test (CPT). Revisions and adaptations of the CPT remain current as measures of sustained attention in assessment and diagnosis of children with ADHD. CPTs and other laboratory measures (LMs) are not without limitations and their ecological validity has been challenged (Barkley, 1991).

Hyperactivity became the focus of research by mid-century. The Diagnostic and Statistical Manual of Mental Disorders (DSM) second edition (American Psychiatric Association, 1968) created a new diagnostic category, "The Hyperkinetic Reaction of Childhood." Since levels of hyperactivity decreased at puberty, it was theorized that affected children would outgrow their problems. Although this view lasted less than a decade, the term hyperactivity remains commonly used today (Fowler, 1992; Barkley, 1991).

Conners (1969) developed a rating scale that included hyperactivity as a factor. This scale was instrumental in establishing the use of empirical methods to assess ADHD. Subjective methods of assessment were gradually replaced by more objective and empirical methods to assess this disorder. Rating scales have proved helpful, but examiners can not base diagnoses solely on their results.

Inattention and impulsivity soon replaced hyperactivity as the primary difficulties faced by children with ADHD. Research in the 1970s supported the emergence of the term Attention Deficit Disorder (ADD), which was first used in the Diagnostic and Statistical Manual (DSM) third edition (American Psychiatric Association, 1980).

Research determined not all children with attention problems showed symptoms of hyperactivity. In response, diagnostic categories ADD with Hyperactivity and ADD without Hyperactivity were established (American Psychiatric Association, 1980). Barkley (1990), a leading investigator, characterized this change as "a radical reconceptualization of the disorder" (p. 27).

Objective measures were needed to assess symptoms of inattention and impulsivity. The CPT, first developed for use with brain damaged individuals, was revised by Gordon (1983) for use with children with ADHD. The Matching Familiar Figures Test (MMFT) developed by Kagan (1966) to measure reflectivity-impulsivity was later revised by Cairns and Cammock (1978) who normed the test. Additional rating scales were developed by Achenbach and Edelbrock (1983); Barkley and Edelbrock (1987); Barkley (1988); Barkley, DuPaul, and McMurray (1990). These remain key components in the diagnosis of ADHD, but are not without controversy.

Parent support groups concerned about ADD became active and promoted public awareness of the disability in the late 1980s. According to Fowler (1992) "just as the term 'ADD' came to enjoy widespread use and public recognition, the disability again became redefined to reflect scientific advances" (p. 6). Investigators demonstrated great differences between children with hyperactivity or without hyperactivity, and the term ADD was replaced by Attention Deficit Hyperactivity Disorder (ADHD) in the Diagnostic and Statistical Manual (DSM) third edition, revised (American Psychiatric Association, 1987). Barkley (1990) lists four reasons this revision was significant. First, instead of three separate lists and cut-off scores (inattention, impulsivity, and hyperactivity) a single item list of symptoms with one cut-off score was used. Second, empirical research based on large field trials was used to help diagnose children with ADHD, other psychiatric disorders or those free of disease. Third, the developmental nature of core features of ADHD and the importance of considering the child's mental age when diagnosing the disorder was stressed. Fourth, a diagnosis of ADHD did not exclude the diagnosis of an

affective disorder. Subsequently, the subtype of ADD without hyperactivity was replaced by the term Undifferentiated ADD.

While the nomenclature remains the same, the disorder was again reconceptualized in 1994. This change mirrored the DSM third edition conceptualization because it separated the three core features of the disorder. The Diagnostic and Statistical Manual (DSM) fourth edition (American Psychiatric Association, 1994) lists four subtypes, predominantly inattentive, predominantly impulsive-hyperactive, combined, and not otherwise specified to reflect the different dimensions of the disorder. The debate over the nature of ADHD continues today. According to Searight, Nahlik, and Campbell (1995) "despite the systematic presentation of these symptoms in DSM-IV, controversy continues regarding the essential or defining features of the disorder. Barkley asserts that the central deficit in ADHD is behavioral disinhibition, i.e., the child is unable to delay responding when necessary. Other writers, stressing hyperactivity as the critical feature, emphasize the excessive bodily movement and frequent vocalization (talking out of turn) of the child with ADHD. Inattention, usually manifested through an inability to retain information long enough to act upon it, has been highlighted by other clinicians" (p. 271).

Clinicians have continued to search for ways to make the diagnosis of ADHD accurate and objective. The components of a comprehensive diagnostic workup for ADHD can be divided into three broad areas. These include behavioral rating scales, CPTs or LMs, and additional information obtained by the clinician from a variety of sources.

Rating scales are often completed by teachers and parents. These ratings convey dimensions of behavior and investigators typically sum or average data to assign a quantitative score. By applying cutoff scores or multivariate-clustering strategies, the same instruments may determine a category which includes a subgroup of children with common characteristics. According to Hinshaw (1992) "a major issue for the field is the validity of narrower dimensions or categories within the externalizing domain. Such

validity depends on the potential separability of dimensions or subgroups, not only on the basis of defining criteria, but--more important--on their degree of independence or divergent validity" (p. 128). Additionally, although adult informants provide the primary information on rating scales regarding behavioral symptomatology, key informants (e.g. parents vs. teachers) show only modest correlation regarding their appraisals (see Achenbach, McConaughy, & Howell, 1987; Hinshaw, 1992) and they are limited in reliability and validity although they do possess some "face" ecological validity. ADHD is also difficult to distinguish from other related psychiatric syndromes including oppositional defiant disorder and conduct disorder which are classified within the category of disruptive behavior disorders (Searight et al., 1996). These factors make rating scale information more difficult to interpret.

Laboratory Measures (LMs) are also used as diagnostic tools in a multimethod assessment of ADHD. Barkley (1991) reports "clinical practitioners are now being encouraged to incorporate cognitive tests of attention and impulsivity as well as behavioral observations of ADHD symptoms in analogue settings as part of their routine comprehensive assessment of ADHD" (p.150). CPTs do not diagnose ADD or ADHD. Instead, they are laboratory measures that assess certain aspects of visual attention under very specific conditions. According to Greenberg and Kindschi (1996) "at best they measure some attentional characteristics which can be altered by any number of contributing factors" (p. 5). Barkley (1991) questions the ecological validity of LMs. He defines ecological validity as "the degree to which the results of LMs represent the actual behaviors of interest as they occur in naturalistic settings" (p. 150). LMs do not need to be ecologically valid to contribute to research on ADHD, however, ecological validity becomes critical in clinical practice. Barkley (1991) writes "at the point where one wishes to predict from the LM results to the behaviors of ADHD children in their natural environments, to predict their outcomes, or to advise about how best to deal with them, the ecological validity of the LM becomes critical" (p. 151).

The Test of Variables of Attention (T.O.V.A.) was the LM used in this study. The T.O.V.A. is a CPT specifically developed for use in screening and diagnosing neurologically based attentional deficits and monitoring the treatment of attention deficits in children and adults. According to Greenberg and Kindschi (1996) "the Tests of Variables of Attention are objective, standardized, and highly accurate continuous performance tests (p. 1). The T.O.V.A. is non-language based, requires no left-right discrimination or sequencing, has no practice effects, and is 21.6 minutes long. T.O.V.A. results include standard scores in the areas of inattention, impulsivity, response time, and variability. The T.O.V.A. was of special interest because it is based on the DSM-IV conceptualization of ADHD. It has been characterized by Teicher, Ito, Glod, and Barber (1996) as "a very simple CPT, designed so that dyslexic children can respond as well as normal controls" (p. 336).

Information obtained by clinicians is a critical part of the assessment. Edwards, Schulz, and Long (1995) believe "the parent interview remains the cornerstone of clinical assessment of children with ADHD" (p. 381). Barkley (1990) writes "the parental interview is an indispensable part of the evaluation of children and adolescents presenting with concerns about ADHD. No adult is more likely to have the wealth of knowledge about history of interactions with, or sheer time spent with a child than the parent" (p. 234). Parent interviews provide information about the child, school related information, information about the parents and family and information about parent-child interactions. Clinicians can also interview the child or adolescent being evaluated. While teachers often provide information on rating scales, they can also be interviewed. Barkley (1990) believes these interviews "provide a wealth of useful information for differential diagnosis and treatment planning that simply cannot be obtained by any other means" (p. 259-261) Some clinicians also use behavior counts in the classroom, comparing the child being evaluated to another child not suspected of having ADHD.

Statement of the Problem

ADHD is quite difficult to diagnose. Because symptoms of hyperactivity, impulsivity, and inattention may sometimes occur in normal individuals, there is a wide spectrum of symptomatology and symptoms can be caused by many situational factors. Parent and teacher rating scales are considered crucial in the diagnosis of ADHD. LMs allow the clinician to obtain direct measurements of the core features of ADHD. They have become more sophisticated and their use has increased in recent years. Research is needed to establish the validity of LMs. The purpose of this study was to examine the degree to which parent and teacher ratings used in the diagnosis of ADHD predicted the T.O.V.A. variables of Inattention, Impulsivity, Response Time, and Variability.

