A COMPARISON OF THE CONTINUOUS PERFORMANCE TEST – TEST OF VARIABLES OF ATTENTION AND THE CONNERS' RATING SCALES - REVISED IN THE CLINICAL DIAGNOSIS OF ATTENTION DEFICIT-HYPERACTIVITY DISORDER

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ATTENTION DEFICIT HYPERACTIVITY DISORDER

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When I embarked on this degree, I had no idea that it would be nearly 10 years later that I would finally graduate. Like all ambitious 20-somethings, I jumped in feet first not fully knowing what I was getting myself into. However, I knew whole-heartedly that I wanted to be a school psychologist working with preschool and school-aged children. I want to thank Dr. Judy Oehler-Stinnett, my dissertation chairperson for accepting me into her ADHD research team and sticking with me all of these years. I appreciate your patience and understanding that life happens along the way. I also want to thank my committee members, Drs. Terry Stinnett, Bob Davis and Eric Mesmer who were kind enough to assess my ideas and writing during this process. I also want to thank my fellow colleagues Drs. Cynthia Boykin, Linda Evans, Lynn Cagle, and Kurt Choate who worked diligently on this research project. To my dear friend, Tammy Howard, I want to thank you for encouraging me to not give up on myself and reminding me that faith in God as small as a mustard seed could achieve what is thought to be impossible. To my parents, Terry and Arlene, I want to thank you for supporting my dream of achieving a doctorate. While I worked what seemed to be endless hours on my dissertation, you were there to take care of my daughter when I could not. I also want to thank my husband, Tim who also continued to push me to finish this project and who sacrificed so much for me. I love you, always. Thank you to Don and Vaughn, Tim's parents who helped entertain Tim and Madeleine on weekend trips to Kansas City so I could work on my dissertation. I dedicate this dissertation to my daughter, Madeleine.

Always remember your dreams can be accomplished with hard work and faith in God. With God at your side anything is possible.

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CHAPTER I

INTRODUCTION

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common problems in children (Barkley, 1998) and the most well studied of childhood disorders (Barkley, 1997a; 1998), encompassing 100 years of scientific inquiry beginning with Still's (1902) investigation describing "abnormal psychical conditions" in children. The diagnosis of ADHD appears to be quite controversial due to the heterogeneous nature of the disorder, thus researchers have accounted for subtypes of ADHD to attempt to operationalize the definition (Goodyear & Hynd, 1992) and the methods for diagnosis (Barkley, 1998). Assessing children who exhibit a conglomerate array of symptoms can be quite challenging for clinicians to determine whether the child presents with ADHD symptomatology, whether the child presents with a comorbid condition which is not ADHD or whether the child is experiencing ADHD-like characteristics influenced by environmental factors but does not meet the DSM-IV criteria for ADHD (Barkley, 1998; DuPaul & Stoner, 2003; Mercugliano, Power, & Blum, 1999). To add to the confusion, many children exhibit characteristics that warrant a diagnosis of ADHD, but also exhibit other concomitant conditions (i.e. comorbid disorder), such as oppositional behavior, conduct problems, anxiety, depression, and learning disorders.

Schools have seen an increase in the frequency of children diagnosed with ADHD (DuPaul & Stoner, 2003; Mercugliano et al., 1999), making it a significant childhood disorder (Barkley, 1998). Parents and teachers rely on school psychologists to diagnosis childhood disorders that impair educational performance and assist with home or school interventions (DuPaul & Stoner, 2003; Mercugliano et al., 1999). To aide school psychologists in determining an accurate diagnosis of ADHD, it is crucial to conduct a comprehensive evaluation utilizing objective and subjective instruments. If ADHD is present, a differential diagnosis of ADHD is important, especially when it is likely that other childhood disorders exist (Barkley, 1996a; 2003).

Many objective and subjective diagnostic instruments have been developed to assist with measuring inattention, impulse control, problem-solving, and rule-governed behavior in children displaying characteristics consistent with ADHD (Barkley, 1998). One of the most frequently used objective measures in clinical settings is the continuous performance test (CPTs), which gives quantitative information about an individual's degree of attention and behavioral (response) inhibition (Riccio, Reynolds, & Lowe, 2001). CPTs are computer-based assessments that evaluate sustained attention (a component of attention) and response inhibition (also referred to as inhibitory control or impulsivity) (DuPaul, Anastopoulos, Riccio et al., 2001; Shelton, Guevremont, & Metevia, 1992).

Rosvold, Mirsky, Sarason, Bransome, & Beck (1956) developed the first CPT to assess sustained attention. Since 1956 many versions of CPTs have been developed for clinical and research settings (Riccio et al., 2001). Researchers and clinicians have seen an increase in the use and research of CPTs indicating that CPTs are accepted by the

psychological community at face validity as measures of attention and executive control (Riccio et al., 2001).

Subjective measures can be a clinical interview with the parents to investigate the history and age of onset of symptoms, broad-band or narrow-band behavior rating scales completed by multiple informants (i.e. parents and teachers), and direct observations conducted by the school psychologist in multiple settings (i.e. home and school; Barkley, 1997b). Behavior rating scales are frequently used subjective measures for assessing ADHD and are a convenient, standardized, and cost-effective method of collecting information about children. Parents and teachers are the primary respondents when completing behavior rating scales (Barkley, 1997b, 1998).

Since both CPTs and scales/subscales of behavior rating scales purport to measure inattention, hyperactivity, and impulsivity, clinicians and researchers would expect that correlations of CPT performance and scales/subscales on behavior rating scales measuring inattention and impulsivity to be high, indicating concurrent validity (Riccio et al., 2001). This information is important because how a test relates to other tests informs clinicians and researchers about the inferences that may be made from test scores and the extent to which common variables may be at work (Anastasi, 1988; R. J. Cohen & Swerdlik, 1999).

A number of studies have investigated the relationship between CPTs and behavior rating scales. Studies that included correlational analyses found that hyperactivity scales/subscales tended to be more strongly associated with CPT measures than inattention scales or impulsivity scales. Also, hyperactivity scales from teacher ratings were strongly correlated with Commission Errors (Barkley, 1991; Halperin et al.,

1988; Kupietz & Richardson, 1978). For example, Kupietz & Richardson found that auditory and visual Commission Errors for the AX-CPT were significantly related to hyperactivity scales from teacher ratings. The visual Commission Errors were more strongly related than auditory errors for teacher ratings on the hyperactivity scale. Teicher, Ito, Glod, & Barber's (1996) study found the inattention/overactivity scale score of the Iowa Conners (Loney & Milich, 1982) to be moderately correlated with the reaction time variable of Greenberg's 1987 Minnesota Computer Assessment, an earlier version of the Test of Variables of Attention.

Factor analytic studies comparing measures of CPTs to behavior rating scales revealed poor loadings on the same factors. Lovejoy and Rasmussen (1990) conducted a factor analytical study using the Child Behavior Checklist (CBCL); (Achenbach & Edelbrock, 1986), the Revised Conners' Parent Rating Scale (RCPRS); (Goyette, Conners, & Ulrich, 1978), the Revised Conners' Teacher Rating Scale (RCTRS); (Goyette et al., 1978), and the Iowa Conners (Loney & Milich, 1982). Results of Lovejoy and Rasmussen's study found that scores from these scales did not load on factors with the variables from the AX-CPT. Campbell, D'Amato, Raggio, and Stephens (1991) investigated the construct validity of an AX-CPT with measures of intelligence, achievement, and behavior. Campbell's et al. study found that Omission and Commission Errors from the AX-CPT did not load on the same factor as the CPRS.

Factor analytic studies yielded inconsistent if not discouraging results regarding the association of CPT measures to scales measuring inattention, hyperactivity, and impulsivity, while correlational analysis also yielded inconsistent findings or low correlations between Omission and Commission Errors and scales measuring inattention,

hyperactivity and impulsivity. Low correlations were also found for CPT measures and other behaviors measured by rating scales such as emotional lability (Stein et al., 1994), oppositional behaviors (Forbes, 1998; Lassiter, D'Amato, Raggio, Whitten, & Bardos, 1994), conduct problems (Forbes, 1998), and social skill deficits (Forbes, 1998; Klee & Garfinkel, 1983; Lassiter et al., 1994). For example, Stein et al. (1994) conducted a study examining the Children's Atypical Development Scale (CADS); (Barkley, 1990) and an X-CPT. Results of Stein's et al. study found that Commission Errors were correlated with emotional lability scores. Forbes (1998) found correlations between the TOVA Omission Errors and the Hyperactivity and Oppositional scales of the ACTeRS (Ullman, Sleator, & Sprague, 1991), while only one correlation was found between the TOVA RT and the Inattention/Passive scale of the RCTRS (Goyette, Conners, & Ulich, 1978) which Forbes interprets as chance. Lassiter's et al. (1994) study found correlations between CPT measures and the Oppositional and Social Skills scales of the ACTeRS.

Comparison of other studies investigating CPTs with behavior rating scales found inconsistent evidence as to relationships between CPT measures and scales/subscales of behavior rating scales and the clinical and ecological validity of CPTs (Barkley, 1991). Forbes (1998) revealed that the TOVA was able to discriminate between the ADD/ADHD group and the group with other clinical disorders. However, the TOVA was unable to differentiate between the ADHD and the ADD group. The CTRS-R (Goyette et al., 1978) and the ACTeRS (Ullman et al., 1991) were able to discriminate between the ADD/ADHD group and the OTHER group, but were also not able to differentiate between the ADD and ADHD subtypes. Forbes hypothesized that all three instruments, the TOVA, CTRS-R and the ACTeRS, had some amount of error when classifying

children into groups, suggesting that the TOVA and the behavior rating scales are measuring similar, yet different aspects of ADHD. Schatz, Ballantyne, & Trauner (2001) examined the sensitivity and specificity of the TOVA and CPRS-R: S in identifying children with ADHD and a control group. Schatz's et al. study revealed significant symptoms of ADHD in 85% of children with a previous diagnosis of ADHD using the TOVA and the CPRS-R: S. The TOVA identified an additional 30% of control children as having attentional problems based on their performance. Schatz et al. concluded that CPTs may overidentify normal children with ADHD symptoms. Due to the inconsistent research findings regarding the relationship and consistency between CPTs and behavior ratings scales and the diagnostic utility of CPTs, additional studies need to be conducted to determine whether CPTs provide researchers and clinicians with valid test results to assist in the diagnosis of ADHD. For this reason, researchers recommend that a multimethod assessment approach be utilized when assessing for ADHD (Anastopoulos & Shelton, 2001; Barkley, 1998; DuPaul & Stoner, 2003).

The purpose of this study is to explore the relationship and consistency between two CPTs, the Test of Variables of Attention (i.e. visual version) (TOVA; Greenberg, 1988-1999) and the Test of Variables of Attention-Auditory (i.e. auditory version) (TOVA-A; Greenberg, 1996-1999), and two behavior rating scales that measure ADHD, the Conners' Parent Rating Scales - Revised: Long Form (CPRS-R: L; Conners, 1997c) and the Conners' Teacher Rating Scales - Revised: Long Form (CTRS-R: L); (Conners, 1997c) and determine the clinical and ecological validity the TOVA and TOVA-A in the assessment of ADHD. The first part of the study will determine the relationship between the TOVA and TOVA-A variables and the scales of the CPRS-R: L and CTRS-R: L. The

second part of this study will determine which variables of the TOVA and TOVA-A predict the DSM-IV scales of the CPRS-R: L and CTRS-R: L. Lastly, this study was developed to determine whether using a CPT, such as, the TOVA and TOVA-A helps to provide additional and useful information when assessing children for characteristics of ADHD. In doing so, this study will investigate whether the proportion of children identified as normal or abnormal by the TOVA and TOVA-A is significantly different to the proportion of children identified as normal or abnormal by the DSM-IV scales of the CPRS-R: L and CTRS-R: L.

METHOD

Participants

Participants were children between the ages of 6 and 12 from a medium-sized land grant university in the central region of the United States. Participants were recruited from the local public schools. The sample was divided by gender, 58.4% male and 41.6% female. Racial and ethnic backgrounds of children reported by parents were 78.4% Caucasian, 3.4% African American, 2.3% Asian/Pacific Islander, 5.7% Native American, 3.4% Hispanic, and 6.8% Other. The sample age of the children included 7.9% 6 years old, 20.2% 7 years old, 18% 8 years old, 20.2 % 9 years old, 13.5% 10 years old, 9.0% 11 years old, and 9.0% 12 years old. The educational level of parents giving consent for their child to participate in the research study was composed of 76.3% of fathers and 71.9% of mothers having completed a college degree, while 15.3% of fathers and 19.3% of mothers obtained a high school diploma. Only 8.8% of fathers and 8.5% of mothers comprised the 'Other' category for educational level indicating their educational level was higher than a college degree. Nearly all of the children, 96.3%, in the sample were

rated by their parent as developing in the normal range, while 3.7% of children were not within the normal developmental limits.

Instruments

The TOVA and TOVA-A is an X-type CPT in that the individual is required to respond as quickly as possible to the target stimulus, while inhibiting response to the nontarget stimulus. The TOVA assesses visual attention and inhibitory control, while the TOVA-A assesses auditory attention and inhibitory control. The TOVA and TOVA-A are completed separately within approximately 21 minutes. The total completion time for both modalities is a little over 40 minutes (Leark, Dupuy, Greenberg, Corman, & Kindschi, 1996). The first half of the TOVA and TOVA-A is considered the stimulus infrequent condition because the target stimuli are present only 22.5% of the time. The second half of the TOVA and TOVA-A is considered the stimulus frequent condition because the target stimuli are presented 77.5% of the time (Greenberg & Kindschi, 1996; Leark et al., 1996). Target and nontarget stimuli are presented for 100ms every 2 seconds. The participant uses a microswitch to respond to the target stimuli.

The TOVA and TOVA-A measures include Omission Errors (missed responses to target stimuli), Commission Errors (responses to nontarget stimuli), Response Time (RT; the time taken to respond to target stimuli), Response Time Variability (RTV; the inconsistency in RT), D-Prime (the accuracy of discriminating between target and nontarget stimuli), Anticipatory Responses (the response to a target or nontarget before its appearance), and Multiple Responses (those in which participants pressed the microswitch more than one time per stimulus presentation). In addition, an ADHD score is provided for the TOVA that compares the participant's performance to an identified

ADHD sample. The TOVA and TOVA-A yield standard scores (SS) and z-scores. The TOVA and TOVA-A standard scores between 85 and 115 are considered to be in the normal range. Standard scores above 115 are considered to be above normal, while standard scores below 85 are considered to be at-risk or abnormal. For the purposes of this research study, standard scores which fall one standard deviation below the mean (SS < 85) will be considered abnormal (Leark et al., 1996).

The Conners' Rating Scales-Revised (CRS-R) (Conners, 1997a) is considered a broad-band behavior rating scale designed to assess externalizing problems and internalizing problems in school-aged children and adolescents, and can also be used in the differentiation of ADHD. The CRS-R provides parent, teacher, and self-report rating scales. The Conners' Parent Rating Scale - Revised: Long form (CPRS-R: L; Conners, 1997c) and Conners' Teacher Rating Scale - Revised: Long form (CTRS-R: L; Conners, 1997c) was utilized in this study.

The CPRS-R: L and CTRS-R: L consists of 80 items. Both forms require the rater to respond to each item based on the child's behavior in the last month using a Likert scale: 0 = Not True At All (Never, Seldom); 1 = Just A Little True (Occasionally); 2 = Pretty Much True (Often, Quite a Bit); 3 = Very Much True (Very Often, Very Frequent). Each subscale of the CPRS-R: L and the CTRS-R: L was empirically derived to assess externalizing, as well as internalizing disorders (Conners, 1997a).

The CPRS-R: L is composed of seven clinical subscales. The clinical subscales produced from factor analyses include: Oppositional, Cognitive Problems/Inattention, Hyperactivity, Anxious-Shy, Perfectionism, Social Problems, and Psychosomatic. The CTRS-R: L includes all of these subscales, except the Psychosomatic subscale. Both the

CPRS-R: L and the CTRS-R: L contain the Conners' ADHD Index that consists of 12 items reported to discriminate between ADHD children and normal children. In addition, both assessments include two composite scales, the Conners' Global Index (CGI) and the DSM-IV Symptoms scales (Conners, 1997a; Gianarris, Golden, & Greene, 2001).

The CGI Total composite scale consists of 10 items that include two subscales, the CGI: Restless-Impulsive and the CGI: Emotional Lability subscales. The DSM-IV: Total composite scale consists of the DSM-IV: Inattentive and DSM-IV: Hyperactive-Impulsive subscales that parallel the 18 diagnostic items used in the DSM-IV to diagnosis ADHD and differentiate between subtypes (Conners, 1997a; Gianarris et al., 2001). The CPRS-R: L and CTRS-R: L yield T-scores with a mean of 50 and a standard deviation of 10 (Conners, 1997a).

The interpretative guidelines outlined in the CRS-R manual (Conners, 1997a) reported that T-scores above 70 represent a markedly atypical score indicating a significant problem; T-scores between 66 and 70 represent a moderately atypical score indicating a significant problem; T-scores between 61 and 65 represent a mildly atypical score indicating a possible significant problem; T-scores between 56 and 60 represent a slightly atypical score indicating a borderline problem that may be of concern; T-scores between 45 and 55 represent an average score which should not raise concern; while T-scores below 44 are considered low and are not a concern. For the purposes of this research study, T-scores one standard deviation above the mean (i.e. T-score $\geq$ 60) will be considered abnormal.

Procedure

Children ages 6 through 12 participating in the research study were administered a series of psychoeducational and neuropsychological assessments by trained graduate students under the supervision of the principal investigator who is a licensed psychologist. The TOVA (Greenberg, 1988-1999) and TOVA-A (Greenberg, 1996-1999) were administered along with other cognitive, neuropsychological and behavioral instruments in a larger study. The CPRS-R: L (Conners, 1997c) was completed by the parent at the time of each child's participation in the study. The CTRS-R: L (Conners, 1997c) was completed by the child's teacher.

RESULTS

Four Pearson correlation analyses were computed between the TOVA and TOVA-A measures (Omission Errors , Commission Errors, RT, RTV, the ADHD score [TOVA only], and D-Prime) and the scales on the CPRS-R: L and CTRS-R: L (Oppositional, Cognitive Problems/Inattention, Hyperactivity, Anxious-Shy, Perfectionism, Social Problems, Psychosomatic [CPRS-R: L only], Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, the Conners' Global Index: Emotional Lability, the Conners' Global Index: Total, the DSM-IV: Inattentive, the DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total) (Conners, 1997a). Due to the number of measures computed for the correlational analyses, only correlation coefficients significant at the $p \leq .01$ will be reviewed to reduce the chance of making a Type I error.

The first correlational analysis examined the relationship among the TOVA measures and the CPRS-R: L scales. Significant negative relationships were found between TOVA the RTV and the CPRS-R: L Cognitive Problems/Inattention scale (r = -

.308, $p \leq .01$) and between the TOVA D-Prime and the CPRS-R: L Cognitive Problems/Inattention scale ($r = -.316$, $p \leq .01$), the Conners' ADHD Index ($r = -.334$, $p \leq .01$), the DSM-IV: Inattentive scale ($r = -.312$, $p \leq .01$), and the DSM-IV: Total scale ($r = -.335$, $p \leq .01$). Correlation coefficients between the TOVA measures and the CPRS-R: L scales are shown in Table 1 in Appendix A.

The second Pearson correlational analysis examined the relationship among the TOVA measures and the CTRS-R: L scales. Significant negative relationships were found for the TOVA ADHD score and the following scales of the CTRS-R: L: Hyperactivity ($r = -.409$, $p \leq .01$), Social Problems ($r = -.408$, $p \leq .01$), Conners' ADHD Index ($r = -.385$, $p \leq .01$), Conners' Global Index: Restless-Impulsive ($r = -.386$, $p \leq .01$), Conners' Global Index: Emotional Lability ($r = -.408$, $p \leq .01$), Conners' Global Index: Total ($r = -.435$, $p \leq .01$), DSM-IV: Hyperactive-Impulsive ($r = -.401$, $p \leq .01$) and the DSM-IV: Total $r = -.424$, $p \leq .01$). In addition, the TOVA D-Prime was negatively correlated with the CTRS-R: L Cognitive Problems/Inattention ($r = -.426$, $p \leq .01$), DSM-IV: Inattentive ($r = -.408$, $p \leq .01$), and DSM-IV: Total scales ($r = -.366$, $p \leq .01$). The TOVA RTV was negatively correlated with the CTRS-R: L Social Problems ($r = -.383$, $p \leq .01$) and DSM-IV: Total ($r = -.351$, $p \leq .01$) scales. No significant correlations were found between the CTRS-R: L scales and the TOVA Commission Errors or RT. Only one significant negative relationship was found between the TOVA Omission Errors and the CTRS-R: L Cognitive Problems/Inattention scale ($r = -.402$, $p \leq .01$). Correlation coefficients between the TOVA measures and the scales of the CTRS-R: L are shown in Table 2 in Appendix A.

The third Pearson correlational analysis examined the relationship between the TOVA-A measures and the scales of the CPRS-R: L. Significant negative correlations were found between the TOVA-A Omission Errors and the following scales of the CPRS-R: L: Cognitive Problems/Inattention ($r = -.379$, $p \leq .01$), Conners' ADHD Index ($r = -.342$, $p \leq .01$), Conners' Global Index: Restless-Impulsive ($r = -.340$, $p \leq .01$), DSM-IV: Inattentive ($r = -.333$, $p \leq .01$), DSM-IV: Hyperactive-Impulsive ($r = -.342$, $p \leq .01$), and DSM-IV: Total ($r = -.380$, $p \leq .01$). Significant negative correlations were found between the TOVA-A Commission Errors and the following scales of the CPRS-R: L: Cognitive Problems/Inattention ($r = -.372$, $p \leq .01$), Conners' ADHD Index ($r = -.305$, $p \leq .01$), DSM-IV: Inattentive ($r = -.328$, $p \leq .01$), DSM-IV: Hyperactive-Impulsive ($r = -.325$, $p \leq .01$), and DSM-IV: Total ($r = -.358$, $p \leq .01$). No significant correlations at the $p \leq .01$ or the $p \leq .05$ were found between the TOVA-A RT and the CPRS-R: L scales. A significant negative correlation at the $p \leq .01$ was found between the TOVA-A RTV and the CPRS-R: L Cognitive Problems/Inattention scale ($r = -.300$). Lastly, four significant negative correlations at the $p \leq .01$ were found between the TOVA-A D-Prime and the CPRS-R: L Cognitive Problems/Inattention scale ($r = -.358$), the CPRS-R: L Hyperactivity scale ($r = -.327$), the DSM-IV: Hyperactive-Impulsive scale ($r = -.373$), and the DSM-IV: Total ($r = -.352$) scales. Correlation coefficients between the TOVA-A measures and scales on the CPRS-R: L are shown in Table 3 in Appendix A.

The fourth Pearson correlational analysis examined the relationship between the TOVA-A measures and the scales of the CTRS-R: L. A significant negative relationship was found between the TOVA-A Omission Errors and the CTRS-R: L Cognitive Problems/Inattention scale ($r = -.336$, $p \leq .01$). Significant negative correlations were

found between the TOVA-A Commission Errors and the CTRS-R: L Cognitive Problems/Inattention ($r = -.421$, $p \leq .01$), Social Problems ($r = -.408$, $p \leq .01$), DSM-IV: Inattentive ($r = -.393$, $p \leq .01$) and the DSM-IV: Total ($r = -.361$, $p \leq .01$) scales. No significant correlations were found at the $p \leq .01$ for the TOVA-A RT or RTV and the scales of the CTRS-R: L. Significant negative correlations were found between the TOVA-A D-Prime and the CTRS-R: L Cognitive Problems/ Inattention ($r = -.447$, $p \leq .01$), Social Problems ($r = -.368$, $p \leq .01$), Conners' ADHD Index ($r = -.355$, $p \leq .01$), the DSM-IV: Inattentive ($r = -.403$, $p \leq .01$) and the DSM-IV: Total ($r = -.370$, $p \leq .01$) scales. Correlations between the TOVA-A measures and scales of the CTRS-R: L are shown in Table 4 in Appendix A.

Twelve regression analyses were conducted to examine the relationship between the variables of the TOVA and TOVA-A and the DSM-IV scales (Inattentive, Hyperactive-Impulsive, and Total) of the CPRS-R: L and the CTRS-R: L for Research Question 2. The first set of three regression analyses found the TOVA D-Prime was the only predictor variable statistically significant at predicting all three of the DSM-IV scales (Inattentive, Hyperactive-Impulsive and Total) for the CPRS-R: L. The second set of three regression analyses found the TOVA RTV was significant for predicting the DSM-IV: Inattentive and DSM-IV: Hyperactive-Impulsive scales of the CTRS-R: L, while the TOVA ADHD score was a significant predictor for the DSM-IV: Total scale of the CTRS-R: L. The third set of three regression analyses found that the TOVA-A Omission Errors was significant for predicting the DSM-IV: Inattentive and DSM-IV: Total scales of the CPRS-R: L, while the TOVA-A D-Prime was significant for predicting the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L. Lastly, the

fourth set of three regression analyses found that the TOVA-A D-Prime was significant for predicting the DSM-IV: Inattentive and the DSM-IV: Total scales of the CTRS-R: L, while no predictor variables were statistically significant for predicting the DSM-IV: Hyperactive-Impulsive scale of the CTRS-R: L.

Chi-square analyses were conducted comparing the proportion of children identified as normal or abnormal for each variable of the TOVA and TOVA-A (Omission Errors, Commission Errors, RT, RTV, D-Prime and the ADHD score [TOVA only]) with the proportion of children identified as normal or abnormal for each variable of the CPRS-R: L and the CTRS-R: L (DSM-IV: Inattentive scale, DSM-IV: Hyperactive-Impulsive scale, and DSM-IV: Total). For the purposes of this research study, abnormal scores on the TOVA and TOVA-A are considered to be more than one standard deviation below the mean (SS < 85), while normal scores are considered to be 85 or above. Abnormal T-scores on the CPRS-R: L and CTRS-R: L are considered to be more than one standard deviation above the mean (T-score > 60), while normal scores are considered to be 59 or below.

Using a 2 x 2 chi-square table, 36 chi-square analyses were computed comparing the proportion of children identified as normal or abnormal for each variable of the TOVA with the proportion of children identified as normal or abnormal for the DSM-IV scales of the CPRS-R: L and the CTRS-R: L. None of the variables of the TOVA yielded a statistically significant chi- square using the Continuity Correction for a 2 x 2 table with the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales of the CPRS-R: L and CTRS-R: L.

In addition, using a 2 x 2 chi-square table, 30 chi-square analyses were computed comparing the proportion of children identified as normal or abnormal for each variable of the TOVA-A with the proportion of children identified as normal or abnormal for the DSM-IV scales of the CPRS-R: L and the CTRS-R: L. Two variables of the TOVA-A, the Commission Errors and D-Prime were statistically significant with the DSM-IV: Inattentive scale of the CPRS-R: L. The TOVA-A Commission Errors yielded a statistically significant chi-square analysis for the DSM-IV: Inattentive scale of the CPRS-R: L ($\chi^2 = 9.570$, df = 1, $p < .001$; $\Phi = .387$, $p < .001$). The TOVA-A D-Prime yielded statistically significant chi-square analysis for the DSM-IV: Inattentive scale of the CPRS-R: L ($\chi^2 = 4.574$, df = 1, $p < .05$; $\Phi = .277$, $p < .05$). While there is a difference between the TOVA-A Commission Errors and the CPRS-R: L DSM-IV: Inattentive scale and the TOVA-A D-Prime and the CPRS-R: L DSM-IV: Inattentive scale, the phi statistic (Φ) indicates that the strength of the association between the two variables is weak suggesting that the statistical significance may be due to chance considering that no other variables of the TOVA-A were statistically significant with the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and DSM-IV: Total scales of the CPRS-R :L or CTRS-R: L.

Discussion

The literature recommends utilizing a multi-method approach for assessing ADHD consisting of collecting data from multiple informants across multiple settings using multiple instruments (Barkley, 1998; DuPaul & Stoner, 2003). This researcher was interested in examining the relationship between a continuous performance test,

TOVA/TOVA-A and a behavior rating scale utilized by parents and teachers, the Conners' Rating Scales – Revised.

Four research questions were developed to investigate the relationship between the TOVA and TOVA-A and the CPRS-R: L and CTRS-R: L. The first research question addressed correlational analyses, which examined the relationship among the measures of the TOVA and TOVA-A and the scales of the CPRS-R: L and CTRS-R: L. Based on research literature, errors of omission purport to measure inattention, while errors of commission purport to measure impulsivity or behavioral disinhibition (Leark, et al., 1996; Sostek, Buchsbaum, & Rapoport, 1980). Due to the large number of correlational analyses and to avoid making Type I errors, correlations with a $p \leq .01$ will be discussed in more detail, while correlations with a $p \leq .05$ will not be emphasized (Keppel, 1991).

Correlational analyses between the TOVA and CPRS-R: L, the TOVA and CTRS-R: L, the TOVA-A and CPRS-R: L, and the TOVA-A CTRS-R: L yielded inconsistent support for the hypotheses that measures of inattention and impulsivity on the TOVA and TOVA-A would be correlated with scales measuring inattention and impulsivity on the CPRS-R: L and CTRS-R: L. Based on the research literature, it would be expected that Omission Errors and Commission Errors to be moderately or even highly correlated with scales measuring inattention, hyperactivity, and impulsivity.

Correlations between the TOVA and CPRS-R: L did not support this hypothesis. The TOVA Omission Errors and Commission Errors revealed no statistically significant correlations for scales of the CPRS-R: L measuring inattention or impulsivity. In addition, correlations between the TOVA and CTRS-R: L revealed only one scale, the Cognitive Problems/Inattention scale to be moderately correlated with the TOVA

Omission Errors, while none of the scales of the CTRS-R: L was moderately correlated with the TOVA Commission Errors.

