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Do Parent and Teacher Ratings of Behavior Measure What They Are Intended to Measure?

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DO PARENT AND TEACHER RATINGS OF BEHAVIOR MEASURE WHAT THEY ARE INTENDED TO MEASURE?

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Abstract

This study involves an examination of the neurocognitive correlates of subscales of the Conners' Rating Scale – Revised (CRS-R), an ADHD behavioral rating form, in both a child (*n*=72) and an adolescent (*n*=49) sample. While both behavioral rating forms and neuropsychological measures are commonly employed in pediatric clinical evaluations, these two forms of assessment do not generally converge as expected. The purpose of the current research was to examine and compare the abilities of intellectual, academic, attentional, and executive skills to account for variance in parent and teacher ratings of behavior across two pediatric age groups in a clinical setting. Additionally, the study compared the relationships between behavioral ratings and cognition in children versus adolescents. The study found parent and teacher ratings of cognitive problems and inattention to be better accounted for by general cognitive ability than by attention and executive skills in children. Conversely, ratings of child hyperactivity, as completed by both parents and teachers, were better explained by attention and executive skills. General cognitive and academic abilities best accounted for parent ratings of overall ADHD likelihood, whereas teacher ratings of ADHD likelihood were equally accounted for by general cognitive abilities and attentional and executive skills. Neither general cognitive and academic abilities nor attention and executive skills accounted for a significant proportion of the variance in the adolescent sample. Furthermore, results showed that the variance in parent and teacher ratings of behavior was significantly accounted for by neurocognitive test performance across ratings subscales for child, but not adolescent clients. Overall, the results suggest that ADHD behavioral rating form accuracy varies according to subscale, informant, and age group. In child clients, ADHD

behavioral ratings converged with theoretically associated cognitive abilities for subscales assessing hyperactive, but not inattentive behaviors. Both parent and teacher informants appear to take children's overall cognitive and academic abilities into consideration more so than attentional and executive skills when rating inattentive behaviors. This suggests either rating form or informant inaccuracy in identifying specific problems in attention and organization. Parents, in particular, appear to be relatively poorer raters of child behavior than teachers as only teacher ratings of overall ADHD likelihood were accounted for by attentional and executive skills. Parent and teacher ratings of behavior appear to be of questionable accuracy across ADHD related behaviors in the assessment of adolescents. As behavioral ratings were not related to cognition in the 11–17-year-old sample, ADHD behavioral rating forms appear to demonstrate poor convergent validity in adolescents. The finding that ratings of behavior were significantly related to cognition in children, but not in adolescents, suggests the presence of age-dependent differences in the presentation of ADHD symptoms or the accuracy of assessment tools between children and adolescents. Clinicians are encouraged to use caution when interpreting ratings of adolescent ADHD behavior and ratings of child inattentive behavior, as these scales may often not assess their purported constructs.

Chapter I: Statement of the Problem

ADHD is estimated to be the largest single source of child referrals (Garland et al., 2001), accounting for as many as 30-50% of all childhood psychiatric evaluations (Stefanatos & Baron, 2007). Because the biological etiology of the disorder is still unknown, brain imaging, genetic testing, and other physical means of evaluation are considered ineffective forms of assessment, placing the burden of diagnosing ADHD on the judgment of the clinician (Furman, 2005). An ADHD evaluation typically consists of a clinical assessment of the child, a face-to-face interview with the child's parents, tests of cognitive functioning, and finally, parent and teacher behavioral rating scales or questionnaires (Nagliera, Goldstein, Delauder, & Schwebach, 2005). Through the integration of these sources of data, the clinician must reach a diagnosis that provides the most likely and parsimonious explanation of a child's presenting problems. Parent and teacher rating scales provide valuable clinical information regarding child behavior as they allow for assessment of behavior across multiple settings and identify clinically meaningful deviations from normality through the conversion of behavioral rating raw scores to standardized scores. In children suspected of ADHD, rating scales assess for the presence and severity of impairment in domains of inattention and hyperactivity/impulsivity as well as identify co-occurring behavioral issues.

Despite the well-recognized utility of behavioral rating scales, their clinical interpretation is often encumbered by poor convergence with other seemingly similar measures. It is not uncommon for ratings of behavior to disagree between informants (e.g. disparate rating scores between parent and parent or between parent and teacher) or with other assessment measures intended to measure similar constructs. A number of research findings provide support for the frequency of such occurrences, often indicating weak associations between parent and teacher ratings of behavior (Achenbach, McConaughy, & Howell, 1987; Conners, 2001; Power et al., 1998) and between ratings of behavior and measures of attention and executive functioning, constructs believed to be implicated in disorders of attention (Willcutt, Doyle, Nigg, Farone, & Pennington, 2005).

Additionally, Gomez, Burns, Walsh, and Alves de Moura (2003) found ratings of inattentive and hyperactive behaviors to be more affected by informant source than by specific trait factors. That is, symptoms of inattention rated by one informant (e.g. parent ratings) were found to relate to a greater extent to symptoms of hyperactivity rated by the same informant than to symptoms of inattention rated by a different informant (e.g. teacher ratings). Such findings may support the influence of a "halo effect", or overall impression of behavior, in guiding behavioral ratings. While Gomez and colleagues do not conclude whether their findings are due to rater biases or to differing child behavior across environments, that parent and teacher ratings of ADHD behavior demonstrate poor convergent and discriminant validity when analyzed together calls into question their ability to accurately measure specific capacities of cognition. Furthermore, while ratings of ADHD related behaviors have been found to poorly correlate with neuropsychological measures assessing hypothetically similar constructs, some research suggests that parent and teacher ratings, specifically ratings of inattention, do predict performance on tests measuring other, seemingly less similar domains of cognition such as intellectual functioning and academic achievement (Nagliera et al., 2005; DeShazo Barry, 2002).

While many studies have found behavioral ratings of inattention and hyperactivity/impulsivity to relate poorly to performance on neuropyshological measures of attention and executive functioning, no study to date has compared these relationships with the relationships between ratings of behavior and other, less theoretically related, cognitive abilities (e.g. academic achievement). Such research is needed to assess whether ratings of child behavior are poor indicators of cognitive functioning in general or if, instead, ratings of behavior measure cognitive abilities other than those which they are intended to measure. Given the influence often apportioned to ratings of behavior in determining and differentiating between child psychiatric diagnoses, this represents a notable shortcoming in the current literature.

Another limitation in the current literature involving ADHD rating scales is the failure by many studies to consider age as a potential moderating variable. Although ADHD remains one of the most researched of childhood disorders, most research studies have utilized samples of preadolescent children to examine the clinical presentation and behavioral and cognitive correlates of ADHD, leaving some uncertainty regarding the nature of the disorder in adolescent samples (Farone, Biedermain, & Monuteaux, 2002; Seidman et al., 2005). Such a failure to utilize adolescent as well as child samples is one of several research methodological limitations impeding conclusive understanding of the cognitive correlates of ADHD (Seidman et al., 2005). Furthermore, those studies that do include adolescents often examine characteristics of behavior or cognition utilizing combined samples that include both children and adolescents. Such a practice potentially masks any characteristics specific to only one of these age groups. This is problematic as the poor convergence between cognitive measures of attention and executive functioning and child behavioral ratings across research studies is believed, by some, to be due to intragroup heterogeneity within ADHD samples (Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005). Age, specifically, might play some part in moderating these relationships, as the presentation of ADHD is believed to change across the developmental span and the sensitivity of some neuropsychological assessment measures to ADHD has been proposed to vary according to age in children (Barkley, Grodzinsky, & DuPaul, 1992). Because of this, research comparing the relationship between ratings of behavior and neuropsychological measures across pediatric age groups is still needed.

Therefore the aim of this study was to determine if parent and teacher ratings of inattention, hyperactivity and impulsivity, and overall ADHD likelihood are more significantly predicted by performance on measures of academic achievement and intellectual functioning than by performance on measures of attention and executive functioning. As these relationships were expected to vary according to age, the study examined them separately for children and adolescents, and concluded by comparing relationships between ratings of behavior and performance on objective measures of cognition across age groups.

Chapter II: Review of the Literature

In order to understand the relevance of the proposed investigation, it is necessary to present past research regarding the Conners' Rating Scales, the relationships between behavioral ratings and neuropsychological measures, and the importance of age as a moderating variable.

The Conners' Rating Scales

The use of parent and teacher behavioral rating scales has been long recognized as an integral component in the diagnostic determination of child behavioral disorders. Of the various behavioral rating scales, the Conners' Rating Scales are of the most commonly used, and have become standard assessment measures of ADHD (Collet, 2003). The Conners' Parent Rating Scale-Revised (CPRS-R) and Conners' Teacher Rating Scale-Revised (CTRS-R) were developed and validated in 1998 as an effort to improve upon the already popular Conners' Parent Rating Scale (CPRS) and Conners' Teacher Rating Scale (CTRS) (Conners, Sitarenios, Parker, & Epstien 1998a). The original CPRS, developed by Dr. Keith Conners, was used as an assessment tool given to the parents of children assessed at an outpatient psychiatric hospital on behavioral disturbances including sleep, eating, temper, keeping friends, and school problems (Conners et al., 1998a). The CPRS was first validated and factor analyzed in 1970 using children recruited from Baltimore-area schools, but multiple versions and adaptations emerged in the years following.

The CTRS was created alongside the CPRS. The first version, the CTRS-39, was a 39 item rating scale used to research the effectiveness of stimulant medications (Gianarris, Golden, & Greene, 2001). While the CTRS and CPRS saw extensive use, both by researchers and clinicians, and evidenced good reliability and validity, the factor structures of the scales varied across research studies (Conners et al., 1998a,b) and the normative sample referenced for each scale was narrow in its geographical and cultural representation. Additionally, many of the scales' individual items were unrelated to the most common behavior problems typically encountered and no longer captured the current conceptualizations of behavioral disorders (Conners et al., 1998b).

To answer these issued, the Conners' Parent Rating Scale – Revised (CPRS-R) and Conners' Teacher Rating Scale- Revised (CTRS-R) were developed and validated in 1998 using 2200 and 1701 students respectively. The CPRS-R contains 80 items, factoring into seven subscales that include Cognitive Problems/Inattention, Oppositional Behavior, Hyperactivity, Anxious-Shy, Perfectionism, Social Problems, and Psychosomatic Behavior. The CTRS-R contains 59 items and includes all of the subscales of CPRS-R with the exception of the psychosomatic subscale. For both scales, items were chosen from a larger set of items based upon their ability to load sufficiently onto a single factor. In addition to the factor analysis derived subscales, the CPRS-R and CTRS-R contain several additional subscales including a 12-item ADHD Index, a 10-item Global Index, and an 18-item ADHD DSM-IV Symptoms subscale. The DSM-IV Symptoms scale, further divides into an Inattention subscale and a Hyperactivity/Impulsivity subscale, and contains items that directly mirror the ADHD symptom criteria of the DSM-IV.

Both the CPRS-R and CTRS-R have demonstrated high diagnostic accuracy rates. In their initial validation studies, sensitivity was 92% for the CPRS-R and 78% for the CTRS-R, specificity was 94% (parent) and 91% (teacher), positive predictive power was

94% (parent) and 90% (teacher), and negative predictive power was 92% (parent) and 81% (teacher) in distinguishing a sample of children diagnosed with ADHD from a sample of non-clinical children (Conners1998a, b).

While both the CTRS-R and CPRS-R demonstrate improvements over previous forms of the Conners' Rating Scales and have become popular forms of assessment for ADHD and other childhood disorders, the scales are not without their critics. Snyder and Drozd (2004) argued that because the same sample was used both for the development and the validation of the discriminant analysis of the CRS-R, rates of sensitivity and specificity provided by Conners (1998a) are likely inflated as such practice overemphasizes random factors found in the sample.

Parent and Teacher Ratings of Behavior

Despite their frequent use by clinicians and researchers, behavioral rating forms have historically evidenced low inter-rater reliability. This has been proven particularly true when comparing parent and teacher ratings of behavior. In the standardization sample of the CRS-R, relationships between parent and teacher forms on the six common subscales of the CRS-R ranged from .12 to .50 (Conners, 2001), indicating only a low to moderate consensus between teachers and parents in their ratings of child behavior. Similarly, in a meta-analysis involving 117 studies, Achenbach et al. (1987) reported a mean correlation of .27 between parent and teacher ratings of behavior. The study found similar relationships when looking at agreement between other pairs of informants involved in contrasting roles (e.g. observer and parent), contributing to the authors conclusion that child ratings from adults across different settings can, at best, only be expected to moderately correlate.

In a large sample of Australian youth in which children were rated by parents and teachers using the DSM-IV AD/HD scale, Gomez et al. (2003) found the variance attributable to source factors to be greater than the variance attributable to trait factors. Similarly, Power et al. (1998) found within-informant correlations between factors of inattention and hyperactivity/impulsivity to be in the moderate to high range for teacher (r = .56) and parent (r = .67) behavioral rating forms. This was in contrast to substantially lower cross-informant correlations between parents and teachers both in inattention (r = .41) and hyperactivity/impulsivity (r = .30). These studies suggest that behavioral rating form subscales and factors tend to be intercorrelated within either of the parent or teacher forms better than between sources.

Yet, more research is still needed to determine if the general lack of concordance between teacher and parent ratings is due to rater bias or rater accuracy (Gomez et al., 2003). Some amount of variance in behavior is expected from setting to setting, as task demands and situational influences upon behavior are likely to be environmentally specific. Achenbach et al. (1987) noted that mean correlations between informants of the same setting (e.g. two parents) are significantly higher than mean correlations of the ratings provided by informants of different settings (.60 vs. .28). The authors concluded that informants of the same setting tend to be more consistent in their ratings and informants of different settings are likely rating different sets of behavior that occur uniquely to the setting.

If it is true that parents and teachers tend to rate child behavior differently, it would be expected that parent and teacher ratings vary in the manner in which they converge with cognitive and academic tests related to attention. In fact, a number of studies have found this to be the case, especially when examining the relationships between parent and teacher ratings and measured academic achievement. A study examining predictors of achievement in kindergarteners indicated that teacher ratings of attention and behavior differentiated a group of children with identified learning problems from one comprised of those without learning difficulties, whereas parent behavior ratings did not (Taylor, Anselmo, Foreman, Schatschneider, & Angelopoulos, 2000). Similarly, in a longitudinal study tracking children from kindergarten through second grade, Dally (2006) found teacher, but not parent, ratings of inattention to significantly relate to performance on reading outcome measures.

Informant source has also been found to moderate the relationship between ratings of behavior and measures of executive functioning. In one study examining the relationship between ratings of inattention and measures of executive functioning, teacher, but not parent, ratings of behavior were found to significantly contribute to the prediction of child performance on tasks of working memory and planning (Oosterlan et al. (2005). Results from Jonsdottir et al. (2006) indicated a similar disparity between the ability of teacher versus parent ratings of behavior to relate with measures of executive functioning. Likewise, Riccio, Hall, Morgan, and Hynd (1994) found significant associations between teacher ratings of ADHD symptoms and the Wisconsin Card Sorting Test (WCST), but found relationships between parent ratings and the WCST to be non-significant.

Findings that teacher ratings of behavior tend to be superior to parent ratings of behavior in predicting cognitive and academic abilities have been attributed to a number of factors. Taylor et al (2000) suggest that teachers may be more accurate in rating behavior than parents as parents may place fewer demands on young children in terms of attention, independent functioning, and self-control. The authors also note that teachers are better equipped to observe a child's interactions with peers and to rate child behavior as it compares to that of other same-aged children.

While the aforementioned studies found teacher ratings of inattention to be better associated with performance on measures of academic achievement and cognitive functioning than parent ratings, ratings from both sources do appear to demonstrate diagnostic utility. As mentioned above, both the parent and teacher forms of the CRS-R demonstrated high accuracy rates in classifying children with and without an ADHD diagnosis in the standardization sample. Power et al. (1998) examined the ability of parent and teacher ratings of inattention and hyperactivity to successfully classify normal controls and children diagnosed with ADHD in a sample of students ranging form age 5-14. The study found both teacher and parent ratings of inattention to significantly and equally predict diagnostic status. However, parent, but not teacher, ratings of behavior accurately predicted diagnostic status when looking only at ratings of hyperactivity. Such findings suggest that both parent and teacher ratings of behavior can provide useful information regarding child ADHD behavior. This implication is underscored by the study's finding (Power et al.) that prediction accuracy when ruling-in ADHD is higher when utilizing both parent and teacher ratings of behavior than when using either form individually.

Ratings of Behavior and Measures of Attention

Researchers have posited the global construct of attention to contain several discrete, but overlapping domains of functioning. While specific labels and descriptions vary across the literature, they tend to tap into three categories which Rezazadeh1, Wilding, and Cornish (2011) refer to as selective attention, sustained attention, and attentional control. Selective attention, also referred to as focus (Mirsky et al., 1991), refers to one's ability to selectively attend to desired stimuli while ignoring irrelevant stimuli. Sustained attention is one's ability to remain alert over a period of time and to maintain attention on a given task. Attentional control refers to the ability to inhibit an off-task response, plan a sequence of responses, and shift from one area of focus to another (Rezazadeh1 et al.). These abilities, while referred to in this section as functions of attention, are sometimes mentioned in discussions of other functions of cognition. This is especially true of attentional control, which is often subsumed under the category of executive functioning.

In examining the relationship between parent and teacher ratings of behavior and attentional abilities, a number of studies have utilized continuous performance tests (CPT's), due to both their sensitivity and ability to assess multiple domains of attention. Of these, the Conners' Continuous Performance Test – Second Edition (CPT-II) has emerged as one of the most utilized in both research and clinical work, in part due to its ability to assess multiple domains of functioning. A factor analysis examining the CPT-II (Egeland & Kovalik-Gran, 2010) found that the test's 13 variables load onto four discrete factors (labeled Focus, Impulsivity, Sustained Attention, and Vigilance), leading the authors to conclude that the CPT-II does indeed measure several overlapping but separate domains of attention. Such output makes the test a good fit with theories of attention (e.g. Mirsky et al, 1991; Rezazadeh1 et al., 2011) which argue that the formulation of attention should be multifaceted, including several specific domains of functioning. Of the CPT-II variables most analyzed in neuropsychology research are Omissions, Commissions, and the ADHD Index. Omissions, neglecting to respond to target stimuli, are theorized to reflect difficulties in focusing attention (Egeland & Kovalik-Gran) where as Commissions, responding erroneously to non-target stimuli, have been theorized to measure response inhibition (Willcutt et al., 2005) or impulsivity (Egeland & Kovalik-Gran). The ADHD Index reflects one's overall performance on the CPT-II and is considered a good measure of capacity to sustain attention.

The CPT-II has been shown to effectively discriminate between groups of children with and without ADHD (Conners, 2000). In a meta-analysis of studies using various forms of the CPT, Losier et al. (1996) compared the performance of children diagnosed with ADHD to children without an ADHD diagnosis across 26 studies. While not all individual studies found significant differences between the groups on commission and omission errors, the studies as a whole, when subjected to meta-analytical techniques, indicated that ADHD groups committed significantly more commission and omission errors than non-ADHD groups. In a more recent meta-analysis using tests of both attention and executive functioning, Willcutt et al. (2005) found the CPT to be among the most effective in discriminating between ADHD and non-ADHD groups, with 77% of 30 studies showing a significant difference between groups on omission errors and 61% of 28 studies showing a significant difference on commission errors.

Results, however, have been largely equivocal when examining the relationship between parent and teacher ratings of inattentive and hyperactive/impulsive behavior and CPT performance, with some studies failing to find any significant relationships between parent and teacher ratings of behavior and the CPT-II and others finding small associations. In a study of 117 children, ranging in age from 6 to 16, Nagliera et al. (2005) failed to find significant relationships between variables of the CPT-II and indices of either the Conners Rating Scales-Revised parent form (CPRS-R) or teacher form (CTRS-R). Edwards et al. (2007) examined the relationships between CPT-II Omissions, Commissions, and the ADHD Index and behavior ratings from the parent and teacher forms of the Conners ADHD/DSM-IV Scales (CADS) in 106 children between 6 and 12 years of age. The study found significant negative correlations between teacher ratings of inattentive and hyperactive/impulsive behaviors and CPT-II Commissions and an absence of any other significant relationships while controlling for IQ. The authors justified partialling out for IQ by noting significant correlations between CPT-II error scores and IQ; yet, other researchers (Nigg, 2001) have argued against this practice as using IQ as a covariate may remove some of the variance attributable to ADHD deficits.

In those studies finding significant associations between the CPT and ratings of behavior, it is not uncommon for the CPT to relate in ways contrary to hypotheses regarding the test or relate to broad rather than specific domains of behavior. The theory that CPT variables, such as Omissions and Commissions, measure distinctly separate constructs of cognitive functioning has led researchers to hypothesize that each variable should relate differentially to manifestations of behavior. For example, some authors have posited that Commissions, measuring failures in inhibiting a prepotent response, should relate to hyperactive and impulsive behavior (Bodnar, Prahme, Cutting, Denckla, & Mahone, 2007; Soreni, Crosbie, Ickowicz, & Schachar, 2009). On the other hand, errors of omission have been hypothesized to more directly relate to stereotypical inattentive behaviors (Epstein et al., 2003). However, studies have failed to find such specific associations when relating CPT measures to parent and teacher ratings of behavior.

Epstein et al. (2003) queried parents about the presence of DSM-IV ADHD inattention, hyperactivity, and impulsivity symptoms and examined the relationship between omissions and commissions and each of the 18 symptoms DSM-IV ADHD symptoms. The study found omission errors to relate significantly to a greater number of parent endorsed symptoms of hyperactivity and impulsivity than to parent endorsed symptoms of inattention. The study also found commission errors to relate equally to symptoms of hyperactivity/impulsivity and inattention. Thus, omission and commission errors did not converge in an exclusive manner with hypothetically similar constructs of behavior when symptoms were rated by parent informants.

Similarly, Bodnar et al. (2007), in examining the relationship between variables of the CPT-II and parent ratings of behaviors related to executive functioning, found omissions, but not commissions, to significantly correlate with ratings of inhibition (.31) and emotional control (.23). Such a finding is contrary to the expectation that commission errors, regarded to be a measure of response inhibition, should relate to measures of behavior requiring the inhibition of behavior. Results from both Bodnar et al. and Epstein et al. (2003) suggest that while errors of omission relate to parent ratings of behavior, they do not relate singularly to ratings of inattention.

Other studies have found similar results in looking at teacher ratings in relation to omissions and commissions on the CPT-II. McGee, Clark, and Symons (2000) found no significant correlations between the CPT-II ADHD index or CPT-II Commissions and various forms of teacher and parent ratings of behavior. Low to moderate significant relationships, however, were found between CPT-II Omissions and the hyperactivity index of the CPRS-R (.21) and the externalizing problems index of the Teacher Rating Form (.26), indicating that Omissions, but not Commissions, related to both parent and teacher ratings of hyperactivity and externalizing behavior problems. Egeland, Johansen, and Ueland (2009) compared CPT-II Omission and Commission scores to behavior ratings from a scale consisting of the 18 DSM-IV ADHD symptoms. The study found omission errors to be significantly related to parent ratings of attention and hyperactivity/impulsivity (.25 and .20) as well as teacher ratings of inattention (.23), but not to teacher ratings of hyperactivity/impulsivity. The study failed to find significant relationships between commission errors and either parent or teacher ratings. Consequently, despite the theoretical link between commissions and behavioral inhibition or impulsivity, such studies question the ability of the CPT-II commission errors to relate to hyperactive or impulsive behaviors as rated by parents and teachers. Furthermore, the above research provides only weak support for omission errors as being related to ratings of inattentive behaviors.

Studies assessing the relationship between behavioral rating scales and cognitive measures of attention have shown even less agreement when utilizing non-CPT instruments (Willcutt et al., 2005). Schwean, Burt, and Saklofske (1999) examined the relationship between mother and teacher ratings of behavior and performance on measures of selective attention in a sample of 51 children diagnosed with ADHD between the ages of 8 and 11. No significant relationships were found between parent or teacher ratings of inattentive or hyperactive-impulsive behaviors and cognitive measures of selective attention.

Overall, the results are mixed when looking at the ability of measures of sustained attention, response inhibition, and selective attention to relate to parent and teacher ratings of behavior. Such results question the extent that parent and teacher ratings of inattention and hyperactivity/impulsivity detect cognitive deficits in attentional functioning as measured by neuropsychological measures.

Executive Functioning and Ratings of Behavior

Executive functioning refers to a number of cognitive abilities related to the function of maintaining goal orientation (Wahlstedt, 2009), and involves "top-down" (Willcutt et al., 2005) or "higher-level" processes (Alvarez & Emory, 2006) involved in the control or regulation of more elementary processes. While definitions of executive functioning differ across authors, most cite its make-up as consisting of such components as planning, inhibition, cognitive flexibility, problem solving, and working memory. Researchers have proposed that impairments in executive functioning underlie the presentation of ADHD behavioral symptoms (Barkley, 1997). Such a hypothesis was generated largely in reaction to findings that impairments in executive functioning are consistently found in adults with frontal lobe damage, a population that, similar to ADHD diagnosed individuals, tends to exhibit hyperactive, impulsive, and inattentive behaviors (Tripp, Ryan, & Peace, 2002). Research demonstrating ADHD individuals perform poorly on measures of executive functioning (Willcutt et al., 2005), as well as brain imaging studies indicating subtle abnormalities and decreased volume in the frontal lobes, specifically the prefrontal cortex, of children with ADHD (Krain & Castellanos, 2006) provide support for the connection between ADHD and deficits in executive functioning.