Limitations of the Study

The following factors restricted the scope of this study.

1. There are two versions of T.O.V.A. available, and in this study only the visual, but not the auditory version was used.
2. This study only assesses predictors of one laboratory measure, the T.O.V.A..

Delimitations of the Study

1. A sample of school children referred for evaluation of ADHD was studied and it did not include children who were only clinically evaluated for the disorder making the finding generalizable only to this population.
2. Children referred for ADHD assessment by parents or teachers were used in this study making the findings generalizable only to this population.
3. This study consisted of children from a small midwestern community with a relatively homogenous population making the findings generalizable only to this population.

Definition of Terms

Attention-Deficit/Hyperactivity Disorder (ADHD):

ADHD is a diagnostic label for a psychiatric disorder. Criteria for making a diagnosis of ADHD are present in the DSM (1994) fourth edition. The DSM-IV classification highlights the essential features of the disorder which include signs of developmentally inappropriate inattention and/or hyperactivity-impulsivity (American Psychiatric Association, 1994). In this study, the sample group consisted of children referred to a school psychologist for an assessment of ADHD.

Inattention

On the T.O.V.A., errors of omission are considered to be a measure of inattention and occur when the subject does not respond to the designated target; that is, the subject fails to press the button when a target appears.

Impulsivity:

On the T.O.V.A., Errors of Commission are considered to be a measure of impulsivity and/or disinhibition and occur when the subject incorrectly responds to the non-target; that is, the subject pushes the button when he or she should not have.

Response Time:

Correct Response Time is the processing time (in msec) that it takes to respond correctly to a target. Counter-intuitively, individuals with ADD often have slower than normal response times, especially in the first half of the test, accounting for 12% of the variance.

Variability:

On the T.O.V.A., Response Time Standard Deviation is considered to be a measure of variability or inconsistency and is the standard deviation of correct response times. Individuals with ADD are inconsistent-they can perform within normal limits for a period, but they lose consistency much sooner than the non-impaired. Greenberg and Kindschi (1996) consider this the single most important measure of the T.O.V.A.(accounting for 80% of the variance). Accuracy on this measure requires an electronic switch be used rather than the less accurate mouse button or keyboard.

Assumptions

The following assumptions were made in this study:

1. Subjects gave their best effort in completing the T.O.V.A.
2. Parents of the subjects gave an honest description and frequency of their child's behavior on the rating scale they were required to fill out.
3. Teachers of the subjects reported symptoms the child displayed in the classroom with accuracy and objectivity.

Chapter 2

REVIEW OF RELATED RESEARCH

ADHD is a psychiatric disorder that affects children, adolescents and adults who present with problems characterized by developmentally inappropriate degrees of inattention, impulsivity, and hyperactivity (Barkley, 1990). The DSM-IV specifies that some symptoms must be present prior to age seven, some impairment must be present in two or more settings and there must be clear evidence of clinically significant impairment in educational, occupational, and/or social functioning (American Psychiatric Association, 1994). ADHD symptoms commonly arise during the preschool or early childhood years and persist into adolescence in more than half of all cases diagnosed in childhood (Barkley, 1990; Barkley, Fischer, Edelbrock, & Smallish, 1990). In clinical studies, boys are six times as likely as are girls to have ADHD, but the ratio falls to three to one in population based studies (American Psychiatric Association, 1994; Barkley, 1990).

Controversy exists regarding the prevalence of ADHD. Silver (1993), a child psychiatrist, estimates between ten and twenty percent of children have ADHD in the elementary years and 50% of those children continue to be symptomatic after puberty. The American Psychiatric Association (1994) estimates between three and five percent of school-age children have ADHD, and Ingersoll (1988), a recognized clinical psychologist, concurs with these figures. Garfinkel and Amrami (1992) also report three to five percent of school age children have ADHD in a pure form, but estimate that another five percent exhibit a combined form of the disorder.

Recently, interest has focused on outcomes of ADHD in adults. Originally, it was believed children "outgrew" symptoms of ADHD. However, it is now believed that as many as 30% to 60% of childhood cases continue into adulthood (Gittelman, Mannuzza, Shenker, & Bonagura, 1985; Weiss & Hechtman, 1993). Presenting complaints in adults include signs such as difficulty finding and maintaining employment, competence in vocational performance, inability to concentrate, lack of organization, depression, low self esteem and inability to establish and maintain a routine (Kane, Mikalac, Benjamin, & Barkley, 1990).

ADHD presents a diagnostic challenge to psychologists, psychiatrists and physicians. The disorder is not easy to understand, diagnose, or treat and is further complicated by the wide range of differences in individuals with the disorder. ADHD is also difficult to distinguish from other related psychiatric syndromes. Oppositional defiant disorder and conduct disorder are categorized along with ADHD under the category labeled "Disruptive Behavior Disorders" and they can present with similar symptoms (Searight, et al. 1996). According to Teicher et al. (1996) ADHD is also associated with "a 10-fold increased incidence of antisocial personality disorder (Klein and Mannuzza, 1991; Weiss et al., 1985), up to a 5 fold increased risk of drug abuse (Gittelman et al., 1985; Klein and Mannuzza, 1995), 25-fold excess rate and risk of institutionalization for delinquency (Satterfield et al., 1982), and up to 9-fold increased risk of incarceration (Mannuzza, et al., 1989)" (p. 334). Desgranges, Desgranges & Karsky (1995) estimate that approximately forty-nine percent of ADHD cases are "pure" cases and the remaining fifty-one percent are comorbid with other disorders.

The challenges presented by ADHD are not new. Throughout its history this disorder has been frequently renamed as efforts have been made to understand the etiology, underlying psychological nature or essence of the disorder. Terms used have included defective moral control and volitional inhibition, restlessness syndrome, postencephalitic behavior disorder, brain-injured child syndrome, minimal brain

dysfunction, hyperkinetic reaction of childhood, hyperactive child syndrome, and attention-deficit disorder with and without hyperactivity (Barkley, 1994a).

New scientific evidence and emerging theoretical concepts in the study of the disorder are still being generated. According to Fowler (1994) scientific evidence suggests that ADHD may be genetically transmitted and result from a chemical imbalance or deficiency in certain neurotransmitters in the brain. Zametkin et al. (1990) in a landmark study conducted by the National Institute of Mental Health, showed the brain uses glucose, its sole energy source, at a lower rate in subjects with ADHD than in subjects without ADHD. Barkley continues to provide theoretical contributions to the field. His new conceptualization of ADHD symptomatology might best be characterized by the term Behavior Inhibition Disorder. In this theory, impulsivity is the central feature of the disorder and the problem is conceptualized as primarily an output problem not an input related problem (Barkley, 1994b; Christie, 1996). It will be interesting to see if this conceptualization will prove useful in increasing understanding of the nature of ADHD.

Multimethod Assessment of ADHD

The identification and assessment of children with ADHD can present a diagnostic challenge for clinicians. Edwards et al. (1995) present four reasons for this dilemma. First, no single objective measure of ADHD associated with acceptable diagnostic validity exists. ADHD is behaviorally defined and relies on subjective reports of caregivers and direct observations of the child. Second, the behaviors associated with ADHD are seen in many children and the defining criteria require these behaviors to present at a level that is inappropriate for the child's mental age and gender. Third, ADHD behaviors may be inconsistent across settings which often results in a low level of agreement among informants. Finally, there are a wide variety of psychiatric, developmental, medical and environmental conditions that mimic ADHD symptoms or coexist with ADHD.

Since ADHD is hard to diagnose, best practice requires a comprehensive, multimethod approach (Barkley, 1990; Cantwell & Baker, 1987). Comprehensive assessments include a diagnostic interview with the parent, completion of behavior rating scales by the parent and teacher, direct observations of behavior, and administration of clinic-based tests (DuPaul, Anastopoulos, Shelton, Guevremeont, Metevia, 1992). Records to review might include school report cards from previous and present years, past treatment records and physical and/or neurological testing results (Desgranges et al., 1995). A multimethod assessment enables clinicians to determine the presence and severity of ADHD symptoms across settings. Multiple informants also contribute unique information about a child's behavior and a composite judgment is superior to scores provided by a single informant (Schaughency & Rothlind, 1991). Such an assessment aids in treatment planning and helps to determine the types of interventions that might be most helpful.

Rating Scales in the Assessment of ADHD

While neurobiological and genetic factors are thought to play a primary role in ADHD, no acceptable biological measure of ADHD has been established. For this reason, the disorder is defined within a social context and subjective reports and ratings from caregivers and observations of the child are the diagnostic standard (Edwards et al., 1995). Since direct observations of behavior are time consuming and costly, clinicians rely heavily on behavior rating scales to aid in the diagnosis of ADHD. In a national survey of 417 randomly selected pediatricians, 58-62% found that rating scales from parents or teachers were at least moderately important in the diagnosis of ADHD (Copeland, Wolraich, Lindgren, Milich, & Woolson, 1987). Barkley (1990) considers well-standardized behavior rating scales an essential component in the evaluation of children with ADHD, second only to a clinical interview.

