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IMPROVING THE LONGITUDINAL ASSESSMENT OF ADHD IN PEDIATRICALLY AND PSYCHIATRICALLY REFERRED SAMPLES

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Abstract

The assessment and diagnostic process for Attention-Deficit/Hyperactivity Disorder (ADHD) is beset with complications relating to the subjectivity of symptom reporting, the nonspecific and dimensional nature of inattention, impulsivity, and hyperactivity, the high prevalence of psychiatric comorbidities, and the shifting expression of symptoms and impairment due to developmental changes from childhood to adolescence and adulthood. Actual diagnostic practices may also differ from recommended best practices. These challenges have led to the proliferation of several clinical guidelines, many of which recommend various diagnostic practices and assessment instruments. Nonetheless, relatively little is presently known about the diagnostic efficiency of these various instruments used in the diagnosis of ADHD at different developmental time points or about possible differences in ADHD presentations in pediatric versus psychiatric clinics. This study was designed to address these gaps in the ADHD knowledge base. Results of the present study suggest that clinicians should prioritize parent and clinician subjective rating scales over tests of academic achievement and neuropsychological functioning when diagnosing ADHD. Specifically, school and social functioning ratings emerged as measures with the strongest discriminatory properties. Results of this study also demonstrated that the diagnostic accuracy of the assessments were higher in pediatrically referred samples compared to psychiatrically referred samples, suggesting that there may indeed be subtle differences in the presentation of ADHD in pediatric versus psychiatric clinics, as well as differences in the comparison populations therein. The present study adds to the literature in helping clinicians in selecting the most diagnostically efficient assessment battery for ADHD across the different developmental time periods.

Keywords: ADHD, Diagnosis, Assessment, Lifespan, Development

IMPROVING THE LONGITUDINAL ASSESSMENT OF ADHD IN PEDIATRICALLY AND PSYCHIATRICALLY REFERRED SAMPLES

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This dissertation is dedicated in memory of my beloved and dearly missed mother, Liu Yi. Her compassion, humor, intellect, wit, and love for humanity continue to inspire me.

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Improving the Longitudinal Assessment of ADHD in Pediatric and Psychiatric Samples

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by hallmark symptoms of inattention and/or hyperactivity-impulsivity (American Psychiatric Association, 2013). A wealth of research finds support for ADHD as a chronic and pervasive developmental disorder that persists into adolescence and adulthood for 50-80% of individuals diagnosed as children (Barkley et al., 2002; Barkley et al., 2006; Biederman, Petty, Evans, Small, & Faraone, 2010; Klein et al., 2012). Research tracking individuals with ADHD over time has consistently found that individuals with ADHD have poorer educational, occupational, interpersonal, and legal outcomes than controls (Biederman, Petty, Monuteaux, et al., 2010; de Graaf et al., 2008; Greven, Asherson, Rijsdijk, & Plomin, 2011; Molina et al., 2009) and perhaps more troublingly, continue to experience functional impairment even when their symptoms fall below-threshold for an ADHD diagnosis (e.g., when the patient is in partial or full remission) (Mick et al., 2011; Young & Gudjonsson, 2008).

To accurately diagnose ADHD, a clinician must use a multifaceted approach to confirm the presence of at least six symptoms of inattention and/or hyperactivity-impulsivity, find evidence that these symptoms cause impairment, occur in two or more settings and cannot be explained better by another disorder, and establish that symptom onset occurred prior to 12 years of age. While this assessment sequence may seem straightforward, ADHD holds a unique distinction in being the one of the most intensely investigated and also diagnostically contested disorders (Barkley, 2002; Wolraich, 1999) due to a confluence of factors that muddle the categorical diagnostic process. The murky diagnostic process is one of the reasons that ADHD elicits much public skepticism (McLeod, Fettes, Jensen, Pescosolido, & Martin, 2007). Complicating the picture further, a study of 8,500 Swedish twin pairs supports the dimensional view of childhood ADHD as the extreme tail end of one or more continuous, heritable traits (Larsson, Anckarsater, Råstam, Chang, & Lichtenstein, 2012), rather than *Diagnostic and Statistical Manual of Mental Disorders (DSM)*-defined discrete categories or presentations.

ADHD Theory

There are multiple theories that attempt to explain the etiology of ADHD. The two most often cited theories have been proposed by Barkley and Sonuga-Barke. Barkley's theory argues that deficits in behavioral response inhibition is the single cause and primary deficit of ADHD, accounting for the associated executive function deficits (e.g., an inability to select, pursue, and maintain goal-directed, problem solving behaviors) and impairments seen in ADHD. Barkley's theory is supported by meta-analytic data (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005) indicating that both children and adults with ADHD (Hervey, Epstein, & Curry, 2004) demonstrate poorer performance on tests of response inhibition. However, not all individuals with ADHD will perform below average on clinic-based tests of executive functioning (Willcutt et al., 2005), suggesting that executive dysfunction is neither a necessary nor sufficient clinical finding for diagnosing ADHD.

Conversely, Sonuga-Barke's model argues that ADHD is the result of dysfunction in at least one of two distinct dopaminergic pathways—mesocortical and mesolimbic. The mesocortical pathway is similar to Barkley's model and conceptualizes ADHD as a disorder of self-regulation of thoughts and actions as a result of inhibitory dysfunction. Deficient inhibitory mechanisms then lead to executive dysfunction and behavioral dysregulation. The mesolimbic pathway conceptualizes ADHD as a delay-averse motivational style with acquired cognitive deficits (Sonuga-Barke, 2002). Both pathways lead to ADHD symptoms and associated impairments in the quality and quantity of task engagement that, in turn, lead to functional impairments. Given the variety of theories that exist which attempt to explain ADHD, it is not surprising that ADHD can be a challenging condition to accurately diagnose.

Complications in Diagnosing ADHD

Subjective reporting. ADHD is defined by the presence of observable behaviors that cause impairment within multiple settings based on self- and collateral-report. For children and adolescents, the diagnostic process rests, primarily, on the clinician asking caregivers, teachers, or other informants a series of questions related to the presence of up to 18 possible behavioral symptoms of ADHD, 9 of which concern inattention, 6 of which concern hyperactivity, and 3 of which concern impulsivity (American Psychiatric Association, 2013). For adults who were never diagnosed with ADHD in childhood, the process rests on the retrospective recall of symptoms and impairments from childhood. Thus, one major limitation of the diagnostic process is its reliance on *subjective* appraisals of appropriate or inappropriate levels of inattention / hyperactivity / impulsivity that may miscategorize mildly deviant or atypical behavior as a disorder (Conrad, 2006). Relatedly, common method variance in assessing for ADHD (e.g., the number and type of informants, screening measures, interviews, etc.) can also exert an influence on the resulting diagnosis and lead to diagnostic instability (Valo & Tannock, 2010). In addition to heavily relying on subjective reporting of symptoms and impairments, other complications can further hamper the diagnostic process and are described below.