Correlational analysis between the TOVA-A and CPRS-R: L demonstrated support for the hypothesis, but correlations between the TOVA-A and CTRS-R: L did not show consistent results. A distinct pattern emerged between the TOVA-A measures and the CPRS-R: L. The TOVA-A Omission Errors, Commission Errors, RTV, and D-Prime revealed low to moderate correlations with the following CPRS-R: L scales: Cognitive Problems/Inattention, Hyperactivity, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total. Correlational analysis between the TOVA-A and CTRS-R: L revealed a low correlation at the $p < .01$ with the TOVA-A Omission Errors and the Cognitive Problems/Inattention scale and low to moderate correlations at the $p < .01$ between the TOVA-A Commission Errors and the following scales of the CTRS-R: L: Cognitive Problems/Inattention scale, the Social Problems scale, the DSM-IV: Inattentive scale, and the DSM-IV: Total scale. In addition, the TOVA-A D-Prime revealed low to moderate correlations at the $p < .01$ with the following scales of the CTRS-R: L: Cognitive Problems/Inattention, Social Problems, and the Conners' ADHD Index. The TOVA-A Omission Errors, Commission Errors, and D-Prime were low to moderately correlated at the $p \leq .01$ or $p \leq .05$ with the CPRS-R: L Hyperactivity and DSM-IV: Hyperactive-Impulsive scales. However, none of the TOVA-A measures was significantly correlated with the CTRS-R: L Hyperactivity or DSM-IV: Hyperactive-Impulsive scales.

Previous research studies also found inconsistent correlations for Omission Errors and Commission Errors and scales measuring inattention and hyperactivity. These studies

typically found low correlations for Omission Errors and scales of inattention and generally low to moderate correlations for Commission Errors and scales measuring hyperactivity (Barkley, 1991; Forbes, 1998; Klee & Garfinkel, 1983; Kupietz & Richardson, 1978; Lassiter et al., 1994). The reason Omission Errors and Commission Errors were not highly correlated with scales of inattention and hyperactivity may be better understood looking at a study conducted by Llorente et al. (2001) investigating the internal consistency, temporal stability and reproducibility of individual index scores of the TOVA. Llorente's study found that individual Omission Errors and Commission Errors exhibited greater bias (i.e. less individual test-re-test score agreement) than scores of RT and RTV. The results of this study are partially supported by Llorente's conclusions. The TOVA RTV appeared to show less bias and a stronger internal consistency than the TOVA Omission Errors and the TOVA Commission Errors scores. For example, the TOVA RTV revealed moderate correlations at the $p \leq .01$ with the CPRS-R: L Cognitive Problems/Inattention scale, the CTRS-R: L Social Problems scale and the CTRS-R: L DSM-IV: Total scale. Several scales from the CPRS-R: L and the CTRS-R: L were correlated at the $p \leq .05$ level with the TOVA RTV. The TOVA RTV appeared to show more consistent results across raters than the TOVA-A RTV. For example, the TOVA-A RTV showed a low correlation at the $p \leq .01$ level with the CPRS-R: L Cognitive Problems/Inattention scale and low correlations at the $p < .05$ with the following CPRS-R: L scales: Hyperactivity, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total. However, the TOVA-A RTV was not correlated at the $p \leq .01$ level

with any of the CTRS-R: L scales. Only the CTRS-R: L DSM-IV: Inattentive scale was correlated at the $p \leq .05$ level with the TOVA-A RTV.

The RT variable of the TOVA and TOVA-A did not prove to be as reliable a measure in this study as Llorente's study. The TOVA RT revealed only low correlation at the $p \leq .05$ level with the CPRS-R: L Cognitive Problems/Inattention scale and did not show any significant correlations with the CTRS-R: L. The TOVA-A RT was not significant with any of the scales of the CPRS-R: L and revealed only a low correlation at the $p \leq .05$ level with the CTRS-R: L Conners' Global Index: Emotional Lability scale.

To investigate any additional support for these findings, Forbes (1998) found RT to be weakly correlated with teacher rating scales that assess attention versus inattention, hyperactivity, hyperkinesis index, and inattention/passivity, while RTV was weak to moderately correlated with teacher rating scales which measured 1) attention/inattention, 2) inattention/passivity, 3) hyperactivity, 4) hyperkinesis index, 5) conduct problems, 6) oppositional behavior, and 7) social skills. Based on previous research and this research study, it appears that the TOVA and TOVA-A RT is not as important as the variability of the reaction time (RTV) when identifying relationships with scales of inattention, hyperactivity-impulsivity and other behaviors characteristics of children with ADHD on the CPRS-R: L and the CTRS-R: L.

One of the most promising measures at identifying characteristics of inattention, hyperactivity, impulsivity, and other behaviors is D-Prime. Within the research literature, D-Prime has not been studied as extensively as Omission Errors or Commission Errors (Riccio et al., 2001). Other studies found D-Prime to be weakly or moderately associated with scales measuring inattention, hyperactivity, externalizing behaviors (Lam & Beale,

1991; Mitchell & Quittner, 1996), and overall total scores (Lassiter et al., 1994; Mitchell & Quittner, 1996). Based on the research literature, it is expected that D-Prime would reveal low to moderate correlations with scales measuring inattention, hyperactivity, externalizing behaviors and overall total scores. Within this research study, the TOVA and TOVA-A D-Prime revealed moderate negative correlations with the Cognitive Problems/Inattention, the DSM-IV: Inattentive and the DSM-IV: Total scales on both the CPRS-R: L and CTRS-R: L. The TOVA-A D-Prime also showed moderate correlations with the CPRS-R: L Hyperactivity and DSM-IV: Hyperactive-Impulsive scales, however, this relationship was not present on the CTRS-R: L. Results of the TOVA and TOVA-A D-Prime appear to be consistent with the research literature at correlating moderately with scales measuring inattention, while the TOVA-A D-Prime may be sensitive to scales measuring hyperactivity.

In addition, the TOVA and TOVA-A D-Prime was moderately correlated with the CTRS-R: L Social Problem scale, but was not significant on the CPRS-R: L suggesting that D-Prime may be a sensitive measure when identifying social problems in children that are observed in a school setting by teachers. Teachers are more likely to observe social problems in children than parents because more social interactions take place at school among a larger more diverse peer group than at home. In addition, teachers are also more likely to observe behaviors of inattention, hyperactivity, and impulsivity because of the situationally specific expectations within a school environment. For example, Melnyk and Das (1992) noted that for children to be perceived as "good attenders", they needed to be able to focus and sustain attention toward tasks for long periods of time and attend selectively to appropriate stimuli, while inhibiting their

response to external stimuli (i.e. distractors). Melnyk and Das concluded that teachers may be more sensitive to a child's ability to resist distractors, which is an aspect of selective attention. Thus, teachers may be more observant at identifying characteristics of inattention, hyperactivity, impulsivity, and other behaviors, such as social problems. These findings appear to support the research literature that D-Prime is measuring sustained attention (amount of time on task), as well as, an aspect of selective attention because the individual must discriminate (i.e. selectively attend) to the target stimulus, while filtering out the nontarget stimulus (Melnyk & Das, 1992).

An ADHD score is provided for the TOVA, but not the TOVA-A. The ADHD score is derived from a formula using the RT z-score, the D-Prime z-score and the RTV z-score (Leark et al., 1996), thus it is not a pure variable for measuring inattention or impulsivity. The TOVA ADHD score did not yield any correlations at the $p \leq .01$ with scales on the CPRS-R: L. Results between the TOVA ADHD score and the CTRS-R: L were more favorable. The TOVA ADHD score revealed moderate negative correlations with the following scales of the CTRS-R: L: Anxious-Shy, Social Problems, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, Conners' Global Index: Emotional Lability, Conners' Global Index: Total, DSM-IV: Hyperactive-Impulsive and the DSM-IV: Total. The discrepancy between statistically significant correlation coefficients between the ADHD score and the CPRS-R: L and the CTRS-R: L may have been due to differences in rater responses due to situationally specific expectations within each setting (Breen & Altepeter, 1990) and the disorder itself may manifest itself differently based on contingencies within the environment (Barkley,1998). The ADHD score was moderately correlated with the Hyperactivity scale and the DSM-IV:

Hyperactive-Impulsive scale of the CTRS-R: L suggesting that it is a significant indicator of children who are exhibiting characteristics of hyperactivity/impulsivity. The TOVA RTV and the D-Prime were not as reliable at demonstrating a relationship or did not demonstrate as strong a relationship as the ADHD score with the Hyperactive scale and/or DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L and CTRS-R: L. The TOVA Omission Errors, the Commission Errors and the RT showed no relationship with the Hyperactive scale or the DSM-VI: Hyperactive-Impulsive scale of the CPRS-R: L or the CTRS-R: L indicating that these measures may not be as sensitive as the ADHD score at measuring hyperactivity and impulsivity.

The researcher was also interested in predicting which variables of the TOVA and TOVA-A predicted the DSM-IV: Inattentive scale, DSM-IV: Hyperactive-Impulsive scale and the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L. Within the research literature, few studies have focused on multiple regression as a statistical analysis for determining relationships among CPT variables and parent and teacher rating scales measuring inattention, hyperactivity and impulsivity. It was expected that TOVA and TOVA-A Omission Errors would predict scales of the CPRS-R: L and the CTRS-R: L measuring inattention and that the TOVA and TOVA-A Commission Errors would predict scales of the CPRS-R: L and CTRS-R: L measuring hyperactivity and impulsivity. Multiple regression analyses found that the TOVA and TOVA-A D-Prime, the Omission Errors, and the RTV score were able to predict the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive and DSM-IV: Total scales, while the TOVA D-Prime predicted the CPRS-R: L DSM-IV: Hyperactive-Impulsive scale and the TOVA ADHD score predicted the CTRS-R: L DSM-IV: Hyperactive-Impulsive scale. The TOVA-A D-

Prime predicted the CPRS-R: L DSM-IV: Hyperactive-Impulsive scale, while the TOVA-A D-Prime entered the equation as the first variable but was not statistically significant at predicting the CTRS-R: L DSM-IV: Hyperactive-Impulsive scale. The TOVA and TOVA-A Commission Errors did not predict scales measuring hyperactivity/impulsivity. While these predictors yielded statistically significant zero-order correlations, none of the predictors accounted for more than 20% of the variance for the criterion suggesting there may be multicollinearity among the variables. Investigation of interrcorrelations of the TOVA and TOVA-A revealed the Omission Errors, RTV, D-Prime, and the ADHD score to be strongly correlated with each other. Another reason variance was low may be due to the possibility of low subject to variable ratios. Increasing the sample size would increase power and reduce the opportunity for multicollinearity (Pedhazur, 1997).

Chi-square analyses for the TOVA and DSM-IV scales of the CPRS-R: L and CTRS-R: L revealed no statistically significant results suggesting that the variables of the TOVA are identifying the same proportion of children as normal or abnormal as the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales of the CPRS-R: L and the CTRS-R: L. Chi-square analyses for the TOVA-A and DSM-IV scales of the CPRS-R: L and CTRS-R: L found two variables (Commission Errors and D-Prime) to be statistically significant with DSM-IV: Inattentive scale of the CPRS-R: L, while no other variables were found to be significantly related to the DSM-IV: Hyperactive-Impulsive or DSM-Total scales of the CPRS-R: L. One would expect differences between Commission Errors which measure impulsivity and the DSM-IV: Inattentive scale which measure symptoms of inattention. However, this significance is

not demonstrated elsewhere in the study suggesting that the results may be due to error. The statistically significant difference expressed between the D-Prime and the DSM-IV: Inattentive scale of the CPRS-R: L may also be due to error because no other statistical significances were found for D-Prime or any other variables of the TOVA-A. Likewise, no significant differences were produced between the variables of the TOVA-A and the DSM-IV scales of the CTRS-R: L. Overall, these results indicate that there is no difference between the proportion of children identified by the TOVA and TOVA-A as normal or abnormal and the proportion of children identified as normal or abnormal by the DSM-IV scales of the CPRS-R: L and CTRS-R: L. This suggests that the variables of the TOVA and TOVA-A are identifying the same proportion of children as the DSM-IV scales of the CPRS-R: L and CTRS-R: L. These results are in contrast to Schatz et al. (2001) concluding that the TOVA over identifies children as exhibiting inattention and impulsivity compared to the abbreviated CPRS. Comparisons of Schatz's et al. study and this research study may not be relevant because of the differences in the research design. This research study utilized a nonreferred sample of children who were not divided into a control group or ADHD group.

Several problems arise when interpreting the chi-square analyses with the correlational and multiple regression analyses. Based on the results of the correlational and multiple regression analyses, the TOVA and TOVA-A variables appear to be measuring different aspects of inattention, hyperactivity, and impulsivity than parent and teacher rating scales. However, when comparing the proportion of children identified as normal or abnormal no differences were found indicating that the TOVA and TOVA-A variables are identifying the same proportion of children as the DSM-IV scales of the

CPRS-R: L and CTRS-R: L. Within the research literature, it is well known that CPTs are able to differentiate between normal controls and an ADHD/ADD group (Corkum & Siegel, 1993). Clinicians and researchers contend that it is not difficult to differentiate between normal and abnormal without the use of CPTs. Rutter (1983) indicated that while a diagnostic instrument may differentiate between normal controls and clinical groups, it does not mean that the instrument is relevant to clinical diagnosis. The real challenge is differentiating between various psychopathologies that may be present. CPTs have not been able to discriminate between an ADHD Combined/ Predominately Hyperactive-Impulsive Type group, an ADHD Predominately Inattentive Type group and other clinical groups (Forbes, 1998). While some clinicians and researchers argue that CPTs do not provide adequate environment utility to justify its use (Barkley, 1991), others believe that CPTs may provide a unique contribution that subjective instruments, such as behavior rating scales are not able to provide due to rater biases and differences within settings (Forbes, 1998). CPTs are still a useful instrument for assessing characteristics of inattention, hyperactivity, and impulsivity and have proven useful for measuring treatment effects (Leark et al., 1996). Based on the results of this research study, the TOVA and TOVA-A CPT may be useful at confirming symptoms of inattention, hyperactivity, or impulsivity when used as part of a multiple-method approach consisting of collecting data from multiple informants across multiple settings using multiple instruments (Anastopoulos & Shelton, 2001; Barkley, 1998; DuPaul & Stoner, 2003).

CHAPTER II

REVIEW OF LITERATURE

Historical Study of Attention and Its Significance

The study of attention has been of significance to the field of psychology since the late 19th century when Ribot (1890) published the first book, Psychology of Attention, summarizing the research of attention. In the early twentieth century, Still (1902) studied attentional problems in children, which he called "abnormal psychical conditions". A few years later, two seminal works, Titchener's (1908) publication entitled Psychology of Feeling and Attention and Pillsbury's (1908) publication entitled Attention devoted extensive study to the research of attention. The study of attention was one of the most important achievements in the field of experimental psychology at that point, and persists as a significant area of research to the present time. Lovie (1983) conducted a survey analyzing the number of publications with attention as the topic, in the title and as a keyword. Between 1911 and 1960 there were 800 studies with attention as the topic. By 2002, there were 1,189 publications with attention in the title and 6,825 with attention as a keyword. The study of attention continues to be a central and perplexing field of interest in the research literature (Johnson and Proctor, 2004).

The psychological community now places attentional problems under the umbrella of Attention-Deficit/Hyperactivity Disorder (ADHD). ADHD is one of the most common problems in children and the most studied of childhood disorders (Barkley,

1998). The diagnosis of ADHD appears to be quite controversial due to the heterogeneous nature of the disorder. Estimating the prevalence of ADHD in the population is difficult due to controversies on how to diagnosis the disorder (Barkley, 1997b, 2003; Goodyear & Hynd, 1992). Estimates have been cited as low as 1% and as high as 20% of the school-aged population (Barkley, 1998; Cohen & Riccio, 1994). However, a general figure cited by the American Psychiatric Association (2000) is approximately 3% to 5% of the population is diagnosed with ADHD.

Schools have seen an increase in the frequency of children diagnosed with ADHD (DuPaul & Stoner, 2003; Mercugliano et al., 1999), thus making it a significant childhood disorder (Barkley, 1998) and a frequent concern among parents and teachers within the schools. To aid school psychologists in determining an accurate diagnosis of ADHD, it is crucial to conduct a comprehensive evaluation utilizing cognitive and behavioral instruments (DuPaul & Stoner, 2003; Mercugliano et al., 1999). If ADHD is present, a differential diagnosis of ADHD is important, especially when it is likely that other childhood disorders exist (Barkley, 1996a; 2003). Researchers recommend collecting information in multiple settings, using multiple informants and multiple instruments (Anastopoulos & Shelton, 2001; Barkley, 1998; DuPaul & Stoner, 2003).

Assessing a child who exhibits a conglomerate array of symptoms can be quite challenging for clinicians trying to determine whether the child presents with ADHD symptoms or ADHD-like characteristics influenced by environmental factors (Barkley, 1998; DuPaul & Stoner, 2003; Mercugliano et al., 1999). To add to the confusion, many children do exhibit characteristics that warrant a diagnosis of ADHD, but also exhibit

other concomitant conditions such as oppositional behavior, conduct problems, anxiety, depression, and learning disorders.

Many cognitive and behavioral diagnostic instruments have been developed to assist in identifying children with attention problems (Barkley, 1998; DuPaul & Stoner, 2003). A predominant cognitive diagnostic tool utilized in clinical settings is the continuous performance test (CPT). CPTs give quantitative information about an individual's degree of attention and behavioral (response) inhibition (Riccio et al., 2001). While quantitative information provides nonbiased information, CPTs are expensive and inconvenient because parents are often asked to take their children out of school for a doctor's appointment in which a clinician administers the CPT and interprets the data. A more convenient and cost-effective method of collecting information about children is behavior rating scales. Behavior rating scales are frequently applied as standardized behavioral measures for assessing ADHD. Parents and teachers are the primary respondents when completing behavior rating scales (Barkley, 1997b, 1998; DuPaul & Stoner, 2003). While one seems more convenient than the other, both diagnostic approaches are not without limitations as will be discussed extensively in this literature review.

The purposes of this literature review are to provide the reader with a historical overview of attention as a significant disorder; emphasize the importance of empirical inquiring into ADHD due to detrimental influences of attentional disorders on the life trajectories of children and youth; explore the differentiation of ADHD subtypes; highlight the constructs of attention, hyperactivity and inhibitory control; and investigate cognitive and behavioral diagnostic instruments utilized to assess the disorder.

The purpose of this study is to examine the relationship between a cognitive/neuropsychological diagnostic instrument that measures inattention and impulsivity and a behavior rating scale that measures ADHD to determine the clinical and ecological validity of utilizing each instrument in the assessment of ADHD.

History of ADHD

The history of ADHD spans over 100 years of research, from the late 1800's until well into the beginning of the 21st century. Barkley (1998) proposed that the period between 1900 to1950 is the period known as "the age of the brain-damaged child" (pg.3). The period started with Still's (1902) description of children seen in his clinical practice who were aggressive, defiant, resistive to discipline, excessively emotional, showed little "inhibitory volition" and had difficulty with sustained attention. Still described these children as lawless, spiteful, and dishonest, and proposed that the major problem with these children was a "defect of moral control". He defined moral control as an individual's ability to control his or her actions and conform for the greater good of others. A defect in moral control meant that children were impaired in three areas: 1) cognition related to the environment, 2) moral consciousness, and 3) inhibitory volition. Still proposed that these defects were related to an underlying neurological deficiency in which he speculated that these children had a decreased threshold for volitional inhibition or possibly a neural disconnection syndrome caused by cell modification that caused significant brain damage. Still believed that this syndrome was permanent and children exhibiting these symptoms needed a special education setting.

Between 1917 and 1918, the United States experienced an encephalitis epidemic that left many children with symptoms manifesting impairment in attention, cognition,

and behavior (Kessler, 1980). Although these children clearly had brain infections causing brain damage, the encephalitis epidemic spurred the empirical interest of physicians, psychologists and researchers in children presenting these symptoms (Barkley, 1998). Strauss and Lehtinen (1947) proposed that children presenting psychological or behavioral symptoms similar to brain damage, but with no evidence of brain injury, were still regarded as having "minimal brain damage" (MBD). Cruickshank and Dophin (1951) extended this notion to nonretarded children who manifested behavioral or psychological disturbances. Other researchers such as Childers (1935) argued against this notion of considering children as having MBD with no history of brain injury.

The period of 1960 to 1969 Barkley (1998, pg. 8) calls "The Golden Age of Hyperactivity". The concept of MBD as the primary cause of behavioral, cognitive, and psychological disturbances started to decline with the inception of a task force by the National Institute of Neurological Disease and Blindness (Clements, 1966). Kirk (1963) pointed out that the term MBD was vague, over inclusive and did not present any neurological evidence. Also at this time, the concept of hyperactive children arose with Chess (1960) emphasizing over-activity as the primary feature of the disorder. Chess described these children as impulsive, aggressive, and defiant, and having a poor attention span, and difficulties in school. However, Chess believed that children would outgrow these problems. The Diagnostic and Statistical Manual of Mental Disorders – Second Edition (DSM-II; American Psychiatric Association, 1968) described this behavioral phenomenon as hyperkinetic syndrome disorder which was "characterized by

overactivity, restlessness, distractibility, and short attention span, especially in young children; the behavior usually diminishes by adolescence" (p. 50).

Barkley (1998) identifies the period between 1970 to 1979 as the "ascendance of attention deficits" (p. 10). Douglas (1972) proposed a model of attention deficits and impulse control as the primary symptoms of this childhood disorder rather than hyperactivity. Douglas's model (1976) emphasized four major deficits that accounted for the symptoms of ADHD: 1) maintenance of attention and effort; 2) the inhibition of impulsive responding; 3) the modulation of arousal levels to meet situational demands, and 4) the need for immediate reinforcement. Research by Douglas' team substantiated this claim that children with hyperactivity also had significant problems with sustained attention when measured by a continuous performance test (CPT). This model of attention deficit was highly recognized by others as the predominant reason for the disorder, thus in 1980 with the publication of the Diagnostic and Statistical Manual – Third Edition (DSM-III; American Psychiatric Association, 1980), the disorder was called Attention-Deficit Disorder (ADD).

Barkley (1998) refers to the period between 1980 and 1989 as "the age of diagnostic criteria and the rise and fall of attention deficits" (p. 21). The problem with the new diagnostic criteria of ADD is that the diagnosis failed to take into account whether the child also exhibited hyperactive-impulsive characteristics. Thus, the Diagnostic and Statistical Manual – Third Edition – Revised (DSM-III-R; American Psychiatric Association, 1987) accounted for two subtypes of the disorder, renaming the disorder Attention-Deficit Hyperactivity Disorder (ADHD). Children could be diagnosed with Attention-Deficit with Hyperactivity (ADD+H) or Attention-Deficit without

Hyperactivity (ADD-H) (Goodyear & Hynd, 1992; Lahey & Carlson, 1992). Research during this time period focused on differentiating the symptoms of those with hyperactivity and those without. By the end of the decade, attention deficit was starting to decline in favor as the primary cause of the disorder (Barkley, 1998).

Barkley (1998) refers to the 1990s as the "decade of neuroimaging, genetics, and adult ADHD" (p. 35). Research led scientists back to behavioral inhibition, first alluded to by Stills (1902) as the primary cause (Barkley, 1997a, 1997c), focusing on the biological-based mechanisms and neurochemical connections of the brain (Zametkin et al., 1990). Genetic research has also given credence to the contention that the disorder of ADHD has a familial link (Biederman, Faraone, & Lapey, 1992; Biederman, et al., 1995; Biederman et al., 1993; Biederman, Keenan, & Faraone, 1990). The Diagnostic and Statistical Manual – Fourth Edition (DSM-IV; American Psychiatric Association, 1994) differentiated the disorder as three subtypes and described the diagnostic criteria for each. The three subtypes are 1) Attention-Deficit Hyperactivity Disorder Predominantly Inattentive Type, 2) Predominantly Hyperactive-Impulsive, and 3) ADHD Combined Type (including characteristics of inattention and hyperactive-impulsive behaviors). See Table 5 in Appendix A for a description of the DSM-IV diagnostic criteria for ADHD.

By the end of the 1990s, Barkley (1997a; 1997c; 1999) theorizes that ADHD may be predominantly a disorder of response inhibition rather than inattention. ADHD is no longer seen as a disorder of childhood or adolescence, but as a disorder spanning a lifetime as evidenced by research studies following children and adolescents with ADHD into adulthood (Wender, 1995). Barkley (1998) noted that at the end of the century, ADHD is one of the most well-studied childhood disorders and appears to be widely

accepted among the majority of mental health and pediatric professionals as a legitimate developmental disorder.

With the beginning of a new millennium and the culmination of research, a consensus statement has been developed describing ADHD as…..

> "a developmental disorder of attention span and/or overactivity – impulsivity in which these deficits are significantly inappropriate for the child's mental age; have an onset in early childhood; are significantly pervasive or cross situational in nature; are generally chronic or persistent over time; and are not the direct result of severe language delay, deafness, blindness, autism, or childhood psychosis" (Barkley, 2002, pg. 1389).

It appears that after 100 years of research into the nature, assessment, diagnosis and treatment of ADHD, researchers and clinicians still are wrestling with the perplexities of the disorder.

Life Trajectory of Children and Youth with ADHD

The life trajectory of children and youth with ADHD follows a course in which the problems experienced in childhood are connected to problems in adulthood (Barkley, 1998; Lahey & Loeber, 1997). For children with behavioral patterns characterized with inattention, hyperactivity and impulsivity, parents reported a much lower age of onset at approximately 3 years of age (Lahey & Loeber, 1997).

It is well known that more boys are affected than girls (Hartung et al., 2002; Merrell & Tymms, 2001) and that children and youth with ADHD have difficulty making friends due to deficiencies in social skills (Erhardt & Hinshaw, 1994; Guevremont & Dumas, 1994; Maedgen & Carlson, 2000). Children and youth with ADHD are more

likely to have disruptive behavior problems at school and home, particularly oppositionality, and conduct problems (Biederman, Mick, Faraone, & Burback, 2001; Lahey, Loeber, Burke, Rathouz, & McBurnett, 2002; Loeber, Green, Lahey, Frick, & McBurnett, 2000; Willcutt, Hartung, Lahey, Loney, & Pelham, 1999) and are at greater risk for meeting the criteria of mood disorders such as anxiety disorder (Biederman, Newcorn, & Sprich, 1991) depression (Biederman et al., 1991), and bipolar disorder (Milberger, Biederman, Faraone, Murphy, & Tsuang, 1995). Lower IQ scores are reported in studies examining the relationship between cognitive functioning and inattention, hyperactivity, and impulsivity; however, these results need to be interpreted with caution because it appears that IQ scores vary depending on the ADHD subtype and other comorbid conditions (Waschbusch, 2002). As a general rule, children and youth with ADHD are more likely to have academic problems (Beitchman & Young, 1997; Hinshaw, 1994; Manguin & Loeber, 1996), be retained, drop out of school, receive special education services, and be rejected by their peers (Barkley, DuPaul, & McMurray, 1990).

A variety of social-emotional problems in children affect the entire family. For example, parenting a child with ADHD increases parental anxiety. Mothers and fathers report increased drinking and substance abuse when parenting a child with ADHD (Chronis et al., 2003). Thus they are ill-equipped to face the problem of attention deficit in their children alone (Pfiffner et al., 1999).

It is important to understand the significance of ADHD in children and youth because of the lifelong effects of this disorder. Early diagnosis and intervention is

essential both at school and the home setting if these children and youth are to have positive life outcomes.

Differentiations between ADHD Subtypes

Within the research literature, the combined type and the predominantly hyperactive-impulsive type have been heavily investigated, while the predominantly inattentive type has been less-examined within the literature (Carlson, 1986; Goodyear & Hynd, 1992). Goodyear and Hynd conducted an extensive meta-analysis in 1992 evaluating the literature regarding the differentiation of ADD subtypes using the DSM-III-R diagnostic criteria and examining the neuropsychological literature concerning the ADD+H and the ADD-H subtype. From 1980 to 1991, twenty-one studies utilizing behavior, cognitive, and neuropsychological instruments addressed methods for differentiating ADD+H and ADD-H and other comorbid conditions, such as learning disorders, oppositionality and conduct problems.

Children who exhibit ADD-H may be identified later than children who exhibit ADD+H because those with symptoms of overactivity may be more noticeable to parents and teachers (Lahey, Schaughency, Hynd, Carlson, & Nieves, 1985). Some researchers believe that ADHD Predominately Inattentive Type as defined in the DSM-IV (American Psychiatric Association, 2000) or ADD-H as defined in the DSM-III-R (American Psychiatric Association, 1987) is a separate disorder from ADHD Predominately Hyperactive-Impulsive or ADHD Combined Types. Individuals that exhibit inattention without hyperactive-impulsive characteristics are thought to be neurologically different and may represent an entirely different disorder from those children that present with the combined type or predominately hyperactive-impulsive type (Barkley, 1997c; Goodyear

& Hynd, 1992; Lahey et al., 1985). However, Routh (1986) questions whether the ADD-H (i.e. ADHD Predominantly Inattentive Type) is a valid subtype distinctly different than the ADD+H (i.e. ADHD Combined Type or ADHD Predominantly Hyperactive-Impulsive Type) because of the lack of controlled studies differentiating ADD-H and the non-ADD groups.

Results of studies indicate that there are different characteristics between the two types, ADD+H and the ADD-H (Goodyear & Hynd, 1992). The ADD+H group is more active and impulsive than the ADD-H (Berry et al., 1985; Hynd et al., 1991; Lahey et al., 1985, 1987, 1988). Both groups appear to have symptoms of inattention, but differ in regards to the type of inattention (Barkley, et al. 1990). Children with ADD-H have more internalizing characteristics such as a sluggish cognitive tempo, inattention, disorganization, and anxiety, while children with ADD+H have more externalizing characteristics such as hyperactivity, impulsivity, inattention, and in some cases behavioral problems (Barkley et al., 1990; Berry et al., 1985; Lahey et al., 1988; Hynd et al. 1991). Children with ADD-H and ADD+H also present with qualitative differences at school. Hynd and colleagues suggest that poor academic performance for children with ADD+H is linked more to behavioral/attentional problems, while children with ADD-H have more cognitive/attentional problems and are more likely to have a learning disorder. In order to better understand ADHD and its effects on children and youth, it may be helpful to consider the constructs and theoretical perspectives associated with ADHD.