Barkley (1997) theorized that deficits in response inhibition, specifically, are central to deficits in other executive functions and thereby serve as an elemental causal factor in ADHD symptom presentation. Bodnar et al. (2007) noted response inhibition requires individuals to 1) not engage in an automatic response, 2) stop an ongoing response, 3) persist on a task despite competing events, and 4) defer reinforcement or gratification. Response inhibition allows children to stop and consider consequences before acting, which allows for better planning, organizing, and problem solving, thus making it a central component to executive functioning (Bodnar et al.). Barkley's model therefore asserts that poor inhibition control subverts processes of executive functioning, leading to observable problems in inattention, hyperactivity, and impulsivity.

In support of the relationship between executive functioning and ADHD, Willcutt et al. (2005) found significant group differences on executive functioning performance between ADHD and non-ADHD groups in 109 of 168 (65%) of comparisons. Such results indicate that children diagnosed with ADHD are likely to perform more poorly than children without the diagnosis on tests of executive functioning. The meta-analysis found this to be truer for some tests than others. Stop-signal reaction time, a measure of response inhibition, and CPT omission errors, a measure of attention, were the most successful at differentiating between groups (82% and 77% of studies). These measures, along with measures of planning and spatial working memory produced the highest weighted mean effect sizes of the 13 measures used in the studies. Wisconsin Card Sorting (WCST) perseverative errors and Trail Making Test Part B (TMT B), which measure set shifting abilities, as well as measures of verbal working memory differentiated between groups less consistently (46% to 55% of studies).

However, while ADHD and non-ADHD groups tend to differ in terms of performance on many measures of executive functioning, correlations between ratings of ADHD behaviors and performance on measures of executive functioning have generally been significant but small (Willcutt et al., 2005; Willcutt et al., 2001). Jonsdottir, Bouma, Sergeant, and Scherder (2006) examined the relationships between parent and teacher ratings of hyperactive and inattentive behavior and executive functioning in a sample of children aged 7-11. While teacher ratings of attention problems significantly related to performance on the Tower Test, a measure of non-verbal planning, monitoring, self-regulation, and problem solving, the relationship was no longer significant once controlling for intelligence. No significant relationships were found between parent ratings of behavior and performance on measures of executive functioning, even without controlling for IQ.

Other studies have found some support for an association between teacher, but not necessarily parent, ratings of behavior and measures of executive functioning. Friedman et al. (2007) examined the relation of teacher ratings of attention problems from ages 7-14 and later executive functioning deficits at age 17. Executive functioning was assessed using nine measures to form three latent variable including, response inhibition, set shifting, and working memory updating. The study found response inhibition to relate significantly to ratings of attention, regardless of the age in which behavioral ratings were employed. Ratings of attention correlated to a much lesser extent to working memory and set shifting.

Additionally, teacher ratings of inattention and cognitive problems have been found to relate to deficits in working memory (Alloway, Gathercole, Kirkwood, & Elliott, 2009). In their study, Alloway et al. identified 308 children from an original sample of 3,189 five-to eleven-year-olds as having a working memory impairment based on their performance on two verbal working memory measures of the Automated Working Memory Assessment. Such children averaged scores two standard deviations above the mean on the Cognitive Problems/Inattention subscale and one standard deviation above the mean on the ADHD index of the CTRS-R. Thirty-two percent of younger children and 15% of older children were considered at high risk for a diagnosis of ADHD based on teacher behavioral ratings using a cut-off of 1.5 standard deviations above the mean. In contrast, ratings of hyperactivity were not significantly elevated in children identified as having deficits in working memory.

Finally, Oosterlan, Sheres, and Sergeant (2005) looked at the relationship between parent and teacher ratings of behavior and measures of executive functioning in the domains of working memory, planning, and verbal fluency. The study, using a sample of 99 children aged 6-12, found teacher ratings, but not parent ratings, of inattentive and hyperactive behavior, to relate significantly (.22 to .34) to performance on measures of working memory and planning.

Overall, the research appears to indicate that while children diagnosed with ADHD are more likely to perform worse on measures of executive functioning than children without the disorder, relationships between ratings of ADHD behavior and executive functioning tend to be, at most, of small to medium effect. Furthermore, these studies suggest that while teacher ratings of behavior tend to relate to measures of executive functioning, parent ratings of behavior do not.

Ratings of Behavior and Academic Achievement

ADHD diagnosis has long been associated with poor academic achievement. The rate of reading disorder in samples of ADHD children typically falls between 25 and 40% (Willcutt et al., 2001). Even in those children diagnosed with ADHD not meeting the criteria for a learning disorder, inattentive and hyperactive behaviors are believed to interfere with the acquisition of essential academic skills. Similarly, even in children not formally diagnosed with ADHD, ratings of inattention have been found to predict underachievement in reading and mathematics (Merrell and Tymms, 2001).

While the existence of a relationship between inattention and reading difficulties is clearly noted in the literature, the nature of this relationship is less defined. Some researchers suggest that shared difficulties in reading and attention are the result of unique and discrete cognitive deficits that happen to co-occur due to similar biological etiologies of the disorders (Willcutt et al., 2001). Others (DeShazo Barry, Lyman, & Klinger, 2002; Dally, 2006) have argued that inattentive behaviors interfere with successful classroom learning, thereby interfering with the development of academic skills.

To examine the extent to which academic underachievement in children diagnosed with ADHD is related to behavioral problems above and beyond cognitive deficits related to the disorder, DeShazo Barry et al. (2002) analyzed the ability of parent ratings of inattention and hyperactivity and measures of executive functioning to predict discrepancies between intellectual functioning and achievement. The study found that parent rating of ADHD symptom severity accounted for a significant proportion of variance in reading, writing, and mathematics underachievement, even after controlling for performance on measures of executive functioning. In contrast, executive functioning only predicted underachievement in mathematics after controlling for parent behavioral ratings. DeShazo Barry et al. (2002) concluded that poor academic performance in reading and writing in children with ADHD is more likely due to the impact of disruptive behavior on learning new material than to neurological deficits.

Dally (2006) examined the direct and indirect effects of inattentive behavior and phonological processing difficulties in kindergarten on reading comprehension in first and second grades. The study found both kindergarten inattentiveness, as assessed by teacher rating forms, and early phonological ability to predict subsequent reading ability. Ratings of inattentive behavior in kindergarten predicted word identification ability in first grade and subsequently reading comprehension in second grade independent of kindergarten phonological abilities and entry reading skills. Additionally, the study found inattentive behavior to influence subsequent sound deletion abilities, an aspect of phonemic awareness. Dally concluded that inattentive behavior, therefore, uniquely contributes to later difficulties in reading by interfering with the acquisition and learning of fundamental reading skills.

Using a sample of 4148 English school children between the ages of 4 and 7, Merrel and Tymms (2001) found that children rated by their teachers as having an elevated number of ADHD Combined or Predominantly Inattentive Subtype symptoms made significantly less academic progress than their peers.

Willcutt et al. (2001) compared the performance of groups of children, aged 8-16, with reading disorder, ADHD, comorbid ADHD and reading disorder, and neither ADHD or reading disorder on measures of executive functioning and phonemic awareness. The study found that children diagnosed with ADHD by means of scores on parent rating scales exhibited deficits in executive functioning, specifically in inhibition, but not in phonemic awareness, whereas children diagnosed with reading disorder exhibited deficits in phonemic awareness, but not inhibition. Children selected for the ADHD and reading disorder group, on the other hand, exhibited deficits in both inhibition and phonemic awareness relative to the control group. The authors concluded the results argue against the notion that reading disorder in children with ADHD is secondary to cognitive correlates or behavioral manifestations of ADHD. However, the study did find that individuals with reading disorder were rated as having a significantly greater number of ADHD symptoms than a comparison group, and that individuals meeting diagnostic criteria for ADHD per parent ratings performed significantly worse overall on a measure of reading achievement than a comparison group. Such findings highlight the relationship between inattentive behaviors and reading even in the absence of comorbid ADHD and Reading Disorder diagnoses.

Taken together, these articles suggest that parent and teacher ratings of inattentive behaviors predict poor acquisition of fundamental academic skills. Furthermore, the studies indicate that both parent and teacher ratings of inattention tend to relate to difficulties with reading and mathematics across childhood, even after controlling for other aspects of cognition, such as executive functioning.

Ratings of Behavior and IQ

Some evidence suggests that ratings of ADHD related behaviors may be better predicted by measures of intellectual functioning and language than by measures of executive and attentional abilities. In a study examining the relationship between parent and teacher ratings of behavior and cognitive functioning (Jonsdottir et al., 2006), teacher rated inattention significantly and negatively related to both measures of intelligence and language development. Furthermore, the study found that performance on measures of executive functioning did not predict variance in ratings of ADHD behavior above and beyond that predicted by measures of intelligence.

Nagliera et al. (2005) examined the relationships between the CRS-R parent and teacher forms and IQ in a sample of 117 child clinic referrals aged 6-16. The CRS-R teacher form significantly correlated with FSIQ (-.31), VC (-.31), and WM (-.35) of the WISC-III. In contrast, the CRS-R parent form did not relate to any of the indices from the WISC-III.

One explanation for these findings is that children with ADHD, in general, perform lower on measures of intellectual ability than children without ADHD (Frasier et al., 2004). In their meta-analysis of 137 studies, Frasier and colleagues found that ADHD groups demonstrated significantly lower FSIQ, Verbal IQ, and Performance IQ than groups of normal controls. This was true regardless of ADHD subtype. Of note, in contrasting FSIQ with other neuropsychological measures, only the CPT and measures of academic achievement produced larger between group effect sizes than IQ.

Age, Rating Scales, and Neuropsychological Performance

The current literature regarding ADHD suggests that age may play a role in symptom presentation, test sensitivity to cognitive deficits, and validity and reliability of behavioral rating scales. Stefanatos & Baron, 2007 proposed that the presentation of ADHD symptoms evolves across the developmental span and that subtype classifications often change as children age, with older children less likely to meet hyperactivity-impulsivity DSM-IV criteria. In support of this, Marsh and Williams (2003) found that symptoms of hyperactivity and impulsivity, as evidenced by parent ratings, decline with age, where as symptoms of inattention remain relatively stable. Similarly, in a large sample of school children, Power et al. (1998) found children meeting criteria for ADHD inattentive type to be significantly older than those meeting criteria for ADHD Combined type.

The inter-rater reliability of ratings of behavior may also be influenced by age. Achenbach et al. (1987) found correlations between parent and teacher ratings of behavior were significantly higher for children aged 6 – 11 than for children aged 12 – 18. This suggests that either adolescent behavior is more likely than child behavior to vary across settings or that the accuracy of teacher or parent ratings of behavior declines when rating adolescents versus children.

While there is a paucity of research examining performance on neuropsychological measures in adolescents with ADHD, the few studies that do exist seem to suggest that the neuropsychological profile of adolescents diagnosed with ADHD differs from that of children with ADHD. Barkley et al. (1992), in a review of 22 studies involving children and adolescents, concluded that the WCST, a measure of executive functioning, may be sensitive to deficits in children, but rarely in adolescents. Barkley, Edwards, Laneri, Fletcher, and Metevia (2001) compared a group of clinic-referred adolescents, aged 12-19, to a group of normal controls across three factors of executive functioning labeled CPT Inattention, CPT Inhibition, and Working Memory. Results of the study indicated group differences in CPT Inattention only, a finding in contrast to a wide body of literature showing differences between groups in all three domains when using child samples. The authors concluded that such a disparity in findings between this study and studies using child samples might be due to age-related improvements or test ceiling effects secondary to insufficient task difficulty.

Yet, other studies suggest that differences between child and adolescents diagnosed with ADHD regarding behavioral and cognitive characteristics are less defined. Farone et al. (2002) examined age group differences in a large sample of children, aged 6-17, diagnosed with ADHD. The study found there to be no significant differences between age groups in overall number of ADHD symptoms or subscale T-scores on the Achenbach Child Behavioral Checklist. The authors concluded that ADHD in adolescence is the same disorder as that affecting younger ADHD subjects. Seidman et al. (2005), found a pre-adolescent (age 9-12) and an adolescent (13-17) group to demonstrate similar executive functioning deficits relative to normal controls. The authors argued that neuropsychological deficits in ADHD are comparable across childhood and adolescence. However, the fact that the younger age group did not consist of any children below age nine represents a limitation of the study.

While few studies exist comparing relationship between parent and teacher ratings of behavior and neuropsychological measures across pediatric age groups, those that have been published suggest that there may be differences due to age. Barkley (1991) found CPT scores to correlate significantly and to a low to moderate degree with parent and teacher ratings of inattention and hyperactivity in a sample of children ages 6 – 11. In contrast, the relationships were generally found to be non-significant in a sample of 12-20 year-olds, leading the authors to conclude that the association between certain measures of cognitive functioning and behavioral ratings of inattention and hyperactivity may be weaker for adolescents than children (Barkley).

Purpose

The purpose of the current proposed research is to examine and compare the abilities of intellectual, academic, attentional, and executive skills in predicting parent and teacher ratings of behavior across two pediatric age groups in a clinical setting. The goal of the current study is to determine if measures of academic achievement and intellectual functioning predict parent and teacher ratings of ADHD related behavior to a greater extent than do measures of attention and executive functioning. Furthermore, this study aims to determine if cognitive measures relate to ratings of behavior in child referrals to a greater extent than adolescent referrals.

Hypothesis 1: Academic achievement and intellectual functioning will account for significantly more of the variance in teacher ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 6-10.

Impairments in attention and executive functioning have been purported to underlie behavioral issues characteristic of childhood ADHD such as inattentiveness, impulsivity, and hyperactivity. Barkley (1997) proposed a theory of ADHD in which response inhibition contributes to deficits in working memory, attention, and planning; forming a constellation of cognitive deficits that is, in turn, hypothesized to explain inattentive, hyperactive, and impulsive behaviors. Research has shown that performance on certain neuropsychological measures intended to measure these constructs of cognition do, in fact, differentiate between children diagnosed with ADHD and those without the disorder (Willcutt et al., 2005, Conners, 2000, Martinussen et al., 2005).

Because ADHD behaviors are expected to present with related cognitive impairment in terms of inattention and inhibition, ratings of inattentive and hyperactive behaviors are interpreted as measuring such cognitive deficits (Conners, 2000). Yet, studies examining the relationship between teacher ratings of inattention and hyperactivity and performance on cognitive measures of attention and executive functioning have demonstrated equivocal results, with some finding no association between these measures (Nagliera et al., 2005), and others finding significant, but small, relationships (Egeland et al., 2009; Friedman et al., 2007; Jonsdottir et al., 2006). Even when these measures do relate, they tend to associate in ways contrary to theories regarding the tests. McGee et al. (2000), for example, found teacher ratings of hyperactivity, but not ratings of inattention, to significantly correlate with measures on the Conners' CPT-II intended to measure inattention (i.e. errors of omission). Such findings question the ability of teacher ratings of behavior to sensitively and specifically measure cognitive deficits believed to contribute to inattentive and hyperactive behaviors.

Despite there being a poor link between teacher ratings of ADHD behavior and cognitive measures sensitive to the disorder, research does suggest that teachers are successful in predicting future academic struggles when rating current learning ability (Taylor et al., 2000); a less than surprising finding given that the primary goal of classroom teachers is to see that students demonstrate expected rates of academic progress. An additional finding of the study by Taylor et al. (2000) was that children identified by teacher ratings as being more susceptible to future learning difficulties were also rated by their teachers as displaying a greater number of ADHD symptoms in comparison to children not identified as having learning difficulties (Taylor). This suggests the possibility that teacher ratings of hyperactive and inattentive behavior may measure a child's overall ability to learn in the classroom to a greater extent than focal abilities in attention and impulse control. Therefore, it is expected that teacher ratings of ADHD related behavior will relate to levels of academic ability and intelligence to a significantly greater extent than to attentional abilities and executive functioning.

Hypothesis 2: Academic achievement and intellectual functioning will account for significantly more of the variance in parent ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 6-10.

As previously mentioned, behavioral problems characteristic of ADHD, such as inattention, impulsivity, and hyperactivity, are often explained as being the manifestation of underlying cognitive deficits. Research has provided support for such theories by demonstrating that children diagnosed with ADHD, in comparison to normal controls, perform significantly worse on measures assessing attention and response inhibition such as the CPT-II and Stop-Signal reaction time (Willcutt et al., 2005). Yet, ratings of inattention and hyperactivity as completed by parents, have empirically demonstrated poor convergence with cognitive measures of attention and executive functioning (Edwards et al., 2007; Schwean et al., 1999; Jonsdottir et al., 2006; Oosterlan et al., 2005). Even when tests are created by the same test developer, as is the case with the Conners' Parent Rating Scales-Revised and the Conners' CPT-II, parent rating scales and cognitive measures assessing hypothetically similar constructs of ADHD related difficulties have demonstrated either weak or non-significant relationships (Nagliera et al., 2005; McGee et al., 2000). Because of this, further research is strongly needed to determine what, if any, cognitive abilities are being assessed in the parent ratings of child inattentiveness and hyperactivity.

Previous research indicates ratings of behavior to vary to a lesser extent across different traits than across different informants (Gomez, 2003), suggesting that parent ratings across domains of behavior are likely vulnerable to a “halo effect”. Such an effect would suggest that deficits in those domains that are most far-reaching and impacting, such as intellectual functioning and school ability, likely have a greater effect on ratings of inattentiveness and hyperactivity than deficits within more focal domains, such as attentional and executive functioning. Therefore, it is expected that parent ratings of inattention, hyperactivity, and ADHD likelihood will show poor convergence with specific abilities in the areas of attention and executive functioning, and relatively better convergence with domains of intellectual functioning and measures of academic achievement.

Hypothesis 3: Academic achievement and intellectual functioning will account for significantly more of the variance in teacher ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners’ Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 11-17.

This hypothesis is based on the empirical literature indicating that cognitive measures of attention and executive functioning relate poorly to teacher ratings of ADHD related behavior (Egeland et al., 2009; Friedman et al., 2007; Jonsdottir et al., 2006). While most of the available studies examined such relationships using child or mixed child and adolescent samples, the relationships are expected to be of similarly small magnitude using a sample of adolescents. Findings by Barkley (1991) and Barkley et al. (2001) suggest that relationships between measures of attention and executive functioning and ratings of behavior may be even less in adolescents than in the children. Research involving samples of older children and adolescents have, however, found significant relationships between ratings of inattentive behavior and academic difficulties (DeShazo Barry et al., 2002, Wilcutt et al., 2001). Therefore, and for those reasons listed in Hypothesis 1, it is expected that teacher ratings of ADHD related behavior will relate to levels of academic ability and intelligence to a significantly greater extent than to attentional abilities and executive functioning in a sample of clients aged 11-17.

Hypothesis 4: Academic achievement and intellectual functioning will account for significantly more of the variance in parent ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 11-17.

This hypothesis is based on the empirical literature indicating that cognitive measures of attention and executive functioning relate poorly to parent ratings of ADHD related behavior (Edwards et al., 2007; Schwean et al., 1999; Jonsdottir et al., 2006; Oosterlan et al., 2005). While most of the studies reviewed examined such relationships using child or mixed child and adolescent samples, the relationships are expected to be of similarly small magnitude using a sample of adolescents. Findings by Barkley (1991) and Barkley et al. (2001) suggest that relationships between measures of attention and executive functioning and ratings of behavior may be even less in adolescents than in the children. Studies involving samples of older children and adolescents have, however, found there to be significant relationships between ratings of inattentive behavior and academic difficulties (DeShazo Barry et al., 2002, Wilcutt et al., 2001). Therefore, and for those reasons listed in Hypothesis 2, it is expected that teacher ratings of ADHD related behavior will relate to levels of academic ability and intelligence to a significantly greater extent than to attentional abilities and executive functioning in a sample of clients aged 11-17.

Hypothesis 5: Performance on objective measures of cognitive functioning, including measures of academic, intellectual, and attentional abilities, will account for significantly more of the variance in ADHD measures from the CRS-R in children (under 11 years of age) than in adolescents (11 years and above).

The current literature suggests that age may play a moderating role in the effect of cognitive functioning and academic achievement on ratings of parent and teacher ratings of ADHD behavior for several reasons. First, patterns of behavior in children with ADHD have been found to change with age, with younger children diagnosed with the disorder being more likely to demonstrate hyperactive and inattentive behaviors, and adolescents being more likely to engage in primarily inattentive behaviors (Marsh and Williams, 2003; Power et al., 1998). Second, cognitive functions often implicated in disorders of inattention and hyperactivity, such as executive functioning, inattention, and impulse control, are believed to progress throughout childhood and adolescence (Klenberg et al., 2001).

Third, Barkley et al. (1992), in his review of 13 studies, found the WCST to be effective in differentiating between children with ADHD and normal controls, but not in distinguishing adolescents with the disorder from normal controls. This suggests that the sensitivity of some neuropsychological measures in detecting ADHD related behaviors is greater for children than for adolescents. Finally, Achenbach et al. (1987) found correlations between parent and teacher ratings of behavior to be significantly higher for children 6 – 11 than for children 12 – 18. Such a decline in inter-rater reliability suggests that parent and teacher behavioral ratings are either less accurate or are more influenced by environmental factors when rating adolescent versus child behavior. Based upon these findings, it is reasonably expected that parent and teacher ratings of behavior will be better predicted by performance on cognitive measures in children than in adolescents.

III: Method

Participants

The study involved archival data from a database of child clinical referrals. All data was deidentified. The participants, 72 children, 6 to 10 years of age, and 49 adolescents, 11-17 years of age, were clinically referred for a comprehensive neuropsychological evaluation at a neuropsychology assessment center affiliated with a university in the Southeastern region of the United States. The demographic information for both samples is listed in Table 1.

Table 1

Demographic Information

	Child (N=72)		Adolescent (N=49)	
Gender	N	%	N	%
Male	44	61.1	35	71.4
Female	28	38.9	14	28.6
Race				
White	45	62.5	28	57.1
Black	10	13.9	4	8.2
Hispanic	8	11.1	9	18.4
Other	9	12.5	7	14.3
	M (SD)	Range	M (SD)	Range
Age (in years)	7.9 (1.3)	6 - 10	13.3 (1.2)	11 - 16
Education (in years)	2.2 (1.5)	0 - 5	7.3 (1.3)	5 - 10

Table 2

Diagnostic Information

	Child		Adolescent	
Diagnosis	N	%	N	%
Conduct Disorder	2	2.8	4	8.2
Oppositional Defiant	3	4.2	5	10.2
Intermittent Explosive Disorder	0	0.0	1	2.0
ADHD Inattentive	2	2.8	3	6.1
ADHD Hyperactive/Impulsive	1	1.4	1	2.0
ADHD Combined	9	9.7	2	4.1
ADHD NOS	1	1.4	0	0.0
Math Learning Disorder	1	1.4	1	2.0
Reading Learning Disorder	10	13.9	4	8.2
Writing Learning Disorder	8	11.1	2	4.1
Learning Disorder NOS	3	4.2	0	0.0
Expressive Language Disorder	4	5.6	0	0.0
Major Depressive Disorder	9	12.5	12	24.5
Dysthymia	1	1.4	5	10.2
Mood Disorder NOS	1	1.4	0	0.0
Anxiety Disorder NOS	7	9.7	5	10.2
Adjustment Disorder	18	25.0	8	16.3
Reactive Attachment Disorder	1	1.4	0	0.0
Post Traumatic Stress Disorder	1	1.4	1	2.0
Mental Retardation	5	6.9	5	10.2
Borderline Intellectual Funct.	7	9.7	5	10.2
Cognitive Disorder NOS	4	5.6	6	12.2
Epilepsy	1	1.4	0	0.0
Traumatic Brain Injury	1	1.4	0	0.0
Encopresis	1	1.4	0	0.0
Enuresis	2	2.8	0	0.0
Autism	0	0.0	2	4.1
Number of Diagnoses				
None	5	6.9	6	12.2
One	37	51.4	19	38.8
Multiple	30	41.7	24	49.0

The 121 children were selected from a database consisting of 1101 participants on the basis of having completed all measures utilized in this study. All participants were previously administered a comprehensive battery of neuropsychological tests that included measures of general intellectual functioning, memory, achievement, personality/emotional functioning and attention. Participants were administered between 15 and 20 hours of testing over approximately a two-month period by clinical psychology graduate students trained in the standard administration of the measures. For the purposes of the present research, however, only tests purported to measure the variables of interest were selected. The clinically referred participants were assigned diagnoses based upon their test results and information gathered from clinical interview, collateral report, and a review of client records. Table 2 lists the diagnostic composition for both the child and adolescents samples.

Measures

Measures were selected based upon the bases of research demonstrating sound reliability and validity as well as their frequent utilization in both clinical and research settings.