Nonspecific symptoms. One commonly cited limitation of the ADHD diagnostic construct is its lack of specificity (Wolraich, 1999). As a heterogeneous disorder that often varies in symptom presentation across the lifespan (Doyle, 2006; Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005) the core symptoms of ADHD (hyperactivity, inattention, and impulsivity) are non-specific and can be difficult to disentangle from the symptoms of other disorders (e.g., anxiety, depression, cognitive impairment, oppositionality) as well as from developmentally appropriate expressions of behavior (e.g., having an especially active or absent-minded child). Thus, one challenge for clinicians is differentiating between ADHD and typical controls (e.g., children and adults who do not have any psychiatric disorders and are developmentally typical or somewhat immature). Likewise, some of the DSM-5 criteria for anxiety disorders and mood disorders include symptoms of inattention and/or motoric restlessness. Therefore, a separate challenge is differentiating between ADHD and non-ADHD, other psychiatric disorders. For example, in one study of children with ADHD compared to non-ADHD psychiatric patients and typical controls, the two psychiatric groups were more inattentive and impulsive compared to controls, but were also indistinguishable from one another (Halperin, Matier, Bedi, Sharma, & Newcorn, 1992). Thus, the non-specificity of ADHD symptoms presents challenges to ADHD diagnosticians.

Developmental change. Furthermore, symptoms of ADHD can also wax and wane over the developmental course. In general, symptoms of hyperactivity and impulsivity (HI) seem to lessen over time (Biederman, Mick & Faraone, 2000; Evans et al., 2013) while symptoms of inattention (IA) seem to persist over time (Klein et al., 2012). Some of these symptom changes may be attributable to biological changes in cortical maturation (Willoughby, 2003). At the same time, the environment also impacts the developmental expression of ADHD symptoms (DuPaul & Stoner, 2014). Thus, a simple snapshot of ADHD symptoms taken via the clinical interview at one time point may be too crude of a metric to truly determine symptom presentation or severity, because typical developmental and environmental changes may play a large role in symptom presentation (Pliszka, 2007b). Yet these longitudinal factors may not be routinely assessed (Matte et al., 2015).

High prevalence of psychiatric comorbidities. Another complication with the diagnostic process is the problem of psychiatric comorbidities. In DSM-IV and DSM-5, the exclusionary criterion (Criterion E) is often one that raises discussion among diagnosing clinicians. Are one's ADHD symptoms *better accounted for* by a cognitive impairment, learning disorder or an anxiety disorder, or are there multiple disorders presenting concurrently? ADHD in childhood is often comorbid with mood, anxiety, and conduct disorders (Spencer, 2006); ADHD in adulthood is often comorbid with mood, anxiety, and substance use disorders (Kessler et al., 2005), leading some researchers to posit that ADHD is not a singular clinical entity but a group of conditions (Spencer, 2006). A long list of medical conditions and environmental insults may mimic or even predispose ADHD; these include childhood physical or sexual abuse, neurologic abnormalities, psychoactive substance use, brain injury, environmental toxicant exposures and other pre- and perinatal factors (Langberg, Froehlich, Loren, Martin, & Epstein, 2008). Given this complicated assortment of comorbidities, some have posited that ADHD may function similar to a fever—diagnostically nonspecific, but foreshadowing other conditions and indicating treatment need (Moffitt et al., 2015).

Best Practices for Diagnosing ADHD

Best practices for assessing and diagnosing ADHD include taking an extensive history, incorporating broad and narrow-band symptom reports (e.g., from self, teachers and caregivers or partners) to document symptom presentation in multiple settings, adhering to the standard DSM or ICD list of ADHD symptoms by using rating scales, ruling out alternative explanations for symptom presentation (e.g., symptoms are not better explained by another mental disorder or by the environmental context) and considering functional impairment (Bukstein, 2010; Hechtman, 2000; Pelham, Fabiano, & Massetti, 2005; Pliszka, 2007a; Rapport, Chung, Shore, Denney, & Isaacs, 2000; Seixas, Weiss, & Muller, 2012; Sibley et al., 2012). These practices represent the practice parameters outlined by the *American Academy of Pediatrics (AAP)* and the *American Academy of Child and Adolescent Psychiatry (AACAP)* (Pliszka, 2007a; Subcommittee on Attention-Deficit/Hyperactivity Disorder, 2011).

Actual Practices for Diagnosing ADHD

Despite general consensus on what are best practices and the existence of formal practice parameters, diagnostic practices can vary widely from clinician to clinician and there is evidence that clinicians may be inappropriately diagnosing ADHD by failing to use evidence-based guidelines (Chan, Hopkins, Perrin, Herrerias, & Homer, 2005; Epstein et al., 2008; Wolraich, 1999) and by allowing gender, relative age, and racial background to influence diagnosis. For example, even though symptoms of ADHD should not depend on birth month or relative age (Biederman, Petty, Fried, Woodworth, & Faraone, 2014), younger children in an elementary school classroom are diagnosed with ADHD at significantly higher rates than older children in the same class (Evans, Morrill, & Parente, 2010). Research has also shown that youngest girls in a grade, born in January, are 70% more likely to receive a diagnosis of ADHD than the oldest girls in a grade, born in December (Morrow et al., 2012). Another literature review and meta-analysis documented the effect of race on ADHD diagnosis, showing significantly higher rates of ADHD symptoms in African American youth, but fewer ADHD diagnoses when compared to Caucasian youth (Miller, Nigg, & Miller, 2009) suggesting a potential racial bias.

Finally, previous research has indicated that gender also moderates ADHD by affecting the nature of hyperactive symptoms and psychiatric comorbidity patterns (Gaub & Carlson, 1997). Nonetheless, gender may not always be considered in ADHD assessments in routine clinical practice (Owens, Cardoos, & Hinshaw, 2015). In a community study of diagnostic practices in Germany, boy and girl versions of one ADHD and three non-ADHD case vignettes were sent out to 1,000 clinicians (child psychologists, psychiatrists, and social workers) who were asked to make a diagnosis from the given information; in the boy version of these vignettes, the clinicians diagnosed ADHD twice as often as they did in the identical girl version (Bruchmüller, Margraf, & Schneider, 2012), again highlighting the influence of child gender on diagnosis. In the same study, when all ADHD criteria were present, boys and girls were as likely to receive an ADHD diagnosis, but when several diagnostic criteria were missing and only a few ADHD symptoms were present in identical vignettes, boys were more likely than girls to receive the ADHD diagnosis, again highlighting the potential overdiagnosis of ADHD in boys and underdiagnosis of ADHD in girls in routine clinical practice. Thus, routine clinical practice for assessing ADHD can be inconsistent with what has been proposed in best practice guidelines and can be impacted by clinician biases and patient factors like relative age, gender, and race.