Constructs of Attention, Hyperactivity, and Impulsivity

ADHD is a complex disorder related to the characteristics of inattention, hyperactivity, and impulsivity. These characteristics are often associated with two

primary constructs, attention and behavioral inhibition. Attention and behavioral inhibition are multidimensional constructs with varying theoretical perspectives (Barkley, 1996b). While the current research literature on ADHD has focused on inhibitory control as the primary deficit of those with ADHD, attentional problems are still a characteristic of the definition of ADHD and are important in the study of ADHD.

Construct of Attention (Inattention)

Theories of attention have not only been applied to the study of ADHD children, youth, and more recently adults, but to individuals with schizophrenia, epilepsy, Alzheimer's disease, and traumatic brain injuries that manifest behavioral symptoms of impaired attention and executive function (R. A. Cohen, 1993). Within the construct of attention, there are three primary theoretical perspectives of attention; 1) information processing, 2) neuropsychological, and 3) behavioral perspectives (Lyon & Krasnegor, 1996) that can be related to the study of ADHD.

Cognitive Information Processing Perspective of Attention

Johnson and Proctor (2004) present a theory of attention based on the information processing perspective. The central theme of information processing is that the individual is a receiver and transmitter of information. Johnson and Proctor describe a framework of information processing, which involves perceiving the stimulus, responding to the stimulus, and executing the response. Children with attentional difficulties often have trouble perceiving the appropriate stimulus due to extraneous stimuli within the environment and often have trouble responding to the stimulus appropriately and executing an appropriate response. Thus, parents and teachers often describe these

children as having difficulty listening when others speak to them directly and having difficulty with paying attention to the appropriate stimulus.

According to the information processing perspective of attention, a distinction is made between four different components of attention; more specifically, 1) arousal (or alertness), 2) sustained attention (also known as vigilance), 3) selective attention (also known as divided attention) and 4) capacity to process information (Posner & Boies, 1971; Broadbent, 1953, 1957). Johnson and Proctor (2004) defined arousal as one's general level of stimulation or readiness to act, while vigilance is defined as the state of readiness to detect and respond to infrequent, randomly occurring events. Selective attention is defined as dividing attention between multiple stimuli in the environment, which is necessary because an individual's rate of processing capacity is limited to the constant barrage of environmental stimuli, which varies from individual to individual. Children with attentional difficulties have trouble paying attention to detail in that they are distracted by extraneous stimuli in their environment, and have difficulty sustaining attention for a long period of time to a particular task, especially if that stimulus does not offer any external reinforcers.

The primary attentional component that has been studied in children with ADHD is sustained attention. Children with and without hyperactivity are said to have difficulties maintaining sustained attention or vigilance. Frequently, arousal and vigilance are used interchangeably to refer to a general state of wakefulness. However, these terms are not synonymous since an individual may be cortically aroused but not vigilant toward a task. To help explain the difference between arousal and vigilance, Broadbent (1971) proposed a theory involving two types of arousal, lower arousal and upper arousal. Lower

arousal referred to cortical arousal affected by noise and sleep, while upper arousal controlled sub- or superoptimal levels of lower arousal and corresponded to the concept of "effort". Broadbent asserted that upper arousal (i.e. vigilance) decreases as time on task increases. This phenomenon is known as the vigilance decrement. When children with attentional problems have been measured on laboratory tasks of sustained attention, the longer the task, the more difficulty the child has sustaining attention and effort toward the task. Frankmann and Adams (1962) proposed that the vigilance decrement occurred due to underarousal in that the individual cannot maintain a sufficient level of arousal due to the monotony of the task. Children with ADD-H or ADD+H often have difficulty sustaining attention toward a boring, dull task because of the lack of internal reinforcers. For example, parents often complain that their child has difficulty following through with a task and completing school assignments and chores. However, children with ADD-H or ADD+H can maintain attention for a long period of time, such as playing video games or watching television, because the external reinforcers within the environment are rewarding the child to maintain attention (Barkley, 1998). Warm, Dember, and Hancock (1996) proposed an alternate theory that for highly demanding tasks, vigilance decreases because of limited information resources over a period of time. It has been hypothesized that children with ADD-H and ADD+H may also have limited informational resources/attentional capacity, which is also known as working memory. Thus, they may have trouble remembering information, may be forgetful, disorganized and lose things easily.

The cognitive information processing perspective is important to the study of ADHD because it provides an explanation of how children with attentional problems process information within their environment.

Neuropsychological Perspective of Attention

The neuropsychological perspective views attention as a process that controls the flow of information processing in the brain. Specific regions within the brain are responsible for the processing of information (Johnson and Proctor, 2004; Riccio et al., 2001; Lyon and Krasnegor, 1996). For children with ADHD, the frontal lobe of the brain has been found to control attention, organization, and the planning of a task (Barkley, Grodinsky, & DuPaul, 1992). Children with deficits in attention are hypothesized to have neurochemical dysfunctions of the frontal lobe.

Several neuropsychological models of attention have been developed to explain the deficits in attention that also relate attentional processes to specific brain regions (Pribram & McGuinness, 1975; Heilman, Watson, Valenstein, & Damasio, 1983; Posner & Petersen 1990; Mesulam, 1987; Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991; Mirsky, 1996; Mirsky, Pascualvaca, Duncan, & French, 1999). One of the more prominent models proposed that has been used in the study of ADHD is the neuropsychological model of attention proposed by Mirsky et al. (1991), Mirsky (1996), Mirsky et al. (1999). To help bridge the gap between cognitive information processing and the neuropsychological fields, Mirsky et al. proposed a five-factor model borrowing from Zubin's (1975) work. Through factor analysis, Mirsky et al. (1991 & 1999) found that attention could be subdivided into five distinct functions: 1) focus/execute, 2) sustain, 3) stabilize, 4) shift, and 5) encode. Each function is associated with a specific

brain region. 1) Focused attention refers to the individual's capability to concentrate attention toward a specific task and be able to screen out peripheral stimuli, which is associated with the superior temporal and inferior parietal cortices and by structures that comprise the corpus striatum. Mirksy et al. was unable to separate focus from the individual's response to the task demand. Thus, the term focus/execute is used. 2) Sustained attention requires the individual being able to stay on task in a vigilant manner for an appreciable amount of time, and is associated with the rostral midbrain structures, the mesopontine reticular formation, and the midline and reticular thalamic nuclei. 3) Stabilize is the reliability or stability of attention focus which occurs within the midline-thalamic and brain stem structures. 4) Shift refers to the individual's ability to be cognitively flexible by shifting or changing attentional focus from one stimulus to another stimulus and is supported by the prefrontal cortex, including the anterior cingulated gyrus. 5) Encode refers to the individual's ability to hold information in the mind and perform a cognitive function and occurs within the hippocampus and amygdala. Among psychologists, this term is also known as working memory.

Children with ADHD may have difficulty with these 5 distinct functions of attention. The primary one that has been studied in children with inattention is sustained attention. The neuropsychological perspective is important to the assessment of ADHD because it has helped link attentional problems to specific brain regions that are hypothesized to be neurochemically dysfunctional, which may assist clinicians with treating the characteristics of ADHD.

Behavioral Analytical Perspective of Attention

The final perspective of attention, the behavior analytical perspective, is less interested in discriminating between the components of attention and more interested in how to modify behavioral attention of an individual to improve functioning within the environment (Halperin, 1996). McIlvane, Dube and Callahan (1996) regard attention from a contingency analysis approach, which includes three types of events: antecedents, behaviors, and consequences. Attention can be influenced by antecedents and consequences and modifiable by reinforcement or punishment. The antecedent is the stimulus that occurs prior to the behavior, which may take place internally within the individual or externally within the environment. Behaviors refer to the individual responding to the stimulus and consequences are defined as reinforcers, neutral events, and punishers. Each of these events is influenced by each other and other variables such as subject variables (age, sex, clinical diagnosis, behavioral history) and state variables (disease, drugs, biological operations).

Viewed from the behavioral analytical perspective, ADHD is seen as being influenced by antecedents and consequences within the environment. Thus, antecedents and consequences can be modified through reinforcement and punishment to manipulate attention. As explained above, children with ADD-H or ADD+H have difficulty sustaining attention for a long period of time because of the lack of internal reinforcers. If the environment is modified to provide the child with attentional problems with external reinforcers and consequences, attention toward a task can be increased.

In summary, cognitive psychologists who adhere to the cognitive information processing perspective view attention as distinct components that are cognitively processed in stages by an individual. Neuropsychologists view attention from a

neuroanatomical perspective in that regions of the brain are responsible for attentional elements and the disorders of attention occur because of damage or neurochemical dysfunction to a specific brain region. Behavioral psychologists believe attention can be modified by changing antecedents, reinforcers, and consequences to improve attention within the individual (Halperin, 1996).

Despite these differences, there is considerable agreement across perspectives in regard to attention. Researchers from all three perspectives believe that attention is multifaceted and cannot be described by a single concept or measured using one type of instrument. However, researchers differ as to how to measure attention. Cognitive psychologists often measure the components of attention using computer-based assessments to evaluate changes in reaction time while manipulating the experiment. Neuropsychologists often use multiple instruments that measure a distinct function of attention such as a computer-based instrument (i.e. continuous performance test) that purports to measure sustained attention, while behavioral psychologists manipulate antecedents, reinforcers, and consequences to observe attending in an individual (Halperin, 1996).

Construct of Hyperactivity

The theories of hyperactivity appear to be lacking within the research literature. Often times, hyperactivity is linked with impulsivity, which may confound the study of ADHD. For example, the DSM-IV divides the criteria of ADHD between items describing symptoms of inattention and items describing symptoms of hyperactive-impulsive behaviors. However, some researchers believe hyperactivity is distinctly different than impulsivity. Hyperactivity is often defined as excessive or developmentally

inappropriate levels of activity, whether motor or vocal. Parents often describe their children's hyperactive behaviors as "having difficulty sitting still", "fidgets or squirms", "always on the go", "talks excessively", and "often hums, sings, or makes loud noises". While many children may exhibit hyperactivity during certain situations, it appears to be the pervasiveness of the overactivity that distinguishes situational hyperactivity from pervasive hyperactivity (Taylor, 1986). Two primary factors are often revealed when factor analyzing behavior rating scales. The first factor loads heavily on inattentive characteristics, while the other factor loads heavily on impulsive/hyperactive characteristics. Thus, hyperactivity may be a characteristic of behavioral inhibition, rather than a distinct disorder. When differentiating between ADHD subtypes, it is the impulsive hyperactive characteristic that must be ruled in or out.

Construct of Impulsivity (Inhibitory Control)

The construct of impulsivity, also known as behavioral inhibition or inhibitory control, is essential for understanding the nature of ADHD. There is no widely accepted theory or model for the construct of behavioral inhibition, also known as impulsivity (Schachar & Logan, 1990; Solanto et al., 2001). Inhibitory control or behavioral inhibition is one aspect of executive function. Executive function is the overarching processes of cognition and information processing that controls encoding, central processing, decision making, and execution of responses based on the appropriateness of the response and the timing of the response (Denckla, 1996). Examples of behavior inhibition are "responding before instructions are given or before a question is completed, responding without first considering all the options, failing to withhold a motor or cognitive response to an irrelevant or inappropriate stimulus, and acting before

considering the consequences of a socially offensive or aggressive behavior" (Solanto et al., 2001, p. 215-216). Thus, children with ADHD may talk-out, interrupt others and act without thinking.

Children with ADHD Combined Type or Predominately Hyperactive-Impulsive Type tend to respond impulsively and make more errors on measures of inhibition (Campbell, Douglas, & Morgenstern, 1971). ADHD was once thought of as a disorder of inattention (Douglas, 1988), however, this thinking has been replaced with the focus of ADHD primarily as a deficiency of inhibitory control (Barkley & Biederman, 1997; Logan, Cowan, & Davis, 1984; Logan & Cowan, 1984; Schachar & Logan, 1990). Barkley (1997a, 1997b, 1997c, 1998, & 1999) proposed a theoretical model of ADHD in which the primary deficit is behavioral inhibition. Barkley theorized that behavioral inhibition is an overarching executive function that is influenced by four other executive functions, 1) working memory, 2) self-regulation of affect/motivation/arousal, 3) internalization of speech, and 4) reconstitution (the ability to reconstruct behavior). Barkley's model is only applicable to children with ADHD Combined Type or Hyperactive-Impulsive Type and does not explain those children with Predominantly Inattentive Type. The primary limitation of Barkley's model is that it is not an empirically-derived model and has little empirical evidence to support the model.

There is no one agreed upon method for measuring inhibition. Inhibition is commonly measured operationally through observation, computer-based assessments, or other laboratory tasks (Schachar & Logan, 1990); or more subjectively by behavior rating scales and parent interviews. Diagnostic methodologies and instruments of inattention, hyperactivity, and inhibition will be discussed in more detail in the following sections.

Diagnostic Methodologies and Instruments for Assessing ADHD

When assessing children or adolescents suspected of ADHD, the school psychologist typically utilizes a multiple-method approach consisting of collecting data from multiple informants across multiple settings using multiple instruments (Anastopoulos & Shelton, 2001; Barkley, 1998; DuPaul & Stoner, 2003). The primary purpose of an evaluation is to determine the presence or absence of ADHD symptoms (Barkley, 1998). Many children have an array of symptoms such as inattention, hyperactivity, impulsivity, aggression, anxiety, depression, and so on. It is important to obtain reliable information from parents and teachers and directly assess behaviors (DuPaul & Stoner, 2003) to determine whether the child manifests symptoms consistent with ADHD, another childhood disorder, concomitant disorders (ADHD and another childhood disorder), or whether the symptoms or behaviors are contingent on the environmental setting (Barkley, 1998).

The major components of an evaluation within the school setting consist of parent and teacher interviews, behavior rating scales completed by parents and teachers, and observations of the child's behavior in multiple settings (DuPaul & Stoner, 2003), which are all considered behavioral methods of assessment. Behavioral measures observe the frequency of the behavior within its environment and assess the antecedents, reinforcers and consequences affecting the behavior. The behavioral analytic methodology for assessing ADHD is the primary approach utilized in the school setting.

A cognitive/neuropsychological method that has been utilized more often in clinic settings to assess ADHD is the Continuous Performance Test (CPT) (Barkley, 1998), which provides a standardized objective cognitive measure for assessing inattention (i.e.

sustained attention) and behavioral inhibition (Riccio et al., 2001). CPTs have not traditionally been utilized in school settings (DuPaul & Stoner, 2003). While each method is limited to some degree, when used in a multimethod assessment approach, a system of "checks and balances" (DuPaul & Stoner, 2003, p. 39) is created in that the limitations of any single method are balanced by data obtained from another method (Anastopoulos & Shelton, 2001; Barkley, 1998).

Diagnostic Instruments Utilizing the Behavioral Assessment Approach

Behavior rating scales

Behavior rating scales are frequently used for assessing ADHD because they provide a convenient, standardized, and cost-effective method. There are two types of behavior rating scales – broad-band behavior rating scales and narrow-band behavior rating scales. Broad-band behavior rating scales refer to instruments that assess a "broad" array of psychosocial problems such as aggression, hyperactivity, impulsivity, attention, anxiety, depression, psychosomatic problems, emotional lability, restless-impulsive behaviors, and adaptive skills, while narrow-band behavior rating scales refer to instruments that assess only one particular psychosocial problem such as anxiety, depression or ADHD (Barkley, 1998). Ramsay, Reynolds, and Kampaus (2002) recommend using broad-band scales, rather than narrow-band scales that lack specificity and are poor at differential diagnosis. Another limitation of behavior rating scales is that results from different raters may be inconsistent due to situational specific expectations (Breen & Altepeter, 1990). Another factor affecting the discriminate responding among raters may be the disorder itself, which may manifest itself differently, based on contingencies within the environment (Barkley, 1997b). The information from multiple

raters may contain significant discrepancies, making it difficult to detect whether the discrepancies between informants is due to biases of the informants or situational specific expectations within the environment (Barkley, 1998).

Comparison of Behavior Rating Scales.

This researcher plans to focus on the comparison of two commonly used behavior rating scales in the schools. While other valid behavior rating scales may be used in clinical settings, such as the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2000), the Behavior Assessment System for Children (BASC; Reynolds & Kamphaus, 1998) and the Conners Rating Scales (CRS-R; Conners, 1997a) are typically used in the school setting (DuPaul & Stoner, 2003) to measure symptoms of inattention, hyperactivity, and impulsivity.

The BASC is considered a broad-band behavior rating scale evaluating preschool (ages 2 ½ to 5 years old), school-aged children (ages 6 to 11 years old) and adolescents (ages 12 to 18 years old) in the areas of externalizing, internalizing, and school problems, as well as adaptive skills (Reynolds & Kamphaus, 1998) and can be utilized to assist in the differentiation of ADHD (DuPaul & Stoner, 2003; Ramsay, et al., 2002). The Conners' Rating Scales-Revised (CRS-R; Conners, 1997a) is also considered a broad-band behavior rating scale designed to assess externalizing and internalizing problems in school-aged children and adolescents, and can also be used in the differentiation of ADHD. Both the BASC and the CRS-R provide parent, teacher, and self-report rating scales (Conners', 1997a; Reynolds & Kamphaus, 1998). However, the BASC self-report form is for children or adolescents (ages 8 to 18 years) (Reynolds & Kamphaus, 1998), while the CRS-R self-report form is for adolescents (ages 12 to 18 years) (Conners',

1997a). Both the BASC and CRS-R yield quantitative scores in the form of T-scores and percentile ranks (Conners', 1997a; Reynolds & Kamphaus, 1998).

The subscales of the BASC parent and teacher forms include more internalizing and adaptive items than the CRS-R. The BASC Parent Rating Scale (PRS) is composed of the Externalizing Problems Composite, the Internalizing Problems Composite, the Adaptive Skills Composite and an overall Behavioral Symptoms Index Composite. On the BASC-PRS, the Externalizing Composite is composed of three subscales: Hyperactivity, Aggression and Conduct; the Internalizing Composite is composed of three subscales: Anxiety, Depression, and Somatization; three additional scales include Atypicality, Withdrawal, and Attention; and the Adaptive Skills Composite is composed of three subscales: Adaptability, Social Skills, and Leadership. The BASC Teacher Rating Scale (TRS) includes the composites and subscales of the BASC-PRS and also a School Problems Composite composed of the Attention and Learning subscales. The BASC-TRS Adaptive Skills Composite includes a Study Skills subscale, as well as, the other scales on the BASC-PRS (Ramsay et al., 2002; Reynolds & Kamphaus, 1998).

The interpretative guidelines for the clinical scales of the BASC indicate that T-scores above 70 represent a clinically significant score, T-scores between 60 and 69 represent an at-risk score, T-scores between 41 and 59 represent an average score, T-scores between 31 and 40 represent a low score, and T-scores below 30 represent a very low score. On the adaptive scales, the scale is reversed in that T-scores above 70 represent a very high score, T-scores between 60 and 69 represent a high score, T-scores between 41 and 59 represent an average score, T-scores between 31 and 40 represent an

at-risk score, and T-scores below 30 represent a clinically significant score (Ramsay et al., 2002; Reynolds & Kamphaus, 1998).

The CRS-R is composed of three types of scales: 1) Parent, 2) Teacher, and 3) Adolescent. The Conners' Parent Rating Scale-Revised: Long form and Conners' Teacher Rating Scale-Revised: Long form will be discussed in more detail due to the focus of this research. The CPRS-R and the CTRS-R have separate norms for boys and girls, in three-year intervals for ages 3 through 17 years. The CPRS-R: L and CTRS-R: L consists of 80 items. Both forms require the rater to respond to each item based on the child's behavior in the last month using a Likert scale: 0 = Not True At All (Never, Seldom); 1 = Just A Little True (Occasionally); 2 = Pretty Much True (Often, Quite a Bit); 3 = Very Much True (Very Often, Very Frequent) (Conners', 1997a).

Subscales of the CPRS-R: L and the CTRS-R: L were empirically derived to assess externalizing, as well as internalizing disorders and correspond to the DSM-IV criteria of ADHD. The CPRS-R: L is composed of 7 clinical subscales. The clinical subscales produced from factor analyses include Oppositional, Cognitive Problems/Inattention, Hyperactivity, Anxious-Shy, Perfectionism, Social Problems, and Psychosomatic. The CTRS-R: L includes all of these subscales, except the Psychosomatic subscale. The CPRS-R: L and the CTRS-R: L both contain the Conners' ADHD Index that consists of 12 items reported to discriminate between ADHD children and normal children (Conners, 1997a; Gianarris, Golden, & Greene, 2001).

In addition, the CPRS-R: L and CTRS-R: L includes two composite scales, the Conners' Global Index (CGI) and the DSM-IV Symptoms scales. The CGI: Total composite scale consists of 10 items that include two subscales, the CGI: Restless-

Impulsive and the CGI: Emotional Lability subscales. The DSM-IV: Total composite scale consists of the DSM-IV: Inattentive and DSM-IV: Hyperactive-Impulsive subscales that parallel the 18 diagnostic items used in the DSM-IV to diagnosis ADHD and differentiate between subtypes (Conners, 1997a; Gianarris et al., 2001).

The interpretative guidelines for the CRS-R parent and teacher forms are as follows: T-scores above 70 represent a markedly atypical score indicating a significant problem, T-scores between 66 and 70 represent a moderately atypical score indicating a significant problem, T-scores between 61 and 65 represent a mildly atypical score indicating a possible significant problem, T-scores between 56 and 60 represent a slightly atypical score indicating a borderline problem that may be of concern, T-scores between 45 and 55 represent an average score which should not raise concern, while T-scores below 44 are considered low and are not a concern (Conners', 1997a).

The researcher is interested in parent and teacher ratings using the long version of the CRS-R. The reason for this interest is that during the time of this study the CRS-R had recently been updated. The revision of the CRS provided an updated normative sample and correlations between subscales with the DSM-IV criteria for ADHD. The long forms of the CPRS-R and the CTRS-R also include three DSM-IV symptom subscales, which assist in differentiating the subtypes of ADHD (Conners, 1997a; 1997b) giving it more of an advantage over the BASC.

This researcher is interested in analyzing the DSM-IV Total composite which includes the DSM-IV: Inattentive subscale and the DSM-IV: Hyperactive-Impulsive subscale of the CPRS-R: L and the CTRS-R: L forms. The 9 items on the DSM-IV: Inattentive subscale corresponds to the 9 items found in the DSM-IV criteria for

differentially diagnosing ADHD Predominantly Inattentive Type. The 9 items on the DSM-IV: Hyperactive-Impulsive subscale corresponds to the 9 items found in the DSM-IV criteria for differentially diagnosing ADHD Predominantly Hyperactive-Impulsive Type. Together these 18 items compose the DSM-IV Total composite of the CPRS-R: L and CTRS-R L. The DSM-IV Total composite consists of both DSM-IV: Inattentive and the DSM-IV: Hyperactive-Impulsive subscales corresponding to the DSM-IV diagnostic criteria of ADHD Combined Type (Conners', 1997a). See Table 6 in Appendix A for a description of items found on the DSM-IV: Inattentive and DSM-IV: Hyperactive-Impulsive subscales of the CPRS-R: L and the CTRS-R: L.

Diagnostic Instruments Utilizing the Cognitive Assessment Approach

Behavior rating scales have a number of limitations such as being subject to biases by the individual completing the behavior rating scale. Direct measures are often utilized to provide the school psychologist with unbiased or "pure" information related to the child. A direct measure often utilized in the school setting is observation. While an observation within the school setting yields valuable ecological validity, it may not account for all of the information needed in determining a diagnosis of ADHD. To provide a comprehensive picture of the child, observations must be conducted in multiple settings such as the classroom, cafeteria, playground, and other settings within the school during different times of the day which may be time consuming for the school psychologist. The child may also become sensitive to the school psychologist's presence and not present with the same behavioral characteristics if the school psychologist were not present in the room. Thus it is often useful to employ another direct objective method

for assessing ADHD, rather than depending solely on indirect behavioral methods. One such cognitive method used in clinical settings is the continuous performance test.

Continuous Performance Tests

Continuous performance tests are computerized-based assessments that evaluate sustained attention (a component of attention) and response inhibition (also referred to as inhibitory control or impulsivity) (DuPaul et al., 1992; Riccio et al., 2001). The basic requirements of the examinee is to respond as quickly as possible to a target stimulus presented on the screen at a fixed rate or interstimulus interval (ISI) by either clicking the mouse button, pressing the spacebar, or pushing a switch. Other stimuli are presented called the nontarget stimuli which the examinee must inhibit responding. Rosvold et al. (1956) developed the first CPT to assess sustained attention. The original Rosvold and colleagues CPT required that the examinee respond to the letter X (target stimulus), while other letters (nontarget stimuli) were presented in which the examinee was asked to inhibit the response (X-type CPT). A later version required the examinee to respond when the letter X is immediately preceded by the letter A (AX-type CPT).

Comparison of Continuous Performance Tests.

Since 1956 many versions of CPTs have been developed for clinical and research settings to measure attention and behavioral inhibition (i.e. impulsivity) (Riccio et al., 2001). It has been suggested that there are over 100 different versions of CPTs (Greenberg and Waldman, 1993). Four CPTs are commercially available and are predominantly utilized in research (Riccio et al., 2001). They include the Conners' CPT (Conners, 1992; 1995), the Gordon Diagnostic System (GDS; Gordon, 1983), the Integrated (or Intermediate) Visual and Auditory CPT (IVA; Sandford & Turner, 1994-

1999), and the Test of Variables of Attention (i.e. visual version) (TOVA; Greenberg, 1988-1999) and the TOVA (i.e. auditory version) (TOVA-A; Greenberg, 1996-1999). While all four CPTs purport to measure inattention and inhibitory control, they all vary according to differences in CPT parameters (Riccio et al., 2001). Some of the main variations include the basic task parameters of each CPT (e.g. X-type CPT, AX-type CPT or a not-X CPT), the differences in target and nontarget stimuli (letters, numbers or nonlanguage symbols), the frequency of the target, the duration of the stimulus presentation, the duration between stimuli presented (either fixed rate or interstimulus rate; ISI), the modality of the test (either visual or auditory or both), the presence or absence of distractors and reinforcers, and the duration of the task itself (Riccio et al., 2001).

One of the most noticeable features of the GDS distinguishing it from the other CPTs is that it is a micro-processor unit (Gordon, 1986), while the TOVA, TOVA-A, IVA and Conners' CPT are all computer-based software programs (Conners, 1995; Leark et al., 1996; Sandford & Turner, 1995a; 1995b). The basic task parameters vary among each of the 4 CPTs. The TOVA and TOVA-A is an X-type CPT in that the individual is required to respond as quickly as possible to the target stimulus, while inhibiting response to the nontarget stimulus (Leark et al., 1996). The standard version of the GDS is composed of 3 tasks; the delay task, the vigilance task, and the distractibility task. The vigilance and distractibility tasks of the GDS are based on an AX-CPT paradigm. On the vigilance task, the individual is required to press a button every time a two-number target combination (a 1 followed by a 9 or a 3 followed by a 5) is presented. On the distractibility tasks, the individual is required to respond to the AX-CPT paradigm;

however, there are distractors (digits) on either side of the target stimulus to determine the extent to which the examinee is able to selectively attend to the target stimuli. The delay task of the GDS does not display target or nontarget stimuli, but requires the examinee to delay responding for a long enough period of time before pressing the blue button to receive a point. If the examinee presses the blue button too soon, the examinee will not receive a point. The GDS is the only CPT discussed in this literature review to have a distractibility task (Gordon Diagnostic Systems, 1996). The Conners' CPT is a not X-CPT paradigm in that the individual is required to respond to all of the nontarget stimuli (letters) and inhibit responding when the target stimulus (X) is presented (Conners, 1995). The IVA is a basic X-CPT paradigm in that the target stimuli are presented either visually or auditorally (Sandford & Turner, 1995a; 1995b).

The presentation of modalities is another parameter variation with each of the CPTs. An advantage of the TOVA/TOVA-A and the GDS is that it assesses visual and auditory sustained attention and inhibitory control separately (Leark et al., 1996; Gordon Diagnostic Systems, Inc., 1996). Thus, it provides a more pure measure. A disadvantage of the IVA is that it measures visual and auditory attention and inhibitory control simultaneously, which may contribute to the confounding of variables. A disadvantage of the Conners' CPT is that it only assesses visual sustained attention and inhibition and does not provide an auditory modality.

The duration of the task is another parameter variation with each of the CPTs. The TOVA and TOVA-A can be completed within approximately 21 minutes. Thus total completion time of both modalities is a little over 40 minutes (Leark et al., 1996). The Conners' CPT and the main portion of the IVA take approximately 14 minutes to

complete (Conners, 1995; Sandford & Turner, 1995a; 1995b). The GDS vigilance task and distractibility tasks take approximately 9 minutes each to complete (Gordon Diagnostic Systems, Inc., 1996). Corkum and Siegel (1993) recommend that the longer the task for measuring sustained attention and inhibition, the heavier the demand on the child's attentional resources.

The presentation of the percentage of target and nontarget stimuli and the type of stimuli presented is variable among the CPTs. An advantage of the TOVA and TOVA-A is the percentage of target and nontarget presentation of stimuli (Corkum & Siegel, 1993). During the first half of the TOVA and TOVA-A, a larger percentage of nontarget stimuli are presented, then during the second half, a larger percentage of target stimuli are presented (Greenberg & Kindschi, 1996; Leark et al., 1996). Corkum and Siegel suggest the large percentage (77.5%) of target stimuli in the second half may be better at differentiating children with ADHD from normal children. The IVA displays 84% of the target stimuli and 16% nontarget stimuli (Sandford & Turner, 1995a; 1995b). The Conners' CPT (Conners', 1995) and the GDS do not vary the target frequency (Gordon Diagnostic Systems, Inc., 1996). The presentation of the type of target and nontarget stimuli also varies with each CPT. The TOVA and the TOVA-A is the only CPT to present non-language stimuli. The TOVA presents nonalphabetic stimuli in that the target stimulus is a geometric square colored in black with a white square in the upper center of the black square, while the nontarget stimulus is a black square with a white square in the bottom center of the black square (Leark et al., 1966). The GDS visual modality and the IVA present numerals as the target and nontarget stimuli (Gordon Diagnostic Systems, Inc., 1996; Sandford & Turner, 1995a; 1995b) and the Conners' CPT presents letters

(Conners', 1995). Leark et al. suggested that the TOVA may represent more of an advantage over the other CPTs because of its non-language based stimuli.