Academic Achievement

Academic achievement was assessed utilizing the Woodcock-Johnson III Tests of Achievement, a comprehensive battery of measures of achievement assessing all major academic skill areas. To determine reading achievement, scores from the composite cluster, Broad Reading, were used in the present study. Broad Reading is comprised of three subtests, including Letter-Word Identification, Reading Fluency, and Passage Comprehension. Taken together, these tests measure general reading achievement, with emphasis on the skill components of word identification, decoding, reading speed, and reading comprehension.

To determine math achievement, scores from the composite cluster, Broad Math, were used in the present study. Broad Math is comprised of three subtests, including Calculation, Math Fluency, and Applied Problems. Taken together, these tests measure general math achievement, with emphasis on problem-solving, number facility, performance of mathematics calculations, speeded computation of simple math facts, and reasoning. The clusters of WJ-III Tests of Achievement demonstrate high correlations with other measures of achievement measuring similar constructs, evidencing strong convergent validity (McGrew & Woodcock, 2001). Test-Retest reliability using a one-year interval is reported at .97 for the Broad Reading cluster and at .98 for the Broad Math cluster (McGrew & Woodcock).

Intelligence

Intellectual functioning was assessed utilizing the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV). The WISC-IV is a measure of intellectual functioning comprised of ten subtests measuring different aspects of intelligence. These WISC-IV subtests load onto four composite indices, which include Verbal Comprehension (VCI), Perceptual Reasoning (PRI), Working Memory (WMI), and Processing Speed (PSI). Additionally, a single factor measuring overall intellectual functioning (FSIQ) is formed from the ten subtests.

The VCI consists of three subtests, Vocabulary, Similarities, and Comprehension. These tests measure word knowledge, verbal reasoning and concept formation, and understanding of general principles and social situations. The test-retest reliability for the Verbal Comprehension Index is .93 (Wechsler, 2003).

The PRI is comprised of the subtests Block Design, Matrix Reasoning, and Picture Concepts. These tests measure the ability to analyze and synthesize abstract visual stimuli, visual perception and organization, nonverbal concept formation, and abstract reasoning ability. The test-retest reliability for the Perceptual Reasoning Index is .89 (Wechsler, 2003).

Attention

Attention was assessed by the Conners' Continuous Performance Test – Second Edition (CPT-II). Specifically, two commonly utilized measures from the CPT-II, Errors of Omission and the Variability, will be used in the present study.

The CPT-II is a computer-based test consisting of 360 trials administered via computer over the course of fourteen minutes. Ninety percent of the presented stimuli on the CPT-II are targets (letters other than the letter "X") and 10% of the stimuli are non-targets (the letter "X"). The individual is asked to respond to targets by pressing a key on the computer and to not respond to non-targets. Errors of Omission occur when an individual fails to respond to target stimuli. A high level of such errors is considered to reflect a deficit in the ability to focus attention on a given task. CPT-II Variability measures within respondent variability across the duration of the test. High scores suggest difficulties maintaining optimal performance levels, and therefore sustaining attention, throughout the test.

CPT-II test-retest reliability after a 3-month interval is reported as .84 for Errors of Omission and .60 for Variability (Conners, 2000). The CPT-II has been shown to successfully discriminate between groups of children with ADHD and normal controls across research studies (Conners, 2000). In a meta-analysis of 83 studies, CPT-II Omission Errors demonstrated superior ability to discriminate between ADHD children and normal controls in comparison to other common neuropsychological measures of attention and executive functioning (Willcutt, 2005).

Executive Functioning

Executive Functioning was assessed using four measures commonly employed in neuropsychological testing, including CPT-II Commission Errors, the WISC-IV Working Memory Index, the Category Test, and Trail Making Test Part B (TMT B).

The CPT-II, in addition to measuring aspects of attention, is also considered to be a measure of response inhibition. Whereas previous versions of the CPT generally required individuals to ignore the frequent occurrence of distracting stimuli and respond to an infrequent target stimulus, the CPT-II requires individuals to respond to frequent stimuli while inhibiting responses to an occasional distractor (McGee et al., 2000). Because of the test's emphasis on the interruption of a continuous motor response, it is regarded as a measure of response inhibition, making it consistent with common theories of ADHD, which view inhibition as being a central deficit of the disorder (McGee et al.). Responses to non-target stimuli are scored as Commission Errors. High scores on this variable suggest impulsivity as well as deficits in response inhibition. Test-retest reliability for Commission Errors is reported to be .65 (Conners, 2000).

The WMI of the WISC-IV is composed of two subtests, Digit Span and Letter-Number Sequencing. These tests measure auditory short-term memory, attention and concentration, sequencing, processing speed, working memory, and mental manipulation.

The WMI has been found to correlate moderately with ratings of cognitive problems and inattention (Nagliera et al., 2005). The test-retest reliability for the Working Memory Index is .89 (Wechsler, 2003).

The Category Test is a visual measure of abstract reasoning, considered a measure of executive functioning due to its requirement on higher order processing abilities such as concept formation and cognitive flexibility. The measure consists of 7 different trials, each of which requires application of a unique strategy that must be deduced based upon feedback given to the examinee. The computerized version of this test was administered. The frequency of incorrect responses, or errors, across trials is utilized in this study. Test retest reliability in a sample of adolescents and adults was .85 (Dikmen, Heaton, Grant, & Temkin, 1997).

Trail Making Test (TMT) consists of two measures, TMT A, a measure of visual scanning and processing speed; and TMT B, considered a measure of executive functioning. TMT B requires individuals to connect circles contains numbers and letters in an alternating and sequential fashion. The task places demands on processing speed and visual scanning in addition to higher order processes such as set-shifting, working memory, and divided attention. TMT Part B completion time will be used in the present study. A meta-analysis conducted by Willcutt et al. (2005) found 8 of 14 reviewed studies to find significant differences in TMT B performance when comparing groups of children diagnosed with ADHD to normal controls. Test-retest reliability of Trails B in a sample of adolescents and adults was .89 (Dikmen, Heaton, Grant, & Temkin, 1997).

Parent and Teacher Behavioral Ratings

The Conners' Parent Rating Scale – Revised (CPRS-R) and Conners' Teacher Rating Scale- Revised (CTRS-R) was used as a measure of parent and teacher ratings of behavior. The Cognitive Problems/Inattention and Hyperactivity subscales, as well as the ADHD index were used in the present study. The Cognitive Problems/Inattention subscale consists of 12 and 8 items, on the CPRS-R and CTRS-R forms, respectively, rating a child's concentration, ability to stay with a task, forgetfulness, organization, attentiveness, and academic skills. High scores may suggest inattention and academic difficulties (Conners, 2001). The Hyperactivity subscale consists of 9 and 7 items, on the CPRS-R and CTRS-R forms, respectively. Children who score high on the Hyperactivity subscale are observed to be restless, have difficulty sitting still, and be "on the go" to a greater extent than same aged peers (Conners). The ADHD Index indicates the likelihood that a child has an attentional problem and consists of a set of items considered to best differentiate ADHD children from normal controls (Conners).

As mentioned above, both the CPRS-R and CTRS-R demonstrated high diagnostic accuracy rates in the initial validation studies. Internal reliability for the parent and teacher form Cognitive Problems/Inattention subscale, Hyperactivity subscale, and the ADHD Index ranged from .87 to .95 (Conners, 2001). Test-retest reliability following a period of 6-8 weeks ranged from .47 to .8 for the CTRS-R and from .69 to .85 for the CPRS-R.

Procedure

An archival database of children and adolescents clinically referred to the Neuropsychology Assessment Center at Nova Southeastern University was utilized. All testing was administered by clinical psychology practicum students enrolled in doctoral training under the supervision of a licensed, board certified clinical neuropsychologist. All practicum students completed Nova Southeastern University Citi training. Multiple measures were administered as part of the complete battery, but only selected measures as described above will be included in the analysis.

Before analyses of the data were conducted, approval was obtained to conduct archival research on this clinical sample from the Institutional Review Board (IRB) at Nova Southeastern University. In keeping with the requirements of the IRB the data was de-identified in order to maintain strict confidentiality.

Statistical Analyses

Preliminary Analyses

IBM SPSS Statistics 20 was utilized for all data analyses in the present study. Demographic characteristics of the sample, including age, education, race, gender, and diagnosis, are reported.

Before using multiple regression to evaluate the hypotheses of this study, the assumptions of multiple regression were assessed. The independent and dependent variables were screened for influential outliers. Cases were considered to exert undue influence if they produced a Cook's Distance statistic greater than 1 (Cook & Weisberg, 1982), a standardized DFBeta statistic or DFFit statistic greater than 2 (Stevens, 2009), or a leverage value greater than three times the average leverage value (Stevens, 2002). If outliers were detected and determined to be influential, the analyses were to be conducted twice, once including all cases, and once excluding any outliers. The results of both analyses were to be reported and the implications regarding any differences between the analyses were to have been discussed. Scatterplots, plotting predicted values against standardized residuals, were examined to assess homoscedasticity and linearity. Any systematic clustering of residuals would indicate model violation. Histograms of the regression residuals were examined for normality of the errors. Finally, multicollinearity were examined and addressed if correlations amongst predictor variables were found to be high and to produce a variable inflation factor (VIF) above 10 (Myers, 1990).

Hypothesis 1: Academic achievement and intellectual functioning will account for significantly more of the variance in teacher ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 6-10.

To evaluate this hypothesis, multiple regression analyses were performed to assess whether a set of independent variables including four distinct measures of academic achievement (AA) and intellectual functioning (IQ) (WJ- III Broad Reading, WJ-III Broad Math, VCI, PRI) explained significantly more of the variance in teacher ratings of child behavior than a set of independent variables containing four measures of attentional and executive abilities (CPT-II Omissions, CTP-II Commissions, CPT-II Variability, and WMI). This comparison required the following steps: 1) A multiple regression analysis was performed to assess the extent to which measures of AA and IQ explain the variance in teacher ratings of behavior, as assessed by subscales of the CRS-R parent form (Cognitive Problems/Inattention subscale, Hyperactivity subscale, ADHD Index). Squared semi-partial correlations were reported for each independent variable to indicate the variance of the dependent variable accounted for above and beyond that of the other independent variables. A squared multiple correlation coefficient (R^2) was reported to indicate the variance explained by the set of independent variables. 2) The procedure outlined in Step 1 was repeated to compute squared semi-partial correlations and the R^2 for the set of independent variables containing measures of attentional and executive abilities. 3) The difference between the R^2 values was formally tested for significance, setting the Type I error rate at $\alpha = .05$ (Alf & Graf, 1999). In addition, a 95% confidence interval was calculated about the R^2 difference to obtain the precision of the difference estimate. The above procedure was conducted for each dependent variable; that is, for each of the three scales of the teacher form of the CRS-R.

Hypothesis 2: Academic achievement intellectual functioning will account for significantly more of the variance in parent ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 6-10.

To evaluate this hypothesis, multiple regression analyses were performed to assess whether a set of independent variables including four distinct measures of academic achievement (AA) and intellectual functioning (IQ) (WJ- III Broad Reading, WJ-III Broad Math, VCI, PRI) explained significantly more of the variance in parent ratings of child behavior than a set of independent variables containing four measures of attentional and executive abilities (CPT-II Omissions, CTP-II Commissions, CPT-II Variability, and WMI). This comparison required the following steps: 1) A multiple regression analysis was performed to assess the extent to which measures of AA and IQ explained the variance in parent ratings of behavior, as assessed by subscales of the CRS-R parent form (Cognitive Problems/Inattention subscale, Hyperactivity subscale, ADHD Index). Squared semi-partial correlations were reported for each independent variable to indicate the variance of the dependent variable accounted for above and beyond that of the other independent variables. A squared multiple correlation coefficient (R^2) was reported to indicate the variance explained by the set of independent variables. 2) The procedure outlined in Step 1 was repeated to compute squared semi-partial correlations and the R^2 for the set of independent variables containing measures of attentional and executive abilities. 3) The difference between the R^2 values was formally tested for significance, setting the Type I error rate at $\alpha = .05$ (Alf & Graf, 1999). In addition, a 95% confidence interval was calculated about the R^2 difference to obtain the precision of the difference estimate. The above procedure was conducted for each dependent variable; that is, for each of the three scales of the parent form of the CRS-R.

Hypothesis 3: Academic achievement and intellectual functioning will account for significantly more of the variance in teacher ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 11-17.

To evaluate this hypothesis, multiple regression analyses were performed to assess whether a set of independent variables including four distinct measures of academic achievement (AA) and intellectual functioning (IQ) (WJ- III Broad Reading, WJ-III Broad Math, VCI, PRI) explained significantly more of the variance in teacher ratings of child behavior than a set of independent variables containing four measures of attentional and executive abilities (CPT-II Omissions, CTP-II Commissions, Category Test, and Trails B). This comparison required the following steps: 1) A multiple regression analysis was performed to assess the extent to which measures of AA and IQ explain the variance in teacher ratings of behavior, as assessed by subscales of the CRS-R parent form (Cognitive Problems/Inattention subscale, Hyperactivity subscale, ADHD

Index). Squared semi-partial correlations were reported for each independent variable to indicate the variance of the dependent variable accounted for above and beyond that of the other independent variables. A squared multiple correlation coefficient (R^2) was reported to indicate the variance explained by the set of independent variables (R^2). 2) The procedure outlined in Step 1 were repeated to compute squared semi-partial correlations and the multiple R^2 for the set of independent variables containing measures of attentional and executive abilities. 3) The difference between the R^2 values was formally tested for significance, setting the Type I error rate at α = .05 (Alf & Graf, 1999). In addition, a 95% confidence interval was calculated about the R^2 difference to obtain the precision of the difference estimate. The above procedure was conducted for each dependent variable; that is, for each of the three scales of the teacher form of the CRS-R.

Hypothesis 4: Academic achievement and intellectual functioning will account for significantly more of the variance in parent ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to abilities and executive skills in clients aged 11-17.

To evaluate this hypothesis, multiple regression analyses were performed to assess whether a set of independent variables including four distinct measures of academic achievement (AA) and intellectual functioning (IQ) (WJ- III Broad Reading, WJ-III Broad Math, VCI, PRI) explained significantly more of the variance in parent ratings of child behavior than a set of independent variables containing four measures of attentional and executive abilities (CPT-II Omissions, CTP-II Commissions, Category Test, and Trails B). This comparison required the following steps: 1) A multiple regression analysis was performed to assess the extent to which measures of AA and IQ explain the variance in parent ratings of behavior, as assessed by subscales of the CRS-R parent form (Cognitive Problems/Inattention subscale, Hyperactivity subscale, ADHD Index). Squared semi-partial correlations were reported for each independent variable to indicate the variance of the dependent variable accounted for above and beyond that of the other independent variables. A squared multiple correlation coefficient (R^2) was reported to indicate the variance explained by the set of independent variables (R^2). 2) The procedure outlined in Step 1 was repeated to compute squared semi-partial correlations and the R^2 for the set of independent variables containing measures of attentional and executive abilities. 3) The difference between the R^2 values were formally tested for significance, setting the Type I error rate at $\alpha = .05$ (Alf & Graf, 1999). In addition, a 95% confidence interval was calculated about the R^2 difference to obtain the precision of the difference estimate. The above procedure was conducted for each dependent variable; that is, for each of the three scales of the parent form of the CRS-R.

Hypothesis 5: Performance on objective measures of cognitive functioning, including measures of academic, intellectual, and attentional abilities, will account for significantly more of the variance in ADHD measures from the CRS-R in children (under 11 years of age) than in adolescents (11 years and above).

To evaluate this hypothesis, several multiple regression analyses were performed to assess whether a set of independent variables containing five measures of AA, IQ, and attentional abilities (WJ- III Broad Reading, WJ-III Broad Math, FSIQ, CPT-II Commissions, CPT-II Omissions) accounts for significantly greater variance in three subscales of parent and teacher ratings of behavior (Cognitive Problems/Inattention subscale, Hyperactivity subscale, ADHD Index) in a sample of clients aged 6-10 than in a sample of clients aged 11-17. This required the following steps: 1) A multiple regression equation was computed to assess the extent that measures of AA, IQ, and attention explained the variance in parent and teacher ratings of behavior, as assessed by subscales of the CRS-R in a sample of children. Squared semi-partial correlations were reported for each independent variable to indicate the variance of the dependent variable accounted for above and beyond that of the other independent variables. A squared multiple correlation coefficient (R^2) was reported to indicate the variance explained by the set of independent variables in the child sample. 2) The procedure outlined in Step 1 was repeated to compute squared semi-partial correlations and the R^2 for measures of cognitive functioning in the adolescent sample. 3) The difference between the R^2 values was formally tested for significance, setting the Type I error rate at $\alpha = .05$ (Zou, 2007). In addition, a 95% confidence interval was calculated about the R^2 difference to obtain the precision of the difference estimate. To summarize, the child sample was compared to the adolescent sample regarding the ability of objective measures of cognition to account for variance in six dependent variables, three of which were based on parent ratings and three of which were based on teacher ratings.

Chapter IV Results

Preliminary Analyses

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) Version 17.0. Statistical assumptions relevant to multiple regression were assessed. Descriptive information for variables utilized in analyses involving the child and adolescent samples are displayed in Tables 3 and 4, respectively.

Table 3

Descriptive Statistics for Child Sample (n = 72)

Variable	M	SD	Skewness	Kurtosis
FSIQ	92.3	16.6	-6.39	.559
VCI	93.1	14.8	-.247	.877
PRI	99.1	17.1	-.259	1.158
WMI	92.0	17.6	-1.508	5.108
Broad Reading	91.6	17.8	-.102	.616
Broad Math	97.3	16.1	-.708	1.868
CPT Omissions	58.9	15.4	1.389	1.476
CPT Commissions	51.5	9.2	-.707	.692
CPT Variability	56.1	9.3	-.311	-.711
CPRS-R Cog/Inattention	66.5	12.3	.169	-.720
CPRS-R Hyperactivity	62.1	14.4	.449	-.950
CPRS-R ADHD	65.2	11.7	.207	-.689
CTRS-R Cog/Inattention	60.6	10.9	.254	-.245
CTRS-R Hyperactivity	57.6	12.5	.656	-.394
CTRS-R ADHD	62.7	12.6	.401	-.194

Note: CTRS-R = FSIQ = Full Scale IQ. VCI = Verbal Comprehension Index. PRI = Perceptual Reasoning Index. CPT = Conners' Conintuous Performance Test - Second Edition. CPRS - R = Conners' Parent Rating Scale - Revised. CTRS = Conners' Teacher Rating Scale-Revised.

In the child sample (Table 3), one variable (i.e. WMI) was leptokurtic. In the adolescent sample (Table 4), several variables were leptokurtic in their distribution (i.e. PRI, CPT Omissions, and Trails B Time) and one variable was positively skewed (i.e. CPT omissions).

Fields (2009) notes that regression predictors do not need to be normally distributed to meet assumptions of regression; rather, only the residuals of the regression model need to be normally distributed. Non-normal distributions of the predictor variables are not uncommon in regression. In fact, such is often the case whenever categorical or dummy variables are used as predictors. However, as the noted predictors departed significantly from normality, their distributions were further assessed. Examining the histogram of each variable revealed that each contained one significant outlier. To test whether these outliers were responsible for the departures from normality, tests of skewness and kurtosis were again conducted after excluding each outlying case from the variables. Under these conditions, each of the investigated variables displayed skewness and kurtosis under 3, indicating that the kurtotic or skewed distributions of the predictors were the result of the outlying variables.

Further investigation for outliers was conducted by examining leverage (hat) values for each case in the model. Leverage was assessed for each case to determine the extent that each observation of the predictor set differed from the centroid of the predictor set. Leverage values greater than three times the average of case leverage values were further examined to determine influence on the model as a whole. Several cases were in excess of the above cut-off value suggesting that the predictor sets associated with these cases were outliers.

Table 4

Descriptive Statistics for Adolescent Sample (N = 49)

Variable	M	SD	Skewness	Kurtosis
FSIQ	91.0	16.8	-.642	.441
VCI	93.7	17.2	-.586	-.208
PRI	95.3	17.7	-1.664	3.432
Broad Reading	91.3	13.7	-.812	.904
Broad Math	91.8	17.5	-1.207	2.761
CPT Omissions	50.7	14.2	3.696	18.033
CPT Commissions	49.8	14.7	-.213	-.1014
Category Errors	72.9	30.9	-.001	-.692
Trails B Time	107.8	48.3	2.226	5.855
CPRS-R Cog/Inattention	67.2	12.3	.241	-.731
CPRS-R Hyperactivity	64.1	15.1	.276	-1.112
CPRS-R ADHD	66.5	13.9	.134	-1.017
CTRS-R Cog/Inattention	63.0	13.9	.245	-.959
CTRS-R Hyperactivity	55.4	14.3	1.470	.963
CTRS-R ADHD	61.0	13.9	.501	-.649

Note: CTRS-R = FSIQ = Full Scale IQ. VCI = Verbal Comprehension Index. PRI = Perceptual Reasoning Index. CPT = Conners' Conintuous Performance Test - Second Edition. CPRS - R = Conners' Parent Rating Scale - Revised. CTRS = Conners' Teacher Rating Scale-Revised.

To determine whether these outliers exerted undue influence over the model parameters, Cook's Distance, DFBeta, and DFFit were utilized. Cook's Distance assesses the influence of an observation by examining the change in the model as a whole that occurs when an observation is omitted. No cases exceeded the recommended cut-off of 1 (Stevens, 2009). The standardized DFFits statistic indicates the number of standard errors the predicted value for a case changes when that case is deleted from the model. The standardized DFBeta statistic assesses the influence of each case on the regression coefficient for each model predictor, measuring the difference between coefficient values caused by excluding individual cases. No cases exceeded the standardized DFFit or DFBeta cut-off values of 2 (Stevens). In sum, these statistics indicated that none of regression models used in this study was affected by influential cases.

As noted by Stevens (2002), the presence of high leverage values or the detection of outliers does not necessarily indicate that individual cases are exerting influence over the regression model. Such findings, rather, indicate the need for further study of the detected cases to then determine the extent to which they affect the model. As the DFBeta, DFFit, and Cook's Distance statistics of these cases fell within acceptable limits, they were not considered to exert undue influence. Outliers that are not influential in affecting the regression equation likely closely follow the trend of the rest of the data (Stevens). Therefore, these cases were not removed from the model.

Homoscedasticity and linearity were assessed by plotting predicted values against standardized residuals. Scatterplots for each model illustrated a random and evenly dispersed array of points, indicating that, for every model, the variance of the residuals was constant across levels of the predictors and that the relationship between the predictor set and the criterion was linear. Histograms of the regression residuals were analyzed to assess for normality of errors. Additionally, the skewness and kurtosis of the

Table 5

Distribution of Residuals for Study Regression Models

Regression Model	Child		Adolescent	
	Skewness	Kurtosis	Skewness	Kurtosis
CTRS-R				
AA/IQ - In/Cog	.103	-.517	.487	-.528
AA/IQ - Hyp	.678	-.090	1.489	1.045
AA/IQ - ADHD	.459	.065	.513	-.764
ATT/EF - In/Cog	.159	-.146	.348	-.652
ATT/EF - Hyp	.499	-.222	1.168	.301
ATT/EF - ADHD	.362	.180	.400	-.820
CPRS-R				
AA/IQ - In/Cog	-.155	-.854	-.047	-.669
AA/IQ - Hyp	.532	-.639	.093	-.684
AA/IQ - ADHD	-.040	-.675	-.151	-1.083
ATT/EF - In/Cog	-.105	-.829	.228	-.862
ATT/EF - Hyp	.546	-.468	.362	-.791
ATT/EF - ADHD	.204	-.607	.122	-1.051

Note: Predictor sets are listed first, followed by the criterion variable for each regression model. CTRS-R = Conners' Teacher Rating Scale-Revised. AA/IQ = Academic Achievement and Intellectual Functioning. ATT/EF = Attentional Skills and Executive Functioning. In/Cog = Inattention/Cognitive Problems subscale. Hyp = Hyperactivity subscale. ADHD = ADHD Index.

distribution of the residuals were assessed for each regression model (Table 5). The skewness and kurtosis for each of the models fell below 2 indicating that the assumption of normality of residuals was met. The variable inflation factor (VIF) was examined using a cut-off score of 10 to screen for multicollinearity amongst independent variables. None of the models' predictor variables reached this level indicating that correlations between predictor values were within acceptable limits. Taken together, these statistics found that the assumptions of multiple regression (i.e. multicolcollinearity, homoscedasticity, normal distributed residuals, and linearity) were tenable across study models and that no individual case exerted undue influence over the parameters of the models.

Hypothesis 1

The first hypothesis stated that academic achievement and intellectual functioning would account for significantly more of the variance in teacher ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 6-10.