Clinical Guidelines for Diagnosing ADHD

To aid clinicians in the challenging task of diagnosing ADHD, in the past decade several health and medical associations around the world have produced and disseminated clinical practice guidelines (Bukstein, 2010). A systematic review identified 14 guidelines / practice parameters encompassing the assessment or management of ADHD (Seixas et al., 2012). These guidelines were produced by medical societies, professional bodies or health ministries from five different countries: the United Kingdom, the United States of America, Germany, New Zealand, Canada; and one European Union group. These groups consistently recommended the use of DSM or ICD diagnostic criteria, using a structured clinical interview as the “gold standard” for assessing ADHD, and screening for physical and psychiatric comorbidities.

These guidelines / practice parameters differ widely, however, in their recommendations on the use of specific questionnaires and rating scales as well as the utility of neuropsychological assessment. While dozens of different rating scales and questionnaires were positively recommended across the guidelines, highlighting the importance, feasibility, and usefulness of these self- and collateral-report measures, recommendations regarding the use of neuropsychological assessment were mixed or nonexistent. Out of the 14 practice guidelines, half did not mention neuropsychological assessments, two recommended its use for informing management and monitoring treatment outcomes of ADHD, one commented that continuous performance tasks were potentially useful, and one made an explicitly negative recommendation against using neuropsychological assessment (Seixas et al., 2012). This suggests a lack of consensus on whether neuropsychological assessments have a place in the standard diagnostic process for ADHD or in the continuing management of ADHD.

Despite this equivocal stance, lab and clinic-based studies of ADHD versus control comparison studies on neuropsychological test performance have proliferated (Boonstra, Oosterlaan, Sergeant, & Buitelaar, 2005; Epstein, Johnson, Varia, & Conners, 2001; Rapport et al., 2000; Seidman, 2006; Seidman, Biederman, Weber, Hatch, & Faraone, 1998). These studies suggest that executive dysfunction is a correlate of ADHD across the lifespan (Seidman, 2006), in line with Barkley's response inhibition model of ADHD (Barkley, 1997) as well as Sonuga-Barke's dual pathway model of ADHD (Sonuga-Barke, 2002).

Although both theoretical models attempt to explain ADHD, there is still great neuropsychological heterogeneity in ADHD that is not well characterized, both within and between clinical samples (Doyle, 2006). Likewise, many of the neuropsychological instruments (e.g., computerized tests of attention) commonly used in the ADHD assessment process have been criticized for failing to show diagnostic specificity (Werry, Elkind, & Reeves, 1987), failing to demonstrate ecological validity (Barkley, 1991), and failing to provide practical, incremental information for the clinician during the diagnostic process (Rapport et al., 2000). Consequently, even researchers who are enthusiastic about neuropsychological measures caution that the use of neuropsychological tests is not necessary to make an ADHD diagnosis (Gallagher & Blader, 2001; Pliszka, 2007b).

To conclude, clinical practice guidelines for assessing ADHD are abundant and largely consistent in terms of recommending abiding by DSM or ICD criteria, using standardized rating scales, checking for psychiatric and physical comorbidities, and using structured clinical interviews. Although individuals with ADHD consistently show executive function deficits (e.g., relating to sustained attention, response inhibition, working memory, and processing speed) relative to non-ADHD control participants (Willcutt et al., 2005), there is no clear consensus on whether neuropsychological tests of executive functioning are supported as adjunctive tools in the diagnostic process, with some researchers highlighting the lack of sensitivity and specificity to ADHD (Seidman, 2006; Solanto, Etefia, & Marks, 2004) and other researchers arguing for utilizing neuropsychological performance as an objective measure of treatment response over time (Coghill, Hayward, Rhodes, Grimmer, & Matthews, 2014). This lack of consensus may be a function of previous research not considering the impact of development upon these tests.

Predictive Utility of Common ADHD Assessment Instruments

While the diagnostic and clinical utility of common ADHD assessment instruments has been researched extensively in childhood and adulthood (Chen, Faraone, Biederman, & Tsuang, 1994; Kooij et al., 2008; Rapport et al., 2000; Sibley et al., 2012), little research has employed a *prospective* design to test the sensitivity and specificity of different assessment instruments at different developmental time points (e.g., childhood, adolescence and adulthood). Rather, the bias in the field has been to assume a “one size fits all” nature to the research data. In other words, if the assessment instruments are not sensitive or specific in childhood, these tests are assumed to not be sensitive and specific in adulthood. Furthermore, few researchers have examined the ability of common instruments used in the assessment of ADHD (e.g., symptom rating scales, stop signal tasks, working memory tests, continuous performance tests, functional impairment scales) to predict the course and prognosis of ADHD. Instead, researchers have largely focused on the question of persistence and remittance of ADHD symptoms and executive dysfunction across time.

In one study that investigated this topic, a clinically referred sample of 85 boys and young adults (ages 9-22) with persistent ADHD were prospectively followed for seven years (Biederman et al., 2007). An executive function deficit (EFD) in this study was defined with a cut-off criterion of scoring 1.5 standard deviations below the mean of the control sample on two or more neuropsychological tests (e.g., tests of continuous performance, planning and organization, interference control, set-shifting, verbal learning, and working memory). At baseline, 26 individuals with ADHD showed EFDs and 59 did not show EFDs. At follow-up, 69% individuals with EFDs at their first assessment continued to evince EFDs while 75% of individuals without EFDs at their first assessment continued to remain without EFDs. This finding underscores how executive functioning skills and deficits within ADHD are not stagnant, but dynamic, and may change as a function of time and maturation, or potentially intervention. A few years later, linear growth curve modeling was completed at ten-year follow-up with this same group of boys with ADHD as well as a control and remittent ADHD group (Biederman et al., 2009) in order to estimate longitudinal cognitive outcomes. No significant differences emerged between the Persistent and Remittent ADHD groups, but main effects indicated that both of these groups had significantly lower scores on all of the neuropsychological tests when compared to the control groups. Given the heterogeneity of ADHD, it is very likely that multiple growth processes may underlie ADHD EFDs; moreover, the sensitivity and specificity of assessment tools for ADHD may also be moderated by patient characteristics that vary as a function of age and developmental stage. These results intimate that a “one size fits all” view of neuropsychological tests may not be a valid way to consider developmental changes in ADHD.