Behavioral rating scales are typically checklists consisting of items that relate to the child's attention and behavior at home and at school. Key psychometric requirements must be met for these scales to be used appropriately. These include reliability (both over time and between raters), adequate construct sampling, an answer format that provides a sufficient range to allow a representative sampling of the range and frequency of the symptom or construct, face validity, discriminant validity and prescriptive validity (Barkley, 1990). While no behavior rating scale meets all these psychometric properties, Barkley (1990) believes current rating scales have a considerably better base of empirical support than they did in the 1980s.

Barkley (1990) sees several advantages to employing rating scales in clinical practice. First, since ADHD characteristics occur to some degree in normal children, the fact rating scales have established adequate normative data permits clinicians to determine the degree of deviance of a particular child within the population of same-age and same-sex children. Second, rating scales allow for collapsing of information about a child across situations and lengthy time intervals into units of information of value to diagnosis. This is far more cost effective than trying to observe children in diverse settings over long periods of time. Third, rating scales allow the clinician to quantify qualitative features that are important to a thorough understanding of a child's current adjustment. Finally, rating scales provide a means for evaluating the effectiveness of strategies used in the treatment of ADHD. Medication effects, social skills training, self-monitoring skills and other interventions can be assessed using behavioral rating scales.

Rating scales have limitations. Searight et al. (1995) state many of the instruments have not been revised to reflect DSM-IV criteria. Another shortcoming is the halo effect. This refers to the fact that raters sometimes see children as "all good" or "all bad" and this affects the diagnostic accuracy of rating scales. Parent ratings seem to be especially subject to the halo effect. When parents are seeing multiple symptoms occurring with high frequency at home, but there is little evidence of problems at school,

other explanations of these behaviors need to be explored. Family conflicts and unrealistic parental expectations may cause ADHD type behaviors at home. Maternal depression may also cause more negative ratings of children's behavior. A study by Webster-Stratton (1988) found there was greater agreement between fathers and teachers in their perceptions of children's behavior than there was between depressed mothers and either fathers or teachers. Other studies have found that parents' and teachers' ratings of ADHD/hyperactive behavior tend to correlate only modestly (Gordon, 1985; McConaughy & Achenbach, 1985; Achenbach et al., 1987). Teacher ratings are an especially useful source of information in diagnosing ADHD. Increased demands are placed on children in the classroom and the core features of inattention, restlessness, and impulsivity are often displayed in this setting (Guevremont, DuPaul, & Barkley, 1990). Teachers also have contact with a wide range of children and may be better able to determine if behaviors are age appropriate from a developmental perspective.

Laboratory Measures and the Assessment of ADHD

Standardized laboratory tests with adequate normative data allow clinicians to directly measure ADHD symptoms. Such measures make it possible to obtain direct information about the core features of ADHD including attention span, impulsivity, and motor activity (Guevremont et al., 1990). Recent advances in establishing normative and validity data on several laboratory measures make these instruments more attractive than they have been in the past. Barkley (1991) raises the question of the ecological validity of these commonly used tasks and analogue behavioral observation procedures. He defines ecological validity as the degree to which the results of laboratory measures (LMs) represent the actual behaviors of interest as they occur in natural settings. Anastasi (1967) referred to this as concurrent or predictive validity. Barkley (1991) discusses ecological validity and writes that it "varies along a continuum from measures that are high in validity and probably strong in their representativeness of natural behavior to those that are quite

weak in validity and make sizable assumptions about their representativeness of 'real world' behavior" (p. 151). He views behavioral observations of ADHD symptoms in the actual settings where such behaviors typically occur as high in validity and strong in their representativeness. LMs of behavior are less ecologically valid because such a setting is unlikely to be encountered in the natural environment.

One of the first LMs used in the assessment of ADHD was the Reaction Time Task (RTT) which measured both mean reaction time and the variability of response times trials. The ecological validity of this measure for ADHD was partially established by demonstrations that ADHD children have longer mean reaction times, greater variability and more commission errors than do normal children (Douglas, 1983; Douglas & Peters, 1979). Dramatic improvements were also seen in ADHD children who had been administered stimulant medications (Barkley, 1977). There is also a modest, yet significant, correlation between commission errors from an RTT and parent ratings of hyperactivity at home (Weiss, 1991).

CPTs have replaced the RTTs for use in assessing attention in ADHD in the United States (Barkley, 1991). The CPT was first developed more than 30 years ago by Rosvold et al. (1956) to compare brain-damaged and none-brain damaged patients in their ability to sustain attention. Gordon (1983) first marketed the CPT for use in assessment and diagnosis of ADHD and, in recent years, CPTs have become widely used as objective measures of sustained attention and impulsivity (Halperin, Greenblatt, Vanshdeep, & Schwartz, 1991). Advances in computer technology and the availability of microcomputers have made LMs even more popular.

The CPT requires a child to pay attention to a screen on which a sequence of digits is presented. The child is instructed to press a button when a particular combination of digits occurs. Typically, hyperactive children make more incorrect responses and detect fewer targets than controls.

Conners (1992) developed a computerized version of the CPT in 1992 and revised and normed it on a sample of children in 1994. In the Conners' version of the CPT twelve dependent measures are evaluated. Commission errors, omission errors, reaction time and variability are several measures of interest in the study of ADHD. Many studies have been done using the Conners' version of the CPT. The commission error score has been validated as a measure of impulsivity by several studies (Halperin et al.,1988 as cited in Halperin et al., 1993; Sostek, Buschbaum, & Rapoport, 1980). Errors of omission are presumed to measure inattention (Conners, 1992; Halperin et al., 1988 as cited in Halperin et al., 1993; Sostek et al. 1980). The hit reaction time score reflects the speed at which a subject responds to letters presented on the screen. It has been hypothesized that a fast hit reaction time measures impulsive responding. The hit reaction time standard error score refers to the pattern of reaction time and may be indicative of attention loss if the reaction time is slower at the end of the test than it was at the beginning. The pattern of standard error scores measure the variability of a subject's reaction time and according to Conners (1994) is presumed to be indicative of attention loss.

The continuous performance test used in this study is the T.O.V.A. According to Greenberg and Kindschi (1996) the T.O.V.A. is an individually administered computerized test developed to assess attention and impulse control in normal and clinical populations. It can be used in conjunction with other information gathering tools or diagnostic tests in neuropsychological or psychological evaluations. The T.O.V.A. was developed to measure attention and impulse control processes in four areas: (a) inattention, or omissions; (b) impulse control, or commissions; (c) response time; and (d) response time variability. During the T.O.V.A., the stimuli are two easily discriminated geometric pictures centered on the computer screen.

The T.O.V.A. was first used in the study of Attention Deficit Disorder (ADD) in 1966 and consisted of a large electronic rack with a tachistoscopic shutter (McMahon,

Deem, & Greenberg, 1970 as cited in Greenberg and Kindschi, 1996). The current design of the T.O.V.A. was created in the late 1970s and made possible by the advent of the Apple IIe computer. The electronic microswitch was also created at that time. The T.O.V.A. was originally named the "MCA" (Minnesota Computer Assessment), however, a copyright conflict forced a name change. In the 1980s the T.O.V.A. was normed and used in a number of clinical trials. According to Greenberg and Kindschi (1996) "discriminant analysis of T.O.V.A. variables with 29 UADD (ADD without hyperactivity) cases and 29 matched controls correctly classified 79% of the ADD cases and 90% of normals. Discriminant analysis of T.O.V.A. variables with 73 ADHD subjects and 73 matched normals correctly classified 84% and 89% respectively. ADHD and UADD subjects performed more slowly and inconsistently and had more errors of omission (inattention) and commission (impulsivity) than normals. Discriminant analysis of the T.O.V.A. and 10-item Conners' Parent-Teacher Questionnaire of 61 of the youngsters with ADHD and 61 of the matched normals correctly classified 87% of normal and 90% of the ADHD subjects with 13% false positives and 10% false negatives" (p. 19).

Chapter 3

METHODOLOGY AND PROCEDURE

Subjects

Subjects consisted of children, 6 through 14 years of age, referred by teachers and parents to a school psychologist in a small midwestern community for evaluation of ADHD symptomatology. Sixty-eight subjects were males and twenty subjects were females. These students attended school at four public elementary schools and three private religious elementary schools served by a psychologist. The group represents all ADHD referrals from these schools.

Children referred for ADHD evaluations were assessed using the following rating scales: 1) The Behavior Assessment System for Children, both the parent and teacher forms; 2) The Conners' Parent and Teacher Rating Scales; 3) the ADHD Rating Scale; and 4) The Academic Performance Rating Scale. The LM used in these evaluations was the T.O.V.A.