Table 6 illustrates the results of multiple linear regression analyses examining the ability of two independent sets of variables (Academic Achievement/Intellectual Functioning and Attention/Executive Functioning) to account for variance across three subscales of the CTRS-R in a child sample. Measures of academic achievement and intellectual functioning, as a set, accounted for 34% of the variance of the Cognitive Problems/Inattention subscale and 16% of the variance of the ADHD Index, but did not account for a significant proportion of the variance of the Hyperactivity subscale. Measures of attentional abilities and executive skills, in combination, accounted for 17% of the variance of the Hyperactivity subscale and 20% of the variance of the ADHD

Table 6

Regression Models Accounting for Variance of CTRS-R Ratings in a Child Sample (N = 60)

Variable	*β*	sr^2	*p*	R^2	*F*	*p*
			Inattention/Cognitive Problems			
AA./IQ				.339	7.066	<.001
Broad Math	.328	.052	.090			
Broad Reading	-.681	.194	<.001			
VCI	-.114	.004	.702			
PRI	-.058	.069	.529			
Attention/EF				.091	1.369	.256
WMI	-.154	.021	.275			
CPT Omissions	-.082	.003	.634			
CPT Commissions	.132	.016	.331			
CPT Variability	.201	.023	.239			
			Hyperactivity			
Acad. Ach./IQ				.094	1.434	.235
Broad Math	.170	.009	.448			
Broad Reading	-.356	.053	.078			
VCI	.015	.000	.933			
PRI	-.098	.004	.642			
Attention/EF				.171	2.835	.033
WMI	-.208	.037	.124			
CPT Omissions	.122	.008	.457			
CPT Commissions	.202	.037	.121			
CPT Variability	.112	.007	.487			
			ADHD Index			
Acad. Ach./IQ				.159	2.599	.046
Broad Math	.260	.022	.231			
Broad Reading	-.344	.050	.077			
VCI	-.065	.002	.702			
PRI	-.238	.021	.245			
Attention/EF				.195	3.332	.016
WMI	-.243	.050	.069			
CPT Omissions	.133	.010	.409			
CPT Commissions	.222	.045	.084			
CPT Variability	.089	.004	.577			

Note: CTRS-R = Conners' Teacher Rating Scale-Revised. AA/IQ = Academic Achievement and Intellectual Functioning. VCI = Verbal Comprehension Index. PRI = Perceptual Reasoning Index. Attention/EF = Attentional Skills and Executive Functioning. WMI = Working Memory Index. CPT = Conners Continuous Performance Test - Second Edition.

Index, but did not account for a significant proportion of the variance of the Inattention/Cognitive Problems subscale.

To compare the ability of measures of academic achievement and intellectual functioning to account for variance in teacher rating scales with that of measures of attention and executive skills, the differences between the models' R^2 coefficients were formally tested for significance using an approach delineated by Alf and Graf (1999). This procedure was applied for each criterion variable in which at least one of the independent variable sets both approached significance ($p < .10$) and accounted for a "practically significant" proportion of the variance ($R^2 > .04$) as specified by Ferguson (2009). Additionally, to obtain the precision of the difference estimates, a 95% confidence interval was calculated about each of the tested R^2 differences. Alf and Graf's approach to comparing regression model effect sizes was chosen for two reason: 1) Myers and Wells (2003) recommend this approach, specifically, in instances in which two regression models using the same sample are compared, citing its ability to take into account shared variance among predictor variables across models; and 2) traditional approaches of comparing simple correlations (e.g. Fisher's z transformations) are inappropriate when comparing multiple correlations (Alf & Graf). Multiple correlations, unlike bivariate correlations, can never be of a negative value as values must lie between zero and 1. Because of this, the distribution of transformed values is "severely" positively skewed and does not approach normality even with increasing sample size (Alf & Graf). This is in contrast to the comparison of simple correlation coefficients, which, due to a range of possible values extending from -1 to 1, is based on a normal distribution of transformed *r* values. Alf and Graf's approach relies on the distribution of the differences between R^2 's, a distribution which is not affected by the same threats to normality.

Table 7 displays comparisons between the Academic Achievement/Intellectual Functioning model and the Attention/Executive Functioning model for each of the three criterion variables. Tests of academic achievement and intellectual functioning accounted for a significantly greater proportion of the variance of the Cognitive Problems/Inattention scale of the CTRS-R as compared to tests of attention and executive skills. Measures of attention and executive skills accounted for a significantly greater proportion of the variance of the Hyperactivity subscale in comparison to that accounted for by measures of academic achievement and intellectually functioning. The difference in the models' abilities to account for variance of scores on the ADHD Index of the teacher form was non-significant. The hypothesis was generally not supported as measures of academic achievement and intellectual functioning accounted for a greater

Table 7

Comparison of Model Effect Sizes in a Child Sample Utilizing CRS-R Teacher Form Subscales

Criterion	*N*	*Model* R^2		R^2 Dif.	95% CI		*p*
		AAIQ	ATT/EF		LL	UL	
Cog. Prob./Inattention	60	**.34**	.09	.25	.13	.37	<.001
Hyperactivity	60	.09	**.17**	.08	.02	.14	.012
ADHD Index	60	.16	.20	.04	-.01	.08	.121

Note: CRS-R = Conners' Rating Scale - Revised. AAIQ = Academic Achievement/Intellectual Functioning. ATT/EF = Attention/Executive Functioning. R^2 Dif. = difference in values R^2 values. CI = Confidence Interval. LL = Lower Limit of Confidence Interval. UL = Upper Limit of Confidence Interval.

proportion of the variance when compared to measures of attention and executive skills for only one of the three criterion variables (i.e. Cognitive Problems/Inattention).

Hypothesis 2

The second hypothesis stated that academic achievement and intellectual functioning would account for significantly more of the variance in parent ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 6-10.

Table 8 illustrates the results of multiple linear regression analyses examining the ability of two independent sets of variables (Academic Achievement/Intellectual Functioning and Attention/Executive Functioning) to account for variance across three subscales of the CPRS-R in a child sample. Measures of academic achievement and intellectual functioning, together, accounted for 31% of the variance of the Cognitive Problems/Inattention subscale and 20% of the variance of the ADHD Index, but did not account for a significant proportion of the variance of the Hyperactivity subscale. Measures of attention and executive functioning accounted for 16% of the variance of the Hyperactivity subscale, but did not account for a significant proportion of the variance of the Inattention/Cognitive Problems subscale or the ADHD Index.

To compare the ability of measures of academic achievement and intellectual functioning to account for variance in teacher rating scales with that of measures of attention and executive skills, the differences between the models' R^2 coefficients were formally tested for significance. This procedure was applied for each criterion variable in

Table 8

Regression Models Accounting for Variance of CTRS-R Ratings in a Child Sample (N = 71)

Variable	*β*	sr^2	*p*	R^2	*F*	*p*
			Inattention/Cognitive Problems			
Acad. Ach./IQ				.314	7.548	<.001
Broad Math	.269	.024	.135			
Broad Reading	-.318	.047	.036			
VCI	-.099	.005	.476			
PRI	-.450	.081	.007			
Attention/EF				.078	1.387	.248
WMI	-.278	.066	.034			
CPT Omissions	.040	.001	.804			
CPT Commissions	.000	.000	.996			
CPT Variability	-.055	.002	.725			
			Hyperactivity			
Acad. Ach./IQ				.063	1.111	.359
Broad Math	.185	.008	.456			
Broad Reading	.139	.000	.027			
VCI	.156	.037	.110			
PRI	.157	.004	.585			
Attention/EF				.161	3.164	.019
WMI	-.065	.003	.596			
CPT Omissions	.410	.093	.009			
CPT Commissions	-.102	.010	.383			
CPT Variability	-.114	.007	.444			
			ADHD Index			
Acad. Ach./IQ				.196	4.021	.006
Broad Math	.237	.017	.223			
Broad Reading	-.188	.017	.247			
VCI	-.259	.036	.089			
PRI	-.265	.028	.133			
Attention/EF				.084	1.517	.207
WMI	-.152	.035	.239			
CPT Omissions	.254	.035	.115			
CPT Commissions	-.023	.000	.848			
CPT Variability	-.107	.020	.492			

Note: CTRS-R = Conners' Teacher Rating Scale-Revised. AA/IQ = Academic Achievement and Intellectual Functioning. Verbal Comprehension Index. PRI = Perceptual Reasoning Index. Attention/EF = Attentional Skills and Executive Functioning. WMI = Working Memory Index.

which at least one of the independent variable sets both approached significance ($p < .10$), and accounted for a "practically significant" proportion of the variance ($R^2 > .04$). Additionally, to obtain the precision of the difference estimates, a 95% confidence interval was calculated about each of the tested R^2 differences. Table 9 displays comparisons between the Academic Achievement/Intellectual Functioning model and the Attention/Executive Functioning model for each of the three criterion variables.

Tests of academic achievement and intellectual functioning accounted for a significantly greater proportion of the variance of two criterion variables, the Cognitive Problems/Inattention subscale and the ADHD Index, when compared to that accounted for by tests of attention and executive skills. Measures of attention and executive skills accounted for a significantly greater proportion of the variance of the Hyperactivity subscale as compared to measures of academic achievement and intellectual functioning.

Hypothesis two was partially supported as measures of academic achievement and intellectual functioning accounted for a greater proportion of the variance when compared to measures of attention and executive skills for two of the three criterion variables (i.e. Cognitive Problems/Inattention and ADHD Index).

Hypothesis 3

The third hypothesis stated that academic achievement and intellectual functioning would account for significantly more of the variance in teacher ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 11-17.

Table 9

Comparison of Model Effect Sizes in a Child Sample Utilizing CRS-R Parent Form Subscales

Criterion	N	Model R^2		R^2 Dif.	95% CI		*p*
		AAIQ	ATT/EF		LL	UL	
Cog. Prob./Inattention	71	**.31**	.08	.24	.13	.34	<.001
Hyperactivity	71	.06	**.16**	.10	.04	.15	<.001
ADHD Index	71	**.20**	.08	.11	.05	.18	<.001

Note: CRS-R = Conners' Rating Scale - Revised. AAIQ = Academic Achievement/Intellectual Functioning. ATT/EF = Attention/Executive Functioning. R^2 Dif. = difference in values R^2 values. CI = Confidence Interval. LL = Lower Limit of Confidence Interval. UL = Upper Limit of Confidence Interval.

Table 10 illustrates the results of multiple linear regression analyses examining the ability of two independent sets of variables (Academic Achievement/Intellectual Functioning and Attention/Executive Functioning) to account for variance across three subscales of the CTRS-R in an adolescent sample. Neither model accounted for a significant proportion of the variance of any of the three criterion variables; however, measures of attention and executive skills approached significance (p = .089) while accounting for 20% of the Inattention/Cognitive Problems subscale. This particular finding is worth noting due to the effect size being well beyond the threshold for what Ferguson (2009) refers to as a practically significant effect (i.e. R^2 = .04) as well as the extent to which statistical power was suppressed by the analyses' small sample size.

To compare the ability of measures of academic achievement and intellectual functioning to account for variance in teacher rating scales with that of measures of attention and executive skills, the differences between the models' R^2 coefficients were

Table 10

Regression Models Accounting for Variance of CTRS-R Ratings in an Adolescent Sample (N = 40)

Variable	*β*	sr^2	*p*	R^2	*F*	*p*
			Inattention/Cognitive Problems			
Acad. Ach./IQ				.106	1.038	.402
Broad Math	-.193	.013	.481			
Broad Reading	.032	.000	.895			
VCI	-.122	.006	.641			
PRI	-.082	.004	.678			
Attention/EF				.201	2.198	.089
Category Errors	.405	.136	.020			
CPT Omissions	.177	.017	.394			
CPT Commissions	.029	.001	.851			
Trails B Time	-.134	.010	.514			
			Hyperactivity			
Acad. Ach./IQ				.007	.061	.993
Broad Math	-.033	.000	.991			
Broad Reading	-.003	.000	.899			
VCI	.019	.000	.944			
PRI	-.074	.004	.723			
Attention/EF				.048	.440	.779
Category Errors	.080	.005	.661			
CPT Omissions	.131	.009	.563			
CPT Commissions	.170	.028	.316			
Trails B Time	-.119	.008	.596			
			ADHD Index			
Acad. Ach./IQ				.020	.181	.947
Broad Math	-.164	.009	.567			
Broad Reading	.163	.011	.524			
VCI	-.057	.001	.834			
PRI	-.007	.000	.973			
Attention/EF				.083	.795	.537
Category Errors	.255	.054	.160			
CPT Omissions	.127	.009	.565			
CPT Commissions	.073	.005	.660			
Trails B Time	-.186	.019	.399			

Note: CTRS-R = Conners' Teacher Rating Scale-Revised. AA/IQ = Academic Achievement and Intellectual Functioning. Verbal Comprehension Index. PRI = Perceptual Reasoning Index. Attention/EF = Attentional Skills and Executive Functioning. WMI = Working Memory Index.

formally tested for significance. This procedure was applied for each criterion variable in which at least one of the independent variable sets both approached significance ($p <$ .10), and accounted for a "practically significant" proportion of the variance ($R^2 > .04$). Cognitive Problems/Inattention was the only criterion variable in which variance was accounted for by at least one of the models to a level approaching significance and was therefore the only criterion for which a comparison was made between the two models. Attentional abilities and executive skills accounted for a significantly greater proportion of the variance of the Cognitive Problems/Inattention subscale when compared to that accounted for by measures of academic achievement and intellectual functioning (R^2 Difference = .09, $p = .022$). When creating a 95% confidence interval about the tested R^2 difference, the lower limit of the interval was -.01 and the upper limit was .18.

Hypothesis three was not supported as measures of academic achievement and intellectual functioning did not account for a greater proportion of the variance when compared to measures of attention and executive skills for any of the three criterion variables.

Hypothesis 4

The fourth hypothesis stated that academic achievement and intellectual functioning would account for significantly more of the variance in parent ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 11-17.

Table 11 illustrates the results of multiple linear regression analyses examining the ability of two independent sets of variables (Academic Achievement/Intellectual

Functioning and Attention/Executive Functioning) to account for variance across three subscales of the CPRS-R in an adolescent sample. Neither model accounted for a significant proportion of the variance of any of the three criterion variables; however, measures of academic achievement approached significance (p = .099) while accounting for 16% of the variance of the ADHD Index.

To compare the ability of measures of academic achievement and intellectual functioning to account for variance in teacher rating scales with that of measures of attentional abilities and executive skills, the differences between the models' R^2 values were formally tested for significance. This procedure was applied for each criterion variable in which at least one of the independent variable sets both approached significance ($p < .10$), and accounted for a "practically significant" proportion of the variance ($R^2 > .04$). Cognitive Problems/Inattention was the only criterion variable in which variance was accounted for by at least one of the models to a level approaching significance.

Measures of academic achievement and intellectual functioning accounted for a significantly greater proportion of the variance of the Cognitive Problems/Inattention subscale as compared to that accounted for by measures of attentional abilities and executive skills (R^2 Difference = .11, p = .002). When creating a 95% confidence interval about the tested R^2 difference, the lower limit of the interval was .05 and the upper limit was .18. The hypothesis was generally not supported as measures of academic achievement and intellectual functioning accounted for a greater proportion of the variance when compared to measures of attention and executive skills for only one of the three criterion variables (i.e. Cognitive Problems/Inattention).

Table 11

Regression Models Accounting for Variance of CTRS-R Ratings in an Adolescent Sample (N = 49)

Variable	β	sr^2	p	R^2	F	p
			Inattention/Cognitive Problems			
Acad. Ach./IQ				.082	.966	.436
Broad Math	-.493	.078	.061			
Broad Reading	.148	.009	.513			
VCI	.244	.020	.330			
PRI	.116	.009	.528			
Attention/EF				.069	.801	.531
Category Errors	-.115	.009	.513			
CPT Omissions	.140	.014	.424			
CPT Commissions	.133	.016	.391			
Trails B Time	.157	.016	.390			
			Hyperactivity			
Acad. Ach./IQ				.137	1.710	.165
Broad Math	-.490	.078	.055			
Broad Reading	.258	.028	.243			
VCI	-.068	.002	.777			
PRI	.047	.001	.792			
Attention/EF				.069	.799	.533
Category Errors	.192	.026	.276			
CPT Omissions	.157	.018	.370			
CPT Commissions	-.084	.007	.584			
Trails B Time	-.040	.002	.828			
			ADHD Index			
Acad. Ach./IQ				.163	2.088	.099
Broad Math	-.675	.148	.008			
Broad Reading	.311	.041	.154			
VCI	.138	.007	.561			
PRI	.226	.033	.203			
Attention/EF				.049	.554	.697
Category Errors	.044	.001	.806			
CPT Omissions	.095	.006	.590			
CPT Commissions	.141	.018	.368			
Trails B Time	.041	.001	.822			

Note: CTRS-R = Conners' Teacher Rating Scale-Revised. AA/IQ = Academic Achievement and Intellectual Functioning. Verbal Comprehension Index. PRI = Perceptual Reasoning Index. Attention/EF = Attentional Skills and Executive Functioning. WMI = Working Memory Index.

Hypothesis 5

The fifth hypothesis stated that performance on objective measures of cognitive functioning, including measures of academic, intellectual, and attentional abilities, would account for significantly more of the variance in ADHD measures from the CRS-R in children (under 11 years of age) than in adolescents (11 years and above).

Table 12 illustrates the results of multiple linear regression analyses examining the ability of measures of cognitive functioning to account for variance of the Cognitive Problems/Inattention Subscale of the teacher form of the CRS-R. While these measures accounted for a significant proportion of the variance in the child sample (R^2 = .341), the results of the regression were not significant for the adolescent sample.

Table 12

Variance Accounted for in the Cognitive Problems/Inattention Subscale of the CTRS-R

	Child			Adolescent		
Variable	*β*	sr^2	*p*	*β*	sr^2	*p*
FSIQ	-.114	.004	.590	.289	.020	.387
Broad Reading	-.653	.151	.001	-.115	.005	.659
Broad Math	.244	.017	.242	-.381	.038	.236
CPT Omissions	-.061	.002	.655	.134	.011	.513
CPT Commissions	.081	.006	.482	.059	.003	.716
R^2		.341			.121	
F		5.580			.939	
p		<.001			.468	

Note: FSIQ = Full Scale IQ. CTRS-R = Conners' Teacher Rating Scale - Revised.

Table 13 illustrates the results of multiple linear regression analyses examining the ability of measures of cognitive functioning to account for variance of the Hyperactivity subscale of the teacher form of the CRS-R. Once again, these measures accounted for a significant proportion of the variance in the child sample (R^2 = .191), but not in the adolescent sample.

Table 13

Variance Accounted for in the Hyperactivity Subscale of the CTRS-R

	Child			Adolescent		
Variable	β	sr^2	*p*	β	sr^2	*p*
FSIQ	-.234	.015	.318	.126	.004	.716
Broad Reading	-.254	.023	.223	-.070	.002	.797
Broad Math	.351	.035	.130	-.034	.000	.919
CPT Omissions	.248	.041	.103	.106	.007	.619
CPT Commissions	.202	.038	.118	.172	.029	.315
R^2		.191			.041	
F		2.544			.288	
p		.039			.916	

Note: FSIQ = Full Scale IQ. CTRS-R = Conners' Teacher Rating Scale - Revised.

Table 14 illustrates the results of multiple linear regression analyses examining the ability of measures of cognitive functioning to account for variance of the ADHD Likelihood subscale of the teacher form of the CRS-R. Once more, these measures accounted for a significant proportion of the variance in the child sample (R^2 = .268), but not in the adolescent sample.

Table 14

Variance Accounted for in the ADHD Index of the CTRS-R

	Child			Adolescent		
Variable	*β*	*sr²*	*p*	*β*	*sr²*	*p*
FSIQ	-.467	.061	.039	.251	.015	.470
Broad Reading	-.204	.015	.302	.062	.002	.819
Broad Math	.413	.049	.062	-.285	.022	.392
CPT Omissions	.190	.024	.188	.094	.006	.657
CPT Commissions	.229	.048	.064	.098	.009	.565
R^2		.268			.045	
F		3.957			.318	
p		.004			.899	

Note: FSIQ = Full Scale IQ. CTRS-R = Conners' Teacher Rating Scale - Revised.

Table 15 illustrates the results of multiple linear regression analyses examining the ability of measures of cognitive functioning to account for variance of the Cognitive Problems/Inattention Subscale of the parent form of the CRS-R. While these measures accounted for a significant proportion of the variance in the child sample (R^2 = .293), the results of the regression were not significant in the adolescent sample.

Table 16 illustrates the results of multiple linear regression analyses examining the ability of measures of cognitive functioning to account for variance of the the Hyperactivity subscale of the parent form of the CRS-R. While these measures accounted for a significant proportion of the variance in the child sample (R^2 = .231), results of the regression were not significant in the adolescent sample.

Table 15

Variance Accounted for in the Cognitive Problems/Inattention Scores of the CPRS-R

	Child			Adolescent		
Variable	*β*	sr^2	*p*	*β*	sr^2	*p*
FSIQ	-.545	.085	.007	.365	.032	.222
Broad Reading	-.258	.028	.113	.135	.006	.599
Broad Math	.200	.011	.311	-.442	.040	.175
CPT Omissions	-.153	.016	.228	.166	.020	.358
CPT Commissions	-.035	.001	.741	.129	.018	.379
R^2		.293			.103	
F		5.399			.992	
p		<.001			.434	

Note: FSIQ = Full Scale IQ. CPRS-R = Conners' Parent Rating Scale – Revised

Table 17 illustrates the results of multiple linear regression analyses examining the ability of measures of cognitive functioning to account for variance of the ADHD Index of the parent form of the CRS-R. As a set, these measures accounted for a significant proportion of the variance in the child sample (R^2 = .220) and approached significance (p = .078) in the adolescent sample (R^2 = .200).

To test the hypothesis that performance on objective measures of cognitive functioning would account for significantly more of the variance in ADHD measures from the CRS-R in children than in adolescents, the differences between the child and adolescent models' R^2 values were formally tested for significance. This procedure was applied for each criterion variable in which at least one of the independent variable sets: 1) at minimum, approached significance ($p < .10$), and 2) accounted for a "practically

Table 16

Variance Accounted for in Hyperactivity Scores of the CPRS-R

	Child			Adolescent		
Variable	β	sr^2	*p*	β	sr^2	*p*
FSIQ	-.442	.056	.033	-.007	.000	.980
Broad Reading	-.027	.000	.874	.333	.035	.192
Broad Math	.483	.066	.021	-.548	.061	.090
CPT Omissions	.368	.094	.006	.014	.000	.936
CPT Commissions	-.113	.012	.312	-.043	.002	.763
R^2		.231			.130	
F		3.906			1.282	
p		.004			.289	

Note: FSIQ = Full Scale IQ. CTRS-R = Conners' Parent Rating Scale - Revised.

significant" proportion of the variance ($R^2 > .04$) as specified by Ferguson (2009).

Additionally, to obtain the precision of the difference estimates, a 95% confidence interval was calculated about each of the tested R^2 differences. Zou's approach to comparing regression model effect sizes was chosen because traditional approaches of comparing simple correlations (e.g. Fisher's z transformations) are inappropriate when comparing multiple correlations due to the "severely" positively affected skewed distribution of multiple correlation coefficients (Alf &Graf). Zou's approach relies on the distribution of the differences between R^2 's, a distribution which is not by the same threats to normality. Furthermore, Zou's approach to comparing R^2 's was utilized for this hypothesis given that regression effect sizes were being compared between two independent samples (i.e. child and adolescent) using an identical set of predictor variables.

Table 17

Variance Accounted for ADHD Index Scores of the CPRS-R

	Child			Adolescent		
Variable	*β*	*sr*^{2}	*p*	*β*	*sr*^{2}	*p*
FSIQ	-.555	.089	.008	.526	.066	.066
Broad Reading	-.166	.012	.329	.279	.030	.253
Broad Math	.360	.037	.085	-.850	.155	.007
CPT Omissions	.085	.005	.523	.028	.001	.867
CPT Commissions	-.057	.003	.610	.164	.027	.238
R^2		.220			.200	
F		3.661			2.150	
p		.006			.078	

Note: FSIQ = Full Scale IQ. CTRS-R = Conners' Parent Rating Scale - Revised.

Table 18 displays comparisons between R^2 values for the child and adolescent samples for each of the six criterion variables. While performance on measures of cognition accounted for more of the variance in rating scale scores in the child sample than in the adolescent sample for each of the six subscales, these differences were not significant. For only one of the criterion variables, the ADHD Index of the CRS-R Teacher form, did the difference between R^2 values approach significance (p = .069).

Hypothesis six was generally not supported as objective measures of cognition did not account for a significantly greater proportion of the variance of parent and teacher ratings of behavior in children than in adolescents.

Table 18

Comparison of Effect Sizes for Child and Adolescent Models across Criterion Variables

Criterion	Model R^2		R^2 Dif	95% CI		p
	Child	Adolescent		LL	UL	
CTRS Cog/Inat	.341	.121	.22	-.06	.42	.126
CTRS Hyper	.191	.041	.15	-.05	.31	.332
CTRS ADHD	.268	.045	.22	-.01	.39	.069
CPRS Cog/Inat	.293	.103	.19	-.06	.37	.134
CPRS Hyper	.231	.130	.10	-.14	.30	.645
CPRS ADHD	.220	.200	.02	-.23	.27	.999

Note: CTRS = Conners' Teacher Rating Scale - Revised. CPRS = Conners Parent Rating Scale - Revised. Cog/Inat = Cognitive Problems/Inattention subscale. Hyper = Hyperactivity subscale. ADHD = Scale ADHD Index. R^2 Dif. = difference in values R^2 values. CI = Confidence Interval. LL = Lower Limit of Confidence Interval. UL = Upper Limit of Confidence Interval.