Common Assessment Practices for ADHD Across Settings and Developmental Stages

Assessing ADHD in psychiatric versus pediatric / primary care settings. Much attention has been paid to the prevalence and clinical/neuropsychological profile of ADHD in psychiatric clinics but less is known about ADHD in the pediatric or primary care setting (Brown et al., 2001). It may seem intuitive that patients referred from pediatric and primary care clinics for ADHD assessment would represent less severe cases and be less impaired than patients referred from psychiatric clinics. However, this was shown not to be the case by Busch et al. (2002) in large a case-control study comparing 522 children and adolescents with (N=280) and without ADHD (N=242). In fact, children with ADHD referred from psychiatric and pediatric clinics exhibited nearly identical levels of ADHD symptomatology, comorbidities, and impairments (Busch et al., 2002). Similar findings of comparability between treatment settings have been reported by other researchers (Rothe et al., 2016; Zima et al., 2010).

In contrast, a recent retrospective chart review study of children seen in either a pediatric or psychiatric ADHD clinic in Canada (N = 118) found that children presenting to the psychiatric ADHD clinic tended to be older (Psychiatric Clinic M Age = 12.09, SD = 3.78 versus Pediatric M Age = 10.01, SD = 2.50), had more instances of the combined presentation of ADHD (50%

versus 33%), and had slightly more comorbidities (more vocal tics, oppositional defiant disorder) than children presenting to their pediatric ADHD clinic (Kolar, Hechtman, Francoeur & Paterson, 2012). However, limitations of these findings include the fact that the diagnostic comorbidities were ascertained through parent and teacher ratings on symptom checklist scales rather than through a thorough diagnostic process that considers full DSM criteria. Thus, this study may have overestimated the frequency of psychiatric comorbidities and therefore overstated the severity and complexity of ADHD presenting to psychiatric compared to pediatric cases.

A study of primarily minority (i.e., African-American and Latino) children (N = 170) presenting to 5 public and private pediatric and psychiatric clinics in Miami-Dade County Florida similarly found that children in the psychiatric clinics were older compared to the pediatric clinics, but additionally revealed that children presenting for treatment in public versus private clinics showed many more markers of socioeconomic disadvantage, more severe ADHD, and higher rates of social phobia and externalizing behaviors (Rothe et al., 2016). In contrast to Kolar et al., 2012, yet in line with Busch et al., 2002, similar levels of ADHD severity and similar comorbidities between psychiatric and pediatric clinics were found, suggesting that psychiatric and non-psychiatric samples of children with ADHD may indeed face similar challenges.

Despite these similarities, the assessment of ADHD can differ dramatically depending on whether the assessment is occurring in a psychiatric clinic or a primary care clinic. However, in pediatric clinical settings, primary care practitioners such as pediatricians and family medicine doctors may not regularly solicit behavioral observations from parents, and thus, behavioral disorders like ADHD may be underdiagnosed or overdiagnosed in these settings, despite research suggesting the similar distribution of severity in symptom presentation and in impairment across settings as seen in psychiatric clinics (Busch et al., 2002). For example, Chan and colleagues (2005) reported that among a nationally representative sample of 2000 American primary care physicians (PCPs), only 28% of physicians reported adhering to DSM criteria to diagnose ADHD (Chan et al., 2005).

Responding to the demonstrated lack of adherence to DSM criteria to diagnose ADHD, a quality improvement intervention in a Cincinnati community of pediatric primary care providers (N = 19 practices, encompassing 82 PCPs) was conducted by Epstein and colleagues to try to improve adherence to *AAP* guidelines for diagnosing ADHD (Epstein et al., 2008). At baseline, i.e., pre-intervention, adherence to evidence-based guidelines was poor to marginal: only 55% of the children seen by these providers had chart documentation indicating that parent or teacher rating scales had been collected as part of the diagnostic process and only 38% of children diagnosed with ADHD had documentation that they met DSM-IV ADHD criteria. Treatment planning was often neglected: only 1% of PCPs provided patients and families with written care-management plans, and only 27% of patients had contact with their PCPs within two weeks of starting medication management. Overall, post-quality improvement intervention results were encouraging: nearly 100% of PCPs were using parent and teacher rating scales in assessing ADHD, and the percentage of children with new ADHD diagnoses who also met DSM-IV ADHD criteria doubled from 38% to 77%; but, because this study was a community-based, interrupted time-series design rather than a randomized clinical trial, selection bias may have explained the positive findings. The PCPs who were recruited and who voluntarily elected to participate in this quality improvement trial were likely the most enthusiastic, motivated, and change-receptive PCPs in the community, and therefore, may not be representative of the general body of PCPs.

Differences have also been shown in the assessment and diagnostic practices in adult psychiatric and primary care practices. One survey of adult psychiatry and primary care clinics showed that primary care providers (PCPs) were more conservative with diagnosing ADHD: while only 27% of primary care patients with initially undiagnosed ADHD were diagnosed with ADHD within six months of their initial visit, 52% of the psychiatry patients with initially undiagnosed ADHD were diagnosed within that same time period. Furthermore, PCPs were also less likely to diagnose psychiatric comorbidities than psychiatrists (Faraone, Spencer, Montano, & Biederman, 2004). These data suggest that common assessment practices for ADHD differ as a function of setting; thus, understanding the differential utility of common assessment instruments for ADHD by type of setting is a clinically significant goal.

Assessing for ADHD according to developmental stage. The ADHD diagnostic process is not only potentially influenced by setting (i.e., pediatric versus psychiatric) but also by developmental stage. For example, the 18 symptoms listed in the DSM-IV diagnostic criteria for ADHD were initially developed with children in mind as the target assessment population. Thus, many of the items were not as applicable to adults, who generally do not experience the kind of hyperactivity that leads to climbing on tables and running around incessantly, as is often characterized by childhood ADHD (McGough & Barkley, 2004). Instead, neurodevelopmental factors may modify the appearance of ADHD, and hyperactivity in adulthood may be experienced as feelings of internal restlessness or feelings of being driven by an internal motor (Barkley, Murphy & Fischer, 2007). To address this issue, several changes were made in DSM-5 to facilitate characterizing ADHD symptoms across the life span. Thus, developmental changes in the expression of ADHD symptoms are one reason that assessment for ADHD should be guided by careful attention to developmental stage. In addition, the fact that approximately 33-50% of children will outgrow their ADHD diagnoses by adolescence and a portion of adolescents with ADHD will also outgrow their diagnoses by adulthood (Barkley, Fischer, Smallish, & Fletcher, 2002; Barkley, Fischer, Smallish, & Fletcher, 2006) is another reason to carefully reassess individuals with ADHD as they progress through developmental stages.