Instruments

1. Behavior Assessment Systems of Children: Teacher Rating Scales (BASC:TRS); Reynolds & Kamphaus (1992)

The BASC:TRS is a comprehensive measure of adaptive and problem behaviors in the school setting. It is primarily designed for use by teachers or others who fill a similar role. The forms contain descriptors of behaviors the responder rates on a four-point scale

of frequency, ranging from Never to Almost Always. The BASC:TRS takes 10 to 20 minutes to complete. This measure assesses clinical problems in the broad domains of Externalizing Problems, Internalizing Problems, and School Problems. The scales of interest in this study were the Hyperactivity scale in the Externalizing Problems domain, and the Attention Problems scale in the School Problems domain.

2. Behavior Assessment Systems of Children: Parent Rating Scales (BASC:PRS); Reynolds & Kamphaus (1992)

The BASC:PRS is a comprehensive measure of a child's adaptive and problem behaviors in community and home settings. Like the BASC:TRS, the BASC:PRS also takes 10 to 20 minutes to complete. This rating scale assesses almost all of the clinical problems and adaptive behavior domains that the BASC:TRS measures, but it does not have a School Problems composite or the Learning Problems and Study Skills scales. Again, the Attention Problems and Hyperactivity scales were utilized in this study.

3. Conners' Parent Rating Scales-48 (CPRS); Goyette, Conners & Ulrich (1978)

The CPRS is completed by a child's parent. The 48 items are rated with four responses which include "not at all," "just a little," "pretty much," and "very much." Responses are coded as 1, 2, 3, and 4. The CPRS-48 includes the following scales: a) Conduct Problems; b) Learning Problems; c) Psychosomatic; d) Impulsive-Hyperactive; and e) the Hyperactivity Index. Normative data for the CPRS are based on a study of 578 children, aged 3 to 17 years, and separated by their gender. The Impulsive Hyperactive scale and the Hyperactivity Index were utilized for this study.

4. The Conners' Teacher Rating Scales-28 (CTRS); Goyette, Conners, & Ulrich (1978)

The CTRS are completed by the child's teacher. Each CTRS item is rated by four responses which include "not at all," "just a little," "pretty much," and "very much." Responses are coded as 1, 2, 3, and 4. The CTRS is based on a study of 383 children, aged 3 to 17 years, and separated by their gender. The Impulsive-Hyperactive Scale and the Hyperactivity Index were utilized for this study.

5. ADHD Rating Scale (ADHD:TRS, ADHD:PRS) DuPaul, (1990)

The ADHD Rating Scale was developed to assess the 14 symptoms of ADHD from the diagnostic criteria in the DSM-II-R (American Psychiatric Association, 1987). It provides direct ratings of the essential symptoms of the disorder from both parents and teachers. Three scores are calculated for the scale. These include the Inattentive-Hyperactive factor score, the Impulsive-Hyperactive factor score and the total score. The Inattentive-Hyperactive factor score and the Impulsive Hyperactive factor score are examined in this study. Parents and teachers fill out identical scales. In this study, to differentiate between scales filled out by parents and scales filled out by teachers, they are referred to as ADHD:PRS and ADHD:TRS.

6. Academic Performance Rating Scale (APRS) DuPaul, Rapport, & Perriello (1990)

The APRS was developed in 1989 to complement other teacher rating scales which the authors believe are inadequate for evaluating a child's academic productivity and accuracy in the classroom. It includes scales of Learning Ability, Academic Performance, Impulse Control, and Social Withdrawal. The Impulse Control scale was of interest in this study.

7. Test of Variables of Attention: Visual Version (T.O.V.A.) Greenberg & Kindschi (1996)

The T.O.V.A., formerly known as the MCA, is a neuropsychological test that was specifically developed for use in screening and diagnosing neurologically-based attention deficits and in monitoring the treatment of attention deficits in children and adults. The T.O.V.A., a continuous performance test, is non-language based, requires no left-right discrimination or sequencing, has no practice effects, and is 21.6 minutes long. Impulsivity, Inattention, Response Time and Variability were the measures of interest in this study.

Procedure

A multimethod assessment of ADHD symptoms occurred. T.O.V.A. testing took place at school and the child's teacher and at least one parent filled out rating scales. All of the children in this study were referred to a school psychologist by a teacher or parent for an evaluation for ADHD symptomatology beginning in the 1995-96 academic year and ending at the end of the 1996-1997 academic year. Each child was administered the T.O.V.A. by a school psychologist. The BASC:PRS, CPRS-48 and the ADHD Rating Scale were filled out by one or both of the child's parents. The child's teacher completed the following rating scales: BASC:TRS, CTRS-28, the ADHD Rating Scale, and the APRS.

Analysis of Data

Teacher and parent rating scale scores were recorded as T-scores and were easily compared. On the CPRS, the Impulsive-Hyperactive and the Hyperactivity Index scale scores were analyzed. The CTRS scores used in the study included the Inattentive-Passive, Hyperactivity, and Hyperactivity Index scale scores. Both the parent and teacher forms of the ADHD Rating Scale had an Inattention-Hyperactivity and an Impulsivity-Hyperactivity scale which were used for analysis. The APRS was filled out by teachers only. The scale score analyzed on this instrument was the Impulse Control scale. Both parent and teacher forms of the BASC had an Attention Problem and a Hyperactivity scale which were also analyzed in this study. T.O.V.A. results analyzed included standard scores in the areas of impulsivity, inattention, hyperactivity, and variability.

Parent rating scales and teacher rating scales were analyzed using multiple regression analyses (Cohen & Cohen, 1983). According to Cohen and Cohen (1983) one of the core concepts of this method is "sets of IVs are treated as units or fundamental entities in the analysis of data" (p.176). Additionally, Cohen and Cohen (1983) explain "using sets of IVs as the primary units of analysis, only those IVs are t-tested for

significance whose sets have given rise to significant F's. This procedure prevents the rapid inflation of setwise and investigationwise Type 1 error that would occur if the individual t's were not so protected and at the same time enjoys the good power characteristics of the t-test" (p. 177) . In this study the set of six parent rating scales was entered first, and the set of eight teacher rating scales was entered second. A set of variables had to lead to a significant change in R^2 for any one rating scale in the set to be tested for significance. Error degrees of freedom for tests of significance were calculated by including all of the variables in the set currently being tested in addition to all variables previously entered in the equation. This method for analysis is an extension of Fisher's protected t-test for multiple regression analyses described by Cohen and Cohen (1983, pp. 166-177).

Research Question and Null Hypotheses

Will the multiple regression analyses reveal statistically significant differences at the .05 level of significance between the set of parent rating scales and the set of teacher rating scale categories to predict the measures of Inattention, Impulsivity, Response Time, and Variability on the T.O.V.A.?

Null Hypothesis #1:

Neither the set of parent rating scales nor the set of teacher rating scales will independently or in combination predict at the .05 level of significance the measure of Inattention on the T.O.V.A.

Null Hypothesis #2:

Neither the set of parent rating scales nor the set of teacher rating scales will independently or in combination predict at the .05 level of significance the measure of Impulsivity on the T.O.V.A.

Null Hypothesis # 3;

Neither the set of parent rating scales nor the set of teacher rating scales will independently or in combination predict at the .05 level of significance the measure of Response Time on the T.O.V.A.

Null Hypothesis #4:

Neither the set of parent rating scales nor the set of teacher rating scales independently or in combination will predict at the .05 level of significance the measure of Variability on the T.O.V.A.

Chapter 4

RESULTS

The purpose of this study was to evaluate parent and teacher rating scales as predictors of the T.O.V.A. variables of Inattention, Impulsivity, Response Time, and Variability. Means and medians for individual parent rating scales, teacher rating scales and T.O.V.A. variables are presented and discussed. Results from correlational analyses of parent rating scales, teacher rating scales and the four T.O.V.A. variables are also presented and discussed. Predictors of T.O.V.A. Impulsivity, Inattention, Variability, Response Time variables were analyzed using multiple regression (Cohen & Cohen, 1983). Predictor variables were entered hierarchically as sets of related variables with sets consisting of parent rating scales and teacher rating scales. Each set of variables required a significant change in R^2 for any single rating scale in the set to be tested for significance. Error degrees of freedom for tests of significance were calculated by including the variables in the set currently being tested in addition to all variables previously entered into the equation. This method of analysis is an extension of the Fisher's protected t-test for multiple regression analyses described by Cohen and Cohen (1983, pp. 166-177).

Subjects in this study consisted of 88 children 6 through 14 years of age, referred by teachers and parents to the school psychologist in a small midwestern community for evaluation of ADHD symptomatology. These students attended school at four public elementary schools and three private religious elementary schools served by a school psychologist. There were 48 males and 20 females in the sample group. Boys included in

the sample group ranged in age from 6 to 14 years of age with a mean of 8 years and four months of age. Girls included in the sample group ranged in age from 6 to 13 years of age with a mean of 8 years and four months of age.