Another important variation among CPTs is the display time for each stimulus and the inter-stimulus interval (ISI), which is the amount of time between the presentations of each stimulus. Corkum and Siegel (1993) recommended a shorter display time and relatively short inter-stimulus intervals (ISI) for increasing diagnostic accuracy and differentiating between children with ADHD and normal children. The TOVA and TOVA-A CPTs provide the examinee with a relatively short display time and ISI. The TOVA and TOVA-A presents the target and nontarget stimuli for 100ms every 2 seconds (Leark et al., 1996), while the Conners' CPT displays the target and nontarget stimuli for 250ms, varying the ISI (1000, 2000, 4000ms) rate within and between blocks (Conners, 1992; 1995). On the vigilance task of the GDS, target and nontarget stimuli are displayed for 200ms with a 1000ms ISI, while the distractibility task stimuli are presented for 200ms with a 1000ms ISI (Gordon Diagnostic Systems, Inc., 1996). The IVA displays the visual target and nontarget stimuli for 167ms, while the auditory target and nontarget stimuli is presented for 500ms. The ISI for the IVA is 1.5ms (Sandford and Turner, 1995a; 1995b).

Even how the individual is asked to respond varies among the four CPTs. The TOVA and TOVA-A uses a microswitch rather than the space bar or mouse to accurately measure the individual's response time to the stimulus and alleviate variability encountered in other CPTs (Leark et al., 1996). The GDS is a microprocessor unit, which requires the individual to press a large blue button in the middle under the LCD panel (Gordon, Diagnostic Systems, Inc., 1996). An individual may respond to the Conners'

CPT target stimuli by either using the space bar or the computer mouse (Conners, 1995), while the IVA requires the individual to respond using the computer mouse (Sandford and Turner, 1995a; 1995b).

This researcher has focused on the TOVA and TOVA-A for this research project because of its many advantages. For example, the TOVA and TOVA-A were designed to avoid confounding of language processing skills or short-term memory problems by using a nonlanguage-based stimulus (Greenberg & Kindschi, 1996). CPT parameters that have been reported in the literature to differentiate children with ADHD from normal children include a short display time, relatively short inter-stimulus intervals, and a higher percentage of targets (Corkum & Siegel, 1993). Corkum and Siegel note these parameters tend to place a heavier demand on a child's attentional resources and increase diagnostic accuracy. The TOVA and TOVA-A meets these parameter specifications in that the TOVA/TOVA-A is one of the longest CPTs in duration, lasting approximately 21 minutes for each modality, is divided into two halves with a low and high target frequency, and has a relatively short inter-stimulus duration (Leark et al., 1996). See Table 7 in Appendix A for a comparison of CPTs.

Description of TOVA and TOVA-A Variables

The TOVA and TOVA-A are divided into 4 quarters. Quarters 1 and 2 represent the first half, which is the stimulus infrequent condition that has 36 targets out of 162 stimuli per quarter. Quarters 3 and 4 represent the second half, which is the stimulus frequent condition having 126 targets out of 162 stimuli presented in a fixed random frequency per quarter. Thus, the first half score refers to the participant's scores for quarters 1 and 2 and the second half score refers to the participant's scores for quarters 3

and 4. A total score is also obtained representing the participant's performance for quarters 1, 2, 3, and 4 or halves 1 and 2. The total test time is 21.6 minutes, which equates to 10.8 minutes per half and 5.4 minutes for each quarter (Leark et al., 1996).

The TOVA and TOVA-A was developed to assess attention and inhibitory control by measuring three areas: 1) Omission Errors, 2) Commission Errors, 3) Response Time (RT) and Response Time Variability (RTV). Omission Errors purport to measure inattention. Errors of omission occur when the participant does not respond to the designated target stimulus, thus the participant omits pressing the microswitch when the target stimulus is presented. The omission score is a result of the participant's errors of omission and is measured as a ratio of the participant's correct responses to the actual number of targets presented minus the number of anticipatory responses toward targets. Omission scores are presented as percentages. Commission Errors purport to measure behavioral inhibition or impulsivity. Errors of commission occur when the participant fails to inhibit responding and incorrectly responds to the nontarget stimulus, thus the participant presses the microswitch when the nontarget stimulus is presented. The Commission Errors score is a result of the participant's errors of commission and is measured as a ratio of the participant's incorrect responses to nontarget stimuli to the actual number of nontarget stimuli presented minus the number of anticipatory responses toward nontarget stimuli. Commission scores are presented as percentages. RT is the measure of processing time it takes to respond correctly to a target stimulus. It is the electronic measure of time from when a target stimulus is presented to when the participant presses the microswitch. The RT score is derived from the sum of all correct RTs divided by the number of targets and is reported in milliseconds for each quarter,

half and total. RTV is a measure of the participant's RT variance or inconsistency in RTs. The RTV score is reported as the standard deviation of the mean correct RTs. It is calculated using the participant's correct target RTs (Leark et al., 1996).

Other secondary measures are provided to measure the participant's performance, such as D-Prime or response sensitivity, an ADHD score (TOVA only; not TOVA-A), anticipatory responses, multiple responses and post-commission response time. The D-Prime score is a response sensitivity measure that reflects the ratio of the hit rate to false alarm rate. It is considered to be a measure of performance decrement, which is the rate of deterioration of performance over time. The measure is derived from the Signal Detection Theory and assists in differentiating non-ADHD participants from ADHD participants. The score refers to the accuracy of target (signal) and nontarget (noise) discrimination and is interpreted as a measure of perceptual sensitivity. The ADHD score is a comparison of the participant's TOVA performance to an identified ADHD sample's performance. The score tells how similar the performance is to the ADHD profile. The formula is derived as follows: ADHD Score = RT z-score (Half 1) + D-prime z-score (Half 2) X (-1) + Variability z-score (Total). Anticipatory response (AR) is calculated when the participant presses the microswitch within 200 msec of the appearance of a target or nontarget stimulus. The AR represents the participant's "guess" to the pending stimulus. These responses are not included in the calculation of the Omission Errors, Commission Errors, and RT or RTV. Anticipatory response is a measure of the test validity and is recorded for each quarter, half and total. Excessive anticipatory responses result in fewer Omission Errors, more Commission Errors, shortened RT and increased variability. Multiple responses occur when the participant presses the microswitch more

than one per stimulus presentation. The multiple response score reflects the actual sum of multiple responses by the participant whether the stimuli are targets or nontargets. Multiple responses do not detract from any other variable. Post-commission errors response time is a measure of time in milliseconds that the participant took to respond to a target stimulus immediately after a commission error has been recorded (Leark et al., 1996).

The TOVA and TOVA-A provides a full report that automatically calculates standard scores and standard deviations (z-scores). A standard deviation indicates the deviance from the norm. The more negative the standard deviation, the greater the problem. A more positive standard deviation indicates a better than average performance. The normal range for a z score is –1.00 to + 1.00. The standard score also compares results to the norm. The standard deviation of a standard score is 15 points. The normal range of a standard score is between 85 and 115. Scores above 115 are considered better than average, while scores below 85 are considered less than average. The TOVA and TOVA-A report provides interpretation codes to assist with the interpretation of scores. Interpretation codes are as follows: [] = invalid score, !! = excessive errors, * = significantly deviant result, and b = borderline result. Additional interpretation rules are provided in the TOVA Clinical Manual to assist in the interpretation of the participant's performance and determine whether the participant's performance is representative of ADHD (Greenberg & Kindschi, 1996). While Greenberg & Kindschi provide some case studies to illustrate the clinical interpretation rules, these rules appear to be cumbersome and "non-user friendly" for clinicians.

Comparison of CPTs to Behavior Rating Scales

Researchers and clinicians have seen an increase in the use and research of CPTs indicating that CPTs are accepted by the psychological community at face validity as measures of attention and executive control (Riccio et al., 2001). Likewise, some CPT versions are the most frequently used laboratory measure for assessing attention (DuPaul, et al., 1992). Since school psychologists often assess students in the school setting with primary referral complaints of inattention, hyperactivity, and impulsivity, CPTs may be an additional instrument to be utilized in the school setting along with other measures, such as, interviews, observations, and behavior rating scales. CPTs could provide the school psychologist with a clinical objective measure to determine whether the child presents with characteristics of ADHD.

Since, both CPTs and scales/subscales of behavior rating scales purport to measure inattention, hyperactivity, and impulsivity, clinicians and researchers would expect that correlations of CPT performance and scales/subscales on behavior rating scales measuring inattention and impulsivity would be strongly correlated (Riccio et al., 2001). This information is important because how a test relates to other tests informs clinicians and researchers about the inferences that may be made from test scores and the extent to which common variables may be at work (Anastasi, 1988; R. J. Cohen & Swerdlik, 1999).

A number of studies have investigated the relationship between CPTs and behavior rating scales. Studies that included correlational analyses found that hyperactivity scales/subscales tended to be more strongly associated with CPT measures than inattention scales or impulsivity scales. Also, hyperactivity scales from teacher ratings were strongly correlated with Commission Errors (Barkley, 1991; Halperin et al.,

1988; Kupietz & Richardson, 1978). For example, Kupietz & Richardson found that auditory and visual Commission Errors for the AX-CPT were significantly related to hyperactivity scales from teacher ratings. The visual Commission Errors were more strongly related than auditory errors for teacher ratings on the hyperactivity scale. Teicher et al. (1996) found the inattention/overactivity scale score of the Iowa Conners (Loney & Milich, 1982) to be moderately correlated with the reaction time variable of an AX-CPT; Greenberg's 1987 Minnesota Computer Assessment, an earlier version of the Test of Variables of Attention.

Factor analytic studies comparing measures of CPTs to behavior rating scales revealed poor loadings on the same factors. Lovejoy and Rasmussen (1990) conducted a factor analytical study using the CBCL (Child Behavior Checklist; Achenbach & Edelbrock, 1986), RCPRS (Revised Conners' Parent Rating Scale; Goyette et al., 1978), RCTRS (Revised Conners' Teacher Rating Scale; Goyette et al., 1978), and the Iowa Conners (Loney & Milich, 1982). Results of Lovejoy and Rasmussen's study found that scores from these scales did not load on factors with the variables from the AX-CPT. Campbell et al. (1991) investigated the construct validity of an AX-CPT with measures of intelligence, achievement, and behavior. Campbell's et al. study found that Omission and Commission Errors from the AX-CPT did not load on the same factor as the CPRS. Factor analytic studies yielded inconsistent if not discouraging results regarding the association of CPT measures to scales measuring inattention, hyperactivity, and impulsivity, while correlational analysis also yielded inconsistent findings or low correlations between Omission and Commission Errors and scales measuring inattention, hyperactivity, and impulsivity. Low correlations were also found for CPT measures and

other behaviors measured by rating scales such as emotional lability (Stein et al., 1994), oppositional behaviors (Forbes, 1998; Lassiter et al., 1994), conduct problems (Forbes, 1998), and social skill deficits (Forbes, 1998; Klee & Garfinkel, 1983; Lassiter et al., 1994). For example, Stein et al. (1994) conducted a study examining the Children's Atypical Development Scale (CADS; Barkley, 1990) and an X-CPT. Results of Stein's et al. study found that Commission Errors were correlated with emotional lability scores. Forbes (1998) study found correlations between the TOVA Omission Errors and the scales, Hyperactivity and Oppositional of the ACTeRS (Ullman et al., 1991), while only one correlation was found between the TOVA RT and the Inattention/Passive scale of the RCTRS (Goyette et al., 1978) which Forbes interprets as chance. Lassiter's et al. (1994) study found correlations between CPT measures and the Oppositional and Social Skills scales of the ACTeRS.

A number of concerns arise when examining these studies in depth. First, the scales may be measuring multiple components of attention and executive control, as well as other behaviors. For example, some scales include behavior clusters such as inattention/passivity (i.e. RCTRS; Goyette et al., 1978), inattentive/overactivity (i.e. IOWA Conners; Loney & Milich, 1982), hyperactive/impulsive or restless/impulsive (i.e. CPRS-R: L and CTRS-R: L; Conners, 1997a). In addition to variations in raters (i.e. parents versus teachers) which may contribute to variability between associations among CPT variables and behavior rating scales, scales measuring behavior clusters and the differences in CPT parameters may effect the variability of results within a study (Riccio et al., 2001). A review of the literature comparing CPTs to behavior rating scales found no study investigating the relationship between the TOVA and TOVA-A measures with

the scales/subscales of the CPRS-R: L and CTRS-R: L. It is for that reason that this researcher wishes to focus on one particular CPT, the TOVA and TOVA-A, and the one particular behavior rating scale utilizing parent and teachers as raters, the CPRS-R: L and the CTRS-R: L to investigate psychometric properties between the TOVA/TOVA-A measures and scales of the CPRS-R: L and CTRS-R: L and infer whether these instruments contribute to the diagnosis of ADHD in children and adolescents.

Comparison of the TOVA and the CRS-R

In regards to the researcher's interests in the relationship between the measures of the TOVA and the parent and teacher rating scales of the CRS-R, a review of the literature revealed only two known studies examining the relationship between the TOVA and the CRS-R (Forbes, 1998; Schatz et al., 2001). Forbes' study evaluated the diagnostic utility of the TOVA, the RCTRS (Goyette et al., 1978) and ACTeRS (Ullman et al., 1991) in discriminating between ADD, ADHD and other clinical disorders. Results of Forbes' study revealed that the TOVA was able to discriminate between the ADD/ADHD group and the group with other clinical disorders. However, the TOVA was unable to differentiate between the ADHD and the ADD group. The RCTRS and the ACTeRS were able to discriminate between the ADD/ADHD group and the OTHER group, but were also not able to differentiate between the ADD and ADHD subtypes. Forbes hypothesized that all three instruments, the TOVA, RCTRS and the ACTeRS, had some amount of error when classifying children into groups, suggesting that the TOVA and the behavior rating scales are measuring similar, yet different aspects of ADHD and concluded that both behavior rating scales and the TOVA contributed unique information and both make a meaningful contribution to the assessment of ADHD.

Schatz et al. (2001) examined the sensitivity and specificity of the TOVA and CPRS-R: S in identifying children with ADHD and a control group. Results of Schatz's et al. study revealed significant symptoms of ADHD in 85% of children with a previous diagnosis of ADHD using the TOVA and the CPRS-R: S. The TOVA identified an additional 30% of control children as having attentional problems based on their performance. Schatz et al. concluded that CPTs may over identify normal children with ADHD symptoms. One of the limitations of the Schatz et al. study was the use of the short form of the CPRS-R rather than the long form, which provides significantly more items and additional subscales corresponding to the 18 items of the DSM-IV ADHD diagnostic criteria.

Forbes (1998) and Schatz et al. (2001) appeared to conclude opposing viewpoints as to whether the TOVA made a significant contribution to the assessment of ADHD. In addition, comparison of other studies investigating CPTs with behavior rating scales found inconsistent evidence as to relationships between CPT measures and scales/subscales of behavior rating scales and the clinical and ecological validity of CPTs. Riccio et al. (2001) calls for researchers to conduct repeated studies to substantiate findings. This researcher believes that more studies need to be conducted using similar CPT parameters and similar behavior rating scales to compare this research findings with previous research before concluding that CPTs are less sensitive than behavior rating scales in identifying the symptoms of ADHD.

Primary Purpose of the Study

The purpose of this study is to explore the relationship and consistency between two CPTs, the Test of Variables of Attention (i.e. visual version) (TOVA; Greenberg,

1988-1999) and the Test of Variables of Attention (i.e. auditory version) (TOVA-A; Greenberg, 1996-1999), and two behavior rating scales, the Conners' Parent Rating Scales – Revised: Long Form (CPRS-R: L; Conners, 1997c) and the Conners' Teacher Rating Scales – Revised: Long Form (CTRS-R: L; Conners, 1997c). A review of the literature indicates that multiple instruments should be utilized when assessing for ADHD (DuPaul and Stoner, 2003). Each instrument, the TOVA/TOVA-A, the CPRS-R: L and the CTRS-R: L has its advantages and limitations and may offer unique contributions to the assessment of ADHD (Forbes, 1998).

CHAPTER III

METHODOLOGY

Participants

Participants in the study were children between the ages of 6 and 12 from a medium-sized land grant university in the central region of the United States. Participants were recruited from the local public schools using a consent letter and recruited using advertisements in the local newspaper during the Spring, Summer and Fall of 1998. The sample was divided by gender, 58.4% male and 41.6% female. Racial and ethnic backgrounds of children reported by parents were 78.4% Caucasian, 3.4% African American, 2.3% Asian/Pacific Islander, 5.7% Native American, 3.4% Hispanic, and 6.8% Other. The sample age of the children included 7.9% 6 years old, 20.2% 7 years old, 18% 8 years old, 20.2 % 9 years old, 13.5% 10 years old, 9.0% 11 years old, and 9.0% 12 years old. The educational level of parents giving consent for their child to participate in the research study was composed of 76.3% of fathers and 71.9% of mothers having completed a college degree, while 15.3% of fathers and 19.3% of mothers obtained a high school diploma. Only 8.8% of fathers and 8.5% of mothers comprised the Other category for educational level indicating their educational level was higher than a college degree. Nearly all of the children, 96.3%, in the sample were rated by their parent as

developing in the normal range, while 3.7% of children were not within the normal developmental limits.

Instrumentation

Socio-Demographic Scale

A scale was constructed to collect the following socio-demographic information: age, ethnicity, grade level, medication usage/type/dosage times, developmental milestones, and highest level of education achieved by both parents.

Test of Variables of Attention

A description of the TOVA was provided in the literature review. Please refer back to those sections.

Normative Data.

Greenberg and Waldman (1993a) present normative data for the TOVA assessing 775 children between the ages of 6 through 16 years. Characteristics of the sample include mainly Caucasian middle to upper-middle class children and adolescents in the Minneapolis Public Schools. Results from the study suggest that attention and impulse control develops in a non-linear fashion with rapid changes in early childhood and leveling off during later childhood and early adolescence. Sex differences also emerged, suggesting that attention and impulse control develop later in males than in females, but, the developmental course was similar for both sexes. Based on the author's findings the TOVA appears to be a highly sensitive measure of attention and impulse control in children and adolescents.

Reliability.

For the visual and auditory TOVA, Chronbach alpha, split half and Kuder-Richardson reliability coefficients are not appropriate for timed tasks such as the TOVA (Anastasi, 1988). Thus, Pearson product correlations were conducted for all TOVA variables across both the stimulus infrequent condition (quarters 1 and 2) and the stimulus frequent condition (quarters 3 and 4). The reliability coefficients for the stimulus infrequent condition and the stimulus frequent condition indicate that the variables are consistent with each variable (convergent validity) and also represent enough distinction between each variable that the variables are different from one another (divergent validity). Within variable coefficients were generally stronger than between variable coefficients for both conditions. RT and RTV were significant for both conditions reported for the visual TOVA. Standard errors of measurements for within condition within variable comparisons were calculated, while between conditions were not calculated due to the nature of the test (Leark et al., 1996).

Validity.

The TOVA was designed to measure variables that have been found to differentiate ADHD groups from normal groups. Sensitivity refers to the test's ability to correctly identify ADHD cases, while specificity refers to the test's ability to correctly identify normal individuals. Participants from the normative sample were assessed by senior faculty level university psychiatrists or psychologists to determine psychiatric problems. Only those solely with ADHD were included in the study. Respectable and similar levels of sensitivity and specificity were found using discriminant analysis and equal weighting using standardized scores (Leark et al., 1996).

The Receiver Operator Characteristic (ROC; Murphy et al., 1987) was used to calculate the overall predictive performances of a score by assessing the score's diagnostic accuracy (true positives vs. false negatives) over a continuum of scores. The ROC analysis was performed for scores for the Omission Errors, Commission Errors, Mean RT, RTV, D-Prime, and Beta for First Half, Second Half, and Total scores. The following combination score proved to have superior overall predictive performance: Mean RT (1^{st} half) + D-Prime (2^{nd} half) + Variability (Total). This formula is used to calculate the ADHD value once scores have been converted to z scores. The cutoff score chosen yielded a sensitivity of .80 (i.e., false negatives at 20%) and a specificity of .80 (i.e., false positives at 20%) (Leark et al., 1996).

The authors also reported a study by Greenberg and Waldman (1993b) in the professional manual version 7.0 citing differences between children with ADHD/ADD and normal controls and those with conduct disorder. Differences between the ADHD and the ADD group were found in that the ADHD group was more impulsive than the ADD group and the ADD group was more impulsive than the control group (Leark, et al., 1996). The TOVA and TOVA-A was also found to be sensitive to caffeine effects (Bernstein, et al., 1994, 1998).

Factor analytic data are also presented in the professional manual version 7.0 for the TOVA and TOVA-A (Leark, et al., 1996). Three significant factors emerged when analyzing the TOVA variables: Factor 1) RT (mean RT) and D-Prime (hit to miss ratio); Factor 2) percentage of Commission Errors; and Factor 3) percentage of Omission Errors. These three factors suggest that the TOVA is measuring distinct variables. Factor analytic data for the TOVA-A indicated five factors: Factor 1) Mean RT and RTV; Factor 2)

Percentage of Commission Errors for the stimulus frequent condition (Quarters 3 & 4/ 2nd half) and D-Prime; Factor 3.) Percentage of Omission Errors for the stimulus frequent condition (Quarters 3 & 4/ 2nd half); Factor 4) Percentage of Commission Errors for the stimulus infrequent condition (Quarters 1 & 2/ 1st half); and Factor 5) Percentage of Omission Errors for the stimulus infrequent condition (Quarters 1 & 2/ 1st half) (Leark, et al., 1996). These results suggest that when the modality of the task changed (i.e. 5 factors for the TOVA-A and 3 factors for the TOVA), then the underlying constructs were also affected (Riccio et al., 2001). These factors also suggest that the TOVA-A is measuring distinct variables with Commission Errors being a significant factor based on the frequency of the stimulus (Leark, et al., 1996).

A comparison of the TOVA and TOVA–A tests was conducted using analysis of covariance (ANCOVA). Controlling for age and gender, performance of participants on the TOVA-A indicated a higher mean percentage of Omission Errors and greater RTV than the TOVA. Participants on the TOVA tended to have a higher percentage of Commission Errors and a faster mean RT (Leark, et al., 1996).

Conners' Parent and Teacher Rating Scales - Revised: Long forms

A description of the CRS-R parent and teacher scales was provided in the literature review. Please refer back to those sections.

Normative Data.

For the parent and teacher forms, separate norms are available for boys and girls, in three-year intervals, for ages 3 through 17. The CPRS-R: L form was normed using 2,482 children ages 3 through 17. The CTRS-R: L form was normed using 1, 973 children ages 3 through 17.

Reliability.

The author of the CRS-R reported that the internal reliability between items is highly satisfactory on all the forms across the normative age groups (Conners, 1997b). Internal reliability coefficients on the CPRS-R: L and the CTRS-R: L range from mid .70's to upper .90's. Test-retest correlations for the CPRS-R: L and the CTRS-R: L range from a low of .47 to a high of .85. Intercorrelational analyses for males and females were conducted between the subscales of the CPRS-R: L and the CTRS-R: L indicating that most of the subscales show some amount of statistical significance at the $p < .05$ level (Conners, 1997a; 1997b).

Validity

Discriminant validity analyses were conducted for the CPRS-R: L and the CTRS-R: L between an ADHD group and a nonclinical group matched according to demographic variables. All of the subscales of the CPRS-R: L were statistically significant at the $p < .001$ except the Anxious-Shy and the Perfectionism subscales (Conners, 1997a; 1997), while all of the subscales of the CTRS-R: L were statistically significant at the $p < .001$ except the Social Problems subscale.

Procedure

The data collection and coding procedures for this research study occurred in 1998 and 1999 from a larger research project led by Dr. Oehler-Stinnett. The majority of the data were collected during the summer of 1998. The principal investigator and team leader met with Stillwater Public School administration and received approval to disseminate parent consent letters to students in grades 2, 3, 4, and 5 describing the purpose of the study and details regarding how data were to be collected. Consent letters

were sent out in students' home folders in April 1998. Parents interested in their children participating in the study signed the parent consent letter. Children were also asked to sign the letter giving their assent to participate in the research project. Consent letters were sent back to the school where team members picked them up and called the parents, asking their consent to schedule appointments in June for their children's participation in the study.

In the summer of 1998, children, ages 6 through 12, participating in the research study were administered a series of psychoeducational and neuropsychological assessments in the school psychology research room located in Willard Hall at Oklahoma State University by trained graduate students under the supervision of the principal investigator who is a licensed psychologist. The TOVA (Greenberg, 1988-1999) and TOVA-A (Greenberg, 1996-1999) were administered along with other cognitive, neuropsychological and behavioral instruments in a larger study. The CPRS-R: L (Conners, 1997c) was completed by the parent at the time of each child's participation in the study. The CTRS-R: L (Conners, 1997c) was completed in the fall of 1998 by the child's teacher during the 1997-1998 school year.

In the fall of 1998, parent consent letters were disseminated to students in grades 2, 3, 4, and 5 at Claremore Public Schools. Parents giving consent were scheduled appointments on the weekends for their children's participation in the study. The same neuropsychological assessments were administered to participating children.

Team members coded data into an SPSS database. In accordance with principle 6.25 in the ethical standards established by the American Psychological Association (1992, 2002), participants' protocols are secured in a locked cabinet for a minimum of

five years. Maintaining the records for this period of time provides the opportunity for verification and replication.

Research Questions

The purpose of this study was to explore the relationship and consistency between two CPTs, the Test of Variables of Attention (i.e. visual version) (TOVA; Greenberg, 1988-1999), and the Test of Variables of Attention (i.e. auditory version) (TOVA-A; Greenberg, 1996-1999), and two behavior rating scales, the Conners' Parent Rating Scales – Revised: Long Form (CPRS-R: L; Conners, 1997c) and the Conners' Teacher Rating Scales – Revised: Long Form (CTRS-R: L; Conners, 1997c). The following research questions will be explored.

1) What is the relationship among TOVA/TOVA-A Omission Errors, Commission Errors, RT score, RTV score, D-Prime, and ADHD score (TOVA only) and the CPRS-R: L and CTRS-R: L scales?
2) Which variable(s) of the TOVA and TOVA-A predict the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and the DSM-IV Total scales of the CPRS-R: L and the CTRS-R: L?
3) Is there a difference between the proportion of children identified by the TOVA CPT variables (Omission Errors, Commission Errors, RT, RTV, and D-Prime, and ADHD score) as normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive, Hyperactive, and Total scales as normal or abnormal?
4) Is there a difference between the proportion of children identified by the TOVA-A CPT variables (Omission Errors, Commission Errors, RT, RTV, and D-Prime) as

normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive, Hyperactive, and Total scales as normal or abnormal?

Operational Hypotheses

This researcher proposes that specific measures from the TOVA and TOVA-A will be correlated with the CPRS-R: L and the CTRS-R: L. Since the CPRS-R: L and the CTRS-R: L are similar scales, the researcher hypothesizes that CPRS-R: L and CTRS-R: L subscales measuring inattention, hyperactivity, and impulsivity will be correlated with TOVA and TOVA-A variables measuring inattention and impulsivity. However, because of differences in rater responses, the scores on one subscale of the CPRS-R: L may have some amount of variability on the CTRS-R: L. Thus, correlations between the CPRS-R: L and the TOVA and correlations between the CPRS-R: L and the TOVA-A variables may be discrepant from correlations between the CTRS-R: L and the TOVA and correlations between the CTRS-R: L and the TOVA-A variables. However, one would expect correlations to be more similar than different. The researcher proposed the following hypotheses for the first research question:

1) Omission Errors for the TOVA and TOVA-A would be correlated with scales measuring inattention on the CPRS-R: L and the CTRS-R: L; specifically, the Cognitive Problems/Inattention scale and the DSM-IV: Inattentive subscale of the DSM-IV: Total.
2) Commission Errors for the TOVA and TOVA-A would be correlated with scales measuring inhibition and impulsivity on the CPRS-R: L and the CTRS-R: L;

specifically, the Hyperactivity scale, Conners' Global Index: Restless-Impulsive and the DSM-IV: Hyperactive-Impulsive scale of the DSM-IV: Total.

3) Omission Errors and Commission Errors for the TOVA and TOVA-A would be correlated with scales measuring both inattention and hyperactivity-impulsivity on the CPRS-R: L and the CTRS-R: L; specifically, Cognitive Problems/Inattention, Hyperactivity, Conners' Global Index: Restless-Impulsive, and the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total scales.
4) The ADHD score for the TOVA would be correlated with scales measuring both inattention and hyperactivity-impulsivity on the CPRS-R: L and the CTRS-R: L; specifically, Cognitive Problems/Inattention, Hyperactivity, Conners' Global Index: Restless-Impulsive, and the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total scales.
5) RT and/or RTV for the TOVA and TOVA-A would be correlated with the CPRS-R: L and CTRS-R: L: Conners' ADHD Index, Conners' Global Index: Total and the DSM-IV: Total scales.
6) D-Prime, a measure of perceptual sensitivity for the TOVA and TOVA-A would be correlated with the CPRS-R: L and CTRS-R: L: Conners' ADHD Index, the Conners' Global Index: Total, and the DSM-IV: Total scales.