Even the most up-to-date and widely referenced practice parameters released by *AACAP* and *AAP* do not provide differential guidelines for assessing for ADHD based on developmental stage (e.g., childhood vs. adolescence) (Pliszka, 2007b). To aid in selecting instruments for assessing ADHD, the *AACAP* practice parameter suggests that clinicians should consider selecting one of 11 common behavior-rating scales with published normative values for different ages and genders. But, the *AACAP* practice parameter guideline does not comment on the sensitivity or specificity of these behavior-rating scales and whether, for example, certain ratings made by parents, teachers, or the patient him/herself are differentially sensitive or specific to an ADHD diagnosis as a function of developmental stage. Likewise, commonly employed neuropsychological tests that are used in the assessment of ADHD (e.g., tests of executive functioning) have not been empirically tested for differential sensitivity or specificity towards an ADHD diagnosis as a function of developmental level.

Given the concerns surrounding the validity and reliability of retrospective reporting of childhood ADHD symptoms (Murphy, Gordon, & Barkley, 2000; Suhr, Zimak, Buelow, & Fox, 2009), the danger of both over-diagnosis (Bruchmüller, Margraf, & Schneider, 2012; Evans et al., 2010; Murphy et al., 2000) and under-diagnosis (Coker, 2016) in clinical practice and the inconsistent reports of ecological validity of neuropsychological tests of executive functioning

(Barkley, 1991; Chaytor, Schmitter-Edgecombe, & Burr, 2006), more work remains to be done on determining what are appropriate and useful assessment tools that will help to accurately diagnose ADHD across the lifespan.

Specific Aims

As an initial step in this line of research, the primary aims of the of the current study were to 1) investigate the diagnostic predictive abilities of common diagnostic tools of ADHD (e.g., stop signal tasks, working memory tests, continuous performance tests, clinician and parent rating scales of family, school, and social functioning) across different developmental periods including childhood, adolescence, and young adulthood, using sensitivity, specificity, and receiver operating characteristic (ROC) curve analysis; and to 2) examine whether referral source (psychiatric vs. pediatric primary care clinics) affects the differential predictive abilities of these ADHD diagnostic assessment tools. These study goals were designed to further the objective of developing appropriate, sensitive and specific diagnostic testing protocols for ADHD by aiding clinicians in selecting an appropriate, useful, and diagnostically efficient assessment battery for ADHD in different time points of the lifespan (childhood versus adolescence).

The current study aims to address the need of improving the diagnostic and prognostic abilities of clinicians who work with children with ADHD and their families. Given the significant heterogeneity in ADHD both between individuals (Sonuga-Barke, 2002) and within individuals (DuPaul, 2016) assumptions that different diagnostic tools have comparable diagnostic efficiencies at various developmental levels may not be accurate. This study is the first to empirically investigate the diagnostic predictive abilities of common diagnostic tools of ADHD across different developmental periods. To further aid clinicians who may practice in different settings, this study is also the first to examine the potential impact of referral source (psychiatric vs. pediatric primary care clinics) on the differential predictive abilities of these ADHD diagnostic assessment tools. The following hypotheses were tested:

Hypotheses. *Hypothesis 1a.* The ADHD group will differ significantly from the control group cross-sectionally in childhood, adolescence, and young adulthood on all neuropsychological test data and on clinician and parent rating scales of functioning.

Hypothesis 1b. Discriminatory accuracy (i.e., AUC) will be higher in assessments of clinician and parent rating scales of functioning (e.g., CBCL, GAF, FES) than neuropsychological (e.g., ROCF, WCST, CPT) and academic achievement (e.g., WRAT-R Reading, WRAT-R Arithmetic) test data when comparing the ADHD and control groups cross-sectionally.

Hypothesis 1c. Discriminatory accuracy of the diagnostic assessments will be higher in psychiatrically referred samples of ADHD and control compared to pediatrically referred samples cross-sectionally in childhood, adolescence, and young adulthood.

Method

Participants and Setting

The present study takes advantage of a large, existing longitudinal dataset by conducting secondary analyses of the data. Participants were derived from two virtually identical longitudinal family case-control studies that followed a group of boys and girls, with and without ADHD. At baseline, girls were 6-17 years old with (N = 140) and without (N = 120) Diagnostic and Statistical Manual of Mental Disorders (third edition, revised *DSM-III-R*) defined ADHD; boys were 9-22 years old with (N = 130) and without (N = 113) DSM-III-R ADHD. DSM-III-R diagnoses were supplanted by DSM-IV diagnoses once the DSM-IV was published in 1994.

Correspondence between DSM-III-R diagnoses and DSM-IV diagnoses of ADHD have been shown to be high, with kappas reported to be in the 0.7 range (Biederman et al., 1997).

For the female participants, the follow-up period was approximately 5 years later, at which time the ADHD group (Mean Age = 16.35, SD = 3.74) and control group (Mean Age = 17.08, SD = 3.02) were in their adolescent years. For the male participants, the follow-up period was approximately six years later, at which time the ADHD group (mean Age = 21.63, SD = 3.33) and control group (mean Age = 22.75, SD = 3.97) were in the early adulthood years. Thus, girls were followed from childhood to adolescence and boys were followed from adolescence into adulthood. Age differences between the two groups were significant across the majority of developmental stages, and thus, age was controlled for in analyses that compared the two groups. See Table 1 for further sample characteristic data across waves.

Ascertainment and inclusion/exclusion criteria. Both ADHD and control groups were initially ascertained through pediatric or psychiatric clinics. The pediatrically referred groups were ascertained from referrals from primary care clinics and from the computerized records of the Harvard Pilgrim Healthcare Health Maintenance Organization (HPH HMO). The psychiatrically referred groups were ascertained via consecutive referrals to a pediatric psychopharmacology program at Massachusetts General Hospital (MGH). Both groups of control participants were stringently determined to not have ADHD, but other psychiatric disorders in the control groups were not reasons for exclusion from the study.

The human research committee at MGH approved all study methodology. Parents provided written informed consent for their children while children provided written informed assent. At baseline, all of the children spoke English and were Caucasian. All participants were examined and excluded for psychosis, autism, a Full Scale IQ (FSIQ) less than 80, and major sensory-motor handicaps (e.g., blindness, deafness, and paralysis). All children were also screened for socioeconomic class; children from the lowest socioeconomic classes were excluded to avoid the confounding impact of extreme socioeconomic adversity. Other exclusion criteria included if the children had been adopted or if their nuclear family was not available for study.