Chapter V: Discussion

This study sought to explore the relationships between measures of cognition and parent and teacher ratings of behavior across child and adolescent age groups. The goals of this study were to (1) determine if parent and teacher ratings of inattention, hyperactivity and impulsivity, and overall ADHD likelihood were better accounted for by intellectual functioning and academic achievement than by performance on measures of inattention and executive functioning, and (2) determine whether or not the relationships between objective measures of cognitive functioning and parent and teacher ratings of inattention, hyperactivity and impulsivity, and overall ADHD likelihood varied significantly as a function of age group.

Hypothesis 1

The first hypothesis stated that academic achievement and intellectual functioning would account for significantly more of the variance in teacher ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 6-10. This hypothesis was largely unsupported as academic achievement and intellectual functioning accounted for a significantly greater proportion of the variance for only one of the three subscales of the CTRS-R, Cognitive Problems/Inattention. For the other two examined subscales of the CTRS-R, the Hyperactivity subscale and the ADHD Likelihood Index, a difference between the regression models was not found to exist in the hypothesized direction. Therefore, the findings for hypothesis one did not support the expectation that teacher ratings of behavior would be biased by impressions of overall academic and cognitive abilities to the extent that these abilities would outweigh the contribution to teacher ratings by focal cognitive abilities in attention and executive functioning. The results of the analyses conducted for hypothesis one have several additional theoretical and clinical implications, which are described in the paragraphs below.

The construction of this hypothesis was based upon several theories regarding teacher ratings of ADHD related behavior and neuropsychological test performance. In order to deconstruct this generally unsupported hypothesis, the individual theories contributing to its formulation will be evaluated in context of the results of the analyses. First, it was theorized that teacher ratings of inattentive, hyperactive, and impulsive behaviors would not relate to performance on neuropsychological measures of attention and executive functioning. Both neuropsychologial measures of attention and executive functioning and teacher ratings of ADHD behavior are commonly used in neuropsychological evaluations as means for assessing attention, impulsivity, and hyperactivity. Despite the fact that both neuropsychological measures of attention and executive functioning and rating scales are often interpreted as assessing similar constructs, past literature has suggested that these assessment approaches often measure different parameters of cognition and behavior, and rarely converge. Therefore it was expected in this study that teacher ratings of ADHD behavior would not be sensitive to inattention, hyperactivity, and impulsivity as measured by neuropsychological measures of attention and executive functioning.

The results of this study, however, did find significant and meaningful relationships between teacher ratings of behavior and performance on neuropsychological measures of attention and executive functioning. Interestingly, the individual relationships between the CRS-R subscales and individual variables of attention and executive functioning were all non-significant. That is to say, CPT omission errors, CPT commission errors, CPT variability, and the Working Memory Index from the WISC-IV all failed to individually account for CTRS-R subscale variance. However, when these variables were combined to form a composite set of variables assessing executive functioning and attention skills, they were able to collectively account for variance in both teacher ratings of hyperactivity and ratings of overall ADHD likelihood. Such a finding suggests that while individual scores on neuropsychological measures of attention and executive functioning may be inadequate in predicting hyperactive behavior and ADHD likelihood, the aggregate of several measures within these domains does have predictive utility.

Theoretically, the findings provide support for an association between ADHD related behavior and attention and executive functioning processes. The scores comprising the attention and executive skills predictor set are involved in such cognitive tasks as focusing, sustaining attention, inhibiting prepotent responses, and mentally manipulating information. Each of these cognitive skills requires the volitional control and regulation of one's cognitive efforts. If a child has difficulty with focusing attention, maintaining focused attention, screening out distracting thoughts or stimuli, or temporarily storing and reorganizing information, they can be thought of as having deficits in the ability to control their cognitive processes. Similarly, hyperactivity and impulsivity are also the product of deficits in self-control; however, in this case, the deficits relate to difficulties in controlling and regulating behavior. Therefore, it is not surprising that inattention and executive dysfunction, and hyperactivity and impulsivity, have been hypothesized by many to be different manifestations of deficits in control and regulation. The results provide quantitative support for this link indicating an association between cognitive dyscontrol, as measured by measures of attention and executive functioning, and behavioral dyscontrol, as measured by teacher ratings of hyperactivity and overall ADHD likelihood. Additionally, the relationship between the CTRS-R and the aggregate of CPT scores and the WMI provides support for the construct validity of both forms of assessment as these measures would be expected to converge to some degree given their theoretical association.

Second, in formulating this hypothesis, it was theorized that teachers should be skilled at rating their students' overall academic and intellectual abilities as teachers routinely evaluate these abilities in the course of classroom education. This particular theory, while not assessed directly, received some support from the results of this hypothesis. The Cognitive Problems/Inattention subscale of the CTRS-R, in addition to being comprised of items assessing attention, contains items relating directly to academic performance and overall cognitive ability. For example the subscale consists of items asking teachers to rate students' spelling, reading, and arithmetic performance. The finding that 34% of the variability of the Cognitive Problems/Inattention subscale is accounted for by overall intellectual ability and academic skills provides support for the theory that teachers are valid raters of academic ability. The finding additionally indicates that the CTRS-R Cognitive Problems/Inattention subscale itself converges with overall intellectual ability and academic performance.

Third, the hypothesis was additionally based on the theory that ADHD is associated with poor academic outcomes and lower intellectual functioning. This theory has received support in the literature, although the factor behind such an association has been an area of debate amongst researchers. The hypothesis was predicated in part on the expectation that ADHD related behaviors, namely hyperactivity and inattentiveness, would interfere with academic learning to the extent that overall academic ability and intellectual functioning would be predictive of teachers' observation of such behaviors in the classroom. It was expected that teachers would rate students who struggle intellectually and academically as also being more hyperactive and inattentive. The findings under this hypothesis, however, do not provide support for this theory. While academic and intellectual functioning accounted for teacher ratings of Cognitive Problems/Inattention and overall ADHD Likelihood, this set of abilities did not account for teacher ratings of Hyperactivity. Thus, the findings provide support that inattentive behaviors are related to students' academic and intellectual struggles. However, they indicate that hyperactive behaviors occurring at school are not associated with broader cognitive and academic difficulties; at least insofar as such behaviors are rated by teachers. This suggests that children with academic and intellectual deficits exhibit varying degrees of hyperactive behaviors, as do children with no such deficits. The findings therefore do not support the theory that all ADHD behaviors interfere with classroom learning to the extent that children rated higher than their peers by their teachers as exhibiting these behaviors suffer academically and cognitively.

A fourth theory contributing to this hypothesis was that each of the subscales of the CRS-R teacher form would be affected by a global impression bias contributed to by students' broad academic and cognitive abilities. Past research has found ADHD rating forms to be better explained by source factors than trait factors and to evidence less than desirable discriminability between subscales. Additionally, because teachers are well practiced in assessing their students' overall academic and cognitive abilities, it was thought that their overall impression of these abilities would influence their ratings of behavior. Furthermore, it was thought that because of the discriminability issues of the CTRS-R, the influence of overall academic and intellectual abilities would influence each scale of the CTRS-R in a similar matter. As the relationship between broad cognitive abilities and subscales of the CTRS-R varied from non-significant to significant and of moderate effect size, this was not found to be the case. Therefore, contrary to prediction, the three subscales of the CTRS-R were not similarly biased by a "halo-effect" caused by general impressions of cognitive ability. Rather, the extent to which they converged with such measures differed, indicating that if ratings of student behavior are biased by overall cognitive impression, this does not occur across all subscales of the measure.

In sum, hypothesis one was founded on the theories that 1) teacher ratings of ADHD behavior would not be significantly accounted for by performance on neuropsychological measures of attention and executive functioning, 2) teachers would be skilled raters of academic ability, 3) all ADHD behaviors would be associated with poor academic ability and low intellectual functioning, and 4) overall academic and intellectual functioning would bias all subscales of the CRS-R teacher form in an indiscriminant manner. These sub-theories contributed to the overall hypothesis that overall cognitive and academic abilities would explain teacher ratings of behavior better than performance on attention and executive functioning measures across behavioral subscales. As most of the individual theories involved in the formulation of the hypothesis were not supported, it is not surprising that the hypothesis itself was also not supported. The results indicate that overall cognitive and academic abilities explain teacher ratings of behavior better than attention and executive functioning only when considering ratings of cognitive problems and inattention.

The results from this hypothesis also provide important information regarding the clinical use of teacher ADHD behavior rating scales and neuropsychological measures of attention and executive functioning. First, the results indicate that each of the three subscales is accounted for by a different combination of cognitive abilities. Therefore, clinicians should consider the cognitive correlates of each subscale of the CRS-R teacher form individually rather than assume that all of the scales are impacted by similar cognitive abilities.

Second, the findings provide important considerations regarding the clinical interpretation of the three subscales of the CRS-R as completed by teachers. The findings suggest that the Cognitive Problems/Inattention subscale of the CTRS-R is to some extent a measure of overall academic and intellectual abilities in children, as 34% of the variance in this subscale was accounted for by these abilities. In particular, the results indicate that reading ability significantly contributes to teacher ratings of cognitive problems and inattention as Broad Reading was the only individual predictor to significantly relate to the subscale once controlling for the other variables within the set. Conversely, despite its title, the Cognitive Problems/Inattention subscale does not appear to relate to children's attentional abilities. Clinicians should therefore refrain from interpreting elevations on the subscale as being indicative of inattention and poor concentration in the classroom as suggested by the CRS-R administration manual

(Conners, 2001); rather, elevations should be read as being suggestive of overall academic and cognitive struggles.

The CTRS-R Hyperactivity subscale, on the other hand, does appear to be influenced by focal cognitive abilities in attention and executive skills, indicating that deficits in these domains should be considered when interpreting elevations on this scale. Previous literature has found that some, but not all, hyperactive children exhibit deficits in executive functioning and attention (Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005). Given the moderate relationship between attention and executive functioning and teacher ratings of hyperactivity, these results support this finding and furthermore suggest that teacher ratings are sensitive to these deficits. Therefore, clinicians should view elevations on the Hyperactivity subscale of the CTRS-R as suggesting possible deficits in attention and executive functioning.

Results indicated that the ADHD Likelihood Index was equally accounted for by academic achievement/intellectual functioning and attention/executive functioning. This is consistent with theories of ADHD positing that poor academic performance, inattention, and behavioral dysregulation are often present in the disorder and that such deficits are often intertwined. Clinicians should consider higher scores on this scale as being suggestive of possible deficits across cognitive abilities. As only a moderate proportion of the ADHD Likelihood Index was accounted for by either of the two scales, the results suggest that some children with elevations on this scale experience difficulties in one or both of the cognitive domains, whereas others do not. Therefore, the results suggest that clinicians should interpret elevations on the ADHD Likelihood Index as being associated with, but not indicative of, cognitive difficulties.

Similarly, the findings imply that deficits on neurocognitive measures should be interpreted as suggestive of increased risk for ADHD related behaviors in the classroom. The results indicate that as performance on measures of attention and executive functioning and measures of academic and intellectual functioning decrease, the likelihood for an ADHD diagnosis increases. The results also indicate that children performing poorly on academic and intellectual functioning measures should be considered to be at greater risk for inattentive behaviors in the classroom and that children performing poorly on neuropsychological measures of attention and executive functioning should be considered to be at greater risk for hyperactive behaviors in the classroom. These findings provide reinforcing evidence for the practice of thoroughly assessing child behavior, either by means of interview or teacher behavioral rating forms, whenever deficits in cognitive functioning are suspected or found in testing.

A fourth implication of these results for clinicians relates to the interpretation of neuropsychological measures of attention and executive functioning. The results indicate that individual scores on measures of attention and executive functioning are not predictive of either hyperactivity or overall ADHD likelihood as rated by teachers. However, when looking at these measures combined, they do help to explain both behavioral sets. This finding suggests that examining patterns of scores across attention and executive functioning measures, versus relying on individual scores from these measures, has more clinical utility in predicting child behavior. A corollary of this finding is that researchers should consider using sets of executive functioning and attention measures versus individual scores when relating the measures to diagnoses or other cognitive tests in children.

Hypothesis 2

The second hypothesis stated that academic achievement and intellectual functioning would account for significantly more of the variance in parent ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 6-10. This hypothesis was partially supported as academic achievement and intellectual functioning accounted for a significantly greater proportion of the variance for two of the three analyzed subscales of the CPRS-R, Cognitive Problems/Inattention and the ADHD Index. For the third subscale of the CPRS-R, the Hyperactivity subscale, a difference between the regression models was found, but in the direction opposite of that hypothesized. That is, ratings of hyperactivity were better explained by performance on measures of attention and executive functioning than by performance on measures of academic achievement and intellectual functioning. Overall, these findings question the veracity of parent ratings as some of these findings are inconsistent with what would be expected given both the content of the subscales and the interpretative guidelines of the CRS-R.

The findings that the Cognitive Problems/Inattention and ADHD Likelihood subscales of the CRS-R parent form were better accounted for by overall intellectual and academic abilities than by attention and executive functioning calls into question the construct validity of these two subscales. Construct validity, a test's ability to measure the construct that it is formally intended to measure, requires two components. First, the test in question must converge with other tests assessing the same or similar constructs, thereby evidencing convergent validity. Second, the measure must not converge, or converge to a relatively smaller magnitude, with measures assessing constructs that are theoretically less related than the focal test. This would provide evidence for discriminant validity.

High scorers on the ADHD Likelihood subscale are interpreted as providing "strong evidence for an attentional problem" and high scorers on the Cognitive Problems/Inattention are interpreted as being inattentive, and having difficulty completing tasks, sustaining mental effort, organizing their work, and concentrating (Conners, 2001). Therefore, one would expect these subscales to relate to performance on neurocognitive measures of attention and executive functioning given that both the parent rating subscales and these neurocognitive tests measure essentially the same construct, inattention and cognitive dyscontrol. However, in these analyses, neither variance of the Cognitive Problems/Inattention subscale or the ADHD Likelihood Index was significantly accounted for by a set of neuropsychological measures assessing attention and executive functioning. These findings show that even when combined, cognitive measures of attention and executive functioning do not significantly relate to parent ratings of inattention or overall ADHD likelihood. Therefore, findings from these analyses indicate that cognitive measures of attention and parent ratings of attention likely assess different functions. Therefore, they do not provide support for the convergent validity of the Cognitive Problems/Inattention and ADHD Likelihood subscales.

It could be argued that the lack of convergence between these measures might be due to differences in method. That is, because one set of measures contains tests designed to directly and objectively assess cognitive capacity and the other measures rely on the subjective observations of parent raters, such discordant approaches to collecting data might be expected to yield unrelated outcomes. However, if the shared variance between behavioral rating scales and neurocognitive measures is lost simply due to differences in method, it would be expected that behavioral ratings of inattention and ADHD behaviors would not converge with any objective measures of cognition. Given that the Cognitive Problems/Inattention and ADHD Likelihood subscales did converge with other objective measures of cognition (i.e. intellectual functioning and academic abilities), it is evident that the lack of convergence between the rating subscales and neurocognitive measures of attention and executive functioning is not due to differences in method, but rather to differences in the constructs being measured. Furthermore, the finding that parent ratings of inattention/cognitive problems and AHDH likelihood were not only significantly accounted for by intellectual functioning and academic achievement, but were, in fact, better explained by these measures than by measures assessing inattention and executive, strongly suggests that these rating subscales, in particular, lack discriminant validity. Therefore, a primary implication of these findings is that parent ratings on the Cognitive Problems/Inattention and ADHD Likelihood subscales of the CRS-R have poor construct validity and do not measure the constructs they are intended to measure.

Another implication of the findings is that parents are likely more aware of their children’s overall cognitive functioning, as assessed by overall intellectual functioning and academic ability, than they are of their children’s focal abilities in areas such as attention and executive functioning. If parents were highly effective raters of their children’s attentional and executive capabilities, one might expect ratings of attention and cognitive problems, as well as ratings on the ADHD Likelihood scale, to be at least partially accounted for by performance on cognitive measures of attention and executive skills. In such a case, parents would rate children with low performance on such cognitive measures as having increased inattention and cognitive difficulties and children who do well on such cognitive measures of attention and executive functioning as having decreased inattention and cognitive difficulties. However, as measures of inattention and executive functioning did not account for a significant proportion of the variance in ratings of inattention and ADHD likelihood, this was not found to be true. Instead, the variance in these ratings was better accounted for by academic and intellectual functioning, implying that parents formulate their ratings of children's cognitive problems/inattention and ADHD likelihood based on global cognitive abilities rather than on specific deficits in attention or executive functioning. Such a finding suggests that many parents lack the psychological sophistication necessary to identify specific deficits in inattentiveness, and instead, rely on observations of their children's overall cognitive presentation when responding to items related to behaviors of inattention.

Within the set of variables measuring academic achievement and intellectual functioning, Broad Reading and Perceptual Reasoning both significantly and uniquely accounted for variance in parent ratings of inattention and cognitive problems, indicating that parent ratings are, to some degree, influenced by perceptions of both children's fluid reasoning and reading abilities. As both domains may impact children's school performance, an easy barometer from which parents may gauge their children's cognitive abilities, it could be the case that parents base their ratings of inattentive behaviors on school performance.

Interestingly, while both the Cognitive Problems/Inattention scale and the ADHD Likelihood Index were better accounted for by academic achievement and intellectual functioning, ratings of hyperactivity were not significantly related to performance on these measures, and, conversely, were better explained by performance on measures of attention and executive functioning. Such a finding has several important implications. First, this suggests that while parents' ratings of many of the characteristic attributes of ADHD are influenced by their perceptions of children's academic abilities and overall intellectual skills, this is not true for those ADHD related behaviors, such as hyperactivity and impulsivity, which are arguably more behavioral, rather than cognitive, in presentation. The results do not clearly indicate why the Hyperactivity subscale, but not the Cognitive Problems/Inattention and ADHD Likelihood subscales, converge with neurocognitive performance on measures of attention and executive functioning. The former subscale contains content primarily assessing for behavioral dyscontrol, whereas the two latter subscales contain relatively more content related to behaviors seen more directly related to cognition and, specifically, inattention. Therefore, one possibility is that parent ratings of hyperactivity are primarily reflective of behavior, and only relate to cognition insofar as these behaviors are determined by specific cognitive deficits. Such a possibility is consistent with prominent theories of ADHD (e.g. Barkley, 1997), which suggest that hyperactive and impulsive behaviors are the result of deficits in cognitive inhibition (a component of executive functioning) and attentional control. While the results of this hypothesis do not directly affirm this theory, they do provide support for an association between these cognitive domains and hyperactivity and impulsivity as they pertain to childhood ADHD.

Additionally, the findings indicate that parent ratings of behavior are not uniformly affected by estimates of children's overall intellectual prowess, and that, rather, they are influenced by different sets of cognitive abilities that depend on the behavioral domain being assessed. Specifically, whereas some scales may be primarily influenced by overall cognitive ability, other scales (i.e. hyperactivity) are not influenced by these domains. Therefore parent ratings of ADHD behavior do not appear to be influenced by an overall impression bias informed by broad cognitive abilities. Additionally, because parent ratings of hyperactivity converged with variables assessing attention and executive functioning, domains to which hyperactivity is conceptually linked, and not to intellectual functioning and academic ability, domains with which hyperactivity is not directly associated, the construct validity of the Hyperactivity subscale, unlike that of the Cognitive Problems/Inattention and ADHD Likelihood subscales, is supported in these analyses.

The finding that neurocognitive measures of attention and executive functioning, as a set, significantly accounted for variance in the Hyperactivity subscale is also of particular importance, especially given the weak relationships between these assessment measures typical of previous studies. The Working Memory Index, CPT Omission errors, CPT Commission errors, and CPT Variability, as a group, explained a significant proportion of the variance in ratings of hyperactivity. This indicates that these measures, when taken together, are expected to covary with ratings of hyperactivity. The significant findings of this study, in light of non-significant findings in previous studies (e.g. Nagliera et al., 2005 & Edwards et. al, 2007), might be due to differences in methodology. Namely, previous studies have generally examined the relationship between parent ratings of behavior and individual tests or variables, whereas the present study examined the relationship between parent ratings and an aggregate of tests and variables.

Although one individual measure of attention and executive skills, CPT Omission errors, did significantly and uniquely relate to ratings of hyperactivity, from a theoretic perspective it is difficult to explain why this particular variable, and not others from the set of attentional and executive abilities, uniquely related to ratings of hyperactive and impulsive behaviors. An elevated rate of omission errors, caused by one's failure to respond to target stimuli, is often interpreted as an indication of inattention. Conversely, an elevated rate of commission errors, caused by undesirable responses to non-target stimuli, is interpreted as indicating deficits in cognitive inhibition and impulsivity, abilities theorized to be causal factors in hyperactive behaviors. Therefore, one would expect CPT commission errors, rather than CPT omission errors, to uniquely account for the variance in ratings of hyperactivity. The finding that CPT Omissions, and not CPT Commissions, uniquely related to ratings of hyperactivity further suggests that individual measures of attention and executive functioning are poor predictors of ratings of behavior. Therefore, examining several measures of attention and executive functioning measures together appears to provide a better predictor of hyperactivity as rated by parents. This might suggest that, for the same reasons that test indices (e.g. Working Memory) are considered to be a more stable indicator of an individual's ability within a given construct than an individual test (e.g. Digit Span), it is preferable to utilize groups of tests measuring overlapping abilities within a similar construct when determining the cognitive correlates of rating scales within empirical research. These results do indicate, however, that if clinicians or researchers were to rely on any one variable of the CPT to predict hyperactive behaviors, CPT omission errors, despite its lack of theoretical association to hyperactivity, may be most appropriate.

Finally, results from hypothesis two have several clinical implications regarding the use and interpretation of parent ratings of ADHD behaviors. Given the partial support of this hypothesis, clinicians should be aware of the effect of intellectual functioning and academic abilities on parent ratings of ADHD behaviors, particularly when interpreting scales assessing inattention. As the ADHD Index is better accounted for by overall intellectual functioning than by focal attentional and executive abilities, an elevation on the ADHD Index should be interpreted as suggesting both the possibility of an ADHD diagnosis, as well as the possibility of school and intellectual difficulties, as one or a combination of both of these may be responsible for the elevation. The results also indicate that the Cognitive Problems/Inattention subscale of the CRS-R parent form should be interpreted as suggesting possible difficulties in overall academic and intellectual functioning more so than problems in attention and executive functioning. As the scale did not correlate with a set of variables measuring attention and executive functioning, it appears to be a poor indicator of true attentional difficulties and should be interpreted within the context of other information when considering an ADHD diagnosis. Conversely, parent ratings on the hyperactivity subscale of the CRS-R do appear to be sensitive to problems with inattention and executive functioning as measured by neuropsychological measures. Higher ratings on this scale correlate with greater difficulties in these cognitive domains, and, importantly, do not appear to be influenced by general cognitive and academic abilities. Therefore, the hyperactivity subscale of the

CPRS-R more purely reflects cognitive abilities within those domains specifically believed to underlie ADHD behavioral presentations (i.e. attention and executive functioning). The implications of this finding are twofold. First, they indicate that clinicians should consider and test for deficits in attention and executive functioning whenever the hyperactivity subscale is elevated. Second, clinicians should consider the appropriateness of an ADHD Hyperactive/Impulsive Subtype diagnosis when performances on measures of attention and executive functioning are below expectations.

In sum, the findings from the analyses of hypothesis two have several implications regarding parent behavioral ratings of ADHD behavior. First, they indicate that the Cognitive Problems/Inattention and ADHD Likelihood Index of the CPRS-R lack construct validity. These subscales do not converge with neurocognitive tests measuring similar attributes and they do converge with neurocognitive test performance in domains that are less theoretically associated. Because of this, clinicians should use caution when interpreting parent ratings of inattention and overall ADHD likelihood and should avoid interpreting elevations on these subscales as indicating cognitive deficits in attention and executive functioning. Second, from a cognitive perspective, parent ratings of hyperactivity do measure those domains that they are purported to assess. Clinicians should consider both hyperactive behaviors and cognitive deficits in attention and executive functioning when interpreting elevations on this subscale. Third, examining the relationship between ratings of behavior and multiple variables of attention and executive functioning may yield more robust results than when examining the relationship between behavioral ratings and individual neurocognitive test variables.

Hypothesis 3

The third hypothesis stated that academic achievement and intellectual functioning would account for significantly more of the variance in teacher ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 11-17. This hypothesis was not supported as academic achievement and intellectual functioning did not account for a significantly greater proportion of the variance for any of the three analyzed subscales of the CTRS-R in adolescents. Moreover, the set of measures analyzing academic achievement and intellectual functioning, even when combined, did not significantly account for any of the variance in teacher ratings across subscales.

The only significant difference between the two sets of cognitive measures was found on the Cognitive Problems/Inattention subscale. On this subscale attention and executive functioning accounted for significantly more of the variance than academic achievement and intellectual functioning. The results from these analyses have several important implications regarding the use of teacher ratings of adolescent ADHD related behavior and for the CTRS-R, specifically.