Means, Standard Deviations and Medians

The sample group's means and standard deviations on the fourteen parent and teacher rating scales were calculated. Median scores were also examined. All ratings were T-scores with a means 50 and standard deviations of 10. T-scores of 50 represent the average of the respective normative group. Two standard deviations above the mean on the BASC Attention Problem and Hyperactivity scales on both the parent and teacher forms (i.e. 70 or greater) is considered to be indicative of ADHD (Reynolds & Kamphaus, 1992). The CTRS and the CPRS also use the cutpoint of 2 standard deviations (i.e. 70) above the mean on the Hyperactive and Hyperactive-Impulsive scales and a score 1.5 standard deviations above the mean on the Hyperactivity Index as criterion for identifying hyperactive children (Conners, 1990). Scores on the teacher and parent forms of the ADHD Rating Scale that exceed 1.5 standard deviations (i.e. 65) above the mean are also indicative of ADHD (Barkley, 1991). T-scores above 65 on the APRS Impulse Control Scale are considered deviant (Barkley, 1991). Sample group means and standard deviations were also calculated for the T.O.V.A. variables of Impulsivity, Inattention, Response Time, and Variability. Scores on the T.O.V.A. variables between 85 and 115 are considered normal. Scores of 80 and below are considered deviant as defined in the T.O.V.A. manual (Greenberg and Kindschi, 1996).

An examination of the means presented in Table 1 indicates the sample group had a high mean and median on the CTRS Hyperactivity Index using Conners (1990) cutpoints in the manual for the Conners' Rating Scales. These high scores suggest the sample group had more problems with hyperactivity than the normative group.

Table 1

Medians, Means and Standard Deviations of the ADHD Sample Group on BASC:PRS, BASC:TRS, ADHD Rating Scale, CPRS, CTRS, APRS and T.O.V.A. Variables

Variables	n	M	SD	Median
BASC:PRS-Attention	99	62.77	8.32	63
BASC:PRS-Hyperactivity	99	56.45	11.96	55
BASC:TRS-Attention	96	68.45	6.85	69
BASC:TRS-Hyperactivity	96	61.68	12.83	63.50
ADHD:PRS-Inatten/Hyper	95	55.84	8.61	54
ADHD:PRS-Impuls/Hyper	95	53.73	9.49	52
ADHD:TRS-Inatten/Hyper	99	64.18	7.76	65
ADHD:TRS-Impuls/Hyper	98	60.93	11.92	62
CPRS-Impuls/Hyper	100	59.39	12.50	60
CPRS-Hyper. Index	100	62.43	13.66	63
CTRS-Inatten/Pass	100	64.83	8.16	65
CTRS-Hyperactivity	99	66.44	13.59	68
CTRS-Hyper. Index	100	67.73*	10.96	70*
APRS-Impulse Control	96	63.50	8.26	64
T.O.V.A. Impulsivity	100	92.50	18.61	94
T.O.V.A. Inattention	100	82.55	24.20	91
T.O.V.A. Response Time	100	78.14*	19.43	80*
T.O.V.A. Variability	100	73.52*	18.72	77*

Note, data were missing for some children on rating scale measures.

Greenberg and Kindschi (1996) report in the clinical guide to the T.O.V.A. test, standard scores between 85 and 115 are considered to be in the normal range, while scores below 80 are not considered normal for the T.O.V.A. variables. The mean was 78.14 for T.O.V.A. Response Time with a median of 80. The mean on the T.O.V.A. Variability variable was 73.52 and the median score was 77.

Correlational Analysis

Pearson Product moment correlation coefficients were calculated and results are displayed in Table 3. An alpha level of .05 was employed to determine if the r value was significantly different from an r value of 0.00.

First, correlations were calculated for the six parent rating scales. These included the CPRS Impulsive-Hyperactive scale, the CPRS Hyperactivity Index, the ADHD:PRS Inattention-Hyperactivity scale, the ADHD:PRS Impulsivity-Hyperactivity Scale, the BASC:PRS Attention Scale, and the BASC:PRS Hyperactivity Scale. Significant positive relations were found among all scales.

Table 2

Correlations Among Parent Rating Scales for the ADHD Sample Group

	C imp/hyp	C hyp/ind	A inattn/hyp	A imp/hyp	B attn	B hyp
C imp/hyp	--					
C hyp/ind	.873*	--				
A inattn/hyp	.615*	.724*	--			
A imp/hy	.785*	.791*	.780*	--		
B attn	.345*	.504*	.706*	.458*	--	
B hyp	.756*	.815*	.661*	.788*	.517*	--

* $p < .05$

Second, correlations were calculated for the eight teacher rating scales (See Table 3). These included the CTRS Inattentive-Passive scale, the CTRS Hyperactivity Scale, the CTRS Hyperactivity Index, the ADHD:TRS Inattention-Hyperactivity scale, the ADHD:TRS Impulsivity-Hyperactivity scale, the APRS Impulse Control scale, the BASC:TRS Attention Problems scale and the BASC:TRS Hyperactivity scale. The CTRS Hyperactivity scale, CTRS Hyperactivity Index, ADHD:TRS Inattention-Hyperactivity scale, the APRS Impulse Control scale and the BASC:TRS Attention Problems scale were significantly and positively correlated with all other teacher rating scales. Significant positive correlations were found between the CTRS Inattentive-Passive scale and the

following: CTRS Hyperactivity scale, CTRS Hyperactivity Index, ADHD:TRS Inattention-Hyperactivity scale, APRS Impulse Control scale and the BASC:TRS Attention Problems scale. Significant positive correlations were found between the ADHD:TRS Impulsivity-Hyperactivity scale and all the teacher rating scales except the CTRS Inattentive-Passive scale. The BASC:TRS Hyperactivity Scale was also positively and significantly correlated with all teacher rating scales except the CTRS Inattentive-Passive scale.

Table 3

Correlations Among Teacher Rating Scales for the ADHD Sample Group

	C inattn/ps	C hy	C hy/in	A in/hy	A im/hy	AP im/c	B attn	B hy
C inattn/ps	--							
C hy	.272*	--						
C hy/in	.450*	.845*	--					
A in/hy	.598*	.688*	720*	--				
A im/hy	.172	.883*	773*	714*	--			
Ap im/c	.411*	.541*	581*	641*	.514*	--		
B attn	.600*	.306*	430*	600*	.309*	.442*	--	
B hy	.121	.815*	720*	541*	.837*	.583*	.334*	--

*p <.05

Correlations between parent and teacher rating scales were examined (See Table 4). Significant negative correlations were found between the CTRS Inattentive-Passive scale and the following: CPRS Impulsive-Hyperactive scale, CPRS Hyperactivity Index, ADHD:PRS Impulsivity-Hyperactivity scale, and the BASC:PRS Hyperactivity scale. Significant positive correlations were found between the CTRS Hyperactivity scale and the following: CPRS Impulsive-Hyperactive scale, CPRS Hyperactivity Index, ADHD:PRS Impulsivity-Hyperactivity scale, and the BASC:PRS Hyperactivity scale. Significant positive correlations were also found between the CTRS Hyperactivity Index and the CPRS Impulsive-Hyperactive scale as well as the BASC:PRS Hyperactivity scale. Significant positive correlations were found between the ADHD:TRS Impulsivity-Hyperactivity scale and the following: CPRS Impulsive-Hyperactive scale, CPRS

Hyperactivity Index, ADHD:PRS Impulsivity-Hyperactivity scale, and the BASC:PRS Hyperactivity scale. Significant positive correlations were also found between the BASC:TRS Hyperactivity scale and the following: CPRS Impulsive-Hyperactive scale, CPRS Hyperactivity Index, ADHD:PRS Impulsivity-Hyperactivity scale, and the BASC:PRS Hyperactivity scale. None of the parent rating scales correlated significantly with the ADHD:TRS Inattention-Hyperactivity Scale, the APRS Impulse Control scale or the BASC:TRS Attention Problems scale.

Table 4

Correlations Among Parent and Teacher Rating Scales for the ADHD Sample Group

	CP imp/hyp	CP hyp/ind	AP inattn/hyp	AP imp/hyp	BP attn	BP hyp
CT inattn/ps	-.220*	-.240*	-.141	-.341*	.091	-.207*
CT hy	.388*	.252*	.079	.270*	.045	.331*
CT hy/in	.228*	.126	.001	.088	.117	.211*
AT in/hy	.173	.109	.197	.128	.178	.170
AT im/hy	.341*	.256*	.164	.294*	.136	.340*
ApT im/c	.175	.138	.057	.068	.148	.122
BT attn	.090	-.104	-.027	-.146	.114	-.098
BT hy	.393*	.324*	.130	.319*	.179	.376*

*p <.05

Correlations among the four T.O.V.A. variables and the parent rating scales were examined (See Table 5). There were no significant correlations between the parent rating scales and the T.O.V.A. Inattention variable. Significant negative correlations were found between the T.O.V.A. Impulsivity variable and the following: CPRS Impulsive-Hyperactive scale, ADHD:PRS Inattention-Hyperactivity scale, ADHD:PRS Impulsivity-Hyperactivity Scale and the BASC:PRS Hyperactivity scale. There were no significant correlations between the T.O.V.A. Response Time variable and the parent rating scales. Significant negative correlations were found between the T.O.V.A. Variability variable and the following parent rating scales: ADHD:PRS Impulsivity-Hyperactivity scale, and the BASC:PRS Hyperactivity scale.