Since this was a naturalistic prospective study, some of the children had been previously medicated, and medication status was not assigned; in the subsequent years, some of the children started pharmacological treatment for ADHD, some started psychosocial interventions (e.g., behavioral therapy), others started a combined treatment approach, and some remained untreated (e.g., never entered pharmacological or psychosocial treatment). With regard to the girls group, approximately 26% received pharmacological treatment, 8% received counseling, 42% received combined treatment, and 24% received no treatment. Treatment data were missing for 12% of the sample of girls with ADHD. With regard to the boys group, approximately 29% received pharmacological treatment, 8% received counseling, 36% received combined treatment, and 27% received no treatment. Treatment data were missing for 6% of the samples of boys with ADHD.

Diagnostic procedures. To protect against false-positive diagnoses and improve diagnostic accuracy (Faraone & Tsuang, 1994), a three-stage ascertainment procedure was used to select subjects. For ADHD participants, the first stage was their referral from a child psychiatrist or a pediatrician. To be referred for this study, a child psychiatrist or a pediatrician needed to have diagnosed with child with ADHD. Since diagnostic practices differ widely in routine clinical practice (Chan et al., 2005), these diagnoses were reconfirmed in a systematic fashion. Step two in the ascertainment procedure included a systematic screening of all referred probands using DSM-III-R criteria. A research staff member conducted a phone interview with mothers of all children who received a diagnosis in the first stage to confirm the diagnosis of ADHD. Lastly, all children who screened positive at the second stage then received a further diagnostic assessment with a structured interview at the last (third) stage. Thus, only children who were classified as ADHD at all three stages were included in the ADHD group.

Non-ADHD controls were also recruited via pediatric primary care clinics when they presented for routine physical exams. During the second stage, research staff also conducted a phone interview with the mothers of the non-ADHD control children during which they responded to the DSM-III-R ADHD telephone questionnaire. Lastly, all children who screened negative for ADHD at the second stage also referred a further diagnostic assessment with a structured interview at the last (third) stage. Thus, the children in the non-ADHD control group were only included in the control group if they were classified as not having ADHD at three separate stages.

At the follow-ups, modules from the DSM-IV modified Schedule for Affective Disorders and Schizophrenia for School-Age Children-Epidemiologic Version (K-SADS-E) were used to assess for current and childhood psychiatric diagnoses. On the K-SADS-E, subjects were first queried about childhood ADHD and disruptive behavioral disorder symptoms, and if these symptoms were present, were asked about continuation of these symptoms into adulthood and the emergence of others. Age at onset was defined as the first emergence of impairing symptoms.

Psychiatric Assessments

Psychiatric assessments were structured interviews based on independent interviews with the mothers of the participants and the participant him/herself. At baseline, the Schedule for Affective Disorders and Schizophrenia for School-Age Children Epidemiologic 4th Version (K-SADS-E; Orvaschel & Puig-Antich, 1987) was conducted with parents. At follow-up, the DSM-

IV based K-SADS-E-IV (Epidemiologic Version) assessing DSM-IV disorders (Orvaschel, 1994) was used with the parents of participants under 18 and the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1997) was used with the participants themselves if they were older than 18.

The interview staff had undergraduate or graduate degrees in psychology and were trained to high levels of inter-rater reliability for psychiatric diagnosis. Kappa coefficients of agreement were computed by having board-certified child and adult psychiatrists listen to the diagnostic interviews and make independent diagnoses: based on 173 interviews, the median kappa coefficient of agreement for all diagnoses was 0.86. The kappa coefficients were 0.98 for ADHD, 0.93 for conduct disorder, 0.80 for multiple anxiety disorders, and 0.83 for major depression. Interviewers assessed lifetime history of psychopathology and lifetime ADHD symptoms as well as current ADHD symptoms. Interviewers were blind to baseline diagnosis (ADHD versus control) and ascertainment site (psychiatric versus pediatric).

Neuropsychological and Academic Achievement Assessments

Several domains of cognitive and neuropsychological functioning were assessed using a wide variety of tests related to domains known to be affected in ADHD: academic achievement, planning and organization, response inhibition, cognitive flexibility, and general intelligence. Tests were administered in a fixed order and an experienced neuropsychologist supervised all testing and scoring. Testing sessions took approximately two hours to administer. Below, brief descriptions of each instrument are provided.

Rey-Osterrieth complex figure test (ROCF). The Rey-Osterrieth complex figure test is a measure of perceptual organization and nonverbal memory. To complete the ROCF, participants were asked to copy a complex figure as accurately as possible. Two PhD-level clinical psychologists, blinded to the diagnostic status of the participants, scored the ROCF using the Waber–Holmes Developmental Scoring System (Waber & Holmes, 1985). Inter-rater reliability for scoring ROCF protocols ranged from 94% to 100% agreement (as previously reported in Seidman et al., 2006). In addition to the Copy trial, one 20-minute delayed-recall trial was also administered. Previous research has shown that children and adults with ADHD perform at developmentally lower levels on the ROCF than age-matched controls, especially on the copy organization and recall (Faraone et al., 2006; Seidman et al., 1995; Hervey et al., 2004; Frazier et al., 2004).

Seidman Continuous performance task (CPT). The Seidman auditory continuous performance task was administered. In this continuous performance task, letters of the alphabet were presented aurally at a rate of one/second for four blocks of 90 seconds. Subjects were required to respond to all target stimuli by lifting their index finger. The simple target vigilance condition required subjects to respond to each "A." A more complex target vigilance condition required subjects to respond to each "A" only if immediately preceded by a "Q". For interference tasks, randomly selected letters of the alphabet were periodically inserted between Q's and A's. The Seidman CPT was created to be more difficult than a standard continuous performance vigilance task by increasing working memory and interference filtering demands and has been used in ADHD populations (Seidman, Breiter, et al., 1998).

Stroop Color-Word Test. The Stroop Color-Word Test (Golden & Freshwater, 1978) measures the ability to inhibit competing responses when salient conflicting information is presented across three stages of the test, and is designed as a measure of inhibition and resistance to distraction. During the first stage of the Stroop Test, color names (e.g., blue, green red, yellow) printed in black ink are read aloud by the participant. During the second stage, the names of repeated series of X's printed in the ink of the same color are also read aloud. In the final stage, designed to measure resistance to distraction, participants must say the color of ink in which another color word is printed, wherein sometimes the color of ink in which the word is printed is the same, while other times the color does not match the color word. Differences between ADHD and control populations have been demonstrated on the Stroop test in both children and adults (Homack & Riccio, 2004). In this study, the Color-Word T-Score was used.