First, contrary to hypothesized, the results indicate that teachers' perceptions of ADHD related behaviors are not significantly influenced by their adolescent students' overall intellectual functioning and academic abilities. This is true for both those behaviors considered indicative of inattentiveness as well as those behaviors characteristic of hyperactivity and impulsivity. It was theorized that because teacher ratings of inattention and hyperactivity have been previously demonstrated to relate poorly to measures of focal cognitive abilities, such ratings might instead reflect abilities in broad cognitive domains such as IQ and academic ability in adolescents. As such a theory was not supported by the results, it appears that teachers' perceptions of their adolescent students' overall cognitive capabilities do not bias their ratings of ADHD behavior. This suggests that teachers generally take into account other student qualities when completing ADHD behavioral rating forms for adolescents.

Second, the results indicated that teacher ADHD ratings of adolescent behavior are generally not accounted for by attention and executive functioning abilities. These cognitive domains, specifically, are even more theoretically associated with both inattention and hyperactivity than are IQ and academic skills. The finding that teacher ratings of behavior generally did not relate to tests measuring these abilities implies that either common theories regarding ADHD or the rating forms used to assess the disorder are invalid.

If teacher rating forms of adolescent behavior and the neurocognitive tests selected for this study were considered to be valid measures of their respective domains, this lack of convergence would imply two things. First, it would means that teachers are likely considering only the behavioral presentation, and not the innate cognitive capabilities of their adolescent students in their ratings. Second, it would imply that the behaviors that are being rated are not of a cognitive origin. The latter implication is in stark contrast to prominent theories of ADHD, which suggest that cognitive deficits, particularly in the domains of executive functioning and attention, are the lynchpin of the disorder (Barkley, 1997). Therefore, if the CTRS-R were established as a valid measure for assessing behavior in the adolescent population, the findings would suggest a lack of support for such theories.

In contrast, if either the teacher rating forms or the neurocognitive tests were not accepted as being valid measures for assessing their respecting domains, then a lack of convergence could no longer be interpreted as being indicative of shortcomings in theory. This is because it would be impossible to determine if the poor convergence was due to issues with the theories linking the measures or to issues with the measures themselves. Previous studies have presented findings questioning the accuracy of ADHD behavioral rating forms, indicating that the construct validity of the CTRS-R is not well established. Because of this, the lack of convergence between teacher ratings and cognitive measures in this hypothesis is interpreted as further supporting the poor accuracy on the part of teacher rating forms.

If the lack of convergence between teacher ratings adolescent behavior and theoretically similar measures of cognition are interpreted as implying poor accuracy of the ratings, there are two possible explanations for these findings. First, teachers themselves may be poor informants of ADHD related behavioral difficulties in adolescents. There could be several reasons for this. Teachers working with adolescent students typically spend far less time with each of their students than those teaching younger children. In most middle and high school settings, teachers may only spend one class period with each adolescent. Additionally, they have a relatively higher volume of students for which they must oversee across the year. Finally, teachers at these levels often spend more time lecturing than they do interacting.

Teachers working in the elementary setting, on the other hand, work with the same set of children throughout most of the day, and thereby have fewer students of which to keep track. Additionally, in comparison to secondary education teachers, they tend to approach teaching from a style that is comparatively more interactive versus didactic. Another salient difference between teachers at the middle and high school levels and the elementary school level is that teachers in the former setting typically only teach the student within a particular domain, and may be unaware of the student's performance in other domains. For these reasons, teachers who work with adolescents may have insufficient information from which to accurately rate the behavior of their students. Therefore, the general lack of convergence between objective measures of neurocognition and teacher ratings of ADHD behavior in adolescents found in the present study may imply poor rater accuracy.

A second possible explanation for the lack of convergence between performance on neurocognitive measures and teacher ratings of behavior in adolescents is that the CTRS-R form, itself, lacks validity when applied to this population. Due to the lack of significant associations between teacher ratings and performance on neurocognitive measures, these assessment approaches are clearly measuring two different constructs. In the case of cognitive measures of attention and executive functioning and teacher ratings, such a weak association questions the construct validity of these two assessment approaches.

From this study alone, one cannot definitely conclude whether it is the CTRS-R rating form or neurocognitive measures that lack construct validity, as poor validity of one or both of these approaches could cause the measures to not converge. However, the construct validity of the neurocognitive measures used in this study has generally been supported, whereas behavioral rating forms have historically demonstrated poor convergence with other methods of assessment. This has been demonstrated even in instances in which the same rating forms are completed by different informants. Therefore, the poor convergence in this hypothesis between the two assessment approaches is most likely due to weak construct validity on part of the CRS-R, as opposed to cognitive measures.

The poor construct validity of the CTRS-R in adolescents may be the result of problems with the instrument itself. Unlike other popular behavior rating forms (Behavioral Assessment System for Children), the CTRS-R uses identical rater forms for both children and adolescents. This is potentially problematic for several reasons. First, the behavioral presentation of childhood psychiatric and behavioral disorders differs according to age. Second, the base rates of childhood disorders change according to developmental stage. Both of these factors would affect both the accuracy of a diagnostically based rating measure, such as the CRS-R, to classify an individual according to diagnosis. They would also lead to poor relationships with other external criteria as seen in this study.

Youth with ADHD are less likely to exhibit hyperactive and impulsive behaviors and are more likely to exhibit inattentive behaviors as they age. A decrease in the prevalence of ADHD mediated hyperactivity and an increase in the prevalence of other similar presenting disorders increases the likelihood that disorders other than ADHD would cause elevations on the CRS-R Hyperactivity subscale and ADHD Likelihood Index. Similarly, depression, which shares some common behaviors with inattentiveness (i.e. poor concentration, difficulty completing tasks, and school problems), becomes increasingly more common in adolescents. This could foreseeably affect the specificity of the Cognitive Problems/Inattention subscale and ADHD Likelihood Index in adolescents. This would foreseeably affect the ability of these scales to converge with measures of cognition as these measures are expected to be impacted by ADHD, but not necessarily depression.

The results of this analysis indicated that these teacher rating scales were not significantly accounted for by cognitive abilities believed to underlie ADHD, which suggests that these scales are measuring something other than ADHD behavior in adolescents. Such a finding, given changes in the manifestation and base rates of psychiatric disorders across childhood and adolescence, suggests that using the same rating form for children and adolescents may be inappropriate for the adolescent population.

While none of the sets of cognitive measures accounted for a significant proportion of the variance for the three subscales of the CTRS-R, attention and executive functioning measures did approach significance in accounting for variance in the Cognitive Problems/Inattention subscale and accounted for 20% of the subscale variance. Such a finding, may suggest that of the three CRS-R subscales used in this study, the Cognitive Problems/Inattention subscale is the most likely to be related to attention and executive skills in adolescents. However, such a conclusion should be considered cautiously given the non-significance of the findings.

Within the set of attention and executive skills, one measure, the Category Test significantly and uniquely related to teacher ratings of cognitive problems and inattention. The Category test measures a number level of higher order executive skills including problem solving, concept formation, and abstract thinking. It is sensitive to deficits in a number of abilities that impact one's executive functioning. The results of this hypothesis indicate that as error frequency on this measure increases, so do teachers ratings of inattention and cognitive problems in their adolescent students.

The Category Test differs from the others within the set of attention and executive functioning in that it measures relatively higher-level abilities such as problem solving and concept formation. While these domains are influenced by deficits in cognitive inhibition, vigilance, and mental flexibility as measured by CPT commissions, CPT omissions, and Trails B, respectively, the Category Test extends beyond these basic executive functions. In addition to these skills, examinees given the Category Test must incorporate feedback in developing and adapting to novel solutions with evolving criteria. Given this, the findings indicate that teacher ratings of adolescent inattention and cognitive difficulties are more influenced by students' higher level problem solving skills than any of the specific executive skills measured by the other tests of the regression model. While the relationship between executive functioning and attention and teacher ratings on the Cognitive Problems/Inattention scale only approached significance, this relationship was significantly greater than that between IQ and academic abilities and teacher ratings.

In addition to the noted theoretical implications regarding teacher ratings of adolescent behavior and the CRS-R, the findings from this hypothesis have several implications for clinicians and researchers. First, clinicians should generally not interpret elevations on teacher rating scales assessing ADHD related behavior as being suggestive of cognitive difficulties in adolescents. Even though these ratings are believed to assess for cognitive difficulties related to inattention, hyperactivity, and impulsivity, they are generally not accounted for by cognitive abilities when completed by teachers of adolescents. The presence of cognitive difficulties should, instead, be determined by other data including cognitive testing and grade reports. Such findings encourage the use of multiple assessment sources when conducting a clinical evaluation for an adolescent suspected of ADHD.

While measures of cognition generally did not related to teacher ratings of adolescent behavior, there was one exception. The Cognitive Problems/Inattention subscale, alone, related to one measure of concept formation and problem solving. This suggests that clinicians should consider the possibility of deficits in higher order problem solving skills when elevations are observed on this teacher subscale. Additionally, given the general lack of evidence for construct validity seen in this study, the results warrant the use of caution when interpreting teacher ADHD behavioral rating forms in adolescents as the findings may be invalid due to either instrument invalidity or rater error.

In sum, the findings from the analyses of hypothesis three have several implications regarding teacher behavioral ratings of ADHD behavior in adolescents. They indicate that all three subscales of the CRS-R teacher form examined in this study, Cognitive Problems/Inattention, Hyperactivity, and ADHD Likelihood, do not assess those constructs which they are purported to measure. What exactly these scales do measure cannot be definitively determined from the results of this study. What is evident is that these ratings, when completed by teachers to assess adolescents, are generally not associated with cognition. This appears to be true for both general cognitive abilities as well as those cognitive functions believed to be closely related to inattention and hyperactivity.

It is not clearly apparent from the current data why the CTRS-R form converges so poorly with measures of cognition in adolescents. For the reasons described above, it very well might be due to some combination of the possible inappropriateness of the CRS-R form as a diagnostic tool when used with adolescents, as well as poor accuracy on part of teacher raters. Overall, the findings suggest the use of caution when interpreting teacher rating forms of ADHD behavior in adolescents, and indicate that such ratings should not be interpreted as being valid indications of either cognition or cognitively mediated behaviors.

Hypothesis 4

The fourth hypothesis stated that academic achievement and intellectual functioning would account for significantly more of the variance in parent ratings of cognitive problems/inattention, hyperactivity, and ADHD likelihood measures from the Conners' Rating Scales-Revised as compared to attentional abilities and executive skills in clients aged 11-17. This hypothesis was largely unsupported as academic achievement and intellectual functioning accounted for a significantly greater proportion of the variance for only one of the three subscales of the CTRS-R, the ADHD Likelihood Index. For the other two examined subscales of the CTRS-R, the Hyperactivity subscale and the Cognitive Problems/Inattention subscale, a significant difference between the regression models was not found. The results from these analyses have several important implications regarding the use of teacher ratings of adolescent ADHD related behavior and for the CTRS-R, specifically.

First, contrary to hypothesized, the results indicate that parents' perceptions of ADHD related behaviors are generally not significantly influenced by their adolescent students' overall intellectual functioning and academic abilities. Academic achievement and intellectual functioning did better explain the variance in the ADHD Likelihood Index than attention and executive skills and did so to a significantly greater extent. The proportion of the variance accounted for by IQ and academic abilities (16%) is of great enough magnitude to be considered a practically significant effect (Fergusen, 2009). However, given that the p-value ($p = .099$) only approaches significance, the likelihood that such a finding is the result of sample variance is high enough to warrant caution in interpreting this effect as being characteristic of the true population.

The fact that the proportion of the variance of the Hyperactivity and the Cognitive Problems/Inattention subscales accounted for by IQ and academic achievement did not even approach significance further suggests that this is a spurious finding. Both subscales include content that is purportedly subsumed under the ADHD Likelihood Index (i.e. hyperactivity and inattentiveness) and one would expect at least one of these scales to relate to IQ and academic achievement if the relationship between the ADHD Likelihood Index and these cognitive measures was indeed reliable.

For the above reasons, the findings for hypothesis four appear to, maximally, provide tenuous support that the ADHD Likelihood is partially explained by academic achievement and IQ. This association should be researched further. However, overall, the findings of this analysis do not support the hypothesis that parent ratings of ADHD related behavior are influenced by IQ and academic achievement. As such, they suggest that parents are not biased by their adolescent's broad cognitive presentation when completing ADHD behavioral ratings. This suggests that parents generally take into account other student qualities when completing ADHD behavioral rating forms for adolescents.

A second implication of the hypothesis four results is that parent ADHD ratings of adolescent behavior are generally not accounted for by attention and executive functioning abilities. These cognitive domains, specifically, are even more theoretically associated with both inattention and hyperactivity than are IQ and academic skills. The finding that parent ratings of behavior generally did not relate to tests measuring these abilities implies that either common theories regarding ADHD or parent rating forms are invalid when considering adolescents.

As previously discussed, past research of ADHD rating forms has not supported the construct validity of these measures in general, or the CRS-R specifically. Because of this, the lack of convergence between parent ratings and cognitive measures found in this hypothesis cannot be interpreted as indicating fault on part of those theories linking ADHD behavior to cognition. Such an inference could only be made if both forms of assessment were considered valid measures of their respective constructs. Instead, this lack of convergence provides further support that ADHD behavioral rating forms are inaccurate measures of their purported constructs when completed by parents rating their adolescent children.

There are two possible explanations for why parent ratings of adolescent ADHD related behavior are of poor accuracy. First, parents themselves are possibly poor informants of ADHD related behavioral difficulties. The findings from the current hypothesis alone do not clearly identify whether parents are in general unreliable informants, or if there are aspects related to rating adolescents, specifically, that obscure parent accuracy.

Parents vary greatly in a number of salient characteristics that could potentially influence their approach to completing behavioral ratings. Factors such as parenting style, behavioral expectations, level of parenting related stress, frequency of parent-child interaction, and levels of parent education and intellectual functioning could all theoretically affect their completion of rating forms. Such factors likely vary to a greater extent across parents than across teachers given that there are no prerequisites to becoming a parent and there are generally few externally derived rules for parenting, with the exception of regulations regarding abuse, neglect, and school attendance.

On behavioral rating forms, such as the CPRS-R, parents are asked to rate the frequency of a behavior on a spectrum that often ranges from never occurring to always occurring. On the CPRS-R, as in other similar measures, there are no specific benchmarks for rating the frequency of these behaviors. As such, whether a parent lists a behavior as sometimes occurring or always occurring is generally left to his or her own discretion. It is foreseeable that characteristics that are unique to each parent and their respective parent-child relationship might significantly impact their behavioral ratings. Both previous research and clinical observation indicate that it is not uncommon for parents of the same child to differ considerably in the manner in which they rate that child's behavior. Therefore, the lack of convergence between subscales of the CPRS-R and performance on cognitive measures purported to assess similar constructs could be due, in part, to parents in general being poor raters of behavior.

In addition to the possibility that parents, overall, are poor raters of behavior, it is also possible that parents are particularly poor raters of adolescents. Adolescents differ considerably from children, and these differences are evident across the domains of cognition, emotion, physical ability, and social interaction. Given these differences and their potential effects on parent-child relationships, one might anticipate there to be differences between the accuracy of parents' ratings of children and their ratings of adolescents.

A central, broad reaching and defining characteristic of adolescence is the progression towards autonomy. As adolescents develop, they gain the ability to think critical, and begin to form opinions that may differ from those of their parents. They become more emotionally independent and less reliant on parental emotional support. They often spend less time with their parents and require less support in functional areas such as transportation, academics, and activity planning. All of these shifts occurring in adolescents and related to increasing autonomy might potentially decrease parents' insight into their adolescent's behavior. This would, in turn, also impact the accuracy of parent ratings of behavior in this age group. Given this, the non-significant findings of this hypothesis may, in part, be due to parent's being poor raters of the behavior of adolescents, specifically.

A second possible explanation for the lack of convergence between performance on neurocognitive measures and parent ratings of behavior in adolescents is that the CPRS-R form, itself, lacks validity when applied to this population. Due to the lack of significant associations between parent ratings and performance on neurocognitive measures, these assessment approaches are clearly measuring two different constructs. Such a weak association questions the construct validity of these two assessment approaches given that they are intended to measure overlapping constructs. As previously discussed, the construct validity of the neurocognitive measures in this study have been better supported than that of behavioral rating forms. Each of the neurocognitive measures used in this study is considered to be a “gold standard” for its respective domain. Collectively, these measures serve as a benchmark for which to assess the validity of CRS-R. Therefore, the poor convergence between the two assessment approaches is considered to evidence weak construct validity on part of the CRS-R.

Unlike other popular behavior rating forms (Behavioral Assessment System for Children), the CPRS-R uses identical rater forms for both children and adolescents. This is potentially problematic for several reasons. First, the behavioral presentation of childhood psychiatric and behavioral disorders differs according to age. Second, the base rates of childhood disorders change according to developmental stage. Both of these factors may affect the accuracy of a diagnostically based rating measure, such as the CRS-R, to classify an individual according to diagnosis. Additionally, as seen in this study, these factors would also lead to poor relationships with other external criteria.

Youth with ADHD are less likely to exhibit hyperactive and impulsive behaviors and are more likely to exhibit inattentive behaviors as they age. A decrease in the prevalence of ADHD mediated hyperactivity and an increase in the prevalence of other similar presenting disorders increases the likelihood that disorders other than ADHD would cause elevations on the CRS-R Hyperactivity subscale and ADHD Likelihood

Index. Similarly, depression, which shares some common behaviors with inattentiveness (i.e. poor concentration, difficulty completing tasks, and school problems) becomes increasingly more common in adolescents. This could foreseeably affect the specificity of the Cognitive Problems/Inattention subscale and the ADHD Likelihood Index in adolescents. This too could negatively impact the ability of ADHD behavioral rating scales to converge with measures of cognition as neurocognitive testing is expected to relate to ADHD, but not necessarily depression.

The results of these analyses indicated that parent rating scales were not significantly accounted for by cognitive abilities believed to underlie ADHD, which suggests that these scales are measuring something other than ADHD behavior in adolescents. Such a finding, given changes in both the manifestation and the base rates of psychiatric and behavioral disorders across childhood and adolescence, suggests that using the same rating form for children and adolescents may be inappropriate for the adolescent population.

Another finding of this hypothesis was that, while none of the sets of independent variables significantly related to any of the parent rating form subscales, one independent variable, broad mathematics, did significantly and uniquely relate to the ADHD Likelihood Index. This is a curious finding, as while mathematics ability was expected to contribute to the variance of ADHD behavioral rating scales, it was not expected to do so independently and uniquely. Theoretically, it is difficult to explain why mathematics ability, and not reading ability, verbal comprehension ability, visuospatial functioning, executive functioning, or attention, singularly related to ADHD behavior. Deficient mathematics ability is not a primary characteristic of the disorder, and while mathematics learning disorder sometimes presents comorbidly with ADHD, it is more common for individuals with ADHD to have accompanying reading difficulties.

It could be argued that several cognitive abilities underlying mathematics performance are also implicated in ADHD behavior. Included on this list of cognitive functions would be the ability to learn math facts, executive functioning, working memory, processing speed, visuospatial ability, nonverbal reasoning, and problem solving. However, all of these functions are arguably better represented amongst the other cognitive tests utilized in this study. If this relationship were due to parents' ratings of ADHD behavior being biased by perceptions of overall academic ability, one would expect the set of independent variables measuring IQ and academic achievement to also significantly relate to the ADHD Likelihood Index. However, this was not the case and the relationship was found to only approach significance.

If the relationship were due to concept formation and reasoning abilities being affected by proclivity to engage in ADHD related behaviors, it would be expected that other measures, such as Category test and Perceptual Reasoning, which are both purer measures of these constructs to also relate to ADHD Likelihood. If it were due to a relationship between inattentiveness and adolescents' ability to learn and apply new mathematics skills, it would be expected for those cognitive skills mediating this relationship, namely attention and response inhibition, to also relate to the ADHD Likelihood Index. As CPT omission and commission errors did not relate to this subscale, this was not the case. Because of this, it is difficult to explain why mathematical ability, but not performance on other neurocognitive measures, significantly related to parent ratings of ADHD.

In addition to the noted theoretical implications regarding parent ratings of adolescent behavior and the CRS-R, the findings from this hypothesis have several implications for clinicians and researchers. First, clinicians should generally not interpret elevations on parent rating scales assessing ADHD related behavior as being suggestive of cognitive difficulties in adolescents. Even though these ratings are believed to assess for cognitive difficulties related to inattention, hyperactivity, and impulsivity, they are generally not accounted for by cognitive abilities when completed by parents of adolescents. The presence of cognitive difficulties should, instead, be determined by other data including cognitive testing and grade reports. Such findings encourage the use of multiple assessment sources when conducting a clinical evaluation for an adolescent suspected of ADHD.

Second, the findings question the accuracy of parent ratings of adolescent behavior. Poor rating accuracy may due to problems with the instrument itself or due to parent inaccuracy when describing and rating adolescent behavior. Clinicians should consider parent ratings as being subjective perceptions versus objective measurements of adolescent behavior. Clinicians should consider what parent ratings might imply about the nature of the relationship between the parent and his or her adolescent. A given ADHD rating scale elevation might indicate the presence of ADHD related behaviors or inaccurate parental perceptions of their adolescent’s behavior. Both findings would be of importance clinically. To distinguish between the two, clinicians must consider other data, which should ideally include a thorough background history, neurocognitive data, and rating forms completed by other informants. A parent rating scale elevation in an adolescent whose data does not otherwise suggest the presence of ADHD or a lack of an elevation in an adolescent who does appear to have ADHD should be analyzed and interpreted. Such an occurrence could potentially affect both the conceptualization of the patient's presenting problem as well as any ensuing treatment recommendations.

In sum, the findings from the analyses of hypothesis three have several implications regarding parent behavioral ratings of ADHD behavior in adolescents. They indicate that all three subscales of the CRS-R teacher form examined in this study, Cognitive Problems/Inattention, Hyperactivity, and ADHD Likelihood, do not assess those constructs which they are purported to measure. What exactly these scales do measure cannot be definitively determined from the results of this study. What is evident is that these ratings, when completed by parents to assess adolescents, are generally not associated with cognition. This appears to be true for both general cognitive abilities as well as those cognitive functions believed to be closely related to inattention and hyperactivity.

Intellectual functioning and academic achievement approached, but did not reach, significance in accounting for variance of the ADHD Likelihood Index. Of the measures within this set, broad mathematics ability uniquely explained parent ratings on this scale. The present study cannot explain this relationship, and the generalizability of this finding beyond the present study is not clear. Future research is encouraged to examine the extent to which academic achievement and intellectual functioning, and specifically mathematics ability, contributes to parent ratings of ADHD related behavior.

Overall, the findings suggest the use of caution when interpreting parent rating forms of ADHD behavior in adolescents, and indicate that such ratings should not be interpreted as being valid indications of either cognition or cognitively mediated behaviors. Clinicians should first and foremost consider parent ratings of ADHD behavior to measure parent perceptions of behavior. Clinically, these ratings should be compared to other patient data. Consistencies and discrepancies between these data points should be considered within the conceptualization of the patient's presenting problem.

Hypothesis 5

The fifth hypothesis stated that performance on objective measures of cognitive functioning, including measures of academic, intellectual, and attentional abilities, would account for significantly more of the variance in ADHD measures from the CRS-R in children (under 11 years of age) than in adolescents (11 years and above). While all of the scales of the CRS-R were significantly accounted for by cognitive performance in children and none were significantly accounted for by cognitive performance in adolescents, the proportion of rating scale explained variance did not differ significantly between these two populations. For only one of the rating subscales, the ADHD Likelihood Index of the CTRS-R, did this difference even approach significance. As such, this hypothesis was generally not supported by the findings.

The findings indicate that ratings of child ADHD related behavior, in comparison to ratings of adolescent ADHD related behavior, are not informed by cognitive abilities to a significantly greater extent. Despite this, several meaningful trends are found within the data, which have implications for the clinical use of ADHD behavioral rating forms in children and adolescents. First, the results indicate that the CRS-R is explained by cognitive ability when utilized to assess children under the age of 11. Whether completed by teacher or parent raters, the variance of the Cognitive Problems/Inattention, Hyperactivity, and ADHD Likelihood subscales was significantly accounted for by neurocognitive test performance. This finding indicates that children with lower intellectual functioning are more likely to be rated as having increased behavioral problems and children with higher intellectual functioning are more likely to be rated as have relatively less difficulty with ADHD behavior.

Ratings of adolescent behavior, on the other hand, were not significantly explained by neurocognitive test performance, regardless of whether the rating forms were completed by parents or teachers. ADHD related behaviors are believed to be cognitively mediated and are associated with cognitive deficits in cognitive inhibition, sustained attention, processing speed, and working memory. Furthermore, ADHD diagnoses are associated with decreased academic performance in both reading and mathematics.

The non-significant relationships between adolescent cognitive performance and behavior ratings in these analyses suggest that the behaviors identified by the CRS-R when used with adolescents are not cognitively mediated. Given that hyperactivity, impulsivity, and inattention are expected to relate to cognitive deficits believed to underlie these behaviors, the results question the construct validity of the CRS-R when evaluating adolescents. Consequently, the primary implication of these results is that the CRS-R is not supported as a valid measure for the assessment of adolescent ADHD behavior.