In addition to looking at overall relationships between variables, this researcher is also interested in determining which variables of the TOVA and TOVA-A predict the CPRS-R: L and the CTRS-R: L DSM-IV: Inattentive, Hyperactive, and Total scales. The following hypotheses are proposed:

1) Omission Errors for the TOVA and TOVA-A which purport to measure inattention will predict the DSM-IV: Inattentive scale on the CPRS-R: L and CTRS-R: L.
2) Commission Errors for the TOVA and TOVA-A which purport to measure inhibition and impulsivity will predict the DSM-IV: Hyperactive-Impulsive scale on the CPRS-R: L and CTRS-R: L.
3) Omission Errors and Commission Errors for the TOVA and TOVA-A will predict scales measuring both inattention and hyperactivity-impulsivity on the CPRS-R: L and the CTRS-R: L; specifically, the DSM-IV: Inattentive scale, DSM-IV: Hyperactive-Impulsive scale, and the DSM-IV: Total scale.
4) The ADHD score for the TOVA will predict scales measuring both inattention and hyperactivity-impulsivity on the CPRS-R: L and the CTRS-R: L; specifically, the DSM-IV: Inattentive scale, DSM-IV: Hyperactive-Impulsive scale, and the DSM-IV: Total scale.
5) RT and/or RTV for the TOVA and TOVA-A will predict a global measure of inattention and impulsivity; the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L.
6) D-Prime, a measure of perceptual sensitivity for the TOVA and TOVA-A will predict a global measure of inattention and impulsivity; the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L.

Lastly, the researcher is interested in whether the proportion of children identified by the TOVA and TOVA-A as normal or abnormal is significantly different than the proportion of children identified by the CPRS-R: L and the CTRS-R: L as normal or

abnormal on the DSM-IV: Inattentive scale, DSM-IV: Hyperactive-Impulsive scale, and DSM-IV: Total scale. The hypotheses proposed are:

1) There is a no difference between the proportion of children identified by the TOVA CPT variables (Omission Errors, Commission Errors, RT, RTV, and D-Prime, and the ADHD score) as normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive scale, the DSM-IV: Hyperactive-Impulsive scale, and DSM-IV: Total scale as normal or abnormal.
2) There is a no difference between the proportion of children identified by the TOVA-A CPT variables (Omission Errors, Commission Errors, RT, RTV, and D-Prime) as normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive scale, the DSM-IV: Hyperactive-Impulsive scale, and DSM-IV: Total scale as normal or abnormal.

Data Analysis Plan

Pearson product correlations were conducted in order to explore the relationship among the variables of the TOVA, the TOVA-A, the CPRS-R: L, and the CTRS-R: L. Multiple regression analyses were employed to examine which variables of the TOVA and TOVA-A predict specific scales from the CPRS-R: L and the CTRS-R: L. Zero-order correlations of the predictor variables with the criterion variables were also examined. Chi-square analyses was utilized to predict group membership to determine the proportion of children identified as normal or abnormal comparing the TOVA, TOVA-A, CPRS-R: L and the CTRS-R: L. See Table 8 in Appendix A for a description of the data analysis plan.

Methodological Assumptions

The data in this study will be used for descriptive and inferential purposes. For descriptive purposes, assumptions are not necessary. No assumptions are necessary for the analyses of data using Pearson Product Correlation and Chi-Square. However, the data will also be used to make inferences, thus Kerlinger and Lee (2000) point out that four assumptions must be met when utilizing multiple regression.

a. Independence – The data collected from any particular participant were independent of scores collected from other participants.
b. Normality - The data were collected from a normal distribution.
c. Homoscedasticity - The data came from a population with common variances.
d. Linearity – The relationship between the independent variable(s) and the dependent variable is linear when all other independent variables are held constant.

Examination of residual scatterplots provided a test of assumptions of normality, linearity, and homoscedasticity between predicted DV scores and errors of prediction. Assumptions of analysis are that the residuals (differences between obtained and predicted DV scores) are normally distributed about the predicted DV scores, that residuals have a straight line relationship with predicted DV scores, and that the variance of the residuals about predicted DV scores is the same for all predicted scores (Tabachnick & Fidell, 1996). Residual scatterplots were examined prior to data analysis and the assumptions of the analysis were met.

Limitations

Limitations associated with the study's research design fall into two categories: sampling and instrumentation. With regard to sampling, this study specifically measures children between the ages of 6 and 12 years old and cannot be generalized to another population such as preschoolers, adolescents, or adults. Another limitation is that a control group was not utilized in this research study. This researcher is primarily interested in describing and making inferences upon a group of nonreferred/nonclinical group of children rather than examining differences between control groups and referred clinical groups. Thus, this study cannot be generalized to another research study utilizing a control group. Another limitation of this study is that this is a convenience sample. According to Kerlinger & Lee (2000), a convenience sample accesses only those who are willing to participate, leading to selection bias. For example, parents who suspect their child of having attentional difficulties will choose to have their child participate rather than parents who do not suspect their child of having attentional difficulties. This sample may contain a larger number of children with suspected attention difficulties. Lastly, the size of the sample and the number of analyses computed may not detect differences if differences exist. This limitation is due to lack of power. Thus increasing sample size increases power and statistically significant differences are more likely to be detected (Stevens, 1996).

There are also limitations associated with instrumentation. Limitations of selecting the TOVA/TOVA-A include possible sample biases. For example, the normative data are not representative of most urban populations due to a large middle to upper-middle class socio-economic group. Also the majority of participants are Caucasian and do not represent some regions of the United States that may have more

ethnic diversity. Caution needs to be exercised when applying these norms to samples with lower socio-economic children and non-Caucasian children (Greenberg & Waldman, 1993a).

This researcher found that the majority of participants in this research study were Caucasian. Socioeconomic status information was not asked on the Socio-demographic form which may be another limitation of this research study. However, based on the percentage of parents with educational levels above a high school education presumes that most of the participants in this study did not come from a low socio-economic background. While the majority of participants in this study were Caucasian, this research study may have a more diverse sample than the TOVA/TOVA-A sample due to participants living in a university town, which is more likely to have diverse ethnic groups. Limitations of using behavior rating scales such as the CPRS-R: L and the CTRS-R: L include problems with response biases. Response bias occurs when raters have different expectations of the subject being rated due to situationally specific expectations. This is likely to be observed between a parent and teacher rating the same child. Examination of results will determine whether response bias is present within this study.

Summary

For the purposes of this research study, the researcher's goal is to describe the performance of a nonreferred sample of children from the central United States region utilizing the TOVA/TOVA-A, two cognitive diagnostic instruments that measure inattention and impulsivity and the CPRS-R: L and CTRS-R: L, two behavioral

diagnostic rating scales in exploring the relationship between the variables of the TOVA/TOVA-A and the CPRS-R: L and CTRS-R: L.

CHAPTER IV

RESULTS

The purpose of this study was to explore the relationship and consistency between two CPTs, the Test of Variables of Attention (TOVA; Greenberg, 1988-1999), and the Test of Variables of Attention – Auditory (TOVA-A; Greenberg, 1996-1999), and two behavior rating scales, the Conners' Parent Rating Scales – Revised: Long Form (CPRS-R: L; Conners, 1997c) and the Conners' Teacher Rating Scales – Revised: Long Form (CTRS-R: L; Conners, 1997c). When assessing children with potential characteristics of ADHD, it is important to utilize multiple assessment instruments; however, often times the assessment instruments yield varying degrees of significance making it difficult to confirm a diagnosis of ADHD. This researcher is interested in school psychologists being able to utilize multiple assessment instruments in the school setting that are reliable and valid in determining an accurate diagnosis of ADHD. This study was developed to consider whether using a CPT helps to provide additional and useful information when assessing students for characteristics of ADHD. The research questions addressed in this study are:

1) What is the relationship among TOVA and TOVA-A Omission Errors, Commission Errors, RT, RTV, ADHD score (TOVA only), D-Prime and the scales of the CPRS-R: L and CTRS-R: L?

2) Which variable(s) of the TOVA and TOVA-A predict the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and the DSM-IV Total scales using the CPRS-R: L and the CTRS-R: L?
3) Is there a difference between the proportion of children identified by the TOVA CPT variables (Omission Errors, Commission Errors, RT, RTV, and D-Prime, and ADHD score) as normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive, Hyperactive, and Total scales as normal or abnormal?
4) Is there a difference between the proportion of children identified by the TOVA-A CPT variables (Omission Errors, Commission Errors, RT, RTV, and D-Prime) as normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive, Hyperactive, and Total scales as normal or abnormal?

Pearson Product Correlations between the TOVA and TOVA-A measures and the scales of the CPRS-R: L and the CTRS-R: L

Research Question 1: What is the relationship among TOVA and TOVA-A Omission Errors, Commission Errors, RT, RTV, ADHD score (TOVA only), D-Prime and the scales of the CPRS-R: L and CTRS-R: L? Four Pearson correlation analyses were computed between the TOVA and TOVA-A measures (Omission Errors, Commission Errors, RT, RTV, ADHD score [TOVA only], and D-Prime) and the scales on the CPRS-R: L and CTRS-R: L (Oppositional, Cognitive Problems/Inattention, Hyperactivity, Anxious-Shy, Perfectionism, Social Problems, Psychosomatic [CPRS-R: L only], Conners' ADHD Index, Conners' Global Index:

Restless-Impulsive, Conners' Global Index: Emotional Lability, Conners' Global Index: Total, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total) (Conners, 1997a).

The first Pearson product correlation examined the relationship between the TOVA measures and the scales on the CPRS-R: L. No significant correlations ($p \leq .05$ or $p \leq .01$) were found between Omission Errors and the scales of the CPRS-R: L. A significant negative correlation at the $p \leq .05$ was found for the TOVA Commission Errors and the CPRS-R: L Oppositional scale. No other scales were correlated with the TOVA Commission Errors. A significant negative correlation at the $p \leq .05$ was found for the TOVA RT and the CPRS-R: L Cognitive Problems/Inattention scale. No other scales of the CPRS-R: L were correlated with the TOVA RT. A significant negative correlation was found at the $p \leq .01$ for the TOVA RTV and the CPRS-R: L Cognitive Problems/Inattention scale. Other scales of the CPRS-R: L that were negatively correlated at the $p \leq .05$ with the TOVA RTV were the Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total. Significant negative correlations at the $p \leq .01$ were found between the TOVA D-prime and the following CPRS-R: L scales: Cognitive Problems/Inattention, Conners' ADHD Index, DSM-IV: Inattentive and DSM-IV: Total. In addition, significant negative correlations at the $p \leq .05$ were found for the TOVA D-Prime and the following CPRS-R: L scales: Oppositional, Conners' Global Index: Restless-Impulsive, and DSM-IV: Hyperactive-Impulsive. No significant correlations at the $p \leq .01$ level were found for the TOVA ADHD score and the scales of the CPRS-R: L. However, negative correlations were found at

the $p \leq .05$ for the TOVA ADHD Score and the following CPRS-R: L scales: Cognitive Problems/Inattention, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total. Correlations between the TOVA measures and scores on the CPRS-R: L are shown in Table 1 in Appendix A.

The second Pearson product correlation examined the relationship between the TOVA measures and the scales on the CTRS-R: L. A significant negative correlation at the $p \leq .01$ was found between the TOVA Omission Errors and the CTRS-R: L Cognitive Problems/Inattention scale. In addition, negative correlations at the $p \leq .05$ were found between the TOVA Omission Errors and the following scales of the CTRS-R: L: Oppositional, Conners' ADHD Index, Conners' Global Index: Emotional Lability, Conners' Global Index: Total, DSM-IV: Inattentive, and DSM-IV: Total. No correlations at the $p \leq .01$ were found for the TOVA Commission Errors and the scales of the CTRS-R: L. Although, significant negative correlations at the $p \leq .05$ were found for the TOVA Commission Errors and the CTRS-R: L Cognitive Problems/Inattention and the DSM-IV: Inattentive scales. No significant correlations ($p \leq .01$ or $p \leq .05$) were found between the TOVA RT and the scales on the CTRS-R: L. Significant negative correlations at the $p \leq .01$ were found between the TOVA RTV and the CTRS-R: L Social Problems and the DSM-IV Total scales. In addition, significant negative correlations at the $p \leq .05$ were found between the TOVA RTV and the following scales of the CTRS-R: L: Hyperactivity, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, Conners' Global Index: Total, DSM-IV: Inattentive, and DSM-IV: Hyperactive-Impulsive. Significant negative correlations were found at the $p \leq .01$ for the TOVA D-Prime and the

following CTRS-R: L scales: Cognitive Problems/Inattention, DSM-IV: Inattentive, and DSM-IV: Total. CTRS-R: L scales that were significant at the $p \leq .05$ with the TOVA D-Prime are Social Problems, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, and Conners' Global Index: Total. The ADHD score, a comparison of the participant's TOVA performance to an identified ADHD sample's performance was negatively correlated at the $p \leq .01$ with the following CTRS-R: L scales: Hyperactivity, Social Problems, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, Conners' Global Index: Emotional Lability, Conners' Global Index: Total, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total. In addition, the DSM-IV: Inattentive scale of the CTRS-R: L was negatively correlated at the $p \leq .05$ with the TOVA ADHD score. Correlations between the TOVA measures and scores on the CTRS-R: L are shown in Table 2 in Appendix A.

The third Pearson product correlation examined the relationship between the TOVA-A measures and the scores on the CPRS-R: L. Significant negative correlations at the $p \leq .01$ were found between the TOVA-A Omission Errors and the CPRS-R: L Cognitive Problems/Inattention, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total scales. In addition, a significant negative correlation at the $p \leq .05$ was found between the TOVA-A Omission Errors and the CPRS-R: L Hyperactivity scale. Significant negative correlations at the $p \leq .01$ were found between the TOVA-A Commission Errors and the following CPRS-R: L scales: Cognitive Problems/Inattention, Conners' ADHD Index, DSM-IV: Inattentive, DSM-IV Hyperactive-Impulsive, and DSM-IV: Total. In addition, significant negative

correlations at the $p \leq .05$ were found between the TOVA-A Commission Errors and the CPRS-R: L Hyperactivity and Conners' Global Index: Restless-Impulsive scales. No significant correlations at the $p \leq .01$ or the $p \leq .05$ were found between the TOVA-A RT and the CPRS-R: L scales. A significant negative correlation at the $p \leq .01$ was found between the TOVA-A RTV and the CPRS-R: L Cognitive Problems/Inattention scale. In addition, significant negative correlations at the $p \leq .05$ were found between the TOVA-A RTV and the CPRS-R: L Hyperactivity, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales. Lastly, significant negative correlations at the $p \leq .01$ were found between the TOVA-A D-Prime and the CPRS-R: L Cognitive Problems/Inattention, Hyperactivity, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales, while significant negative correlations at the $p \leq .05$ were found between the TOVA-A D-Prime and the CPRS-R: L Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, and DSM-IV: Inattentive scales. Correlations between the TOVA-A measures and scores on the CPRS-R: L are shown in Table 3 in Appendix A.

The fourth Pearson product correlation examined the relationship between the TOVA-A measures and the scores on the CTRS-R: L. A significant negative correlation at the $p \leq .01$ was found between the TOVA-A Omission Errors and the CTRS-R: L Cognitive Problems/Inattention scale, while significant negative correlations were also found at the $p \leq .05$ between the TOVA-A Omission Errors and the CTRS-R: L Conners' ADHD Index, DSM-IV: Inattentive, and DSM-IV: Total scales. Significant negative correlations at the $p \leq .01$ were found between the

TOVA-A Commission Errors and the CTRS-R: L Cognitive Problems/Inattention, Social Problems, DSM-IV: Inattentive and DSM-IV: Total scales. In addition, significant correlations were also found at the $p \leq .05$ between the TOVA-A Commission Errors and the CTRS-R: L Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, and Conners' Global Index: Total scales. No significant correlations were found at the $p \leq .01$ for the TOVA-A RT and the scales of the CTRS-R: L. However, significant negative correlations at the $p \leq .05$ were found between the TOVA-A RT and the CTRS-R: L Anxious-Shy and Conners' Global Index: Emotional Lability scales. Likewise, no significant correlations were found at the $p \leq .01$ for the TOVA-A RTV and the scales of the CTRS-R: L. However, a significant negative correlation at the $p \leq .05$ was found for the TOVA-A RTV and the CTRS-R: L DSM-IV: Inattentive scale. Significant negative correlations at the $p \leq .01$ were found between the TOVA-A D-Prime and the CTRS-R: L Cognitive Problems/Inattention, Social Problems, Conners' ADHD Index, DSM-IV: Inattentive and DSM-IV: Total scales. In addition, negative correlations at the $p \leq .05$ were found between the TOVA-A D-Prime and the following scales of the CTRS-R: L: Anxious-Shy, Conners' Global Index: Restless-Impulsive and Conners' Global Index: Total. Correlations between the TOVA-A measures and scores on the CTRS-R: L are shown in Table 4 in Appendix A.

Multiple Regression Analyses of the TOVA and TOVA-A Variables and the DSM-IV scales of the CPRS-R: L and the CTRS-R: L

Research Question 2 states: Which variable(s) of the TOVA and TOVA-A predict the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and DSM-IV

Total scales using the CPRS-R: L and the CTRS-R: L? Twelve multiple regression analyses were conducted to answer Research Question 2. The twelve multiple regression analyses are:

1) Which variable(s) of the TOVA predict the DSM-IV: Total scale using the CPRS-R: L?
2) Which variable(s) of the TOVA predict the DSM-IV: Inattentive scale using the CPRS-R: L?
3) Which variable(s) of the TOVA predict the DSM-IV: Hyperactive-Impulsive scale using the CPRS-R: L?
4) Which variable(s) of the TOVA predict the DSM-IV: Total scale using the CTRS-R: L?
5) Which variables(s) of the TOVA predict the DSM-IV: Inattentive scale using the CTRS-R: L?
6) Which variables(s) of the TOVA predict the DSM-IV: Hyperactive-Impulsive scale using the CTRS-R: L?
7) Which variable(s) of the TOVA-A predict the DSM-IV: Total scale using the CPRS-R: L?
8) Which variable(s) of the TOVA-A predict the DSM-IV: Inattentive scale using the CPRS-R: L?
9) Which variable(s) of the TOVA-A predict the DSM-IV: Hyperactive-Impulsive scale using the CPRS-R: L?
10) Which variable(s) of the TOVA-A predict the DSM-IV: Total scale using the CTRS-R: L?

11) Which variable(s) of the TOVA-A predict the DSM-IV: Inattentive scale using the CTRS-R: L?

12) Which variable(s) of the TOVA-A predict the DSM-IV: Hyperactive-Impulsive scale using the CTRS-R: L?

The first set of three multiple regression analyses examined the variables of the TOVA CPT, which include the Omission Errors, Commission Errors, RT, RTV, D-Prime, and the ADHD score regressed upon each criterion variable of interest. The criterion variables of interest are the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total scales of the CPRS-R: L.

Using the forward method, the predictor that entered into the regression equation at the $p \leq .05$ level of significance that accounts for the most variance was the TOVA D-Prime for each of the criterion variables, the DSM-IV: Total, the DSM-IV: Inattentive, and the DSM-IV: Hyperactive-Impulsive scales.

As indicated in Table 9 in Appendix A, the TOVA D-Prime accounted for 10.7 % of the variance for the DSM-IV: Total scale of the CPRS-R: L. The TOVA D-Prime entered the equation as the first independent variable at the $p \leq .05$, followed by the TOVA Omission Errors, which entered the equation as the second independent variable at the $p \leq .05$. None of the remaining variables that entered into the equation were statistically significant. R-squared increased only from .107 when the TOVA D-Prime was entered to .127 when all the variables had been entered. Examination of the zero-order correlations showed that only the TOVA D-Prime was significantly correlated at the $p \leq .05$ with the criterion score, the DSM-IV: Total scale of the CPRS-R: L.

As indicated in Table 10 in Appendix A, the TOVA D-Prime accounted for 9.0 % of the variance for the DSM-IV: Inattentive scale of the CPRS-R: L. The TOVA D-Prime entered the equation as the first independent variable at the $p \leq .05$, followed by the TOVA Omission Errors, which entered the equation as the second independent variable at the $p \leq .05$. None of the remaining variables that entered into the equation were statistically significant. R-squared increased only from .090 when TOVA D-Prime was entered to .130 when all the variables had been entered. Examination of the zero-order correlations showed that only the TOVA D-Prime was significantly correlated at the $p \leq .05$ with the criterion score, the DSM-IV: Inattentive scale of the CPRS-R: L.

As indicated in Table 11 in Appendix A, the TOVA D-Prime accounted for 7.9 % of the variance for the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L. None of the remaining variables that entered the equation were statistically significant. R-squared increased only from .079 when the TOVA D-Prime was entered to .118 when all the variables had been entered. Examination of the zero-order correlations showed that only the TOVA D-Prime was significantly correlated at the $p \leq .05$ with the criterion score, the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L.

The second set of three multiple regression analyses examined which variables of the TOVA predicted the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and the DSM-IV: Total scales of the CTRS-R: L. The TOVA variables, which included the Omission Errors, Commission Errors, RT, RTV, D-Prime, and the ADHD score served as predictors. Consequently, the DSM-IV: Inattentive, DSM-IV:

Hyperactive-Impulsive, and the DSM-IV: Total scales of the CTRS-R: L served as the criterion variables.

Using the forward method, the predictor that entered into the regression equation at the $p \leq .01$ level of significance that accounted for the most variance was the TOVA RTV for the DSM-IV: Total and the DSM-IV: Inattentive criterion variables. For the DSM-IV: Hyperactive-Impulsive criterion, the predictor that entered into the regression equation at the $p \leq .01$ level of significance was the TOVA ADHD Score.

As indicated in Table 12, the TOVA RTV accounted for 18.2 % of the variance in the DSM-IV: Total scale of the CTRS-R: L. The TOVA RTV entered the equation as the first independent variable at the $p \leq .01$, followed by the TOVA Omission Errors which entered the equation as the second independent variable at the $p \leq .01$, followed by the TOVA Commission Errors which entered the equation as the third independent variable at the $p \leq .05$. None of the remaining variables were statistically significant. R-squared increased only from .182 when the TOVA RTV was entered to .199 when all the variables had been entered. Examination of the zero-order correlations showed that only the TOVA RTV was significantly correlated at the $p \leq .01$ with the criterion score, the DSM-IV: Total scale of the CTRS-R: L.

As indicated in Table 13 in Appendix A, the TOVA RTV accounted for 14.1% of the variance in the DSM-IV: Inattentive scale of the CTRS-R: L. The TOVA RTV entered the equation as the first independent variable at the $p \leq .01$, followed by the TOVA Omission Errors which entered the equation as the second independent variable at the $p \leq .05$. None of the remaining variables were statistically

significant. R-squared increased only from .141 when the TOVA RTV was entered to .172 when all the variables had been entered. Examination of the zero-order correlations showed that only the TOVA RTV was significantly correlated at the $p \leq .01$ with the criterion score, the DSM-IV: Inattentive scale of the CTRS-R: L.

As indicated in Table 14 in Appendix A, the TOVA ADHD score accounted for 16.1% of the variance in the DSM-IV: Hyperactive-Impulsive scale of the CTRS-R: L. The TOVA ADHD score entered the equation as the first independent variable at the $p \leq .01$ followed by the TOVA RT which entered the equation as the second independent variable at the $p \leq .05$, followed by the TOVA D-Prime which entered the equation as the third independent variable at the $p \leq .05$. None of the remaining variables were statistically significant. R-squared increased only from .161 when the TOVA ADHD score was entered to .185 when all the variables had been entered. Examination of the zero-order correlations showed that only the TOVA ADHD score was significantly correlated at the $p \leq .01$ with the criterion score, the DSM-IV: Hyperactive-Impulsive scale of the CTRS-R: L.

The third set of three multiple regression analyses examined which variables of the TOVA-A predicted the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total scales of the CPRS-R: L. The TOVA-A variables, Omission Errors, Commission Errors, RT, RTV, and D-Primes served as predictors. Consequently, the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales of the CPRS-R: L served as the criterion variables.

Using the forward method, the predictor that entered into the regression equation at the $p \leq .001$ level of significance that accounted for the most variance was

the TOVA-A Omission Errors for the CPRS-R: L DSM-IV: Total. For the CPRS-R: L DSM-IV: Inattentive criterion, the predictor that entered into the regression equation at the $p \leq .01$ level of significance that accounted for the most variance was the TOVA-A Omission Errors. For the CPRS-R: L DSM-IV: Hyperactive-Impulsive criterion, the predictor that entered into the regression equation at the $p \leq .001$ level of significance was the TOVA-A D-Prime.

As indicated in Table 15 in Appendix A, the TOVA-A Omission Errors accounted for 14.5 % at the $p \leq .001$ level of the variance in the DSM-IV: Total scale of the CPRS-R: L. The TOVA-A Omission Errors entered into the equation as the first independent variable at the $p \leq .001$, followed by the TOVA-A Commission Errors which entered into the equation as the second independent variable at the $p \leq .01$, followed by the TOVA-A RT which entered into the equation as the third independent variable at the $p < .01$, followed by the TOVA-A D-Prime which entered into the equation as the fourth independent variable, and lastly, the TOVA-A RTV entered into the equation as the fifth independent variable at the $p \leq .05$. As each predictor was entered into the equation, R-squared increased from .145 to .183 when all of the variables were entered. Examination of the zero-order correlations showed that only the TOVA Omission Errors was significantly correlated at the $p \leq .001$ with the criterion score, the DSM-IV: Total scale of the CPRS-R: L.

As indicated in Table 16 in Appendix A, the TOVA-A Omission Errors accounted for 11.1% of the variance at the $p \leq .01$ at predicting the DSM-IV: Inattentive scale of the CPRS-R: L. The TOVA-A Omission Errors entered into the equation as the first independent variable at the $p \leq .01$, followed by TOVA-A

Commission Errors which entered the equation as the second independent variable at the $p \leq .01$, followed by TOVA D-Prime which entered the equation as the third independent variable at the $p \leq .01$, followed by TOVA-A RT which entered the equation as the fourth independent variable at the $p \leq .05$, and lastly, the TOVA-A RTV entered the equation as the fifth independent variable at the $p \leq .05$. R-squared increased from .111 when the TOVA-A Omission Errors was entered to .173 when all the variables had been entered. However, examination of the zero-order correlations showed that only the TOVA-A Omission Errors was significantly correlated at the $p \leq .01$ with the criterion score, the DSM-IV: Inattentive scale of the CPRS-R: L.

As indicated in Table 17 in Appendix A, TOVA-A D-Prime accounted for 13.9% of the variance in the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L. The TOVA-A D-Prime entered into the equation as the first independent variable at $p \leq .001$, followed by the TOVA-A RT which entered the equation as the second independent variable at the $p \leq .001$, followed by TOVA-A Omission Errors which entered the equation as the third independent variable at the $p \leq .001$, followed by TOVA-A RTV which entered the equation as the fourth independent variable at the $p \leq .05$ and lastly, the TOVA-A Commission Errors entered the equation as the fifth independent variable at the $p \leq .05$. R-squared increased from .139 when the TOVA-A D-Prime was entered to .172 when all the variables had been entered. However, examination of the zero-order correlations showed that only the TOVA-A D-Prime was significantly correlated at the $p \leq .001$ with the criterion score, the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L.

The fourth set of three multiple regression analyses examined which variables of the TOVA-A predicted the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total scales of the CTRS-R: L. The TOVA-A variables included the Omission Errors, Commission Errors, RT, RTV and D-Prime as predictors. Consequently, the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total scales of the CTRS-R: L served as the criterion variables.

Using the forward method, the predictor that entered into the regression equation at the $p \leq .01$ level of significance that accounted for the most variance was TOVA-A D-Prime for the DSM-IV: Total and the DSM-IV: Inattentive criterion variables. None of the TOVA-A variables were statistically significant for predicting the DSM-IV: Hyperactive-Impulsive criterion of the CTRS-R: L.

As indicated in Table 18 in Appendix A, TOVA-A D-Prime accounted for 13.7 % of the variance at the $p \leq .01$ fort predicting the DSM-IV: Total scale of the CTRS-R: L. The TOVA-A D-Prime entered the equation as the first independent variable, followed by the TOVA Commission Errors which entered the equation as the second independent variable at the $p \leq .05$, followed by TOVA-A RT which entered the equation as the third independent variable at the $p \leq .05$, followed by TOVA-A RTV which entered the equation as the fourth independent variable at the $p \leq .05$ and lastly, the TOVA-A Omission Errors entered the equation and was not significant. As each predictor was entered into the equation, R-squared increased from .137 when the TOVA-A D-Prime was entered to .167 when all the variables had been entered. Examination of the zero-order correlations showed that only the

TOVA-A D-Prime was significantly correlated at the $p \leq .01$ with the criterion score, the DSM-IV: Total scale of the CTRS-R: L.

As indicated in Table 19 in Appendix A, TOVA-A D-Prime accounted for 16.2% of the variance at the $p \leq .01$ at predicting the DSM-IV: Inattentive scale of the CTRS-R: L. The TOVA-A D-Prime entered the equation as the first independent variable, followed by the TOVA-A Commission Errors which entered the equation as the second independent variable at the $p \leq .01$, followed by TOVA-A RT which entered the equation as the third independent variable at the $p \leq .05$, followed by the TOVA-A RTV which entered the equation as the fourth independent variable at the $p \leq .05$, and lastly, the TOVA-A Omission Errors entered the equation and was not significant. R-square increased from .162 when the TOVA-A D-Prime was entered to .186 when all the variables had been entered. Examination of the zero-order correlations showed that only the TOVA-A D-Prime was significantly correlated at the $p \leq .01$ with the criterion score, the DSM-IV: Inattentive scale of the CTRS-R: L.

As indicated in Table 20 in Appendix A, when the TOVA-A variables were regressed upon the CTRS-R: L criterion variable, DSM-IV: Hyperactive-Impulsive scale, none of the TOVA-A variables were statistically significant at the $p \leq .05$ level of significance.

Chi-Square Analyses of the TOVA and TOVA-A Variables and the DSM-IV: scales of the CPRS-R: L and the CTRS-R: L

Chi-square analyses were utilized for Research Question 3 and Research Question 4. Research Question 3 states: Is there a difference between the proportion of children identified by the TOVA CPT variables (Omission Errors , Commission

Errors, RT, RTV, D-Prime, and the ADHD score) as normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive, Hyperactive-Impulsive, and Total scales as normal or abnormal?