Table 5
Correlations Among Parent Rating Scales and T.O.V.A. Variables for the ADHD Sample Group

T.O.V.A.	Inattention	Impulsivity	Response Time	Variability
CPRS imp/hyp	-.100	-.242*	.015	-.145
CPRS hyp/ind	-.057	-.177	.022	-.115
ADHD:PRS ina/hyp	-.190	-.221*	-.087	-.178
ADHD:PRS imp/hy	-.154	-.277*	-.085	-.228*
BASC:PRS attn	-.110	-.102	-.077	-.159
BASC:PRS hyp	-.103	-.264*	-.028	-.208*

*p <.05

Correlations between the four T.O.V.A. variables and the teacher rating scales were also examined (See Table 6). Significant negative correlations were found between the T.O.V.A. Inattention variable and the ADHD:TRS Inattention-Hyperactivity scale as well as the APRS Impulse Control scale. A significant negative correlation was also found between the T.O.V.A. Impulsivity variable and the CTRS Hyperactivity scale. There were no significant correlations between the T.O.V.A. Response Time variable and the teacher rating scales. Significant negative correlations were found between the T.O.V.A. Variability variable and the following: CTRS Hyperactivity scale, CTRS Hyperactivity Index, and the BASC:TRS Hyperactivity scale.

Table 6
Correlations Among Teacher Rating Scales and T.O.V.A. Variables for the ADHD Sample Group

T.O.V.A.	Inattention	Impulsivity	Response Time	Variability
CTRS ina/pas	-.160	-.059	.027	-.005
CTRS hyper	-.139	-.240*	.041	-.197*
CTRS hyp/ind	-.136	-.145	.047	-.226*
ADHD:TRS ina/hyp	-.278*	-.096	.026	-.129
ADHD:TRS imp/hy	-.193	-.096	-.051	-.193
APRS impulse	-.242*	-.086	.019	-.175
BASC:TRS attn	-.164	.129	-.034	-.165
BASC:TRS hyper	-.085	-.183	-.048	-.281*

*p <.05

Multiple Regression

Predictors for the T.O.V.A. variables of Inattention, Impulsivity, Response Time, and Variability were analyzed using multiple regression analyses. Predictor variables included the set of teacher rating scales and the set of parent rating scales.

The T.O.V.A. measure of Inattention was entered as the dependent variable in the multiple regression analysis. The set of parent rating scales was entered first, followed by the set of teacher rating scales. In this analysis, neither the set of parent nor the set of teacher rating scales added significantly to R^2 (See Table 7). The total model, including sets of parent rating scales and sets of teacher rating scales accounted for an adjusted R^2 of .033, F(14,85)=1.242, ns

Table 7

Predictors of the T.O.V.A. Inattention Variable

	Beta	R^2 Change
I. PARENT RATING SCALES		.062
CPRS imp/hyp	-.210	.009
CPRS hyp/ind	.396	.025
ADHD:PRS ina/hyp	-.280	.018
ADHD:PRS imp/hy	-.034	.0001
BASC:PRS attn	.006	.0001
BASC: PRS hyp	-.060	.001
II. TEACHER RATING SCALES		.108
CTRS ina/pas	-.149	.007
CTRS hyper	.153	.003
CTRS hyp/ind	.101	.002
ADHD:TRS ina/hyp	.025	.0001
ADHD:TRS imp/hy	-.443	.025
APRS impulse	-.263	.031
BASC:TRS attn	-.052	.001
BASC:TRS hyp	.313	.018

The T.O.V.A. measure of Impulsivity was entered as the dependent variable in the multiple regression analysis. Initially, the set of parent rating scales was entered first, followed by the set of teacher rating scales. In this analysis, the set of parent rating scales did not lead to a significant increase in R^2. The set of teacher rating scales added significantly to R^2. The R^2 change above parent rating scales = .169, $p < .05$ (See Table 8). The total model, including sets of parent rating scales and sets of teacher rating scales accounted for an adjusted R^2 of .162, $F(14, 85) = 2.367$, $p < .008$.

Table 8

Predictors of the T.O.V.A. Impulsivity Variable

	Beta	R^2 Change	Sig.
I. PARENT RATING SCALES		.111	
CPRS imp/hyp	-.274	.015	
CPRS hyp/ind	.419	.027	
ADHD:PRS ina/hyp	-.146	.005	
ADHD:PRS imp/hy	-.101	.002	
BASC:PRS attn	.061	.002	
BASC: PRS hyp	-.254	.017	
II. TEACHER RATING SCALES		.169	<.05
CTRS ina/pas	-.253	.020	
CTRS hyper	-.557	.035	<.05
CTRS hyp/ind	.036	.0001	
ADHD:TRS ina/hyp	.008	.0001	
ADHD:TRS imp/hy	.671	.057	<.05
APRS impulse	.009	.0001	
BASC:TRS attn	.317	.049	<.05
BASC:TRS hyp	-.354	.024	

Individual teacher rating scales in the set of teacher rating scales that contributed significantly to R^2 were the CTRS Hyperactivity scale (R^2 change = .035, $p<.05$), the ADHD:TRS Impulsivity-Hyperactivity scale (R^2 change = .057, $p<.05$), and the BASC:TRS Attention Problems scale (R^2 change =.049, $p<.05$). The ADHD:TRS

Impulsivity-Hyperactivity scale and the BASC:TRS Attention Problems scale related positively with the T.O.V.A. Impulsivity measure, while the CTRS Hyperactivity scale related negatively with the T.O.V.A. Impulsivity measure.

The T.O.V.A. measure of Response Time was entered as the dependent variable in the multiple regression analysis. The set of parent rating scales was entered first, followed by the set of teacher rating scales. In this analysis, neither the set of parent nor the set of teacher rating scales added significantly to R^2 (See Table 9). The total model, including sets of parent rating scales and sets of teacher rating scales accounted for an adjusted R^2 of -.062, $F(14,85)=.585$, ns

Table 9

Predictors of the T.O.V.A. Response Time Variable

	Beta	R^2 Change
I. PARENT RATING SCALES		.041
CPRS imp/hyp	.003	.0001
CPRS hyp/ind	.148	.003
ADHD:PRS ina/hyp	-.013	.0001
ADHD:PRS imp/hy	-.290	.018
BASC:PRS attn	-.111	.005
BASC: PRS hyp	.197	.010
II. TEACHER RATING SCALES		.046
CTRS ina/pas	-.152	.007
CTRS hyper	.350	.014
CTRS hyp/ind	.065	.001
ADHD:TRS ina/hyp	.230	.009
ADHD:TRS imp/hy	-.450	.026
APRS impulse	.004	.0001
BASC:TRS attn	-.050	.001
BASC:TRS hyp	-.087	.001

The T.O.V.A. measure of Variability was entered as the dependent variable in the multiple regression analysis. The set of parent rating scales was entered first, followed by the set of teacher rating scales. In this analysis, neither the set of parent nor the set of

teacher rating scales added significantly to R^2 (See Table 10). The total model, including sets of parent rating scales and sets of teacher rating scales accounted for an adjusted R^2 of .054 F(14,85)=1.419, ns

Table 10

Predictors of the T.O.V.A. Variability Variable

	Beta	R^2 Change
I. PARENT RATING SCALES		.082
CPRS imp/hyp	-.109	.002
CPRS hyp/ind	.356	.020
ADHD:PRS ina/hyp	.028	.0001
ADHD:PRS imp/hy	-.245	.013
BASC:PRS attn	-.114	.006
BASC: PRS hyp	-.183	.009
II. TEACHER RATING SCALES		.103
CTRS ina/pas	.078	.002
CTRS hyper	.117	.002
CTRS hyp/ind	-.337	.024
ADHD:TRS ina/hyp	.192	.006
ADHD:TRS imp/hy	.198	.005
APRS impulse	-.066	.002
BASC:TRS attn	-.170	.014
BASC:TRS hyp	-.287	.015

Chapter 5

DISCUSSION OF FINDINGS, SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Discussion of Findings

The investigation evaluated predictors of the T.O.V.A. variables of Inattention, Impulsvity, Response Time and Variability. Correlations were examined to determine the relationship between parent rating scales, teacher rating scales and T.O.V.A. variables. Correlations within the set of six parent rating scale measures, and the correlations within the eight teacher rating scale measures were examined. Correlations between the six parent rating scales and the eight teacher rating scales were also examined. Correlations between parent rating scales and the T.O.V.A. variables of Impulsivity, Inattention, Variability, and Response Time were examined as were correlations between teacher rating scales and the four T.O.V.A. variables. Multiple regression analysis examined sets of six parent rating scales and eight teacher rating scales as predictors of the T.O.V.A. variables of Inattention, Impulsivity, Response Time and Variability.