California Verbal Learning Test (CVLT). The California Verbal Learning Test (Test) is designed to assess overall short-term memory and verbal learning abilities. Two versions of the California Verbal Learning Test were used: the California Verbal Learning Test- Second Edition (CVLT-II) for children 17 years or older (Delis et al., 2000) and the California Verbal Learning Test – Child Edition, for children 17 years and younger (Delis, Kramer, Kaplan, & Ober, 1994). On each CVLT version, the Total List A (Trials 1-5) Recall Standard Score was used. In the CVLT, 16 words drawn from four semantic categories are presented five consecutive times; after the list is presented each time, participants are asked to recall as many words as they can remember. Past research has shown that adults and children with ADHD have poorer performance on the CVLT compared to controls (Downey et al., 1997; Mahone, Koth, Cutting, Singer, and Denckla, 2001).

Wisconsin Card Sort Test (WCST). The computerized Wisconsin Card Sort Test (Heaton, 1993) is a widely used instrument used to characterize executive functioning deficits by assessing one's ability to form abstract concepts, sustain attention, and set-shift in response to changing conceptual rules. Errors on the WCST can be divided into perseverative and non-perseverative errors. Past research has shown that high school and college-aged individuals with ADHD complete less WCST categories than controls and have more perseverative and nonperseverative errors than age-matched controls (Seidman, Biederman, Faraone, Weber & Oulette, 1997; Hervey et al., 2004).

Wide Range Achievement Test- Revised (WRAT-R). The WRAT-R (Jastak & Wilkinson, 1984) is used to assess academic achievement and screen for the presence of learning disorders. In this study, the arithmetic and reading tests of the WRAT-R were administered. The WRAT-R has been shown to be a consistent and stable measure of academic achievement in children in special education classes (Woodward, Santa-Barbara, & Roberts, 1975). In children with ADHD, poorer executive function has also been linked to worse performance on both the reading and arithmetic subtests of the WRAT-R (Biederman et al., 2004).

Functional Outcome Assessments

Global Assessment of Functioning (GAF). The global assessment of functioning (American Psychiatric Association, 1980) scale is a simple clinician-rated global measure of functioning on a scale ranging from 0-100 that clinicians use to subjectively rate patients on their social, academic, occupational, and psychological functioning, with higher scores representing better functioning. The GAF has been shown to have satisfactory reliability (Jones, Thornicroft, Coffey, & Dunn, 1995) and has been used to measure clinical change and outcomes (Söderberg, Tungström, & Armelius, 2005).

Child Behavior Checklist (CBCL). The Child Behavior Checklist (Achenbach, 1991) is a 120-item questionnaire consisting of eight clinical subscales (anxious/depressed, withdrawn/depressed, somatic complaints, social problems, thought problems, attention problems, rule-breaking problems, and aggressive behavior). Also included in the CBCL are questions relating to the child's functioning, including school, social, and activities competence. The CBCL is designed to assess children's behavior from a parent's perspective and is often used to characterize behavior problems as well as areas of social competence and has been shown to be adequately reliable and valid (Dutra, Campbell, & Westen, 2004). For the purpose of assessing functional outcomes, the T-Scores calculated from CBCL summary scales relating to competence are used as outcome measures (Total Competence, School Competence, Activities Competence, and Social Competence).

Family Environment Scale (FES). The Family Environment Scale (Moos & Moos, 1994) is a 90-item true/false instrument with three global dimensions of family functioning designed to assess the social and environmental characteristics of a family and is used to assess family functioning. The three global dimensions include Family System Maintenance, Social Relationships, and Personal Growth. For the present study, the three subscale scores that form the Social Relationships domain were used and consisted of: a) cohesion—the degree of commitment and support family members provide for each other; b) expressiveness—the degree to which family members are encouraged to express their feelings openly with each other; and c) conflict—the degree to which family members openly express anger and aggression towards each other. The FES is a well-validated tool and has been used in several child and family research studies of ADHD (Pressman et al., 2006; Schroeder & Kelley, 2009). Higher scores on family conflict and lower scores on family cohesion and expressiveness indicate poorer overall family functioning. Research with the FES shows that parents of children with ADHD rate their families as higher in conflict than controls (Pressman et al., 2006).

Social Adjustment Inventory for Children and Adolescents (SAICA). The Social Adjustment Inventory for Children and Adolescents (John, Gammon, Prusoff, & Warner, 1987) is a 76-item instrument designed to assess adaptive social functioning and problem behaviors in six different domains of functioning, including school behavior, spare time, same-sex peer relationships, opposite sex peer relationships, sibling relationships, and parent relationships, with higher scores indicating greater impairment from an area of social functioning. The SAICA was administered to the participants' parents (typically mothers) in an interview format and all SAICA items about their child were rated on a 4-point scale. Research with the SAICA has shown high inter-rater reliability (King et al., 1993), and concurrent validity (Biederman, Faraone, & Chen, 1993) in psychiatric and nonpsychiatric samples.

ADHD Symptom Measures

Schedule of Affective Disorders and Schizophrenia for Children – Epidemiologic Version (K-SADS-E) ADHD Module

The K-SADS-E (Ovraschel & Puig-Antich, 1987), a structured diagnostic clinical interview, was administered to establish diagnoses of ADHD, based on criteria from the DSM-III-R (American Psychiatric Association, 1987), as well as provide dimensional data about the number of threshold-level ADHD symptoms demonstrated by the proband. If children were younger than 12, interviews were conducted with the mother, and when the children were older than 12, direct interviews with the child were taken into account. In subsequent waves, the DSM-IV based K-SADS-E-IV (Epidemiologic Version) assessing DSM-IV disorders (Orvaschel, 1994) was administered. All interviewers were blind to the child's status and referral site. Board-certified child and adolescent psychiatrists reviewed all diagnostic data.

Research Design and Data Analytic Plan

Research Design. The current study is a secondary analysis of a controlled, naturalistic, longitudinal study with two follow-up periods for the male participants and two follow-up periods for the female participants (See Tables 1 and 2). The primary aims of the present study are to examine the diagnostic utility of various assessment instruments for ADHD across the lifespan and to assess for differences in the diagnostic accuracy of assessments for ADHD from pediatric versus psychiatric clinics. Since the data were collected at different time points several years apart from each other and since the study varies in follow-up length for the boys versus the girls, these samples are considered non-comparable and the analyses were conducted separately by sex. This decision is further supported by the data suggesting that child gender can affect ADHD diagnostic practices (Bruchmüller, Margraf, & Schneider, 2012).

Prior to conducting data analyses related to the two specific aims, preliminary data cleaning and restructuring was completed. The dataset is large. There are 2133 columns and 9264 rows. Each subject is identified by an individual id (id), family ID (famid), ADHD status (status) and wave number (wave) yielding a total of 2279 unique individual IDs, 523 unique family IDs, and 4 waves. First, non-informative columns were identified and removed. This included columns / variables that contain the same value (e.g., missing data, or same data for all subjects). Next, the data was restructured from long to wide format. Thus, what was previously a single variable (e.g., "current_gaf") was expanded to six separate variables, each with a suffix designating the wave (e.g., "current_gaf _w1," …, "current_gaf_w6").