The researcher has chosen to analyze the data using a 2 x 2 chi-square table to maximize the number of values per cell and to avoid having expected values less than 5 per cell. A general rule of the chi-square test is that each cell needs to have expected values of at least 5 or more. Chi-square should not be used if more than 20% of the cells have expected values less than 5 or if the minimum expected frequency is less than 1 (Norusis, 1998).

The *Conners' Rating Scales – Revised: User's Manual* (Conners', 1997a) provided interpretation guidelines for T-score ranges. According to the manual, T-scores of 44 or below are of "No Concern", T-scores between 45 and 55 are considered "Average", T-scores between 56 and 60 are "Slightly Atypical", T-scores between 61 and 65 are "Mildly Atypical", T-scores between 66 and 69 are considered "Moderately Atypical", and T-scores of 70 or above are interpreted as "Markedly Atypical". For the purposes of this research, the examiner chose to interpret T-scores one standard deviation above the mean as "atypical or abnormal". Since T-scores have a mean of 50 and a standard deviation of 10, T-scores of 60 or above are considered "abnormal", while. T-scores of 59 or less are considered "normal" for the purposes of this research study.

The *TOVA Test of Variables of Attention: Clinical guide* (Greenberg & Kindschi, 1996) used standard scores or standard deviation (z-scores) to interpret a subject's performance. The researcher has chosen to interpret standard scores.

Standard scores have a mean of 100 and a standard deviation of 15. According to Greenberg and Kindschi (1996), standard scores between 85 and 115 are considered to be in the "average" or "normal" range. Standard scores above 115 are considered to be better than average and standard scores below 85 are considered to be less than average or "abnormal". For the purposes of utilizing chi-square analyses, the researcher chose to interpret standard scores of 85 or above as normal. Standard scores more than one standard deviation below the mean (84 or less) are interpreted as "abnormal" for the purposes of this research study.

Using a 2 x 2 chi-square table, 36 chi-square analyses were computed for Research Question 3 comparing the proportion of children identified as normal or abnormal for each variable of the TOVA with the proportion of children identified as normal or abnormal for the DSM-IV scales of the CPRS-R: L and the CTRS-R: L. None of the variables of the TOVA yielded a statistically significant chi square using the Continuity Correction for a 2 x 2 table with the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales of the CPRS-R: L and CTRS-R: L. Chi-square statistics for depicting the variables of the TOVA and the DSM-IV scales of the CPRS-R: L and CTRS-R: L are presented in Tables 21 and 22 in Appendix A. Table 23 is presented in the Appendix A to illustrate the frequency of normal and abnormal scores for each variable of the TOVA and TOVA-A. Tables 24 and 25 are presented in Appendix A to illustrate the frequency of normal and abnormal scores for the DSM-IV scales of the CPRS-R: L and CTRS-R: L.Research Question 4 states: Is there a difference between the proportion of children identified by the TOVA-A CPT variables (Omission Errors , Commission Errors, RT, RTV, and D-Prime) as

normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive, Hyperactive-Impulsive, and Total scales as normal or abnormal?

Research question 4 is similar to research question 3 except, the TOVA-A CPT variables are being analyzed with the CPRS-R: L and the CTRS-R: L DSM-IV scales. Again, the researcher chose to utilize a 2 x 2 chi-square analysis to determine whether the proportion of children identified as normal or abnormal for each variable of the TOVA-A CPT (Omission Errors , Commission Errors, RT, RTV, and D-Prime) is related to the proportion of children identified as normal or abnormal for the CPRS-R: L and the CTRS-R: L DSM-IV scales (Inattentive, Hyperactive-Impulsive, and Total).

Using a 2 x 2 chi-square table, 30 chi-square analyses were computed for research question 4. Two TOVA-A variables were statistically significant with the DSM-IV: Inattentive scale of the CPRS-R: L, while none of the TOVA-A variables were statistically significant with the DSM-IV scales of the CTRS-R: L. The TOVA-A Commission Errors yielded a statistically significant chi-square analysis for the DSM-IV: Inattentive scale of the CPRS-R: L ($\chi^2 = 9.570$, df = 1, $p < .001$; $\Phi = .387$, $p < .001$). In addition, the TOVA-A D-Prime yielded a statistically significant chi-square analysis for the DSM-IV: Inattentive scale of the CPRS-R: L ($\chi^2 = 4.574$, df = 1, $p < .05$; $\Phi = .277$, $p < .05$). While there is a difference between the TOVA-A Commission Errors and the CPRS-R: L DSM-IV: Inattentive scale and the TOVA-A D-Prime and the CPRS-R: L DSM-IV: Inattentive scale, the phi statistic (Φ) indicates that the strength of the association between the two variables is weak suggesting that

the statistical significance may be due to chance considering that no other variables of the TOVA-A were statistically significant with the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and DSM-IV: Total scales of the CPRS-R :L or CTRS-R: L. Chi-square analyses for the TOVA-A variables and the DSM-IV scales of the CPRS-R: L and CTRS-R: L are presented in Tables 26 and 27. Table 23 is presented in the Appendix A to illustrate the frequency of normal and abnormal scores for each variable of the TOVA and TOVA-A. Tables 24 and 25 are presented in Appendix A to illustrate the frequency of normal and abnormal scores the DSM-IV scales of the CPRS-R: L and CTRS-R: L.

Summary

The first research question, "What is the relationship among TOVA and TOVA-A variables (Omission Errors, Commission Errors, RT, RTV, ADHD score [TOVA only)], and D-Prime) and the scales of the CPRS-R: L and CTRS-R: L (Oppositional, Cognitive Problems/Inattention, Hyperactivity, Anxious-Shy, Perfectionism, Social Problems, Psychosomatic [CPRS-R: L only], Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, Conners' Global Index: Emotional Lability, Conners' Global Index: Total, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total)" yielded four correlational analyses. The relationships analyzed were the TOVA measures and the CPRS-R: L scales, the TOVA measures and the CTRS-R: L scales, the TOVA-A measures and the CPRS-R: L scales and the TOVA-A measures and the CTRS-R: L scales. Several Pearson coefficients were examined to determine the relationship and consistency among the TOVA and TOVA-A measures and the scales of the CPRS-R: L and the CTRS-R: L.

The first correlational analysis examined the relationship and consistency between the TOVA measures and the CPRS-R: L scales. The TOVA D-Prime was negatively correlated at the $p \leq .01$ with the following scales of the CPRS-R: L: Cognitive Problems/Inattention, Conners' ADHD Index, and the DSM-IV: Inattentive. Likewise, the TOVA RTV was negatively correlated at the $p \leq .01$ for the Cognitive Problems/Inattention scale of the CPRS-R: L.

The second correlational analysis examined the relationship and consistency between the TOVA measures and the CTRS-R: L scales. The following correlations were significant at the $p \leq .01$. The TOVA Omission Errors was negatively correlated with the CTRS-R: L Cognitive Problems/Inattention scale. The TOVA RTV was negatively correlated with the CTRS-R: L Social Problems and DSM-IV: Total scales. The TOVA D-Prime was negatively correlated with the CTRS-R: L Cognitive Problems/Inattention, the DSM-IV: Inattentive, and the DSM-IV: Total scales. Lastly, the TOVA ADHD score was negatively correlated with the Hyperactivity, Social Problems, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, Conners' Global Index: Emotional Lability, Conners' Global Index: Total, DSM-IV: Hyperactive-Impulsive, and the DSM-IV: Total scales.

The third correlational analysis examines the relationship and consistency between the TOVA-A measures and the CPRS-R: L. The following correlations were significant at the $p \leq .01$. The TOVA-A Omission Errors was negatively correlated with the following CPRS-R: L: Cognitive Problems/Inattention, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales. The TOVA-A Commission Errors

was negatively correlated with the following CPRS-R: L scales: Cognitive Problems/Inattention, Conners' ADHD Index, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total. The TOVA-A RTV was negatively correlated with the CPRS-R: L Cognitive Problems/Inattention. Lastly, the TOVA-A D-Prime was negatively correlated with the following CPRS-R: L scales: Cognitive Problems/Inattention, Hyperactivity, DSM-IV: Hyperactive-Impulsive and DSM-IV: Total.

The fourth correlational analysis examines the relationship and consistency between the TOVA-A measures and the CTRS-R: L scales. The following correlations are significant at the $p \leq .01$. The TOVA-A Omission Errors was negatively correlated with the CTRS-R: L Cognitive Problems/Inattention scale. The TOVA-A Commission Errors was negatively correlated with the following CTRS-R: L scales: Cognitive Problems/Inattention, Social Problems, DSM-IV: Inattentive, and DSM-IV: Total. Lastly, the TOVA-A D-Prime was negatively correlated with the following CTRS-R: L scales: Cognitive Problems/Inattention, Social Problems, Conners' ADHD Index, DSM-IV: Inattentive, and the DSM-IV: Total.

The second research questions, "Which variable(s) of the TOVA and TOVA-A predict the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and the DSM-IV: Total variables using the CPRS-R: L and the CTRS-R: L?" consisted of twelve regression analyses. The first set of three regression analyses consisted of examining the variables of the TOVA CPT with the CPRS-R: L DSM: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total variables. Using multiple regression analyses, the TOVA D-Prime was significant at the $p \leq .05$ level of significance for

predicting the CPRS-R: L DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and DSM-IV: Total scales.

The second set of three regression analyses examined which variables of the TOVA predicted the CTRS-R: L DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales. Using multiple regression analyses, the TOVA RTV was significant at the $p \leq .01$ level for predicting the DSM-IV: Inattentive and DSM-IV: Hyperactive-Impulsive scales of the CTRS-R: L. However, the TOVA ADHD score was significant at $p \leq .01$ level for predicting the DSM-IV: Total scale of the CTRS-R: L.

The third set of three regression analyses examined which variables of the TOVA-A predicted the CPRS-R: L DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales. Using multiple regression analyses, the TOVA-A Omission Errors was significant at the $p \leq .001$ level for predicting the DSM-IV: Inattentive and DSM-IV: Total scales of the CPRS-R: L. However, the TOVA-A D-Prime was significant at the $p \leq .001$ level for predicting the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L.

The fourth set of three regression analyses examined which variables of the TOVA-A predicted the CTRS-R: L DSM-IV: Inattentive, DSM-IV Hyperactive-Impulsive, and DSM-IV Total scales. Using multiple regression analyses, the TOVA-A D-Prime was significant at the $p \leq .01$ level for predicting the DSM-IV: Inattentive and the DSM-IV: Total scales of the CTRS-R: L. No predictor variables were statistically significant for predicting the DSM-IV: Hyperactive-Impulsive scale of the CTRS-R: L.

Using a 2 x 2 chi-square table, 66 chi-square analyses were computed for Research Question 3 and Research Question 4 comparing the proportion of children identified as normal or abnormal for each variable of the TOVA and TOVA-A with the proportion of children identified as normal or abnormal for the DSM-IV scales of the CPRS-R: L and the CTRS-R: L. None of the variables of the TOVA yielded a statistically significant chi squares using the Continuity Correction for a 2 x 2 table with the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales of the CPRS-R: L and CTRS-R: L. Only two TOVA-A variables (Commission Errors and D-Prime) were statistically significant with the DSM-IV: Inattentive scale of the CPRS-R: L. None of the TOVA-A variables were statistically significant with the DSM-IV scales of the CTRS-R: L.

CHAPTER V

DISCUSSION

The purpose of this study was to examine the relationship and consistency between two continuous performance tests, the TOVA and TOVA-A, and two behavior rating scales, the CPRS-R: L and CTRS-R: L. The researcher was interested in whether specific measures of the TOVA and TOVA-A would be correlated with CPRS-R: L and CTRS-R: L scales. In addition, the researcher was also interested in whether variables of the TOVA and TOVA-A predicted the DSM-IV scales of the CPRS-R: L and the CTRS-R: L. Another area of interest consisted in determining whether the frequency of children identified as normal or abnormal by the TOVA and TOVA-A was related to the frequency of children identified as normal or abnormal by the DSM-IV scales of the CPRS-R: L and the CTRS-R: L. The researcher's interest was based on previous research suggesting that the TOVA may overidentify normal children as ADHD (Schatz, et al., 2001). However, other researchers believe that the TOVA may provide a unique contribution to the assessment of ADHD that other instruments are unable to provide (Forbes, 1998). Thus, the research questions addressed in this study were:

1) What is the relationship among TOVA and TOVA-A Omission Errors , Commission Errors, RT, RTV, ADHD score (TOVA only), D-Prime and the scales of the CPRS-R: L and CTRS-R: L?
2) Which variable(s) of the TOVA and TOVA-A predict the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and the DSM-IV: Total variables using the CPRS-R: L and the CTRS-R: L?
3) Is there a difference between the proportion of children identified by the TOVA CPT variables (Omission Errors, Commission Errors, RT, RTV, D-Prime, and the ADHD score) as normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive, Hyperactive-Impulsive, and Total scales as normal or abnormal?
4) Is there a difference between the proportion of children identified by the TOVA-A CPT variables (Omission Errors, Commission Errors, RT, RTV, and D-Prime) as normal or abnormal and the proportion of children identified by the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive, Hyperactive-Impulsive, and Total scales as normal or abnormal?

Research Question 1 examined the relationship of the measures of the TOVA and TOVA-A with the CPRS-R: L and CTRS-R: L. Four Pearson product correlational analyses were conducted to investigate the relationships between the TOVA measures and the CPRS-R: L scales, the TOVA measures and the CTRS-R: L, the TOVA-A measures and the CPRS-R: L scales, and the TOVA-A measures and the CTRS-R: L scales. Six hypotheses were proposed for the first research question.

The first hypothesis for Research Question 1 proposed that Omission Errors for the TOVA and TOVA-A would be correlated with the CPRS-R: L and CTRS-R: L Cognitive Problems/Inattention and the DSM-IV: Inattentive scales. While this hypothesis yielded inconsistent results in regards to the relationship between the TOVA Omission Errors and the CPRS-R: L Cognitive Problems/Inattention scale and the DSM-IV: Inattentive scale, the relationship between the TOVA Omission Errors and the CTRS-R: L Cognitive Problems/Inattention scale and the DSM-IV: Inattentive scale and the TOVA-A Omission Errors and the CPRS-R: L and CTRS-R: L Cognitive Problems/Inattention and DSM-IV: Inattentive scales supported this hypothesis.

The second hypothesis for Research Question 1 proposed that the Commission Errors for the TOVA and TOVA-A would be correlated with the CPRS-R: L and the CTRS-R: L Hyperactivity scale, Conners' Global Index: Restless-Impulsive scale, and the DSM-IV: Hyperactive-Impulsive scale. Results for this hypothesis yielded inconsistent results for the TOVA and TOVA-A Commission Errors. No relationship was found between the TOVA Commission Errors and the Hyperactivity, Conners' Global Index: Restless-Impulsive, and DSM-IV: Hyperactive-Impulsive scales of the CPRS-R: L and the CTRS-R: L. The TOVA-A Commission Errors and the Hyperactivity, Conners' Global Index: Restless-Impulsive, and the DSM-IV: Hyperactive-Impulsive scales of the CPRS-R: L supported this hypothesis. However, the TOVA-A Commission Errors revealed somewhat inconsistent results related to this hypothesis in that the only the CTRS-R: L Conners' Global Index: Restless-

Impulsive scale supported this hypothesis, while no relationship was found for the Hyperactivity or DSM-IV: Hyperactive-Impulsive scales of the CTRS-R: L.

The third hypothesis for Research Question 1 proposed that the Omission Errors and Commission Errors for the TOVA and TOVA-A would be correlated with the Cognitive Problems/Inattention, Hyperactivity, Conners' Global Index: Restless-Impulsive, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales of the CPRS-R: L and CTRS-R: L. Correlational analyses for the TOVA Omission Errors and the Commission Errors and the proposed CPRS-R: L scales did not support the third hypothesis. In fact, no relationships were found for the TOVA Omission Errors or the Commission Errors and the CPRS-R: L scales, except for a slight negative relationship between the TOVA Commission Errors and the Oppositional scale of the CPRS-R: L. The relationship between TOVA Omission Errors and the Commission Errors and the CTRS-R: L yielded inconsistent results with the proposed hypothesis. The TOVA Omission Errors were negatively correlated with the proposed scales measuring inattention, the Cognitive Problems/Inattention and the DSM-IV: Inattentive scales. However, the TOVA Commission Errors did not support the hypothesis that there would be a relationship between the TOVA Commission Errors and scales measuring impulsivity and hyperactivity for the CTRS-R: L. In fact, the TOVA Commission Errors revealed negative correlations with scales measuring inattention, such as the Cognitive Problems/Inattention scale and the DSM-IV: Inattentive scale of the CTRS-R: L. Correlational analyses between the TOVA-A Omission Errors and Commission Errors and the proposed scales of the CPRS-R: L supported the hypothesis. For example, the TOVA-A Omission Errors

was negatively correlated with the Cognitive Problems/Inattention scale, the DSM-IV: Inattentive scale, and the DSM-IV: Total scale. Unexpected negative correlations were found between the TOVA-A Omission Errors and the following CPRS-R: L scales: Hyperactivity, Conners' Global Index: Restless-Impulsive and the DSM-IV: Hyperactive-Impulsive. The TOVA-A Commission Errors was negatively correlated with the proposed scales measuring hyperactivity and impulsivity, the Hyperactivity scale, the Conners' Global Index: Restless-Impulsive scale, DSM-IV: Hyperactive-Impulsive scale, and DSM-IV: Total scale of the CPRS-R: L. Also of interest, the TOVA-A Commission Errors was unexpectedly negatively correlated with scales measuring inattention, such as the Cognitive Problems/Inattention scale and the DSM-IV: Inattentive scale of the CPRS-R: L. Lastly, the TOVA-A Omission Errors was negatively correlated with the Cognitive Problems/Inattention and DSM-IV: Inattentive scales supporting the hypothesis that Omission Errors would be correlated with scales measuring inattention on the CTRS-R: L. However, the TOVA-A Commission Errors yielded inconsistent results with scales measuring impulsivity and hyperactivity in that only the CTRS-R: L Conners' Global Index: Restless-Impulsive scale was negatively correlated with the TOVA-A Commission Errors, while no relationship was found between the Hyperactivity and DSM-IV: Hyperactive-Impulsive scales of the CTRS-R: L. Interestingly, the TOVA-A Commission Errors was unexpectedly negatively correlated with the Cognitive Problems/Inattention and DSM-IV: Inattentive scales of the CTRS-R: L, traditionally thought to measure inattention.

The fourth hypothesis for Research Question 1 proposed that the ADHD score for the TOVA would be correlated with scales measuring both inattention, hyperactivity, and impulsivity on the CPRS-R: L and the CTRS-R: L; specifically, Cognitive Problems/Inattention, Hyperactivity, Conners' Global Index: Restless-Impulsive, and DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales. While the results of the correlational analysis between the TOVA ADHD score and the CPRS-R: L revealed only slight correlations between a few of the proposed scales, results of the correlational analysis between the TOVA ADHD score and the CTRS-R: L tended to provide stronger support for the hypothesis. For example, the TOVA ADHD score was negatively correlated with the following scales of the CPRS-R: L Cognitive Problems/Inattention, the DSM-IV: Hyperactive-Impulsive and DSM-IV: Total; however, only at the $p \leq .05$ level. No other relationships were found between the TOVA ADHD score and other scales of the CPRS-R: L. However, results of the TOVA ADHD score revealed negative correlations at the $p \leq .01$ for the following CTRS-R: L scales purported to measure inattention, hyperactivity and/or impulsivity: Hyperactivity, Conners' Global Index: Restless-Impulsive, DSM-IV: Inattentive ($p \leq .05$), DSM-IV: Hyperactive-Impulsive and DSM-IV: Total. No relationship was found between the TOVA ADHD score and the Cognitive Problems/Inattention scale. However, other relationships were found between the TOVA ADHD score and CTRS-R: L scales measuring interpersonal relationships such as Social Problems and scales measuring global clinical problems such as Conners' ADHD Index, Conners' Global Index: Emotional Lability, and Conners' Global Index: Total scales.

The fifth hypothesis for Research Question 1 proposed that the RT and/or RTV for the TOVA and TOVA-A would be correlated with global indexes such as the Conners' ADHD Index, the Conners' Global Index: Total, and the DSM-IV: Total. Limited support for the hypothesis was found for the TOVA and TOVA-A RT and RTV and the proposed scales of the CPRS-R: L and CTRS-R: L. The TOVA and TOVA-A RT was not significantly correlated at the $p \leq .01$ with any of the CPRS-R: L or CTRS-R: L scales. The TOVA and TOVA-A RT was not significantly correlated at the $p \leq .01$ with any of the CTRS-R: L scales. Only the CPRS-R: L Cognitive Problems/Inattention scale was negatively correlated ($p \leq .01$) with the TOVA and TOVA-A RTV. While the CTRS-R: L DSM-IV: Total scale and Social Problems scale was negatively correlated ($p \leq .01$) with the TOVA RTV. None of the CTRS-R: L scales were correlated at the $p \leq .01$ with the TOVA-A RTV.

The sixth hypothesis for Research Question 1 proposed that D-Prime, a measure of perceptual sensitivity for the TOVA and TOVA-A would be correlated with global indexes, such as the Conners' ADHD Index, Conners' Global Index: Total, and DSM-IV: Total. Inconsistent results were found to support this hypothesis. The TOVA and TOVA-A D-Prime was negatively correlated at the $p \leq .01$ with the CPRS-R: L and CTRS-R: L DSM-IV Total scale. In addition, the TOVA and TOVA-A D-Prime was negatively correlated at the $p \leq .05$ or $p \leq .01$ with the CPRS-R: L and CTRS-R: L Conners' ADHD Index. However, the TOVA and TOVA-A D-Prime was not correlated with the CPRS-R: L Conners' Global Index: Total. The TOVA D-Prime was negatively correlated at the $p \leq .01$ with the CTRS-R: L Conners' Global

Index: Total, while the TOVA-A D-Prime was negatively correlated at the $p \leq .05$ with the CTRS-R: L Conners' Global Index: Total.

Research Question 2 investigated whether variables of the TOVA and TOVA-A would predict the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and DSM-IV: Total scales of the CPRS-R: L and CTRS-R: L. Six hypotheses were proposed for Research Question 2. The first hypothesis proposed that Omission Errors for the TOVA and TOVA-A would predict the DSM-IV: Inattentive scale of the CPRS-R: L and CTRS-R: L. This hypothesis was confirmed for the multiple regression analysis between the TOVA-A Omission Errors and the CPRS-R: L DSM-IV: Inattentive scale. The TOVA-A Omission Errors was statistically significant at the $p \leq .01$ at predicting the DSM-IV: Inattentive scale of the CPRS-R: L. Other variables, such as the TOVA-A Commission Errors and the D-Prime were also significant at the $p \leq .01$. However, Omission Errors was the only variable to have a statistically significant zero-order correlation. Even so, it only accounted for 11.1% of the variance indicating that other variables may also predict the DSM-IV: Inattentive scale of the CPRS-R: L.

The second hypothesis for Research Question 2 proposed that Commission Error, which purport to measure inhibition and impulsivity for the TOVA and TOVA-A would predict the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L and CTRS-R: L. This hypothesis was not confirmed for any of the multiple regression analyses. Neither the TOVA nor the TOVA-A Commission Errors predicted the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L or CTRS-R: L.

The third hypothesis for Research Question 2 proposed that Omission Errors and Commission Errors for the CPRS-R: L and CTRS-R: L would predict scales measuring the DSM-IV: Inattentive scale, DSM-IV: Hyperactive-Impulsive scale, and the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L. The TOVA-A Omission Errors predicted the CPRS-R: L DSM-IV: Inattentive scale at the $p \leq .01$ and the CPRS-R: L DSM-IV: Total scale at the $p \leq .001$. However, it was not significant at predicting the CTRS-R: L DSM-IV: Inattentive scale or DSM-IV: Total scale. In addition, the TOVA Omission Errors was not significant at predicting either the DSM-IV: Inattentive or DSM-IV: Total scales of the CPRS-R: L or CTRS-R: L. The TOVA and TOVA-A Commission Errors did not predict either the CPRS-R: L or the CTRS-R: L DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales.

The fourth hypothesis for Research Question 2 proposed that the ADHD score for the TOVA would predict the DSM-IV: Inattentive scale, DSM-IV: Hyperactive-Impulsive scale and the DSM-IV: Total scale. The ADHD score predicted the DSM-IV: Hyperactive-Impulsive scale of the CTRS-R: L at the $p \leq .01$, but did not predict the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L. While the TOVA ADHD score was statistically significant at the $p \leq .01$, it only accounted for 16% of the variance at predicting the DSM-IV: Hyperactive-Impulsive scale of the CTRS-R: L indicating that other variables may also predict this scale. In addition, the ADHD score did not predict either DSM-IV: Inattentive scale or DSM-IV: Total scale of either the CPRS-R: L or CTRS-R: L

The fifth hypothesis for Research Question 2 proposed that the RT and the RTV for the TOVA and TOVA-A would predict a global measure of inattention and impulsivity, the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L. The TOVA RT did not predict any of the DSM-IV scales of either the CPRS-R: L or CTRS-R: L. Although, the TOVA RTV predicted the CTRS-R: L DSM-IV: Total scale at the $p \leq .01$, it did not predict the CPRS-R: L DSM-IV: Total scale, nor did the TOVA-A RTV predict the CPRS-R: L or CTRS-R: L DSM-IV: Total scale.

The final hypothesis for Research Question 2 proposed that D-Prime, a measure of perceptual sensitivity for the TOVA and TOVA-A would predict a global measure of inattention and impulsivity, the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L. The TOVA D-Prime predicted the CPRS-R: L DSM-IV: Total scale, but did not predict the CTRS-R: L DSM-IV: Total scale. The TOVA-A D-Prime predicted the CTRS-R: L DSM-IV: Total scale, but did not predict the CPRS-R: L DSM-IV: Total scale. In addition, the TOVA D-Prime also predicted the DSM-IV: Inattentive scale and the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L, while the TOVA-A D-Prime predicted the DSM-IV: Inattentive scale of the CTRS-R: L and the DSM-IV: Hyperactive-Impulsive of the CPRS-R: L.

Lastly, for Research Question 3 and 4, the researcher was interested in whether the proportion of children identified by the TOVA and TOVA-A variables as normal or abnormal is significantly different than the proportion of children identified by the CPRS-R: L and the CTRS-R: L as normal or abnormal on the DSM-IV: Inattentive scale, DSM-IV: Hyperactive-Impulsive scale and DSM-IV: Total scale. Chi-square analyses indicated that only two variables, the TOVA-A Commission

Errors and D-Prime were statistically significant with the DSM-IV: Inattentive scale of the CPRS-R: L. No other variables of the TOVA-A were significant with the CPRS-R: L or CTRS-R: L. In addition, no variables of the TOVA were found to be statistically significant with the DSM-IV scales of the CPRS-R: L or CTRS-R: L. Given these findings, the null hypothesis is retained indicating that no differences were found between the proportion of children identified as normal or abnormal by the TOVA and TOVA- A variables and the DSM-IV scales of the CPRS-R: L and CTRS-R: L.

The literature recommends utilizing a multi-method approach for assessing ADHD consisting of collecting data from multiple informants across multiple settings using multiple instruments (Barkley, 1998; DuPaul & Stoner, 2003). This researcher was interested in examining the relationship between a continuous performance test, TOVA/TOVA-A and a behavior rating scale utilized by parents and teachers, the Conners' Rating Scales – Revised (CRS-R). Continuous performance tests (CPTs) were developed to assess sustained attention in a number of neurological disorders based on theoretical perspectives of attention derived from the cognitive information processing and neuropsychological methodologies (Lyon & Krasnegor, 1996), while behavior rating scales were designed utilizing factor analysis derived from systematic questioning of parents (Gianarris, Golden, & Greene, 2001).

Four research questions were developed to investigate the relationship between the TOVA and TOVA-A and the CPRS-R: L and CTRS-R: L. The first research question addressed correlational analyses, which examined the relationship among the measures of the TOVA and TOVA-A and the scales of the CPRS-R: L and

CTRS-R: L. Based on the research literature, errors of omission purport to measure inattention, while errors of commission purport to measure impulsivity or behavioral disinhibition (Leark, et al., 1996; Sostek et al., 1980). Due to the large number of correlational analyses and to avoid making Type I errors, correlations with a $p \leq .01$ will be discussed in more detail, while correlations with a $p \leq .05$ may not be emphasized (Keppel, 1991). Results of the first research question found inconsistent support for the proposed hypotheses.

Correlational analyses between the TOVA and CPRS-R: L, the TOVA and CTRS-R: L, the TOVA-A and CPRS-R: L, and the TOVA-A and CTRS-R: L yielded inconsistent support for the hypotheses that measures of inattention and impulsivity on the TOVA and TOVA-A would be correlated with scales measuring inattention and impulsivity on the CPRS-R: L and CTRS-R: L. Based on the research literature, it would be expected that Omission Errors and Commission Errors to be moderately or even highly correlated with scales measuring inattention, hyperactivity, and impulsivity.

Correlations between the TOVA and CPRS-R: L did not support this hypothesis. The TOVA Omission Errors and Commission Errors revealed no statistically significant correlations for scales of the CPRS-R: L measuring inattention or impulsivity. In addition, correlations between the TOVA and CTRS-R: L revealed only one scale, the Cognitive Problems/Inattention scale to be moderately negatively correlated at the $p \leq .01$ with the TOVA Omission Errors, while none of the scales of the CTRS-R: L were moderately correlated at the $p \leq .01$ with the TOVA Commission Errors.