The finding that cognitive ability significantly related to each of the CRS-R subscales in children, accounting for as much as 34% of the variance in behavioral ratings, suggests that the limitations of the behavioral rating forms apply specifically to adolescents. One possible explanation for the poor convergence between ratings of behavior and cognition is that parents and teachers are inaccurate raters of adolescents. Teachers of adolescents generally instruct only one subject and consequently are afforded a narrower perspective of each of their students. Whereas primary school teachers may work with a class of twenty-five students throughout the duration of the school day, middle and high school teachers may teach well over 100 students and spend only one class period with each student. Consequently, teachers in higher grade levels typically spend relatively less time with each of their adolescent students in comparison to their elementary school counterparts.

Additionally, instruction in middle school and high school is typically more didactic versus interactive. Teachers instructing these grades may find it more difficult to develop a thorough understanding of their students due to less involved interactions. Given this, teachers of adolescent students must base their behavioral ratings on knowledge acquired from relatively brief and casual encounters. This could foreseeable limit the accuracy of a given teacher's ratings, regardless of his or her ability as a rater.

Parents of adolescents also likely face limitations in the knowledge of their adolescent child. As adolescents struggle for increasingly greater physical, social and emotional autonomy, parents generally have increasingly less direct and indirect exposure to their adolescent's behavior. In comparison to children under 11, adolescents generally spend more time in school, employment, and work activities, rely less on their parents for transportation, require less supervision, and are more capable of carrying out activities independently within the home. Additionally, many adolescents seek greater emotional autonomy as they mature, discussing their thoughts, feelings, and behavior increasingly less with their parents. All of these changes, may negatively impact a parent's ability to accurately identify and rate cognitive and behavioral problems. Taken together, such considerations suggest that the accuracy of parent and teacher ratings of adolescents may be impeded by age-specific factors.

Another possible reason for the lack of convergence between parent and teacher ratings of adolescents is that the behavioral rating forms, themselves, are not valid measures of ADHD behavior when used with adolescents. A major limitation of the CRS-R, also found in many other ADHD behavioral rating forms, is that the item content is identical regardless of age. The same questions used to assess the behavior of a six-year-old are used to evaluate that of a 17-year-old. This could be problematic as certain questions can be readily viewed as appropriate for one end of the age range, but not the other. For example, the item, "Runs about or climbs excessively in situations where it is inappropriate" may be relevant to the assessment of children, but not adolescents.

In addition to the CRS-R having item content that is inappropriate for older age levels, it does not appear that the measure takes into account expected developmentally related changes in the behavioral expression of ADHD. Studies have consistently found that adolescents are much less likely to meet criteria for hyperactivity/impulsivity symptoms of ADHD and that the severity of ADHD related hyperactivity decreases with age. Even when hyperactivity is present in adolescents, it is expressed differently than in children, manifesting in fidgeting and restless versus difficulty controlling behavior. On the other hand, the proportion of ADHD diagnosed individuals meeting criteria for Inattentive subtype increases in adolescents.

The current findings suggest that changes in the expression of ADHD due to age may negatively impact the construct validity of behavioral rating forms in adolescents. The frequency and severity of symptoms of ADHD related hyperactivity is expected to decline in adolescents. Similarly, the prevalence of both ADHD Hyperactive/Impulsive and Combined subtypes has been shown to fall in adolescents. Given these changes, one would expect the number of individuals with elevations on hyperactivity scales of behavioral rating forms to also decline considerably from childhood to adolescence. This was not the case in the current sample.

The proportion of participants identified as having a "clinically significant problem" (T-Score $\geq$ 65) was only slightly less in adolescents (23%) than in children (30%) when comparing teacher ratings of hyperactivity. When comparing parent ratings of hyperactivity, the proportion of adolescents (45%) was actually greater than the proportion of children (43%) identified as having clinically significant problems with hyperactivity. These finding are problematic given that the prevalence of hyperactivity in adolescents is expected to be less than that in children. They suggest that some adolescents with elevations on the Hyperactivity subscale may not in fact have clinically significant problems with hyperactivity. Furthermore, these findings provide further support that the CRS-R subscales are measuring something other than what they are purported to measure.

Given the finding that the frequency of elevations on the Hyperactivity subscale remained static across the two age groups as well as the lack of convergence between neurocognitive measures and ADHD rating scales intended to measure similar constructs, it appears that the subscales of the CRS-R are not specific to ADHD in adolescents.

Whereas the prevalence and severity of ADHD related hyperactivity has been demonstrated to decline in adolescence, other psychiatric disorders, including major depressive disorder, generalized anxiety disorder, bipolar disorder, and oppositional defiant disorder all become more prevalent as age increases. Such changes in the base rates of these disorders may have additionally contributed to the poor construct validity of the CRS-R. As the prevalence of disorders overlapping with ADHD increases while the prevalence of true ADHD decreases, the rate of ADHD behavioral rating subscale elevations that are true positives would also be expected to decrease. This would affect both the accuracy of the ADHD rating subscales as well as their ability to correlate with extra-test measures. The findings that the CRS-R rating scales did not significantly relate to neurocognitive tests purported to measure similar constructs may, therefore, also be contributed to by developmentally based changes in disorder base rates.

Another important finding of hypothesis five results is that ratings of child behavior are consistently explained by cognitive ability. In a broad sense, the nature of the relationship between cognition and ratings of ADHD related behaviors is not clear from these results and may, in fact, be multifactorial. The set of independent variables utilized for these analyses contained tests measuring academic ability, sustained attention and response inhibition, as well as FSIQ. Given this, it is difficult to determine from this data alone whether these relationships are due to the mediating effect of certain cognitive skills on ADHD behavior, the influence of cognitive presentation on raters' perceptions of child behavior, or a combination of both factors.

FSIQ significantly and uniquely accounted for the variance in four of the child rating form subscales, including the ADHD Likelihood Index of the CRS-R teacher form and all three rating subscales of the CRS-R parent form. As FSIQ is a composite index comprised of tests assessing general verbal and visuospatial intellectual abilities, as well as working memory and processing speed, the implications of this finding are not clear. It could be that general intellectual ability accounted for these relationships, or it may be the case that working memory and processing speed, cognitive abilities commonly associated with ADHD behaviors, were responsible for these findings.

When considering these findings alone, it is also possible that children rated by parents and teachers as having increased levels of ADHD behaviors struggle cognitively across domains. FSIQ, alone, uniquely accounted for the variance of the CPRS-R Cognitive Problems/Inattention subscale, as well as the ADHD Likelihood Index of both the CTRS-R and CPRS-R. However, the R^2 of FSIQ was considerably less than that of the overall model for each of these subscales. This suggests that cognition, in a general versus specific sense, accounts for variance in behavioral ratings. On one subscale, the Hyperactivity subscale of the CRS-R parent form, Broad Math and CPT Omissions, in addition to FSIQ, uniquely accounted for a significant proportion of the variance. This suggests that this subscale, in particular, relates to a number of aspects of cognition, including both focal cognitive abilities believed to underlie the disorder as well as academic abilities. Similarly, the CTRS-R Hyperactivity subscale was significantly accounted for by the overall set of neurocognitive measures, but was not uniquely explained by any of the individual variables of the set. This suggests that the relationship was also due to the combined influence of the set of cognitive predictors.

Broad Reading ability uniquely accounted for a significant proportion of the variance for only one of the six rating subscales. Reading ability accounted for 15% of the variance in teacher's ratings of cognitive problems and inattention. No other variables significantly accounted for the variance of this subscale when controlling for the effects of the other variables. Such a finding may highlight the impact of impaired attention on reading abilities or it may suggest that teacher's perceptions of cognition and inattention are highly informed by students' reading ability.

The findings that parent and teacher ratings of child ADHD behavior related to performance on neurocognitive measures does not necessarily provide evidence for the construct validity of the CRS-R. While relationships between these two methods of assessment were found, it cannot be confirmed from these results that these relationships were due to convergence between ratings of ADHD behavior and those neurocognitive abilities to which they are most theoretically associated. If the relationships were, instead, due to an association between ADHD rating scales and cognitive abilities to which they are less directly theoretically related, such a finding would not provide support for construct validity. At the same time, contrary to the findings regarding the use of rating forms in adolescents, the results of the hypothesis five analyses do not provide any evidence against the construct validity of the CRS-R in the evaluation of children.

In addition to the noted theoretical implications regarding parent and teacher ratings of behavior and cognitive ability, the findings from this hypothesis have several implications for clinicians and researchers. The findings indicate that both parent and teacher ratings of adolescent behavior fail to relate to true cognitive ability in adolescents. This suggests issues with the instrument itself, parent and teacher inaccuracy when describing and rating adolescent behavior, or a combination of both factors. Regardless, the findings of these analyses raise serious questions regarding the construct validity of the CRS-R in the evaluation of adolescents. As such, the CRS-R and similarly developed ADHD behavioral ratings forms should be interpreted with great caution in this population.

When rating forms of adolescent behavior are interpreted, clinicians should consider parent and teacher ratings as being subjective perceptions versus objective measurements of adolescent behavior. Additionally, clinicians should consider the possibility that elevations on the CRS-R might be due to psychiatric disorders other than ADHD in adolescent clients. Regardless, clinicians should generally not interpret elevations on adolescent rating scales assessing ADHD related behavior as being suggestive of cognitive difficulties. The findings encourage the use of multiple assessment sources when conducting clinical evaluations for adolescents suspected of ADHD. Evaluations should ideally include a thorough background history, neurocognitive data, grade reports, and information from multiple informants.

Whereas ADHD behavioral rating forms should be used cautiously when evaluating adolescents, the findings do not provide evidence against the use of the CRS-R in child clients. Ratings of child ADHD related behavior are expected to converge with cognitive ability in children regardless of whether the behavior is rated by the child's parents or teacher. Elevations on rating scales assessing for ADHD behaviors should be followed up with neurocognitive testing to determine specific areas of weakness.

Finally, the disparate findings between the child and adolescent samples of this study, suggest that future research should examine these two populations separately in future studies of ADHD. The phenotypic expression of the disorder, prevalence rates of comorbid and similarly presenting disorders, and informant rating accuracy are all expected to vary considerably between child and adolescent age groups. The current results suggest that these age-related differences may in fact exert influence over study results.

In sum, the findings from the analyses of hypothesis five have several implications regarding parent and teacher behavioral ratings of ADHD behavior. While the rating scale variance accounted for by cognitive performance did not differ significantly between children and adolescents, there appears to be clinically meaningful differences in the way behavioral ratings and cognitive ability relate in these two samples. Namely, the results indicate that the CRS-R convergences with cognitive ability in children, but not adolescents. Taken together, these findings provide support for the use of the CRS-R in children and, conversely, question the use of the measure in adolescents. This implies the possibility that qualities specific to the rating of adolescents, specifically, threaten the validity of the CRS-R when applied to that population.

Conclusion

This dissertation asked the question: Do parent and teacher ratings of ADHD behavior measure what they are intended to? The results from this study indicate that, in general, they do not. ADHD is distinct from many other psychiatric disorders in that deficits in cognition are considered to by a central feature of the disorder. While the criteria utilized to diagnose the disorder are based on observations of behavior, these behaviors are believed to be manifestations of deficits in cognition, particularly executive functioning and attentional control (Barkley, 1997; Fischer, Barkley, Smallish, & Fletcher, 2005; Nigg, 2001).

Neuropsychological research has supported such theories and studies have consistently found children with ADHD to perform worse than children without the disorder across measures of executive functioning (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Given this, if ADHD behavioral rating forms indeed assess the constructs that they are intended to measure, it would be expected that the variance of these measures would be accounted for by cognition. Furthermore, it would be expected that the cognitive abilities most directly associated with the disorder (i.e. executive functioning and attention) would account for a significantly greater proportion of the variance than those less associated.

The current study examined the association between cognition and ratings of ADHD related behavior using both parent and teacher informants and by examining both children and adolescents referred for clinical evaluation. In children, all three subscales, across both parent and teacher forms of the CRS-R, were accounted for by cognitive abilities. However, for more subscales than not, the variance was not accounted for by attention and executive functioning abilities to a significantly greater extent than by broad intellectual and academic abilities. Such a finding questions the ability of the CRS-R, overall, to validly assess those behavioral constructs it is purported to measure. However, as some scales did converge with performance on cognitive measures assessing theoretically related constructs, it appears that certain scales of the CRS-R (i.e. Hyperactivity) maintain better construct validity than others when the measure is applied to children.

Findings from the current study found that the Cognitive Problems/Inattention subscale, in particular, does not appear to measure its purported construct when completed by either parents or teachers in the evaluation of children. While the subscale is intended to assess the severity of problematic behaviors related to inattention and organization, it was not significantly accounted for by attention and executive functioning abilities in children. Instead, the Cognitive Problems/Inattention subscale related only to IQ and academic achievement abilities. This suggests that the subscale is a significantly better assessment of general cognitive abilities than it is of attention and executive functioning. It also suggests that the subscale's relationship to academic and general intellectual abilities is not mediated by children's attentional and executive abilities.

The finding that IQ and academic abilities accounted for a significant proportion of the variance in the Cognitive Problems/Inattention scale is consistent with previous research. Past studies have demonstrated that parent and teacher ratings of inattention are significantly and negatively associated with academic performance (Merrell & Tymms, 2001; Dally 2006). Similar relationships have been found between parent and teacher ratings of inattention and intellectual functioning (Jonsdottir, Bouma, Sergeant, & Scherder, 2006; Naglieri, Goldstein, Delauder, & Schwebach 2005). DeShazo Barry, Lyman, and Klinger (2002) found academic difficulties to account for incremental variance in parent ratings of inattention above and beyond that of executive functioning abilities, but did not find the inverse to be true. The authors concluded that ADHD related inattention most notably results in academic deficits, and that these deficits are not the result of impairments in executive functioning.

One possible explanation for the results of these studies, as noted by DeShazo Barry, Lyman, and Klinger (2002), is that the severity of ADHD related inattentive behavior is better associated with general academic and intellectual ability than with executive functioning. However, a major limitation, in the above research studies is their reliance on behavioral rating forms as a means to quantify ADHD symptom severity. While these studies aimed to examine the relationship between academic performance and ADHD symptom presentation, such a goal necessitates that both behavioral rating forms and tests of academic performance be established as valid measures of their respective constructs. Given that the accuracy of behavioral rating forms has been questioned (Snyder & Drodz, 2004; Gomez, Burns, Walsh, & Alves de Moura, 2003) a second possible explanation for these findings is that behavioral ratings of inattention are more sensitive to academic difficulties than they are to behavioral expressions of ADHD.

The same issues confounding the interpretation of previous studies examining the cognitive correlates of behavioral inattention are present in the current study. Similar to previous studies, it is difficult to determine the meaning of the demonstrated relationship between behavioral ratings and general cognitive and academic abilities. The relationships between these two domains may be due to inaccuracies in behavioral ratings of inattention resulting in poor convergent validity. Alternatively, similar to conclusions made by DeShazo Barry and colleagues (2002), these findings may simply indicate that the most salient cognitive deficits of ADHD related inattention are lower general academic and intellectual abilities.

A study by Willcutt et al. (2001) provides some guidance in making this distinction and interpreting the relationship between the Cognitive Problems/Inattention subscale and cognitive test performance. Unlike the studies by DeShazo Barry et al. (2002), Merrell and Tymms (2001), and Dally (2006), Willcutt et al. (2001) examined the association between diagnosis, as opposed to behavioral rating scales, and skills in executive functioning and reading ability. The study compared groups of children with only ADHD, only reading disorder, and comorbid ADHD and reading disorder. It found that ADHD was associated with deficits in response inhibition, reading disorder was associated with deficits in basic reading skills, and reading disorder and ADHD was associated with deficits in both domains. These findings held true even after controlling for FSIQ.

The results of Willcutt et al. (2001) suggest that while deficits in general cognitive and academic abilities may be found in some children with ADHD, deficits in executive functioning are relatively more pervasive. Given that deficits in reading ability were only associated with ADHD in the presence of comorbid reading disorder and executive functioning deficits were found in ADHD children regardless of comorbidity, one would expect ADHD symptom severity to be associated with executive dysfunction to a greater degree than with general cognitive and academic weakness. In light of this, it seems more likely that the findings from the present study are due to problems with parent and teacher ratings of attention versus a lack of association between ADHD symptom severity and executive dysfunction. However, future research is needed to support this contention.

Whereas the Cognitive Problems/Inattention subscale did not converge with those cognitive abilities it is believed to assess, the Hyperactivity subscale of the CRS-R did converge with theoretically similar cognitive abilities. Ratings of hyperactivity, on both the parent and teacher rating forms, were accounted for by performance on measures of attention and executive functioning to a significantly greater extent than by performance on measures of IQ and academic abilities. This finding is consistent with popular theories of ADHD related hyperactivity (Barkley, 1997; Fischer, Barkley, Smallish, & Fletcher.

2005; Nigg, 2001), which identify deficits in executive functioning, namely response inhibition, as being central to the cognitive and behavioral symptoms of ADHD. This finding is also consistent with research indicating that children with ADHD demonstrate deficits in attention and executive functioning abilities as measured by neuropsychological measures (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005).

The finding that ratings of hyperactivity were significantly explained by executive and attentional skills, therefore, provides further support for theories that view executive dysfunction as being closely intertwined with ADHD related hyperactivity. Furthermore, the finding that attention and executive functioning accounted for a significantly greater proportion of the variance in ratings of hyperactivity than intellectual and academic abilities supports both the convergent and discriminate validity of the Hyperactivity subscale. As attention and executive functioning abilities accounted for both parent and teacher ratings of hyperactivity in children, the findings lend support to the accuracy of these ratings as completed by both informant sources. Therefore, the results suggest that elevations on the Hyperactivity subscale are reflective of true hyperactivity in children and that these behaviors are associated with deficits in executive functioning and attentional control.

While the cognitive correlates of both the Cognitive Problems/Inattention subscale and the Hyperactivity subscale of the CRS-R were consistent across teacher and parent informants, the correlates of the ADHD Likelihood Index varied according to informant source. The ADHD Likelihood Index on the CRS-R, as completed by teacher informants of child behavior, was significantly accounted for by attentional and executive skills and by broader intellectual and academic abilities to a statistically equivalent extent. Past research has shown that children with ADHD have relatively greater deficits in attention and executive skills (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005) tend to have lower IQ's (Frasier, Demaree, & Youngstrom, 2004), and have increased academic difficulties (Willcutt et al., 2001; Cantwell & Baker, 1992). Whereas other subscales analyzed in this study (i.e. Cognitive Problems/Inattention) were explained by academic and intellectual abilities in the absence of similar relationships with executive and attentional skills, the ADHD Likelihood Index, as completed by teachers, was accounted for by both skill sets. Given that ADHD is expected to be associated with deficits across these domains, this finding appears to support the general accuracy of the scale as completed by teachers rating children.

On the other hand, the ADHD Likelihood Index when completed by parent raters was not significantly accounted for by attentional and executive skills. Rather, parent ratings of overall ADHD likelihood were far better explained by general cognitive abilities. This finding questions the accuracy of this particular subscale of the CRS-R, but it also raises significant questions about the accuracy of parent raters of child ADHD related behavior.

Given that ADHD is associated with attention and executive functioning deficits (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005), one would expect difficulties in these cognitive domains to increase as the severity of ADHD related behaviors increases. This expected association was found between attention and executive functioning and parent ratings of hyperactivity, but not ratings of overall ADHD likelihood. This suggests that while parents may be accurate raters of hyperactivity, when asked to rate behaviors across both hyperactivity and inattention, their net ratings are less accurate.

As teacher behavioral rating subscales converged with theoretically associated cognitive abilities more frequently than parent rating subscales, the findings suggest that teacher ratings of child ADHD behavior may be more accurate than parent raters. Such a finding is consistent with past research. Several studies (Oosterlan, Sheres, & Sergeant, 2005; Riccio, Hall, Morgan, & Hynd, 1994; Jonsdottir, Bouma, Sergeant, & Scherder, 2006) found teacher, but not parent, ratings of ADHD related behavior to significantly correlate with child performance on measures of executive functioning. Additionally, studies have found teacher ratings of child behavior to demonstrate significantly greater accuracy than parent ratings in distinguishing between children with and without the disorder (Tripp, Schaughency, and Clarke, 2007; Power et al., 1998).

Researchers have theorized as to why teachers may be better raters of child behavior than parents. Stefanatos and Baron (2007) note that many ADHD behaviors easily observed by teachers are less apparent to parents as home environments are often less structured and place fewer expectations on child behavior than school environments. Additionally, Taylor, Anselmo, Foreman, Schatschneider, and Angelopoulos, J. (2000) note that teachers have a distinct advantage over parents in that teachers have observed a large sample of same-aged children from which to draw comparisons when rating child behavior.

While the results of this dissertation provided evidence that ADHD behavioral ratings are associated with cognitive abilities in child clients, they did not provide support for such an association in adolescent clients. Results of hypotheses three and four indicate that neither focal skills in attention and executive functioning nor broad based intellectual and academic abilities explain the variance in parent or teacher ratings of ADHD behavior. When considering these findings in isolation, they indicate that parent and teacher ratings of ADHD behavior may lack construct validity in adolescents. When considering these findings in light of those demonstrating significant relationships between cognition and ratings of behavior in child clients, the results suggest that the weak construct validity of behavioral rating forms in adolescents may be, in part, due to the impact of age-related factors.

Despite the large body of published research on the various facets of ADHD, there is a relative paucity of literature available regarding the impact of age on either the manifestation or diagnosis of the disorder. Much of the ADHD research utilizes preadolescent samples (Seidman et al., 2005) and there remain significant gaps in our understanding of the diagnosis and treatment of ADHD in adolescents (Wolraich et al., 2005). Those studies that do utilize adolescent samples are often longitudinal studies comprised of adolescents clinically diagnosed with ADHD early in childhood. Such a practice may be problematic given the possible differences between these youth and those for whom ADHD is first clinically detected in adolescence (Faraone, Biederman, & Monoteaux, 2002).

An extensive review of the literature revealed a number of articles addressing the relationships between parent and teacher ratings of behaviors and neuropsychological test performance. Most of these studies utilized either mixed child and adolescent samples or child only samples. Only one peer-reviewed study (Barkley, 1991) was found to examine the relationship between ADHD rating forms and cognitive performance specifically in adolescents. Interestingly, similar to the current study, Barkley’s study also found these relationships to be present in children under age 12, but not in adolescents.

The results from this study suggest the presence of salient differences in the extra-test correlates of ADHD behavioral rating forms when used in children versus adolescents. While research examining ADHD in adolescents is limited, that which is available suggests several possible explanations for the current findings. One possibility is that age-related changes in the symptom expression of the disorder reduce the sensitivity of behavioral rating forms as age increases.

Studies have demonstrated that there are developmentally related changes in the manifestation of ADHD, generally characterized by decreasing levels of hyperactivity with age (Marsh & Williams, 2004; Hurtig et al., 2007). Other studies (Biederman, Mick, & Faraone, 2000) have demonstrated that symptoms of inattentive behaviors may also decline with age, although to a lesser extent than hyperactive and impulsive behaviors. While the severity of hyperactive symptoms appears to generally lessen with age, deficits in daily functioning typically continue to persist (Faraone, Biederman, & Mick, 2006). Consistent with this, Marsh and Williams (2004) found that many individuals who met criteria for ADHD Combined type as children progressed to ADHD Inattentive type in adolescence.

While ADHD symptom severity has been demonstrated to decline as children mature, some (Barkley, 2003; Biederman, Mick, & Faraone, 2000; Wolraich et al., 2005) have suggested that this occurrence is not due to remission, but rather to a failure in DSM-IV criteria to account for developmental changes in symptom presentation. Some items that are relevant in childhood may not be relevant in adolescence. Similarly, due to changes in socialization and brain development, adolescents with ADHD likely become increasingly capable of inhibiting their behavior, despite persistence of hyperactive impulses (Faraone, Biederman, and Mick, 2006).

A hyperactive adolescent may no longer leave their classroom seat or “run about excessively,” but instead demonstrate increased difficulty fidgeting and keeping still while seated. Similarly, the content of ADHD criteria may be more appropriate for children than for adolescents and adults (Barkley, 2003; Faraone, Biederman, & Mick, 2006). Given that ADHD rating forms such as the CRS-R are based upon DSM-IV diagnostic criteria for the disorder, these concerns are likely germane to behavioral rating forms as well as well as to diagnostic criteria.

Barkley (2003) criticizes DSM-IV ADHD criteria for viewing ADHD as a static disorder in which symptom criteria are not adjusted for age, versus a developmental disorder in which symptoms are based on age-specific behavioral concerns. The CRS-R, like the DSM-IV, contains uniform content across age groups and does not appear to consider the degree to which the relevance of such content varies according to age. Given arguments that behaviors common of childhood ADHD are less common in adolescents with the disorder, such a practice likely reduces the sensitivity of the CRS-R as well other behavioral ratings forms for which item content is not adjusted according to age.