Sample Group Means

Relative to normative data, the sample group's means on teacher and parent rating scales were above the normative group's mean of 50. However, the only scale with a mean above the cutpoint as defined by Conners (1990) was the CTRS Hyperactivity Index. According to Conners (1990) this scale was developed to provide an easily

measured empirical assessment of the extent to which a child performs behaviors usually considered to indicate an underlying diagnosis of hyperkinesis. The Hyperactivity Index was also printed on a separate form called the Conners' Abbreviated Symptoms Questionnaire or Conners' ASQ. While the Conners' ASQ was originally developed to study the efficacy of various drugs for treating hyperactivity, it is now believed to be a more general index of child psychopathology and not a syndrome specific to the diagnosis of hyperactivity or ADD. Intuitively, it is not surprising that children referred to the school psychologist for assessment of ADHD would evidence psychopathology of varying degrees.

Conners (1990) reports the Hyperactivity Index is considered to be functionally equivalent to all Conners' Rating Scales. Interestingly, the CPRS Hyperactivity Index mean of 62.43 for the ADHD group is not above the cutpoint of 65 required for clinical significance on this scale (See Table 1). While the standard deviations of each measure are large, the median for the CPRS Hyperactivity Index is 63 and the median for the CTRS Hyperactivity Index is 70.

Means and standard deviations were calculated for the four T.O.V.A. variables of Inattention, Impulsivity, Response Time, and Variability. Scores below 80 on this measure are not considered normal. The T.O.V.A. Inattention variable had a mean of 82.55 which is a borderline score. Greenberg and Kindschi (1996) report that excessive omission errors appear to indicate nonspecific neurologic immaturity or dysfunction.

The T.O.V.A. Impulsivity variable was in the normal range. Since Greenberg and Kindschi (1996) report excessive errors of commission affect other variables, they are an important measure of test validity. The median score of 91 on this variable also suggests at least half of the sample group's T.O.V.A. tests were valid.

The sample group's T.O.V.A. Response Time and Variability means were not in the normal range. These measures are considered critical in the diagnosis of ADHD. Correct Response Time accounts for 12% of the variance on the T.O.V.A. while

Variability accounts for 80%. Greenberg and Kindschi (1996) view the Variability variable as the single most important measure on the T.O.V.A. The T.O.V.A. microswitch is able to measure this variable in milliseconds, making the timing significantly more accurate than that obtained using a mouse button or keyboard. The Variability variable is the standard deviation of correct response times. Greenberg and Kindschi (1996) write "individuals with ADD are inconsistent-they can perform within normal limits for a while, but they 'lose it' much sooner than the non-impaired" (p. 13). This variable also helps explain why a child with ADD can focus and stay on task when they are performing a task that is interesting or novel, but cannot sustain that level of attention to complete a dull or repetitive task. The sample group clearly had more difficulty than the normative group performing consistently on T.O.V.A Variability. Barkley (1990) reports "much research has been accumulated to suggest that ADHD individuals show wide swings or considerably greater variation in the quality, accuracy, and speed with which they perform assigned work" (p. 1). He comments on the difficulty a person with ADHD has maintaining a relatively even level of accuracy over time when performing repetitive or tedious tasks. The T.O.V.A. is specifically designed to assess attention over time.

Parent Rating Scales

This study found high intercorrelations (0.345-0.873) on the six parent rating scale measures. All correlations between parent rating scales were significantly and positively correlated. The lowest correlations were between the BASC:PRS Attention Problems scale and the five other rating scales. According to Reynolds and Kamphaus (1992) factor analyses of the items on the BASC:TRS and BASC:PRS revealed that heightened activity and impulsivity were statistically indistinguishable, but both could be differentiated reliably from inattention. The sample group's means seem to follow this statistical trend.

Teacher Rating Scales

The eight teacher rating scales also showed relatively high correlations. The only scale that did not correlate significantly with the other seven scales was the CTRS Inattentive-Passive scale. It was not significantly correlated with either the ADHD:TRS Inattention-Hyperactivity scale or the BASC:TRS Hyperactivity scale. Reynolds & Kamphaus (1992) believe it may be difficult to directly compare teacher scales with each other. When comparing the CTRS-39 and the BASC TRS they found the instruments clearly are different measures with several non-parallel scales. When comparing an inattentive-passive scale and an inattention-hyperactivity scale it is difficult to predict if they would contain similar questions.

Relationships Between Parent Rating Scales and Teacher Rating Scales

The correlations between parent ratings and teacher ratings have been of great interest to researchers. Convincing arguments can be made advocating the advantages of either parent or teacher ratings. Since the DSM-IV requires the child exhibit ADHD type behaviors across settings, a comprehensive evaluation must include information from both sources. At times, parent and teacher rating scales complement each other. Difficulty arises when they provide conflicting information. Conners (1990) believes parent ratings have strengths and weaknesses when compared to teacher ratings. He writes "the most important strength of parent ratings is that the parent may spend more time in a day with the child than the teacher does, and has the advantage of having seen the child over a number of years in a very large number of situations" (p. 7). He further states the parent has a greater knowledge of the situational context of the child's behaviors and the settings in which these behaviors are most likely to occur. Teachers are generally viewed as more objective and dispassionate observers. Teachers also have the distinct advantage of having worked with a large number of children. Conners (1990) writes, "The parent will also

tend not to be a trained observer of children who has the context of having observed hundreds of children on a day-to-day basis over a period of years" (p. 7).

The CTRS Inattentive-Passive scale significantly and correlated with the four parent rating scales that measured some aspect of impulsivity and/or hyperactivity. In other words, in this study impulsive and hyperactive behaviors were negatively correlated with inattentive passive behaviors. Interestingly, the CTRS Inattentive-Passive scale did not have significant positive correlations with the ADHD:PRS Inattention-Hyperactivity scale or the BASC:PRS Attention Problems scale. An inattentive-passive scale and an inattention-hyperactivity scale appear to measure conflicting constructs. However, it could be argued these scales correspond to the DSM-IV which includes the classifications of ADHD Predominately Inattentive Type and ADHD Predominantly Combined Type.

The CTRS Hyperactivity scale, the ADHD:TRS Impulsivity-Hyperactivity scale and the BASC:TRS Hyperactivity scale correlated positively with the same four parent rating scales that were negatively correlated with the CTRS Inattentive-Passive scale. Correlations between this scale and the ADHD:PRS Inattention-Hyperactivity scale as well as the BASC:PRS Attention scale were not significant.

The CTRS Hyperactivity Index related significantly and positively with both the CPRS Impulsive-Hyperactive scale and the BASC:PRS Hyperactivity scale, but not with other parent rating scales.

The ADHD:TRS Inattention Hyperactivity scale, the APRS Impulse Control scale and the BASC:TRS Attention Problems scale did not correlate significantly with any parent rating scales.

In short, all teacher measures and all parent measures related positively. However, when looking at the relationships between parent and teacher measures, some were positive, some negative and many non existent. With few exceptions, parents and teachers are rating independently of one another and sometimes in direct opposition to each other (negative correlations).

The T.O.V.A. Variables and Parent Rating Scales

Correlations between the T.O.V.A. variables of Inattention, Impulsivity, Response Time, and Variability and the six parent rating scales were examined. None of the parent rating scales correlated significantly with the T.O.V.A. variables of Response Time and Inattention.

Low but significant negative correlations were found between the T.O.V.A. Variability variable and the ADHD:PRS Impulsivity-Hyperactivity scale as well as the BASC:PRS Hyperactivity scale while the T.O.V.A. Impulsivity variable was negatively correlated with a number of parent rating scales. These included the CPRS Impulsive-Hyperactive scale, the ADHD:PRS Inattention-Hyperactivity scale, the ADHD:PRS Impulsivity-Hyperactivity scale, and the BASC:PRS Hyperactivity scale. These results are consistent with expectations.

The T.O.V.A. Variables and Teacher Rating Scales

Correlations between the T.O.V.A. variables and the eight teacher rating scales were also examined. None of the teacher rating scales correlated significantly with the T.O.V.A. Response Time variable. This indicates T.O.V.A. Response Time, for this sample group, cannot be predicted by either teacher or parent rating scales.

In contrast to the four parent rating scales that predicted T.O.V.A. Impulsivity, only one teacher rating scale, the CTRS Hyperactivity scale, correlated significantly with T.O.V.A. Impulsivity. As expected, high scores on the CTRS Hyperactivity scale predicted low scores on the T.O.V.A. Impulsivity scale.

T.O.V.A. Inattention had significant negative correlations with the ADHD:TRS Inattention-Hyperactivity scale and the APRS Impulse Control Scale. In comparison, the ADHD:PRS Inattention-Hyperactivity scale did not correlate significantly with T.O.V.A. Inattention even though the questions are identical on the parent and teacher scales. While several scales attempt to measure impulsivity and hyperactivity, the ADHD Rating scale is the only measure in the study that attempts to assess both hyperactivity and inattention.