Correlational analysis between the TOVA-A and CPRS-R: L demonstrated support for the hypothesis, but correlations between the TOVA-A and CTRS-R: L did not show consistent results. A distinct pattern emerged between the TOVA-A measures and the CPRS-R: L. The TOVA-A Omission Errors, Commission Errors, RTV, and D-Prime revealed low to moderate negative correlations at either $p \leq .01$ or $p \leq .05$ with the following CPRS-R: L scales: Cognitive Problems/Inattention, Hyperactivity, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total. Correlational analysis between the TOVA-A and CTRS-R: L revealed low to moderate negative correlations at $p \leq .01$ with the auditory Omission Errors and auditory Commission Errors and the Cognitive Problems/Inattention, DSM-IV: Inattentive scale, and DSM-IV: Total scale. While the TOVA-A Omission Errors, Commission Errors, and D-Prime revealed low negative correlations at the $p \leq .01$ or $p \leq .05$ with the CPRS-R: L Hyperactivity and DSM-IV: Hyperactive-Impulsive scales, none of the TOVA-A measures was significantly correlated with the CTRS-R: L Hyperactivity or DSM-IV: Hyperactive-Impulsive scales.

Previous research studies also found inconsistent correlations for Omission Errors and Commission Errors and scales measuring inattention and hyperactivity. These studies typically found low correlations for Omission Errors and scales of inattention and generally low to moderate correlations for Commission Errors and scales measuring hyperactivity (Barkley, 1991; Forbes, 1998; Halperin et al., 1988; Klee & Garfinkel, 1983; Kupietz & Richardson, 1978 Lassiter et al., 1994;). The reason Omission Errors and Commission Errors were not highly correlated with

scales of inattention and hyperactivity may be better understood looking at a study conducted by Llorente et al. (2001) investigating the internal consistency, temporal stability and reproducibility of individual index scores of the TOVA. Llorente's study found that individual Omission Errors and Commission Errors' scores exhibited greater bias (i.e. less individual test-re-test score agreement) than scores of RT and RTV. The results of this study are partially supported by Llorente's conclusions. The TOVA RTV appeared to show less bias and a stronger internal consistency than the TOVA Omission Errors and the Commission Errors. For example, the TOVA RTV showed a moderate negative relationship with the CPRS-R: L Cognitive Problems/Inattention scale, CTRS-R: L Social Problems and CPRS-R: L and CTRS-R: L DSM-IV: Total scales, while the TOVA RT revealed only one low correlation with the CPRS-R: L Cognitive Problems/Inattention scale and did not show any significant correlations with the CTRS-R: L. The TOVA-A RT was not significant with any of the scales of the CPRS-R: L and only significant at the $p \leq .05$ with the CTRS-R: L Anxious-Shy scale and the CTRS-R: L Conners' Global Index: Emotional Lability scale. The TOVA-A RTV was moderately significant at the $p \leq .01$ with the CPRS-R: L Cognitive Problems/Inattention scale and revealed low negative correlations at the $p \leq .05$ with the following CPRS-R: L scales: Hyperactivity, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive and DSM-IV: Total. The TOVA-A RTV was not as consistent with the CTRS-R: L and only revealed a low negative correlation at the $p \leq .05$ with the CTRS-R: L DSM-IV: Inattentive scale. In this study, the TOVA and TOVA-A RT revealed only two low correlations with the

CPRS-R: L and CTRS-R: L, while the TOVA and TOVA-A RTV revealed several low to moderate correlations with scales of the CPRS-R: L and CTRS-R: L.

To support these findings, Forbes (1998) found RT to be weakly correlated with teacher rating scales measuring attention/inattention, hyperactivity, hyperkinesis index, and inattention/passivity, while RTV was weakly to moderately correlated with teacher rating scales measuring attention/inattention, inattention/passivity, hyperactivity, hyperkinesis index, conduct problems, oppositional behavior, social skills. Based on previous research and this research study, it appears that the TOVA and TOVA-A RT is not as important as the variability of the reaction time (RTV) when identifying relationships with scales of inattention, hyperactivity-impulsivity and other behaviors characteristics of children with ADHD on the CPRS-R: L and the CTRS-R: L.

One of the most promising measures at identifying characteristics of inattention, hyperactivity, impulsivity, and other behaviors is D-Prime. D-Prime is a measure of perceptual sensitivity derived from the Signal Detection Theory and is considered a measure of performance or vigilance decrement; attention toward a task decreases as time on task increases (Broadbent, 1971; Johnson & Proctor, 2004; Leark et al., 1996). The score refers to the accuracy of target (signal) and nontarget (noise) discrimination. It can be inferred that D-Prime is measuring sustained attention (amount of time on task), as well as, an aspect of selective attention. Selective attention requires the individual to attend to the stimuli and inhibit responding to nonselected or external stimuli (i.e. distractors) (Johnson & Proctor, 2004). Within the research literature, D-Prime has not been studied as extensively as

Omission Errors or Commission Errors. Other studies found D-Prime to be weakly or moderately associated with scales measuring inattention, hyperactivity, externalizing behaviors (Lam & Beale, 1991; Mitchell & Quittner, 1996), and overall total scores (Lassiter et al., 1994; Mitchell & Quittner, 1996). Based on the research literature, it is expected that D-Prime would reveal low to moderate correlations with scales measuring inattention, hyperactivity, externalizing behaviors and overall total scores. Within this research study, the TOVA and TOVA-A D-Prime revealed moderate negative correlations with the Cognitive Problems/Inattention, the DSM-IV: Inattentive and the DSM-IV: Total scales on both the CPRS-R: L and CTRS-R: L. The TOVA-A D-Prime also showed moderate negative correlations with the CPRS-R: L Hyperactivity and DSM-IV: Hyperactive-Impulsive scales, however, this relationship was not present on the CTRS-R: L. Results of the TOVA and TOVA-A D-Prime appear to be consistent with the research literature at correlating moderately with scales measuring inattention, while the TOVA-A D-Prime may be sensitive to scales measuring hyperactivity.

In addition, the TOVA and TOVA-A D-Prime was moderately correlated with the CTRS-R: L Social Problem scale, but was not significant on the CPRS-R: L suggesting that D-Prime may be a sensitive measure at identifying social problems in children that are observed in a school setting by teachers. Teachers are more likely to observe social problems in children than parents because more social interactions take place at school among a larger more diverse peer group than at home. In addition, teachers are also more likely to observe behaviors of inattention, hyperactivity, and impulsivity because of the situationally specific expectations within a school

environment. For example, children are required to focus and sustain attention toward tasks for long periods of time and attend selectively to appropriate stimuli, while inhibiting their response to external stimuli (i.e. distractors). Teachers may be more sensitive to the child's ability to resist distractors, which is an aspect of selective attention. Thus, teachers may be more observant at identifying characteristics of inattention, hyperactivity, impulsivity, and other behaviors, such as social problems. These findings appear to support the research literature that D-Prime is measuring sustained attention and to some degree selective attention.

An ADHD score is provided for the TOVA, but not the TOVA-A. The ADHD score is derived from a formula using the RT z-score, the D-Prime z-score and the RTV z-score (Leark et al., 1996), thus it is not a pure variable for measuring inattention or impulsivity. However, this researcher believes that the ADHD score provides unique information that the other scores do not because it is a comparison of an individual's performance to an identified ADHD sample's performance, thus, the score tells how similar the individual's performance is to an ADHD profile (Leark et al., 1996). The TOVA ADHD score did not yield any correlations at the $p \leq .01$ with scales on the CPRS-R: L and only revealed low correlations at the $p \leq .05$ with the CPRS-R: L Cognitive Problems/Inattention, DSM-IV: Hyperactive-Impulsive and DSM-IV: Total scales. Results between the TOVA ADHD score and the CTRS-R: L were more favorable. The TOVA ADHD score revealed moderate negative correlations at the $p \leq .01$ with the following scales of the CTRS-R: L: Hyperactivity, Social Problems, Conners' ADHD Index, Conners' Global Index: Restless-Impulsive, Conners' Global Index: Emotional Lability, Conners' Global Index: Total, DSM-IV:

Hyperactive-Impulsive and the DSM-IV: Total. Differences between the ADHD score and the CPRS-R: L and CTRS-R: L may have been due to differences in rater responses due to situationally specific expectations within each setting (Breen & Altepeter, 1990). Another reason might be that the disorder itself may manifest itself differently based on contingencies within the environment (Barkley, 1998).

The ADHD score appears to be a significant indicator of children who are exhibiting characteristics of hyperactivity/impulsivity in that it was moderately correlated with the Hyperactivity scale and the DSM-IV: Hyperactive-Impulsive scale of the CTRS-R: L. The TOVA RTV and the D-Prime were not as reliable at demonstrating a relationship or did not demonstrate as strong a relationship as the ADHD score and the Hyperactive scale and the ADHD score and the DSM-IV: Hyperactive-Impulsive scale of the CPRS-R: L and CTRS-R: L. The TOVA Omission Errors, Commission Errors and the RT showed no relationship with the Hyperactive scale or the DSM-VI: Hyperactive-Impulsive scale of the CPRS-R: L or the CTRS-R: L indicating that these measures may not be as sensitive as the ADHD score at measuring hyperactivity and impulsivity.

For Research Question 2, the researcher was interested in predicting which variables of the TOVA and TOVA-A predicted the DSM-IV: Inattentive scale, DSM-IV: Hyperactive-Impulsive scale and the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L. Within the research literature, few studies have focused on multiple regression as a statistical analysis for determining relationships among CPT variables and parent and teacher rating scales measuring inattention, hyperactivity and impulsivity. It was expected that Omission Errors would predict scales measuring

inattention and that Commission Errors would predict scales measuring hyperactivity and impulsivity on the CPRS-R: L and CTRS-R: L. Results of the multiple regression analyses found that the TOVA and TOVA-A D-Prime, Omission Errors, and RTV scores were able to predict the CPRS-R: L and CTRS-R: L DSM-IV: Inattentive and DSM-IV: Total scales, while the TOVA D-Prime predicted the CPRS-R: L DSM-IV: Hyperactive-Impulsive scale and the TOVA ADHD score predicted the CTRS-R: L DSM-IV: Hyperactive-Impulsive scale. The TOVA-A D-Prime predicted the CPRS-R: L DSM-IV: Hyperactive-Impulsive scale, while the TOVA-A D-Prime entered the equation as the first variable but was not statistically significant at predicting the CTRS-R: L DSM-IV: Hyperactive-Impulsive scale. The TOVA and TOVA-A Commission Errors did not predict scales measuring hyperactivity/impulsivity. While these predictors yielded statistically significant zero-order correlations, none of the predictors accounted for more than 20% of the variance for the criterion suggesting there may be multicollinearity among the variables. Investigation of interrcorrelations of the TOVA and TOVA-A revealed the Omission Errors, RTV, D-Prime, and the ADHD scores to be strongly correlated with each other. Another reason variance was low may be due to low subject to variable ratios. Increasing the sample size would increase power and reduce the opportunity for multicollinearity.

For the Research Questions 3 and 4, the researcher was interested in whether the proportion of children identified by the TOVA and TOVA-A as normal or abnormal was different to the proportion of children identified by the CPRS-R: L and the CTRS-R: L as normal or abnormal on the DSM-IV: Inattentive, DSM-IV: Hyperactive-Impulsive, and DSM-IV: Total scales. Results of the chi-square analyses

for the variables of the TOVA and DSM-IV scales of the CPRS-R: L and CTRS-R: L found none of the variables to be statistically significant with DSM-IV: scales of the CPRS-R: L or CTRS-R: L. In addition, chi-square analyses for the TOVA-A and DSM-IV scales of the CPRS-R: L and CTRS-R: L found only two variables (Commission Errors and D-Prime) to be statistically significant with DSM-IV: Inattentive scale of the CPRS-R: L, while no other variables were found to be significantly related to the DSM-IV: Hyperactive-Impulsive or Total scales of the CPRS-R: L. Likewise, no significant differences were produced between the variables of the TOVA-A and the DSM-IV scales of the CTRS-R: L.

One would expect differences between Commission Errors which measure impulsivity and the DSM-IV: Inattentive scale which measures symptoms of inattention. However, this significance is not demonstrated elsewhere in the study suggesting that the results may be due to error. The statistically significant difference expressed between the D-Prime and the DSM-IV: Inattentive scale of the CPRS-R: L may also be due to error because no other statistical significances were found for D-Prime or any other variables of the TOVA-A. In addition, the phi statistic for the chi-square analysis for both significant differences is weak indicating that the association between the two variables is not strong. Since only two chi-square analyses were statistically significant out of 66, these differences may be due to error. Overall, these results indicate that there is no difference between the proportion of children identified by the TOVA and TOVA-A as normal or abnormal and the proportion of children identified as normal or abnormal by the DSM-IV scales of the CPRS-R: L and CTRS-R: L suggesting that the variables of the TOVA and TOVA-A are

identifying the same proportion of children as the DSM-IV scales of the CPRS-R: L and CTRS-R: L. These results are in contrast to Schatz et al. (2001) concluding that the TOVA over identifies children as exhibiting inattention and impulsivity compared to the abbreviated CPRS. These findings suggest that the TOVA and TOVA-A may be measuring inattention, hyperactivity, and impulsivity in a similar manner as the CPRS-R: L and CTRS-R: L. However, this is difficult to determine given the inconsistent results of the correlational and multiple regression analyses. According to the correlational and multiple regression analyses, the TOVA and TOVA-A variables may be measuring an aspect of inattention, hyperactivity, and impulsivity that CPRS-R: L and the CTRS-R: L are not able to reliably measure. Given that very few differences were found for the chi-square analyses, two hypotheses are considered as potential for this conundrum. Either chi-square analyses are a valid indicator that the TOVA and TOVA-A are able to identify the same proportion of children as normal or abnormal as the CPRS-R: L or CTRS-R: L or chi-square analyses were not a sensitive enough measure to discover the differences between CPTs measures and behavior rating scales. Further research needs to be conducted to determine whether this hypothesis is true.

In any case, CPTs like any other instrument should not be used solely to make diagnostic decisions. CPTs may be used as an additional instrument to provide an objective measure of inattention, hyperactivity, and impulsivity when discrepancies exist among parent and teacher rating scales. Within the research literature, CPTs are able to differentiate between normal controls and an ADHD/ADD group. Clinicians and researchers contend that it is not difficult to differentiate between normal and

abnormal without the use of CPTs. The real challenge is differentiating between various psychopathologies that may be present. CPTs have not been able to discriminate between an ADHD Combined/ Predominately Hyperactive-Impulsive Type group, an ADHD Predominately Inattentive Type group and other clinical groups (Forbes, 1998). While some clinicians and researchers argue that CPTs do not provide adequate environmental utility to justify its use (Barkley, 1991), others believe that CPTs may provide a unique contribution that subjective instruments, such as behavior rating scales are not able to provide due to rater biases and differences within settings (Forbes, 1998). CPTs are still a useful instrument for assessing characteristics of inattention, hyperactivity, and impulsivity and have also been proven useful for measuring treatment effects (Leark et al., 1996). In conclusion, this researcher believes that the TOVA and TOVA-A CPT may be useful at confirming symptoms of inattention, hyperactivity, or impulsivity when used as part of a multiple-method approach consisting of collecting data from multiple informants across multiple settings using multiple instruments (Anastopoulos & Shelton, 2001; Barkley, 1998; DuPaul & Stoner, 2003;).

Correlational analyses were conducted between the variables of the TOVA and scales of the CPRS-R: L, the variables of the TOVA and scales of the CTRS-R: L, the variables of the TOVA-A and the scales of the CPRS-R: L, and the variables of the TOVA-A and scales of the CTRS-R: L. While numerous correlations were observed at the $p \leq .05$ and $p \leq .01$ level, the variable of the TOVA and TOVA-A that yielded statistically significant relationships across all four correlational analyses was the visual and auditory D-Prime. The visual and auditory D-Prime was consistently

correlated with the Cognitive Problems/Inattention scale, the Conners' ADHD Index, and the DSM-IV: Inattentive scale and the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L. The RTV also showed a statistical relationship among these scales, although not as consistent a pattern. The ADHD score of the TOVA provided additional information that the other scores of the TOVA did not provide in that it was consistently correlated with the CPRS-R: L and CTRS-R: L DSM-IV: Hyperactive-Impulsive scale. When analyzing patterns of correlations between parent and teacher rating scales the TOVA and TOVA-A D-Prime was statistically correlated with the CTRS-R: L Social Problems scale suggesting that teachers may observe significant social problems and provide a unique contribution as raters.

Statistically significant results were found in 11 of the 12 multiple regression analyses conducted to identify relationships among variables of the TOVA and TOVA-A and the DSM-IV scales (Inattentive, Hyperactive-Impulsive, and Total) on the CPRS-R: L and CTRS-R: L. Results of the multiple regression analyses found that the TOVA and TOVA-A D-Prime, Omission Errors , and RTV scores would be more likely to predict parent and teacher rating scales measuring inattention, while the TOVA and TOVA-A D-Prime or the TOVA ADHD score would be more likely to predict parent and teacher rating scales measuring hyperactivity and/or impulsivity.

Chi-square analyses investigated the difference between the proportion of children identified as normal or abnormal by the variables of the TOVA/TOVA-A and the proportion of children identified as normal or abnormal by the DSM-IV scales of the CPRS-R: L and CTRS-R: L. Only 2 out of 66 chi-square analyses were statistically significant, however, none of the statistical significances yielded strong

relationship; thus, significant chi-square analyses were interpreted as error. These findings suggest that there are no differences in the proportion of children identified as normal or abnormal by the variables of the TOVA/TOVA-A and the DSM-IV scales of the CPRS-R: L and CTRS-R: L.

Recommendations for Research

The following research recommendations are presented as a result of the study:

1) It is recommended that future research studies utilize a common CPT paradigm or the same combination of CPTs and common behavior rating scales designed to measure ADHD.
2) It is recommended that future researchers obtain a larger sample size to increase statistical and environmental utility and increase generalizability to the population.
3) This study did not address control groups; thus, findings from this study can not be generalized to studies utilizing control groups. It is recommended that future research studies examine differences among different groups, such as a control group, an identified ADHD Combined Type/Predominately Hyperactive-Impulsive group, an identified ADHD Predominately Inattentive Type group, and other clinical groups representing other childhood disorders, such as oppositional defiant disorder, conduct disorder, anxiety disorder, depression, learning disabilities, emotional disturbance, social skill deficits, schizophrenia, traumatic brain injury, and bipolar disorder. Medical controls and an

extensive mental health history are also essential. Researchers may be able to make inferences about differences between groups and determine whether CPT variables can discriminate among these groups.

4) Riccio et al. (2001) suggests that researchers need to move beyond the weak approach (i.e. examining relationships between CPT scores and scores on other measures) and move toward using more sophisticated statistical analyses such as confirmatory factor analytic (CFA) procedures, such as path models, saturated models, constrained models, and factor analytic models to examine the constructs of CPT scores.
5) Lastly, Messick (1995) also proposes that future researchers examine results from a unitarian concept of validity that goes beyond interpreting correlation coefficients between test scores and includes interpretation and value implications of test scores, as well as, the utility and social consequences of using the test.

Recommendations for Practice

The following recommendations for practice are presented as a result of the study:

1) It is recommended for practice that the TOVA and TOVA-A CPTs may be useful to confirm symptoms of inattention, hyperactivity, or impulsivity when used as part of a multiple-method approach consisting of collecting data from multiple informants across multiple settings using multiple instruments.

2) There are a few dilemmas for licensed school psychologists working in a school setting in Oklahoma. School psychologists are traditionally utilized in a school setting to assess children for disability categories under the Individuals with Disabilities Education Act (IDEA). School district policies often prohibit trained licensed school psychologists from making a DSM-IV diagnosis. Children suspected of displaying characteristics of ADHD may be referred to a physician. However, even then a school psychologist referring the child for suspected symptoms of ADHD to a physician is precarious. If recommendations are made by the school psychologist or other school personnel for parents to seek a diagnosis or treatment from a physician for their child's suspected disorder, the school districts may be held accountable for medical treatments. Further information needs to be provided to administrators and policy makers to better utilize the skills and training of school psychologists working in a school setting.

Summary

Due to the inconsistent results of the correlational, multiple regression, and chi-square analyses, the TOVA and TOVA-A variables may be measuring an aspect of inattention, hyperactivity, and impulsivity that parent and teacher rating scales are not able to reliably measure. This researcher believes that the TOVA and TOVA-A CPTs may be useful at confirming symptoms of inattention, hyperactivity, or impulsivity when used as part of a multiple-method approach consisting of collecting

data from multiple informants across multiple settings using multiple instruments (Anastopoulos & Shelton, 2001; Barkley, 1998 DuPaul & Stoner, 2003).

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APPENDIX A

TABLES

Table 1

Pearson Correlation Coefficients between the TOVA Measures and the CPRS-R: L Variables (N = 73)

Scales	Visual Omission Errors	Visual Commission Errors	Visual RT	Visual RTV	Visual D-Prime	Visual ADHD Score
Oppositional	-.190	-.255*	-.062	-.208	-.295*	-.221
Cognitive Problems/Inatt.	-.178	-.171	-.251*	-.308**	-.316**	-.272*
Hyperactivity	-.071	-.121	-.033	-.188	-.195	-.172
Anxious-Shy	.075	.065	-.089	.030	.008	.071
Perfectionism	.170	.136	.109	.201	.213	.051
Social Problems	-.083	.016	-.187	-.093	-.088	-.103
Psychosomatic	.066	.024	-.056	.065	.048	.116
Conners' ADHD Index	-.199	-.164	-.206	-.285*	-.334**	-.242
CGI: Restless-Impulsive	-.159	-.163	-.112	-.236*	-.274*	-.223
CGI: Emotional Lability	-.063	-.220	.022	-.103	-.210	-.022
CGI: Total	.130	.036	.191	.161	.104	.209
DSM-IV: Inatt.	-.174	-.139	-.181	-.226	-.312**	-.203
DSM-IV: HI	-.145	-.166	-.077	-.259*	-.276*	-.272*
DSM-IV: Total	-.192	-.167	-.155	-.272*	-.335**	-.256*

Note. $p \leq .05$.** $p \leq .01$.

Table 2

Pearson Correlation Coefficients between the TOVA Measures and the CTRS-R: L Variables (N= 58)

Scales	Visual Omission Errors	Visual Commission Errors	Visual RT	Visual RTV	Visual D-Prime	Visual ADHD Score
Oppositional	-.265*	-.178	.004	-.218	-.238	-.282
Cognitive Problems/Inatt.	-.402**	-.284*	-.118	-.236	-.426**	-.269
Hyperactivity	-.226	-.131	-.162	-.292*	-.236	-.409**
Anxious-Shy	-.217	.132	-.158	-.079	-.086	-.260
Perfectionism	-.080	.010	.007	.008	.012	-.133
Social Problems	-.228	-.198	-.144	-.383**	-.301*	-.408**
Conners' ADHD Index	-.299*	-.150	-.181	-.307*	-.320*	-.385**
CGI: Restless-Impulsive	-.254	-.180	-.173	-.266*	-.327*	-.386**
CGI: Emotional Lability	-.267*	-.054	-.121	-.237	-.168	-.408**
CGI: Total	-.314*	-.101	-.204	-.297*	-.288*	-.435**
DSM-IV: Inatt.	-.323*	-.267*	-.143	-.300*	-.408**	-.343*
DSM-IV: HI	-.238	-.128	-.124	-.303*	-.216	-.401**
DSM-IV: Total	-.331*	-.213	-.170	-.351**	-.366**	-.424**

Note. $p \leq .05$. ** $p \leq .01$.

Table 3

Pearson Correlation Coefficients between the TOVA-A Measures and the CPRS-R: L Variables (N= 73)

Scales	Auditory Omission Errors	Auditory Commission Errors	Auditory RT	Auditory RTV	Auditory D-Prime
Oppositional	-.221	-.199	.078	-.179	-.229
Cognitive Problems/Inatt.	-.379**	-.372**	-.082	-.300**	-.358**
Hyperactivity	-.290*	-.278*	.051	-.272*	-.327**
Anxious-Shy	-.121	-.106	.038	-.083	-.052
Perfectionism	.133	.077	.068	.093	.131
Social Problems	-.100	-.080	.071	-.098	-.035
Psychosomatic	-.051	-.096	.109	-.103	-.058
Conners' ADHD Index	-.342**	-.305**	-.026	-.255*	-.290*
CGI: Restless-Impulsive	-.340**	-.261*	.085	-.233*	-.281*
CGI: Emotional Lability	-.174	-.165	.130	-.148	-.145
CGI: Total	.103	.123	.067	.068	.112
DSM-IV: Inatt.	-.333**	-.328**	-.037	-.240*	-.264*
DSM-IV: HI	-.342**	-.325**	.037	-.286*	-.373**
DSM-IV: Total	-.380**	-.358**	-.015	-.293*	-.352**

Note. * $p \leq .05$. ** $p \leq .01$.

Table 4

Pearson Correlation Coefficients between the TOVA-A Measures and the CTRS-R: L Variables (N= 58)

Scales	Auditory Omission Errors	Auditory Commission Errors	Auditory RT	Auditory RTV	Auditory D-Prime
Oppositional	-.090	-.176	-.048	-.013	-.130
Cognitive Problems/Inatt.	-.336**	-.421**	-.076	-.248	-.447**
Hyperactivity	-.166	-.211	-.170	-.152	-.234
Anxious-Shy	-.215	-.237	-.321*	-.126	-.329*
Perfectionism	.188	.049	-.119	.182	.182
Social Problems	-.216	-.408**	-.020	-.236	-.368**
Conners' ADHD Index	-.298*	-.316*	-.202	-.228	-.355**
CGI: Restless-Impulsive	-.225	-.308*	-.154	-.196	-.305*
CGI: Emotional Lability	-.180	-.171	-.259*	-.137	-.232
CGI: Total	-.188	-.259*	-.129	-.160	-.287*
DSM-IV: Inatt.	-.328*	-.393**	-.138	-.260*	-.403**
DSM-IV: HI	-.198	-.246	-.227	-.177	-.250
DSM-IV: Total	-.298*	-.361**	-.180	-.248	-.370**

Note. * $p \leq .05$. ** $p \leq .01$.

Table 5 DSM-IV Criteria for Attention-Deficit/Hyperactivity Disorder

A. Either (1) or (2):

(1) six (or more) of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Inattention

(a) often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities
(b) often has difficulty sustaining attention in tasks or play activities
(c) often does not seem to listen when spoken to directly
(d) often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)
(e) often has difficulty organizing tasks and activities
(f) often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
(g) often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools)
(h) is often easily distracted by extraneous stimuli
(i) is often forgetful in daily activities

(2) six (or more) of the following symptoms of hyperactivity-impulsivity have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Hyperactivity

(a) often fidgets with hands or feet or squirms in seat
(b) often leaves seat in classroom or in other situations in which remaining seated is expected
(c) often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)
(d) often has difficulty playing or engaging in leisure activities quietly
(e) is often "on the go" or often acts as if "driven by a motor"
(f) often talks excessively

(g) impulsivity
(h) often blurts out answers before questions have been completed
(i) often has difficulty awaiting turn
(j) often interrupts or intrudes on others (e.g., butts into conversations or games)

B. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before age 7 years.

C. Some impairment from the symptoms is present in two or more settings (e.g., at school [or work] and at home).

D. There must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.

E. The symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another mental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorder, or a Personality Disorder).

Code based on type:

314.01 Attention-Deficit/Hyperactivity Disorder, Combined Type: if both Criteria A1 and A2 are met for the past 6 months

314.00 Attention-Deficit/Hyperactivity Disorder, Predominately Inattentive Type: if Criterion A1 is met but Criterion A2 is not met for the past 6 months

314.01 Attention-Deficit/Hyperactivity Disorder, Predominately Hyperactive-Impulsive Type: if Criterion A2 is met but Criterion A1 is not met for the past 6 months

Coding note: For individuals (especially adolescents and adults) who currently have symptoms that no longer meet full criteria, "In Partial Remission" should be specified.