Age-dependent changes in the prevalence rates of other psychiatric disorders may present additional threats to the accuracy of ADHD behavioral rating forms in adolescents. Generalized Anxiety Disorder, Major Depressive Disorder, Conduct Disorder, Oppositional Defiant Disorder, and Bipolar Disorder all become more prevalent as age increases (Stefanatos & Baron, 2007). Differentiating these disorders from ADHD becomes increasingly difficult in adolescence given that these disorders present with symptoms similar to ADHD and often co-occur with the disorder (Wolraich et al., 2005). A decrease in the sensitivity of ADHD diagnostic criteria along with an increase in the prevalence of similarly presenting disorders would be expected to decrease the accuracy of behavioral rating forms. The findings of this study indicating that neither parent nor teacher ratings of adolescent ADHD behavior converged with cognitive abilities believed to be impacted by the disorder is certainly consistent with such a possibility.

Another possible explanation for the poor convergence of the CRS-R with purportedly associated measures of cognition in adolescents is that parent and teachers are less accurate raters of adolescent behavior than they are of child behavior. Molina, Pelham, Blumenthal, and Galiszewski (1998) found that agreement among secondary school teachers' ratings of adolescent behavior were generally poor, with Pearson correlations ranging from .40 to .50. Similarly, Achenbach, McConaughy, and Howell (1987) found that correlations between parent and teacher ratings of adolescent behavior were significantly less than those of child behavior.

Parents and teachers rating adolescents typically have less direct contact with their students than parents and teachers who work with children. Wolraich et al. (2005) note that adolescents, compared to children, are supervised and monitored significantly less by both their teachers and parents. Adolescents have greater functional independence, strive for higher levels of autonomy, and are less disclosing in relation to children. These factors may help to partially explain the findings of the current study, which show ratings of adolescent behavior to have relatively poor convergent validity.

Considering the numerous threats to the validity of parent and teacher ratings of adolescent ADHD behavior noted above, the findings that ratings of adolescent behavior do not converge with similar extra-test measures is not surprising. However, the possibility that the poor convergence is due to age-related reductions in the sensitivity of neuropsychological measures must also be considered. A number of variables related to the evaluation of ADHD (i.e. symptom manifestation, criteria sensitivity, and informant accuracy) are purported to change from childhood to adolescence (Stefanatos & Baron, 2007; Barkley, 2003; Biederman, Mick, & Faraone; Wolraich et al., 2005; Achenbach, McConaughy, & Howell, 1987). Given this, it is also worth considering the possibility that neuropsychological measures become less sensitive to ADHD related cognitive deficits with increasing age. However, studies (e.g. Seidman et al., 2005; Barkley, Edwards, Laneri, Fletcher, & Metevia, 2001) have shown that neuropsychological deficits generally remain stable across development in children and adolescents. Furthermore, others have found that the risk of developing learning disabilities involving reading, math, and written expression due to ADHD actually increases in the transition from childhood to adolescence (Tannock & Brown, 2000). As ADHD related cognitive and behavioral deficits interfere with the acquisition of basic academic skills, the impact of the disorder on academic ability is expected to compound with age (Rapport, Scanlan, & Denney, 1999).

Given past neuropsychological research, one would expect deficits in attention, executive functioning, reading, and mathematics to remain stable, if not increase, with advancing age in youth with ADHD. Therefore, it does not appear that the poor convergence between parent and teacher ratings of adolescent behavior and performance on measures of cognitive performance can be attributed to age-related limitations of neurocognitive measures. Rather, it appears that characteristics of parent and teacher ratings of behavior specific to adolescents confound the relationships between measures of cognition and behavioral ratings scales purported to measure similar constructs. As such, it appears that parent and teacher ratings forms are of questionable validity when used to evaluate adolescents and should be interpreted with caution in this population.

A primary implication of the findings of this study is that parent and teacher ratings of behavior lack construct validity, particularly when used to assess adolescent clinical referrals. It was theorized that this might be due to poor sensitivity and specificity of the CRS-R when used to evaluate adolescents. As previously noted, the classification accuracy of the CRS-R was well supported in its initial validation studies (Conners, 1998a, b). High classification accuracy rates, in fact, have generally been noted for most rating forms of ADHD behavior when differentiating between children and normal controls (Pelham, Fabiano, & Massetti, 2005).

However, while behavioral rating forms have demonstrated validity in distinguishing children with ADHD from non-clinical participants, little research is available regarding the ability of these instruments to accurately classify children within mixed clinical samples. Such an omission is potentially problematic as behavioral rating forms are typically employed in the context of clinical evaluations for the purpose of differentiating between ADHD and other psychiatric disorders. The discrepancy between the current results and those of previous studies may reflect the use of a mixed clinical sample in the present study.

An additional shortcoming of previous studies employed to validate ADHD behavioral rating scales is the nearly predominate use of child only samples (Pelham, Fabiano, & Massetti, 2005). Few validation studies have included adolescent participants.

Those validation studies that have included adolescents typically utilized combined samples, without looking at the measures' performances in adolescents exclusively. The omission of adolescents from rating scale validation studies and the use of non-clinical control groups could explain the strong classification accuracy rates found in previous studies. Given the poor support for construct validity of the CRS-R in this study's adolescent sample, the generalizability of these results to adolescents and mixed clinical samples appears questionable. Further research appears needed to indicate whether behavioral rating forms are able to accurately contribute to diagnosis among adolescent clinical referrals with behavioral difficulties due to varied etiologies.

Results from this study question the ability of ADHD behavioral rating scales to measure their intended constructs, particularly in adolescents. Despite this, only one of the five hypotheses proposed in this study, hypothesis two, received even partial support. Furthermore, theories proposed in this study attempting to explain why ratings of ADHD behavior converge poorly with measures of attention and executive functioning were not supported.

It was theorized that parent and teacher ratings of behavior might by susceptible to a global impression bias informed by overall cognitive abilities. This theory, specifically, was not supported by the results as academic abilities and intellectual functioning accounted for the variance of only some subscales, and only when considering children. It appears that only the Cognitive Problems/Inattention subscale is influenced by overall cognitive abilities in children. Given that the Cognitive Problems/Inattention subscale is not intended to assess for overall cognitive abilities, such findings do suggest that parents and teachers may be biased by global impressions of cognition, but only when completing items loading onto this particular scale. In sharp contrast to the theory of a global impression bias, the Hyperactivity subscale was better accounted for by attention and executive functioning than by overall cognitive skills in children. Such findings indicate that parents and teachers consider a variety of factors when rating child behavior and that these factors differ according to the type of behavior being rated.

Limitations

The use of sub-optimal sample sizes represents a major limitation of the present study. The analyses conducted in this study involved regression models consisting of either four or five independent variables. To adequately power multiple regression analyses involving 4 and 5 variables, Miles and Shevlin (2001) recommend the use of samples of at least 40 and 45 participants, respectively, to detect large effect sizes. The authors suggest using samples comprised of at least 85 participants when attempting to detect medium effect sizes or less.

Clearly the sample sizes utilized in this study restricted the power needed to determine statistical significance. Reduced power was most impactful on the analyses involving the adolescent sample, as this sample contained only 49 participants when examining the teacher form of the CRS-R and 40 participants when examining the parent form. With such a sample size, only relationships of a moderate to large size effect are likely to reach statistical significance. The small effect sizes noted in many of the findings for adolescents perhaps would have been of statistical significance if larger samples had been employed.

While limitations on power may have reduced the ability of these analyses to find statistically significant relationships between behavioral ratings and cognitive ability, the differences between the R^2 values of the regression models were often significantly different. For this particular study, the power of the regression models for hypotheses one and two was of less importance than the power of the analyses used to compare the effect of the models. Many of the analyses comparing the R^2 values of complementary regression models yielded significant results for hypotheses one and two. Such differences would also be expected with the use of even larger samples. However, a majority of the comparisons between the regression models of hypotheses three, four, and five, were not found to be significantly different. The near lack of significant differences between these models was also likely contributed to by the sample size of the relatively smaller adolescent sample.

Hypotheses one through four utilized a method developed by Alf and Graf (1999) to compare the R^2 values between two regression models based on the same sample. The authors recommend that, minimally, a sample size of 60 be used for such analyses. As the sample size was 40 for hypothesis three and 49 for hypothesis four, significant differences between the regression models may have been detected had the samples been larger. Given that the sample sizes used in hypotheses three and four allowed for sub-optimal levels of power regarding both the individual regression analyses and the comparisons between regression models, some caution is recommended before drawing conclusions from these analyses.

Hypothesis five utilized an approach outlined by Zou (2007) to compare the R^2 values of regression models utilizing two independent samples. This approach was used to compare the variance in ratings of behavior accounted for by cognitive ability in child versus adolescent clients. While no recommendations on sample size were noted for Zou's method, the results suggest that these comparisons also lacked adequate power to detect statistically meaningful effects. For almost every dependent variable analyzed in hypothesis five, the variance accounted for in behavioral ratings for child participants was significant and of a medium effect size. Conversely, only one of the models analyzing the variance accounted for by adolescent cognitive test performance yielded significant results and R^2 values were generally below .150. Despite these divergent trends, the differences in R^2 values between the child and adolescent groups did not reach levels of statistical significance for any of the dependent variables.

In addition to the relationships between cognitive test performance and behavioral ratings being consistently significant for children and generally non-significant for adolescents, the differences in R^2 values between the adolescent and child models appeared to be of levels of clinical significance. The differences between R^2 values of the child and adolescent sample were as high as .22, yet none of these differences reached statistical significance. By comparison, an R^2 differences as low as .08 reached statistical significance on hypothesis one.

The restrictions on power using Zou's (2007) approach were likely contributed to by the relatively smaller size of the adolescent sample used in hypothesis five. However, even though the sample size of hypothesis one was also relatively small (n = 40), an R^2 difference of .09 was statistically significant when employing Alf and Graf's (1999) approach. Thus it seems that Alf and Graf's method of comparing regression models requires a relatively smaller sample size than that required by Zou's approach. This suggests the possibility that R^2 comparisons utilizing dependent samples necessitate the use of smaller sample sizes than those comparing independent samples in order to provide adequate statistical power. Regardless, the power of the analyses used in hypotheses three, four, and five would have benefited notably had larger sample sizes employed.

Utilization of small samples may be particularly problematic when analyzing relationships between psychological measures of disparate methods. Meyer and Archer noted that when comparing instruments such as the WAIS, MMPI, and Rorschach variables to extra-method assessments of the same constructs, correlations generally ranged from .25 to .35. Similarly, Barkley (1992) noted that the method differences between behavioral ratings and neuropsychological measures likely confound the ability for these measures to relate at satisfactory effect size levels.

While the utilization of smaller sample sizes reduced the ability of many of the analyses to find significance at small effect sizes, this does not negate the findings of this study. One advantage of the study is that it compared effect sizes between relationships that were equally prone to the same limitations. That is, when comparing the relationship between parent ratings of inattention and general cognition with the relationship between parent ratings of inattention and attentional and executive skills, both relationships were constrained by equally small sample sizes. The question asked in this dissertation was not; does the variance accounted for by sets of cognitive abilities reach significance? Rather, the dissertation asked, which set of cognitive abilities best accounts for ratings of behavior? Therefore, while the reduced power of the individual regression models may represent a limitation of the study, a bigger issue appears to be the questionable power of the comparisons between the models.

Another limitation of the present study is the lack of other external criteria which to compare the accuracy of behavioral ratings and cognitive test performance. While diagnoses were available for each participant, these diagnoses were formulated, in part, on the basis of the test results used in the analyses. As such, the variable of child diagnosis was not utilized given its dependence on both independent and dependent variables of the study. However, the utilization of an additional external criterion, such as an independently formulated diagnosis or the behavioral ratings by trained observer, would have benefited the present study. Many of the conclusions made regarding the validity of the CRS-R in adolescents perhaps could have been better refined had parent and teacher ratings been compared not only to cognitive performance, but also to other forms of behavioral assessment.

A limitation of this study that is also true of much of the neuropsychological literature is the reliance on laboratory measures to assess for cognitive performance. While the neurocognitive measures used in this study are both well validated and commonly utilized by both researchers and clinicians, they too have their limitations. Performance on any given test may not always reflect real world functionality and factors other than cognitive ability sometimes impact test performance.

Another limitation of the study, that also represents an advantage, is the utilization of clinically referred samples. The individuals comprising the samples used in this dissertation were all referred for a clinical neuropsychological or psychological evaluation. It is likely that these individuals were identified by their parents, teachers, treatments providers, or some combination of these sources as demonstrating some combination of cognitive, behavioral, or emotional difficulties. Therefore, the distribution of scores, as well as the prevalence of impaired performances across both behavioral and cognitive assessment measures, is expected to differ from those found in non-clinical populations. Such an assertion is supported by the mean standardized scores, which were noted in the results section. Those measures for which low scores reflect abnormality had mean scores below the 50th percentile of the normative sample and those scores for which high scores reflect abnormality had mean scores above the 50th percentile. The mean score for some measures was more than a standard deviation discrepant from the mean, suggesting that, on those particular measures, a majority of the study's sample had scores suggestive of abnormality. Such findings indicate differences between the test performances of the current sample and those of the populations used to norm the tests.

Because the distribution of test scores for the clinical samples used in this study likely differ from those of the general population, the nature of the relationships between these measures may also differ in the general population. A non-representative sample was used in this study and, as such, the results of the current study should not be generalized to the overall population. The sample composition also differs from a number of previous ADHD studies, which often employed samples comprised exclusively of either "normal" children or children diagnosed with ADHD. Unlike these studies, the current samples were made up of a mixed group of child referrals who were ultimately diagnosed with a wide range of psychiatric, behavioral, neurologic, and learning disorders. The results and conclusions of the current study should not be directly compared to those studies that utilized comparatively more homogenous samples.

The use of a clinically referred sample, however, seems to be more of a strength than a limitation of this study. Of utmost interest to clinicians is how well a particular assessment instrument functions in its diagnostic capacity as applied to client and patients. The current study provides findings regarding the construct validity of behavioral rating forms in a mixed group of clinic referrals. It suggests that some ratings subscales may not converge in expected ways with other extra-method assessment measures, particularly when used to evaluate adolescents. While these measures may have converged differently if studied in either more representative or homogenous samples, the current study best reflects how these measures are expected to function within the context of a clinical evaluation.

Recommendations for Future Research

Despite ratings of behavior typically being significantly associated with cognition in children, adolescent ratings of behavior were typically not related to cognitive performance. Given that the small size of the adolescent sample limited the power to find significant relationships in this group, future research utilizing larger adolescent samples is necessary. Furthermore, there appear to be salient differences in the degree that ratings of behavior relate to cognition in adolescents versus children. While a number of possibilities for these findings were suggested in the present study, the results do not allow for an explanation to be derived conclusively, warranting a need for future research.

Research is needed to determine if the findings of this study, showing poor convergence between behavioral ratings and neurocognitive performance in adolescents, is in fact due to inaccurate ratings of adolescent behavior. An alternative explanation for the current results is that there are fundamental differences between adolescents and children in the manner in which neurocognitive abilities and behavior relate. Although previous research suggests that the latter explanation is likely not to be the case, more research is needed to support the conclusions suggested by this study that ADHD behavioral rating forms may have relatively weaker validity in adolescents than children. One such method would be to examine the ability of behavioral rating forms to correctly classify clients to independently derived diagnostic categories. Given that the results of the current study suggest that behavioral rating form accuracy may differ between children and adolescents, classification between these two age groups should be analyzed and compared.

This study concluded that the relatively poorer convergence between behavioral rating forms and cognition in adolescents versus children was likely a result of age-dependent limitations affecting the accuracy of behavioral rating scales in adolescents. Many possible explanations as to why behavioral ratings may be less accurate in adolescents versus children were proposed. Such explanations included age-dependent changes in symptom presentation, diagnostic criteria sensitivity, psychiatric disorder prevalence rates, and rater accuracy. Future research is recommended to examine if one or several of these possibilities contribute to changes in the accuracy of behavioral ratings across child and adolescent groups.

A number of ADHD researchers and theorists have questioned the practice of applying assessment tools and diagnostic criteria that were initially designed to diagnose ADHD in children to adolescents. Past research has suggested that there may be notable differences between children and adolescents in the presentation of ADHD and others have noted that the current diagnostic criteria are insufficient for identifying many adolescents with the disorder. The current findings are not in disagreement with the assertion of such differences, but certainly more research is needed to determine exactly what the differences are and why they might exist. Additionally, the findings seem to reinforce the need to examine adolescents and children separately in future ADHD research, and appear to caution against generalizing findings derived from one age group to imply knowledge about the other.

The current study suggested possible differences between parent and teacher informants when completing behavioral rating forms. While teacher ratings of child behavior were accounted for by those cognitive skills believed to underlie ADHD behavioral issues for more subscales than not, such a relationship was found for only one of the three parent form subscales. While this may imply that teachers are more accurate raters of ADHD behavior, further research comparing the rating accuracy of these informant sources is needed. While past studies suggest teachers may be more accurate raters than parents, research is needed to further identify the factors contributing to this disparity. Furthermore, researchers should examine whether differences in rating accuracy are global across behaviors or specific to certain behaviors.

For both child and adolescent ratings of behavior, additional research is needed to determine the nature of parent and teacher inaccuracy on behavioral rating forms. Determining what factors contribute to rater inaccuracy will help future researches to control for potential confounds in studies such as this and assist clinicians in determining the degree to which particular rating forms provide accurate information.

Finally, many of the studies used to validate ADHD behavioral rating forms, including those used to validate the CRS-R, examined the ability of these scales to differentiate children diagnosed with ADHD from those without clinical diagnoses. While the classification accuracy rates in these studies were generally high, the ability of behavioral forms to make such a distinction seems to be of little clinical relevance. The population of child and adolescent clinical referrals encompasses a much more diverse group than the homogenous "normal" and ADHD samples which were used for these studies. Furthermore, clinicians are very rarely asked the question "does the client have ADHD or no pathology at all?" Therefore, future research is strongly needed to determine the extent that the CRS-R, and other similar measures, is able to differentiate between individuals with ADHD and individuals with other psychiatric disorders. Given the results of the present study, it is recommended that such research examine the classification accuracy of these forms in children and adolescents, separately.

Summary

The findings help to answer the question set forth by the title of this dissertation as they suggest that some subscales of the CRS-R do not measure those constructs that they are intended to measure. In children referred for clinical evaluation, only parent and teacher ratings of hyperactivity and teacher ratings of ADHD likelihood appear to converge with cognitive tests assessing similar constructs. Conversely, parent and teacher ratings of cognitive problems and inattention, as well as parent ratings of overall ADHD likelihood, appear to better reflect overall cognitive deficits than inattention specific deficits in children. In adolescents, behavioral ratings do not appear to assess cognitive functioning at all, let alone abilities in the domains of attention and executive functioning.

Unfortunately, the results do not lend themselves to an explanation for the poor convergence between ratings of ADHD behavior and attentional and executive abilities found both in this study and others. A primary goal of the dissertation was to assess whether or not parent and teacher ratings were biased by a client's general cognitive functioning. The results indicate that this was not the case; at least not to the extent that such a bias impacted ratings across behaviors. When considering teacher ratings of behavior, only cognitive problems and inattention appear to be informed by overall cognitive ability, and this is only the case in child clients.

Parent ratings appear to be influenced by cognitive ability across a relatively wider variety of child behaviors than teacher ratings, as both the ADHD Likelihood and Cognitive Problems/Inattention subscales were better explained by overall cognitive and academic functioning than attention and executive abilities. However, the impact of general cognitive ability on parent behavioral ratings was not universal across behaviors, as attentional and executive skills but not general cognitive and academic functioning better accounted for the variance of the Hyperactivity subscale. Thus, it appears that while ratings of child behaviors, particularly those completed by parents, might not often converge with those cognitive abilities that purportedly underlie the behaviors, such an occurrence cannot be explained by a global bias based on perceptions of overall cognitive functioning.

In adolescent clients, cognitive abilities failed to explain the variance in any of the behavioral rating form subscales, across both parent and teacher informant. Given that

ADHD behaviors are expected to be associated with cognitive deficits regardless of age, such findings question the accuracy of behavioral rating forms as completed by adolescent informants. However, similar to the findings involving the child sample, the findings involving the adolescent sample do not indicate that rater inaccuracy is attributable to parent and teacher raters being biased by adolescent general cognitive functioning.

Another finding of this study was that parent and teacher ratings of adolescent ADHD behavior may be generally less accurate than parent and teacher ratings of child ADHD behavior.

Many possibilities were offered to explain the findings that adolescent behavioral ratings subscales converged significantly less frequently with cognitive abilities than children behavioral rating subscales. However, the results of this study, while suggestive of differences between the properties of child and adolescent ratings of ADHD behavior, do not explain the nature of such differences and further research is needed to address this issue.

In addition to differences between behavioral rating accuracy across age groups, the accuracy of behavioral rating forms appears to vary according to informant and the behaviors being assessed. Even in children, a number of behavioral rating form subscales were better accounted for by general cognitive functioning than focal attentional and executive skills. This was more often true of the subscales given by parent, versus teacher, ratings, suggesting that teachers may be more accurate raters of behavior than parents. Despite this, parents do appear to rate child hyperactive behaviors in a manner that considers commonly associated cognitive deficits of ADHD hyperactivity. Thus, the accuracy of parent ratings may be domain specific.

The findings question the accuracy of parent and teacher ratings of behavior to assess for specific cognitive deficits as well as their ability to assess for those behaviors believed to be associated with these deficits. However, the findings of this study do not necessarily argue against the use of behavioral ratings in clinical evaluation of neuropsychological and psychiatric disorders. Parent and teacher ratings of behavior provide useful clinical information in a standardized format, information that may be otherwise difficult for the clinician to efficiently acquire. Behavioral rating forms can be easily distributed to a client's parents and teachers. They provide useful information regarding each informant's perceptions of a client's behavior across a variety of behavioral domains. While the information provided by a single informant may not always accurately depict the nature of a child's behavior, such information may still be useful when integrated within the context of a thorough evaluation integrating multiple data points.

When formulating a diagnosis, clinicians must consider the patient's current behavioral and cognitive presentation, the impact of environmental influences on behavior, and the history of functional difficulties so as to differentiate between similarly presenting diagnoses and determine whether or not co-occurring diagnoses are warranted. Such a task can be particularly difficult in the consideration of ADHD as the disorder shares a number of behavioral symptoms similar to other disorders and very often presents with co-morbid diagnoses.

Behavioral rating forms provide important data that may help to clarify the nature of a client's presenting problem. Even when the information provided by a rating form is inaccurate, it may provide useful information regarding the relationship of a child with a particular informant, the presence of inaccurate or unfair parent and teacher perceptions or expectations, and the presence of environmentally specific behaviors. Behavioral ratings that are generally discrepant from other data sources may suggest that a parent or teacher is either negatively or positively biased towards a student. Similarly, a discrepancy might suggest that a parent or teacher has deficits in coping with normal levels of child-adult related stress, or conversely, is overly accepting and dismissive of a child's poor behavior. Finally, poor convergence between a parent or teacher's behavioral ratings and other data points might suggest poor insight or sophistication on part of the rater. Each of these possible findings might yield clinically important information about the accuracy of an informant's report and, in some cases, the nature of a child's relationship with a particular parent or teacher.

While behavioral rating forms do provide clinically important information, the poor convergence between these measures and other measures assessing similar constructs highlights the need for clinicians to employ a wide variety of assessment tools when evaluating childhood disorders. Clinicians evaluating children for ADHD are encouraged to gather data from a number of sources in order to inform diagnosis as any single data source has its limitations when used independently. As noted, parents and teachers may be inaccurate due to biases, overly accepting or condemning reactions, poor sophistication, or limited exposure to a client's behavior. Such factors would likely influence the accuracy of an informant's behavioral ratings, but they would additionally be expected to impact the veracity of an informant's report on interview.

Children and adolescents often cannot be relied upon as accurate informants and may not display those behaviors for which they have been referred during the clinical interview. Therefore, even astute clinicians cannot be expected to correctly identify or rule out a diagnosis of ADHD based only on a clinical interview with the patient. Neurocognitive testing is not sufficient as a means for diagnosis when relied upon without consideration of other data. Some children with ADHD may not present with cognitive deficits and impaired performance on even those measures most associated with the disorder is not specific to ADHD. Review of standardized test results and grade reports is also insufficient, as poor grades and school-based standardized test results are even less sensitive and specific to ADHD. Therefore, determining a diagnosis of ADHD requires a comprehensive evaluation that ideally includes a clinical evaluation of the client and the client's parents, neurocognitive testing, a review of academic performance, and finally, parent and teacher ratings of behavior.

While it is not recommended that ratings of behavior be omitted from childhood diagnostic evaluations, the results of the present study do suggest that common interpretations of these measures may be more reliable in some cases more than others. First, it appears that the forms are generally more accurate measures of their purported constructs in children than adolescents. Second, the results suggest that, even in children, subscales measuring hyperactive and impulsive behaviors are better associated with true ADHD related deficits than scales measuring inattention. Finally, it appears that teachers may be more accurate raters of overall ADHD behavior than parents in children.

Clinicians are encouraged to consider all possible explanations when considering elevations on ADHD rating scales, including the possibility of rater inaccuracy.

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