T.O.V.A. Variability had the highest number of significant correlations. T.O.V.A. Variability was significantly and negatively correlated with the CTRS Hyperactivity scale, CTRS Hyperactivity Index, and BASC:TRS Hyperactivity scale. Interestingly, all significant correlations with the T.O.V.A. Variability variable on both teacher and parent ratings are said to measure hyperactivity in children.

Sets of Parent and Teacher Rating Scales as Predictors of the T.O.V.A. Variables

Advances in computer technology and the availability of microcomputers have made using laboratory measures (LMs) popular in clinical practice and educational settings. Advances in establishing normative and validity data on LMs have further justified their use in a multimethod assessment of ADHD in children. Corkum and Siegel (1993) believe the changing emphasis on characteristics of ADHD children over the last two decades from motor restlessness to deficits in attention has also contributed to the rise in LMs' popularity as research and diagnostic instruments.

Parent and teacher rating scales are critical components of an ADHD assessment. However, LMs allow the clinician to obtain direct measurements of the core features of ADHD. An important question is the relationship between LMs and behavioral rating scales. This study examined a set of six parent rating scales and a set of eight teacher rating scales to determine whether they were significant predictors of the T.O.V.A. variables of Inattention, Impulsivity, Response Time and Variability. Additionally, if a set of rating scales significantly predicted a T.O.V.A. variable, it was possible to examine individual rating scales to see if they also predicted the T.O.V.A. variable in question.

In this study the set of six parent rating scales and the set of eight teacher ratings scales did not significantly predict the T.O.V.A. variables of Inattention, Response Time or Variability. The fact that inattention was not significantly predicted is consistent with Thompson and Nichols' (1992) study of the association between a continuous performance test and parents' ratings of attention problems and impulsivity which did not

indicate a significant association. The reasons for this lack of congruence included the multidimensional nature of attention problems and impulsivity and the extreme differences in task and environmental demands. Corkum and Siegel (1993) concluded that task, situational and external variables can affect CPT performance and believe LMs may be a valuable research tool to help elucidate the true nature of deficits associated with ADHD. They point out, however, LMs cannot be utilized as measures of a unitary concept of sustained attention. One study also examined the validity of the CPT as a diagnostic instrument and found that a third of ADHD children scored within an average range on this test and therefore would not be detected (Lorber and Armstrong, 1988 as cited in Barkley, 1991).

The multiple regression analysis using sets of parent and teacher rating scales did significantly predict the T.O.V.A. Impulsivity variable. In this analysis the set of parent rating scales was not a significant predictor. However, when the set of teacher rating scales was entered above the set of parent rating scales it significantly predicted T.O.V.A. Impulsivity. Since the set of teacher rating scales significantly predicted T.O.V.A. Impulsivity, it was possible to examine individual teacher rating scales. Three teacher rating scales significantly predicted T.O.V.A. Impulsivity above the set of parent and teacher rating scales. These included the CTRS Hyperactivity scale, the ADHD:TRS Impulsivity-Hyperactivity scale and the BASC:TRS Attention Problems scale. The BASC:TRS Attention Problems scale and the ADHD:TRS Impulsivity-Hyperactivity scale related positively to the T.O.V.A. variable of Impulsivity. Since inattention appears to be a separate factor from impulsivity or hyperactivity it was difficult to predict how the BASC:TRS Attention Problems scale would relate to T.O.V.A. Impulsivity.

The positive correlation between the ADHD:TRS Impulsivity variable and the T.O.V.A. Impulsivity variable was unexpected. The CTRS Hyperactivity scale related negatively to the T.O.V.A. Impulsivity measure and this finding was expected.

In all, the set of parent and teacher rating scales contributed to 16% of the variance in predicting the T.O.V.A. variable of Impulsivity. The set of parent and the set of teacher rating scales did not, however, significantly predict the three other T.O.V.A. variables.

Summary

The Summary of the study section includes a restatement of the problem, procedures used, and restatement of the research hypotheses.

Statement of the Problem and Statement of Procedures

Attention Deficit Hyperactivity Disorder (ADHD) is difficult to understand, diagnose and treat. Rating scales are an essential component in the diagnosis of ADHD. They allow clinicians to process large amounts of data that would otherwise be difficult to obtain in a cost effective manner. Rating scales also allow investigators to compare ratings provided by parents and teachers to determine if behavior problems are situationally specific or persist across settings.

Rosvold et al. (1956) developed the CPT. It was developed to measure the effect of brain damage on sustained attention and was the first quantitative method of assessment. The CPT has undergone multiple revisions and, in revised form, is still used today to quantitate ADHD symptoms.

The T.O.V.A. was the CPT used in this study. It was of special interest because it was updated in 1996. Unlike most other CPTs, the T.O.V.A. is based on the DSM-IV conceptualization of ADHD. According to Greenberg and Kindschi (1996) the auditory and visual versions of the T.O.V.A. are "objective, standardized, and highly accurate continuous performance tests (CPTs) that are used to assess attention" (p. 1). The T.O.V.A. uses a highly accurate electronic microswitch to record responses. This is far more accurate the keyboard or a mouse. Additionally, the T.O.V.A. does not use letters

and the authors define the T.O.V.A.s as a "non-language based, sufficiently long (21.6 minutes) computerized tests that requires no left-right discrimination or sequencing and have no appreciable practice effects" (p. 1).

The purpose of this study was to examine the T.O.V.A. variables of Inattention, Impulsivity, Response Time, and Variability. Predictors consisted of a set of six parent rating scales and a set of eight teacher rating scales.

Subjects consisted of 88 children ranging from 6 -14 years of age. These children were referred to the school psychologist by parents or teachers for an evaluation of ADHD symptoms. The children were assessed using the following rating scales: 1) The Behavior Assessment System for Children (BASC), both the parent and teacher forms; 2) The Conners' Parent and Teacher Rating Scales (CPRS, CTRS); 3) the ADHD Rating Scale; and 4) The Academic Performance Rating Scale (APRS). The LM used in these evaluations was the T.O.V.A..

Hypotheses

The following hypotheses were tested:

1. Null Hypothesis 1: Neither the set of parent rating scales nor the set of teacher rating scales will independently or in combination predict at the .05 level of significance the measure of Inattention on the T.O.V.A.

Null Hypothesis 1 failed to be rejected.

2. Null Hypothesis 2: Neither the set of parent rating scales nor the set of teacher rating scales will independently or in combination predict at the .05 level of significance the T.O.V.A. measure of Impulsivity.

Null hypothesis 2 was rejected. In this analysis while the set of parent rating scales did not significantly predict the T.O.V.A measure of Impulsivity, but the set of teacher rating scales did significantly predict the T.O.V.A. Impulsivity measure. Individual teacher rating scales that significantly predicted T.OV.A. Impulsivity were the CTRS

Hyperactivity scale, the ADHD:TRS Impulsivity-Hyperactivity scale and the BASC:TRS Hyperactivity scale. In total, the sets of parent and teacher rating scales explained 16% of the variance for the T.O.V.A. Impulsivity score.

3. Null Hypothesis 3: Neither the set of parent rating scales nor the set of teacher rating scales will independently or in combination predict at the .05 level of significance the T.O.V.A. measure of Response Time.

Null Hypothesis 3 failed to be rejected.

4. Null Hypothesis 4: Neither the set of parent rating scales nor the set of teacher rating scales will independently or in combination predict at the .05 level of significance the T.O.V.A. measure of Variability.

Null Hypothesis 4 failed to be rejected.

Conclusions and Recommendations

As discussed previously, limitations and delimitations of this study need to be addressed in future research. This study was generalizable only to the population of children referred to the school psychologist for an evaluation of ADHD and consisted of a relatively homogenous population. This study examined parent and teacher rating scales as predictors of the visual version of the T.O.V.A., and not parent and teacher rating scales as predictors of the auditory version of the T.O.V.A.

While both parent and teacher rating scales and T.O.V.A. measures are purported to be measures of ADHD in children, the rating scales predict only a small amount of variance on the T.O.V.A. measures. The combination of the sets of parent and teacher rating scales explains approximately one-sixth of the variance of the T.O.V.A. Impulsivity measure. The combination of the sets of parent and teacher rating scales did not explain an important part of the variance of the T.O.V.A. Inattention, Response Time or Variability measures.

The role of parent and teacher rating scales and the reasons they are not predictors of the four T.O.V.A. variables requires further explanation. It may be the rating scales are not determining critical areas due to their wording. Other methods of obtaining data such as structured clinical interviews with parents and teachers may prove more useful in the assessment of children with ADHD.

Second, parent and teacher rating scales used in this study were labeled to reflect the aspect of ADHD they were attempting to measure. In comparing the scales, it became apparent that even when scales had similar names, they were not always measuring the same constructs. For this reason, clinician's need to look at the content in individual scales and not assume scales are measuring what they purport to measure. As Reynolds and Kamphaus (1992) reported, it is difficult to directly compare different instruments because they may be non parallel scales.

Finally, new instruments need to be developed to reflect the DSM-IV conceptualization of ADHD. Parent and teacher rating scale categories reflect earlier DSM criteria and this makes assessment more difficult.

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