Table 6

Items of the DSM-IV: Inattentive and DSM-IV: Hyperactive-Impulsive subscales of the CPRS-R: L and the CTRS-R: L forms

DSM-IV: Inattentive subscale

Item 3: Forgets things he/she has already learned
Item 9: Fails to give close attention to details or makes careless mistakes in school work, work, or other activities
Item 12: Avoids, expresses reluctance about, or has difficulties engaging in tasks that require sustained mental effort (such as schoolwork or homework)
Item 18: Does not seem to listen to what is being said to him/her
Item 27: Has difficulty organizing tasks or activities
Item 28: Has difficulty sustaining attention in tasks or play activities
Item 49: Loses things necessary for tasks or activities (e.g., school assignments, pencils, books, tools, or toys)
Item 57: Does not follow through on instructions and fails to finish schoolwork (not due to oppositional behavior or failure to understand instructions)
Item 58: Easily distracted by extraneous stimuli

DSM-IV: Hyperactive-Impulsive subscale

Item 11: Is always "on the go" or acts as driven by a motor
Item 20: Leaves seat in classroom or in other situations in which remaining seated is expected
Item 29: Has difficulty waiting his/her turn
Item 36: Talks excessively
Item 39: Runs about or climbs excessively in situations where it is inappropriate
Item 42: Has difficulty playing or engaging in leisure activities quietly
Item 44: Fidgets with hands or feet or squirms in seat
Item 46: Blurts out answers to questions before the questions have been completed
Item 55: Interrupts or intrudes on others (e.g., butts into others' conversations or games)

Table 7 Comparison of CPT parameters

Configuration	Conners' CPT	GDS	IVA	TOVA/ TOVA-A
Set-up requirements	IBM/PC	None (microprocessor)	IBM/PC	IBM/PC
CPT type	Not-X	AX	X	X
Modality	Visual	Visual/Auditory	Visual/Auditory same task	Visual (TOVA)/ Auditory (TOVA-A)
Task Duration	14 minutes	9 minutes	13 minutes	22 minutes for TOVA/TOVA-A
Target frequency varied	No	No	Yes	Yes
Display time (ms)	250	200	167 auditory 500 visual	100 TOVA/ TOVA-A
Interstimulus Interval (ms)	Varied within each block 1,000, 2,000, 4,000	1,000	1,500	2,000
Response technique	Space bar or mouse	Press blue button	Mouse	Microswitch
Distraction/No distraction	No distraction	Distraction on Distractibility task	No distraction	No distraction

Table 8 Description of Data Analysis Plan

Population of Interest	IV or related constructs	Measure(s)	DV or related constructs	Measure(s)	Relationship/ Difference	Analysis
Nonreferred sample of children ages 6 through 12 years old	Omission Errors Commission Errors RT RTV D-Prime ADHD score (TOVA only)	TOVA TOVA-A	Oppositional Cognitive Problems/Inattention Hyperactivity Anxious-Shy Perfectionism Social Problems Psychosomatic (CPRS-R: L only) Conners' ADHD Index Conners' Global Index: Restless-Impulsive Conners' Global Index: Emotional Lability Conners' Global Index: Total DSM-IV: Inattentive DSM-IV: Hyperactive-Impulsive DSM-IV: Total	CPRS-R: L CTRS-R: L	Relationship	Pearson Product Correlation
Nonreferred sample of children ages 6 through 12 years old	Omission Errors Commission Errors RT RTV D-Prime ADHD score (TOVA only)	TOVA TOVA-A	DSM-IV: Inattentive DSM-IV: Hyperactive-Impulsive DSM-IV: Total	CPRS-R: L CTRS-R: L	Prediction	Multiple Regression
Nonreferred sample of children ages 6 through 12 years old	Omission Errors Commission Errors RT RTV D-Prime ADHD score (TOVA only)	TOVA TOVA-A	DSM-IV: Inattentive DSM-IV: Hyperactive-Impulsive DSM-IV: Total	CPRS-R: L CTRS-R: L	Prediction of membership	Chi-Square

Table 9

Multiple Regression Analyses of the TOVA Measures and the CPRS-R: L DSM-IV: Total Scale (N=59)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Visual D-Prime	.327	.107	6.837*	.107	6.837*	-.327*
Visual Omission Errors	.352	.124	3.949*	.017	1.056	-.185
Visual Commission Errors	.356	.126	2.654	.003	.179	-.151
Visual RTV	.356	.127	1.955	.000	.003	-.244
Visual RT	.356	.127	1.541	.000	.027	-.166
Visual ADHD Score	.357	.127	1.262	.000	.010	-.256

Note. * $p \leq .05$

Table 10

Multiple Regression Analyses of the TOVA Measures and the CPRS-R: L DSM-IV: Inattentive Scale (N=59)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Visual D-Prime	.300	.090	5.624*	.090	5.624*	-.300*
Visual Omission Errors	.332	.110	3.472*	.021	1.292	-.154
Visual Commission Errors	.339	.115	2.387	.005	.303	-.128
Visual ADHD Score	.345	.119	1.825	.004	.239	-.203
Visual RT	.359	.129	1.571	.010	.608	-.152
Visual RTV	.361	.130	1.298	.001	.073	-.209

Note * $p \leq .05$.

Table 11

Multiple Regression Analyses of the TOVA Measures and the CPRS-R: L DSM-IV: Hyperactivity-Impulsive Scale (N=59)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Visual D-Prime	.282	.079	4.914*	.079	4.914*	-.282*
Visual Omission Errors	.304	.092	2.844	.013	.791	-.158
Visual ADHD Score	.317	.101	2.049	.008	.510	-.272
Visual RTV	.333	.111	1.684	.010	.630	-.233
Visual RT	.339	.115	1.379	.004	.252	-.146
Visual Commission Errors	.343	.118	1.157	.003	.157	-.149

Note.* $p \leq .05$.

Table 12

Multiple Regression Analyses of the TOVA Measures and the CTRS-R: L DSM-IV: Total Scale (N=46)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Visual RTV	.426	.182	9.763**	.182	9.763**	-.426**
Visual Omission Errors	.443	.196	5.237**	.014	.764	-.348
Visual Commission Errors	.443	.197	3.426*	.001	.037	-.129
Visual D-Prime	.444	.197	2.520	.001	.040	-.381
Visual RT	.445	.198	1.975	.001	.032	-.316
Visual ADHD Score	.446	.199	1.614	.001	.043	-.424

Note.* $p \leq .05$. ** $p \leq .01$.

Table 13

Multiple Regression Analyses of the TOVA Measures and the CTRS-R: L DSM-IV: Inattentive Scale (N=46)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Visual RTV	.375	.141	7.222**	.141	7.222**	-.375**
Visual Omission Errors	.394	.155	3.948*	.014	.720	-.318
Visual ADHD Score	.402	.162	2.703	.007	.336	-.343
Visual RT	.407	.166	2.040	.004	.204	-.288
Visual D-Prime	.414	.172	1.658	.006	.275	-.353
Visual Commission Errors	.415	.172	1.351	.000	.020	-.116

Note. * $p \leq .05$.** $p \leq .01$

Table 14

Multiple Regression Analyses of the TOVA Measures and the CTRS-R: L DSM-IV: Hyperactivity-Impulsive Scale (N=46)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Visual ADHD Score	.401	.161	8.430**	.161	8.430**	-.401**
Visual RT	.421	.177	4.620*	.016	.841	-.248
Visual D-Prime	.425	.181	3.093*	.004	.209	-.314
Visual Omission Errors	.429	.184	2.309	.003	.145	-.289
Visual RTV	.430	.185	1.813	.001	.045	-.365
Visual Commission Errors	.430	.185	1.473	.000	.001	-.159

Note.* $p \leq .05$.** $p \leq .01$.

Table 15

Multiple Regression Analyses of the TOVA-A Measures and the CPRS-R: L DSM-IV: Total Scale (N=73)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Auditory Omission Errors	.380	.145	12.017***	.145	12.017***	-.380***
Auditory Commission Errors	.410	.168	7.090**	.024	1.994	-.358
Auditory RT	.424	.179	5.028**	.011	.920	-.015
Auditory D-Prime	.427	.183	3.799**	.003	.273	-.352
Auditory RTV	.428	.183	3.009*	.001	.057	-.293

Note. * $p \leq .05$.** $p \leq .01$.*** $p \leq .001$.

Table 16

Multiple Regression Analyses of the TOVA-A Measures and the CPRS-R: L DSM-IV: Inattentive Scale (N=73)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Auditory Omission Errors	.333	.111	8.832**	.111	8.832**	-.333**
Auditory Commission Errors	.366	.134	5.427**	.024	1.909	-.328
Auditory D-Prime	.414	.171	4.746**	.037	3.064	-.264
Auditory RT	.415	.173	3.545*	.001	.123	-.037
Auditory RTV	.415	.173	2.795*	.000	.004	-.240

Note.* $p \leq .05$. ** $p \leq .01$.

Table 17

Multiple Regression Analyses of the TOVA-A Measures and the CPRS-R: L DSM-IV: Hyperactive-Impulsive Scale (N=73)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Auditory D-Prime	.373	.139	11.480***	.139	11.480***	-.373***
Auditory RT	.403	.162	6.775**	.023	1.921	.037
Auditory Omission Errors	.411	.169	4.674**	.007	.558	-.342
Auditory RTV	.414	.172	3.524*	.003	.229	-.286
Auditory Commission Errors	.414	.172	2.779*	.000	.009	-.325

Note. *p ≤ .05.** p ≤ .01.*** p ≤ .001.

Table 18

Multiple Regression Analyses of the TOVA-A Measures and the CTRS-R: L DSM-IV: Total Scale (N=58)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F	r
Auditory D-Prime	.370	.137	8.875**	.137	8.875**	-.370**
Auditory Commission Errors	.386	.149	4.803*	.012	.768	-.361
Auditory RT	.401	.161	3.446*	.012	.772	-.180
Auditory RTV	.409	.167	2.661*	.007	.418	-.248
Auditory Omission Errors	.409	.167	2.090	.000	.004	-.298

Note $p \leq .05$. ** $p \leq .01$.

Table 19

Multiple Regression Analyses of the TOVA-A Measures and the CTRS-R: L DSM-IV: Inattentive Scale (N=58)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Auditory D-Prime	.403	.162	10.841**	.162	10.841**	-.403**
Auditory Commission Errors	.420	.176	5.888**	.014	.945	-.393
Auditory RT	.424	.180	3.938*	.003	.208	-.138
Auditory RTV	.431	.185	3.017*	.006	.389	-.260
Auditory Omission Errors	.431	.186	2.378	.001	.039	-.328

Note.* $p \leq .05$.** $p \leq .01$.

Table 20

Multiple Regression Analyses of the TOVA-A Measures and the CTRS-R: L DSM-IV: Hyperactive-Impulsive Scale (N=58)

TOVA Measures	R	Rsq	F (eqn)	Rsqch	F (ch)	r
Auditory D-Prime	.250	.063	3.78	.063	3.748	-.250
Auditory RT	.298	.089	2.672	.026	1.559	-.227
Auditory Commission Errors	.323	.104	2.098	.016	.954	-.246
Auditory RTV	.335	.112	1.675	.008	.467	-.177
Auditory Omission Errors	.335	.112	1.316	.000	.007	-.198

Note. * $\underline{p} < .05$.

Table 21

Chi-square Statistics for the TOVA Variables and the DSM-IV Scales of the CPRS-R: L (N = 73)

Variables	χ^2	df	Asymp. Sig. (2-sided)
Omission Errors * DSM-IV: Inattentive	.441	1	.507
Omission Errors * DSM-IV: Hyperactive-Impulsive	.000	1	.991
Omission Errors * DSM-IV: Total	.025	1	.875
Commission Errors* DSM-IV: Inattentive	.000	1	1.000
Commission Errors* DSM-IV: Hyperactive-Impul.	.269	1	.604
Commission Errors* DSM-IV: Total	.779	1	.377
RT * DSM-IV: Inattentive	2.068	1	.150
RT * DSM-IV: Hyperactive-Impulsive	.035	1	.851
RT * DSM-IV: Total	1.008	1	.315
RTV * DSM-IV: Inattentive	1.302	1	.254
RTV * DSM-IV: Hyperactive-Impulsive	1.216	1	.270
RTV * DSM-IV: Total	1.017	1	.313
D-Prime* DSM-IV: Inattentive	3.063	1	.080
D-Prime* DSM-IV: Hyperactive-Impulsive	.041	1	.839
D-Prime* DSM-IV: Total	1.390	1	.238
ADHD score * DSM-IV: Inattentive (N = 65)	.901	1	.343
ADHD score * DSM-IV: Hyperactive-Impulsive (N = 65)	.000	1	1.000
ADHD score * DSM-IV: Total (N = 65)	.261	1	.609

Table 22

Chi-square Statistics for the TOVA Variables and the DSM-IV Scales of the CTRS-R: L (N = 58)

Variables	χ^2	df	Asymp. Sig. (2-sided)
Omission Errors * DSM-IV: Inattentive	.777	1	.378
Omission Errors * DSM-IV: Hyperactive-Impulsive	.000	1	1.000
Omission Errors * DSM-IV: Total	.000	1	1.000
Commission Errors* DSM-IV: Inattentive	.000	1	1.000
Commission Errors* DSM-IV: Hyperactive-Impulsive	.000	1	1.000
Commission Errors* DSM-IV: Total	1.004	1	.316
RT * DSM-IV: Inattentive	.000	1	1.000
RT * DSM-IV: Hyperactive-Impulsive	.000	1	1.000
RT * DSM-IV: Total	.080	1	.777
RTV * DSM-IV: Inattentive	.009	1	.926
RTV * DSM-IV: Hyperactive-Impulsive	.435	1	.509
RTV * DSM-IV: Total	1.135	1	.287
D-Prime* DSM-IV: Inattentive	.447	1	.504
D-Prime* DSM-IV: Hyperactive-Impulsive	.000	1	1.000
D-Prime* DSM-IV: Total	.316	1	.574
ADHD score * DSM-IV: Inattentive (N = 50)	.670	1	.413
ADHD score * DSM-IV: Hyperactive-Impulsive (N = 50)	1.443	1	.230
ADHD score * DSM-IV: Total (N = 50)	1.048	1	.306

Table 23

Frequency of Normal and Abnormal Scores for the TOVA and TOVA-A

Variable		Frequency	Percent
Visual Omission Errors	Normal	39	43.8
	Abnormal	44	49.4
Visual Commission Errors	Normal	61	68.5
	Abnormal	22	24.7
Visual RT	Normal	46	51.7
	Abnormal	37	41.6
Visual RTV	Normal	32	36.0
	Abnormal	51	57.3
Visual D-Prime	Normal	34	38.2
	Abnormal	49	55.1
Auditory Omission Errors	Normal	40	44.9
	Abnormal	42	47.2
Auditory Commission Errors	Normal	36	40.4
	Abnormal	48	53.9
Auditory RT	Normal	55	61.8
	Abnormal	29	32.6
Auditory RTV	Normal	43	48.3
	Abnormal	41	46.1
Auditory D-Prime	Normal	30	33.7
	Abnormal	54	60.7

Table 24

Frequency of Normal and Abnormal Scores of the DSM-IV Scales of the CPRS-R: L

Scales		Frequency	Percent
DSM-IV: Inattentive	Normal	44	49.4
	Abnormal	35	39.3
DSM-IV: Hyperactive-Impulsive	Normal	46	51.7
	Abnormal	33	37.1
DSM-IV: Total	Normal	42	47.2
	Abnormal	37	41.6

Table 25

Frequency of Normal and Abnormal Scores of the DSM-IV Scales of the CTRS-R: L

Scales		Frequency	Percent
DSM-IV: Inattentive	Normal	42	47.2
	Abnormal	20	22.5
DSM-IV: Hyperactive-Impulsive	Normal	44	49.4
	Abnormal	18	20.2
DSM-IV: Total	Normal	45	50.6
	Abnormal	17	19.1

Table 26

Chi-square Statistics for the TOVA-A Variables and the DSM-IV Scales of the CPRS-R: L (N = 74)

Variables	χ^2	df	Asymp. Sig. (2-sided)
Omission Errors * DSM-IV: Inattentive (N = 72)	3.138	1	.076
Omission Errors * DSM-IV: Hyperactive-Impulsive (N = 72)	1.973	1	.160
Omission Errors * DSM-IV: Total (N = 72)	1.674	1	.196
Commission Errors* DSM-IV: Inattentive	9.570	1	.002**
Commission Errors* DSM-IV: Hyperactive-Impulsive	2.495	1	.114
Commission Errors* DSM-IV: Total	1.880	1	.170
RT * DSM-IV: Inattentive	.016	1	.900
RT * DSM-IV: Hyperactive-Impulsive	.024	1	.877
RT * DSM-IV: Total	.197	1	.657
RTV * DSM-IV: Inattentive	.942	1	.332
RTV * DSM-IV: Hyperactive-Impulsive	.587	1	.444
RTV * DSM-IV: Total	.067	1	.795
D-Prime* DSM-IV: Inattentive	4.574	1	.032*
D-Prime* DSM-IV: Hyperactive-Impulsive	.427	1	.514
D-Prime* DSM-IV: Total	.665	1	.415

Note.* $p \leq .05$** $p \leq .01$.

Table 27

Chi-square Statistics for the TOVA-A Variables and the DSM-IV Scales of the CTRS-R: L (N = 59)

Variables	χ^2	df	Asymp. Sig. (2-sided)
Omission Errors * DSM-IV: Inattentive (N = 57)	.000	1	1.000
Omission Errors * DSM-IV: Hyperactive-Impulsive (N = 57)	.000	1	1.000
Omission Errors * DSM-IV: Total (N = 57)	.057	1	.812
Commission Errors* DSM-IV: Inattentive	1.019	1	.313
Commission Errors* DSM-IV: Hyperactive-Impulsive	.173	1	.678
Commission Errors* DSM-IV: Total	1.639	1	.200
RT * DSM-IV: Inattentive	.389	1	.533
RT * DSM-IV: Hyperactive-Impulsive	2.763	1	.096
RT * DSM-IV: Total	.443	1	.506
RTV * DSM-IV: Inattentive	.685	1	.408
RTV * DSM-IV: Hyperactive-Impulsive	.107	1	.744
RTV * DSM-IV: Total	.003	1	.956
D-Prime* DSM-IV: Inattentive	.096	1	.756
D-Prime* DSM-IV: Hyperactive-Impulsive	.000	1	1.000
D-Prime* DSM-IV: Total	.027	1	.868

APPENDIX B

Institutional Review Board

Oklahoma State University Institutional Review Board

Request for Determination of Non-Human Subject or Non-Research

Federal regulations and OSU policy require IRB review of all research involving human subjects. Some categories of research are difficult to discern as to whether they qualify as human subject research. Therefore, the IRB has established policies and procedures to assist in this determination.

1. Principal Investigator Information

First Name: Heather	Middle Initial: E	Last Name: Murphy
Department/Division: School of Applied Health and Educational Psychology		College: College of Education
Campus Address:		Zip+4:
Campus Phone:	Fax:	Email: Murphy35@cox.net
Complete if PI does not have campus address:		
Address: 8216 South Florence Ave,		City: Tulsa
State: OK	Zip: 74137	Phone: 918-640-2211

2. Faculty Advisor (complete if PI is a student, resident, or fellow) ☐ **NA**

Faculty Advisor's name: Judy Oehler-Stinnet	Title: Associate Professor
Department/Division: School of Applied Health and Educational Psychology	College: College of Education
Campus Address: 425 Willard Hall	Zip+4:
Campus Phone: 405-744-9450	Email: jos@okstate.edu

3. Study Information:

A. Title

A Comparison of the Continuous Performance Test- Test of Variables of Attention and the Conners' Rating Scales, Revised in the Clinical Diagnosis of Attention Deficit Hyperactivity Disorder

B. Give a brief summary of the project. (See instructions for guidance)

This researcher wishes to utilize an existing archival database from a previous IRB protocol (IRB# ED-98-033A). The current study proposes to analyze data within the archival database. The data to be analyzed is a continuous performance test, the Test of Variables of Attention (TOVA) that contains two versions, the visual and auditory version. Continuous performance tests are direct measures of attention and impulsivity and assist the clinician in determining whether Attention Deficit-Hyperactivity Disorder is present. Two behavior-rating scales will also be analyzed within the archival database. The Conners' Parent Rating Scales-Revised: Long Form (CPRS-R: L) and Conners' Teacher Rating Scales-Revised: Long Form (CTRS-R: L) are behavior rating scales completed by the parent and teacher, respectively that also purport to measure attention difficulties such as inattention, hyperactivity, impulsivity and other related behavioral concerns (i.e. oppositionality, anxiety, cognitive problems, restlessness, and social problems). This researcher would like to compare the data between the TOVA visual and auditory versions with the CPRS-R: L and the CTRS-R: L to determine the relationship between the instruments.

Oklahoma State University Institutional Review Board

Request for Determination of Non-Human Subject or Non-Research

C. Describe the subject population/type of data/specimens to be studied. (See instructions for guidance)

The archival database does not contain the subject's name. Data will be reported in this researcher's dissertation in the form of quantitative analyses. A journal article will also be submitted to professional journals for publication. No information will be reported regarding the subject's name or linking the subject's name to the subject's data.

4. Determination of "Human Subject".

45 CFR 46.102(f): *Human subject* means a living individual about whom an investigator (whether professional or student) conducting research obtains: (1) data through intervention or interaction with the individual or (2) identifiable private information. Intervention includes both physical procedures by which data are gathered (for example venipuncture) and manipulations of the subject or the subject's environment that are performed for research purposes. Interaction includes communication or interpersonal contact between investigator and subject. Private information includes information about behavior that occurs in a context in which an individual can reasonably expect that no observation or recording is taking place, and information which has been provided for specific purposes by an individual and which the individual can reasonably expect will not be made public (for example, a medical record). Private information must be individually identifiable (i.e., the identity of the subject is or may be ascertained by the investigator or associated with the information) in order for obtaining the information to constitute research involving human subjects.

All of the following must be "no" to qualify as "non-human subject":

A. Does the study involve intervention or interaction with a "human subject"?
☒ No ☐ Yes

B. Does the study involve access to identifiable private information?
☒ No ☐ Yes

C. Are data/specimens received by the Investigator with identifiable private information?
☒ No ☐ Yes

D. Are the data/specimen(s) coded such that a link exists that could allow the data/specimen(s) to be re-identified?
☒ No ☐ Yes
If "*Yes*," is there a written agreement that prohibits the PI and his/her staff access to the link?
☐ No ☐ Yes

5. Determination of "Research".

45 CFR 46.102(d): *Research* means a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge. Activities, which meet this definition, constitute research for purposes of this policy, whether or not they are conducted or supported under a program, which is considered research for other purposes.

One of the following must be "no" to qualify as "non-research":

A. Will the data/specimen(s) be obtained in a systematic manner?
☐ No ☐ Yes

B. Will the intent of the data/specimen collection be for the purpose of contributing to generalizable knowledge (disseminating the knowledge obtained outside of Oklahoma State University, e.g., presentation or publication)?
☐ No ☐ Yes

Oklahoma State University Institutional Review Board

Request for Determination of Non-Human Subject or Non-Research

6. **Signatures**

Signature of PI Heather E. Murphy **Date** 11/18/05

Signature of Faculty Advisor (If PI is a student) Judy Ashley-Stewart **Date** 11/21/05

☒ Based on the information provided, the OSU-Stillwater IRB has determined that this research **does not** qualify a human subject research as defined in 45 CFR 46.102(d) and (f) and **is not subject to oversight by the OSU IRB.**

☐ Based on the information provided, the OSU-Stillwater IRB has determined that this research **does** qualify as human subject research and **submission of an application for review by the IRB is required.**

Sue C Jacobs

Dr. Sue C. Jacobs, IRB Chair

11/28/05

Date

Revision Date: 07/2005

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APPENDIX C

Participant Consent Form

Parent Consent Form for Research

USE OF DIRECT MEASURES OF ATTENTION, LEARNING AND MEMORY IN DIAGNOSIS AND INTERVENTION PLANNING FOR CHILDREN WITH ATTENTIONAL DIFFICULTIES

Dear Parent:

We are asking you to allow your child to participate in a study which will allow us to compare specific measures of attention, learning, behavior and memory. We are interested in determining which measures most accurately describe children's attention and behavior, and how measures of attention relate to measures of learning, memory, and achievement. Results will aid school psychologists and teachers who wish to help children to be successful. The information obtained for all children in the study will be used to compare and contrast the instruments to develop intervention plans and to develop a procedural handbook for school psychologists. The results of the study will have direct benefits to your child as results will be available to you in order to assist you in understanding your child's strengths and weaknesses. If you choose, results may also be shared with school personnel to aid in designing interventions which should be more relevant and beneficial.

We will ask you and your child's teacher to complete some behavior rating scales. Your child will be assessed with a comprehensive psychoeducational battery consisting of continuous performance tests (direct computerized measures of attention), memory, learning, achievement, motivation, and behavior scales. These are routine psychological tests which cause no discomfort and involve no risks and are similar to those you might have conducted privately. There are some questions of a personal nature on the rating scales, and some of the tasks your child is asked to do may become difficult. Testing is discontinued when items become too difficult, as is always done in psychological testing. For example, on the memory scale, testing will be discontinued when your child is unable to remember a certain number of items. Testing will be discontinued for any reason necessary.

Sessions will take place at Willard Hall on the OSU campus, unless your child is participating at a particular off-campus research site. Sessions would be scheduled after school unless you request a day appointment. Testing may also be conducted during the summer for some children. Because of the comprehensiveness of the study, it will take at least four hours for test completion, which will be broken across at least two test sessions as needed. All testing will be done by trained graduate assistants in school or counseling psychology, under the supervision of the supervising professor. The professor will ensure that only qualified examiners will be on the research team.

A research team member will meet with you following the testing to explain results. If any information revealed of a sensitive or diagnostic nature is deemed to need follow up, you will be informed and consulted as to appropriate action which might be taken.

Your child's participating is strictly voluntary. Both your consent and your child's assent will be obtained, and you or your child may choose to withdraw from the study at any time. Information from the stud will be kept in strict confidence. A number rather than a name will be listed on the tests; the master list linking names to the numbers will be kept in a confidential file and destroyed at the completion of the

study. You may contact me, Dr. Judy Oehler-Stinnett, at Willard Hall, School of Applied Health and Educational Psychology, Oklahoma State University at 405-744-9448 at any time if you have additional questions. You may also contact Gay Clarkson, Executive Secretary of the Institutional Review Board, 305 Whitehurst, Oklahoma State University, Stillwater, OK 74078.

By signing below, I indicate that I have read and fully understand this consent form. I sign it freely and voluntarily and a copy has been given to me. I agree to allow my child, myself, and my child's teacher to participate in this study as described above.

Signed_____ Date_____
Home phone _____ Business phone _____
I certify that I have personally explained all elements of this form to the participate or his/her representative before requesting them to sign it.
Signed _____ Date_____
Project Director or Representative

APPENDIX D

Parent Information Sheet

PARENT INFORMATION SHEET (Please Print)

Child's Name_____Date of Birth_____

Address_____

Parents' Name: _____(Please print) Ethnic Origin_____

Mother's Phone Number (Day) _____(Evening)_____

Father's Phone Number (Day)_____(Evening)_____

Child'sSchool_____City_____

Name of Teacher_____

Current Grade (if tested during school year) or grade just completed_____

Is your child on any medication of any kind (allergies, Ritalin, antidepressants, etc.) Y/N

Name of Medication & Dosage_____

Times of medication administration (a.m., noon, afternoon, evening?)_____

Was your child's delivery normal? Y/N

If you answered no, explain please (forceps, caesarian, abnormal length of labor, etc.)

Were developmental milestones within normal limits? Y/N

Age sat up?_____ Crawled?_____Walked alone?_____Talked?_____

Reason you wished your child to be part of this research project?

_____

_____

_____

Highest Educ Level – Mother HS__ GED___ College 1, 2, 3, 4, Grad___
Father HS ___ GED___ College 1, 2, 3, 4 Grad___

VITA

Heather Elaine Murphy

Candidate for the Degree of

Doctor of Philosophy

Thesis: A COMPARISON OF THE CONTINUOUS PERFORMANCE TEST – TEST OF VARIABLES OF ATTENTION AND THE CONNERS' RATING SCALES – REVISED IN THE CLINICAL DIAGNOSIS OF ATTENTION DEFICIT-HYPERACTIVITY DISORDER

Major Field: School of Applied Health and Educational Psychology

Biographical:

Personal Data: Born in Oklahoma City, Oklahoma on October 26, 1969 to David R. and F. Arlene Adams. Married Tim M. Murphy on August 5, 2000 and gave birth to Madeleine Elsie Murphy on December 15, 2001.

Education: Received a Bachelor of Arts degree in Psychology with a minor in Sociology from Oklahoma State University, Stillwater, Oklahoma, in December 1992; Received a Master of Science degree in Applied Behavioral Studies from Oklahoma State University, Stillwater, Oklahoma in July 1994; Completed the requirements of the Doctor of Philosophy degree in the School of Applied Health and Educational Psychology with specialization in school psychology at Oklahoma State University in December 2006.

Experience: Employed as a school psychologist at Jenks Public Schools, Jenks, Oklahoma, 2005 to present. Completed a doctoral school psychology internship at Sand Springs Schools, Sand Springs, Oklahoma, 2002-2004. Graduate assistant at Oklahoma State University from 1997 to 2001. Employed at Tulsa Public Schools as a Special Education Teacher for children with Emotional Disturbance, 1994 to 1997.

Professional Memberships: Member of Oklahoma School Psychology Association, Student Affiliate of National Association of School Psychologists, Student Affiliate of American Psychological Association, Student Affiliate of School Psychology Division 16 of the American Psychological Association.

Name: Heather Elaine Murphy Date of Degree: December, 2006

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: A COMPARISON OF THE CONTINUOUS PERFORMANCE TEST TEST OF VARIABLES OF ATTENTION AND THE CONNERS'RATING SCALES – REVISED IN THE CLINICAL DIAGNOSIS OF ATTENTION DEFICIT HYPERACTIVITY DISORDER

Pages in Study: 192 Candidate for the Degree of Doctor of Philosophy

Major Field: Applied Health and Educational Psychology

Scope and Method of Study: The purpose of the this study was to examine the relationship and consistency between the Test of Variables of Attention (TOVA) and the Test of Variables of Attention – Auditory (TOVA-A) and the Conners' Parent Rating Scale – Revised: Long Form (CPRS-R: L) and the Conners' Teacher Rating Scale – Revised: Long Form (CTRS-R: L). Participants in the study were a group of nonreferred children between the ages of 6 and 12. Children completed the TOVA and TOVA-A CPTs. The CPRS-R: L and CTRS-R: L scales were completed by the participant's parent and teacher. Pearson Product correlations, multiple regression and chi-square analyses were utilized to determine the relationship and consistency between the TOVA and TOVA-A measures and the scales of the CPRS-R: L and CTRS-R: L.

Findings and Conclusions: The TOVA and TOVA-A D-Prime was consistently correlated with the Cognitive Problems/Inattention scale, the Conners' ADHD Index, and the DSM-IV: Inattentive scale and the DSM-IV: Total scale of the CPRS-R: L and the CTRS-R: L; and the Social Problems scale of the CTRS-R: L. The RTV also showed a statistical relationship among these scales, although not as consistent a pattern. The ADHD score of the TOVA was consistently correlated with the CPRS-R: L and CTRS-R: L DSM-IV: Hyperactive-Impulsive scale. Multiple regression analyses found that the TOVA and TOVA-A D-Prime, Omission Errors, and RTV scores would more likely to predict parent and teacher rating scales measuring inattention, while the TOVA and TOVA-A D-Prime or the TOVA ADHD score would be more likely to predict parent and teacher scales measuring hyperactivity and/or impulsivity. Chi-square analyses suggested that there are no differences in the proportion of children identified as normal or abnormal by the variables of the TOVA/TOVA-A and the scales of the CPRS-R: L and CTRS-R: L. These findings indicate that the TOVA and TOVA-A are measuring similar aspects of inattention, hyperactivity, and impulsivity as the CPRS-R: L and the CTRS-R: L.

Judy Oehler-Stinnett, Ph.D.

ADVISOR'S APPROVAL: Judy Oehler-Stinnett, Ph.D.