Analytic Plan. SPSS for Mac v21.0 was used to conduct receiver operating characteristic (ROC) curve analyses, sensitivity and specificity analyses to evaluate the diagnostic accuracy of test performance in three developmental periods corresponding with three waves of the study: childhood, adolescence, and emerging adulthood. Given the missing data patterns in the dataset (i.e., substantial missing data for girls in young adulthood and for boys in childhood), waves in childhood and adolescence were examined within the girls population, and waves in adolescence and young adulthood were examined within the boy's population. The correlations among the neuropsychological and academic achievement data as well as the correlations among the parent and clinician subjective rating scales were computed during the two baseline waves: childhood for girls and adolescence for boys. See Tables 14-17. Sensitivity refers to the percentage of true positive cases identified while specificity refers to the percentage of true negative cases identified. The following neuropsychological variables and tests of academic achievement, chosen to represent domains of functioning thought to be impaired in ADHD across the lifespan (e.g., academic achievement, vigilance and distractibility, planning and organization, response inhibition, selective attention, and verbal learning and memory (Hervey, Epstein, & Curry, 2004; Frazier et al., 2004) were each be examined for sensitivity and specificity: Rey-Osterrieth Copy Organization Score and Rey-Osterrieth Delay Organization Score; Seidman Auditory CPT Correct Responses, Late Responses, Omissions, and False Alarms; WCST Correct Responses, WCST Incorrect Responses, WCST Perseverative Errors, and WCST Non-perseverative Errors; CVLT List A T-Score , and WRAT-R Reading and Arithmetic Scaled Scores from wave to wave.

The following functional variables were also examined and were selected based upon domains of functioning that are typically the most impaired in individuals with ADHD: behavioral, school, social, and family impairment (Wehmeier, Schacht & Barkley, 2010; DuPaul, McGoey, Eckert &Vanbrakle; Strine et al., 2006). The variables included: clinician-rated GAF; FES Expressiveness, FES Conflict, FES Cohesion; SAICA school behavior, SAICA spare time, SAICA same-sex peer relationships, SAICA opposite sex peer relationships, SAICA sibling relationships, and SAICA parent relationships and CBCL Total-Competence T-Score, CBCL School T-Score, CBCL Social T-Score and CBCL Activities T-Score. All of these scales represented the subjective reporting of clinician and parent ratings.

Because good sensitivity and specificity do not necessarily correlate to test quality (Kraemer, 1992), these classification analyses will be supplemented with receiver-operating characteristic (ROC) curves. The ROC produces an area under the ROC curve (AUC), a useful parameter for comparing relative test performance and overall accuracy of test prediction (Florkowski, 2008). The accuracy of any test depends on its ability to separate a group of individuals being tested into two groups: those who are true positives and true negatives. ROC analyses allow for the assessment and comparison of the diagnostic efficiency of various tests by evaluating the AUC statistic and graphical plots of sensitivity and (1-specificity) at each cut point. The AUC can range from 0.5, representing a perfectly useless test, to 1.0, representing a perfectly accurate test. The ROC approach to analyzing the accuracy of test prediction has been applied to countless tests and disorders (Swets, 1986), including tests and screeners for ADHD (Chen et al., 1994; Fazio, Doyle, & King, 2014). There are many ways to establish cut points and many factors which determine the setting of cut points, including clinical setting, clinical goals, and the risk-benefit profile of having false negatives versus false positives (Youngstrom, 2013). The present study identified cut points at optimal levels of sensitivity (90%) and optimal specificity (90%), as these values provide key information about a measure's ability to classify true positives and true negatives.

To achieve the aim of identifying satisfactory versus non-satisfactory screeners at each time point, the predicted values from logistic regression models will be calculated, where the outcome is a positive ADHD diagnosis. To do this, each of the screeners was treated as independent predictors and positive ADHD status was used as the outcome variable with an AUC cut score value of .80. Then, with the predicted values generated from the logistic regression, these predicted values were used as the “test” variable in the ROC curve analysis. Missing data is indicated by “N/A” in the tables.

Results

Participant Characteristics

Demographics. The sample of boys in adolescence included 130 boys with ADHD and 113 controls and the sample of girls in childhood included 140 girls with ADHD and 120 controls, ascertained from psychiatric and pediatric clinic settings. For demographics information by gender across all waves, please see Table 1.

ADHD Subtypes. Since the data in the initial waves made use of DSM-III-R criteria, which did not differentiate between ADHD subtypes, additional symptoms required to make DSM-IV diagnoses were collected in the girls study and proxy diagnoses for the DSM-IV subtypes were made available for the boys study. For the girls with ADHD ascertained during childhood (N = 140), the most prevalent presentation was the combined subtype (N = 86), followed by the inattentive subtype (N = 39), and then the hyperactive subtype (N = 12). For the ADHD boys ascertained during adolescence (N = 130), the most prevalent presentation was also the combined subtype (N = 108), followed by inattentive (N = 22), and then the hyperactive (N = 8). For demographics information by gender across all waves, please see Table 1. Means, standard deviations, sensitivity, specificity, and area under the curve (AUC) calculations of the neuropsychological tests, tests of academic achievement, and the assessments of subjective clinician and parent rating scales for boys and girls during are shown in Tables 2 through 7; the same sets of analyses are represented in Tables 8 through 13 for the population of pediatrically referred versus psychiatrically referred populations of boys and girls.

Attrition. Analyses identified some attrition over time in the number of participants retained across waves, but the majority of participants were retained over time. Approximately 86% of the sample of the boys with ADHD recruited during adolescence (N = 130) were retained at young adulthood, ten years later (N = 112). Among the girls with ADHD, approximately 88% of the baseline sample of participants who were recruited during childhood (N = 140) were present in adolescence (N = 123). Among the control groups, some attrition also exists: Approximately 93% of the baseline control group of girls recruited in childhood (N = 120) were present at adolescence (N = 112). Among the control adolescent boys, approximately 93% of the baseline group of boys recruited during adolescence (N = 113) were present during young adulthood (N = 105). There were no significant differences in attrition between groups.

Hypothesis 1a

Group Differences Between ADHD and Control Girls Across Waves.

Childhood. During childhood for girls, the data largely supported Hypothesis 1a in that clear differences emerged between the group of girls with ADHD and control groups of girls. Group differences were seen across the majority of neuropsychological variables, including WCST perseverative errors $t(203) = -2.20$, $p = .03$, Stroop Color-Word T-Scores, $t(253) = 2.97$, $p = .003$, Seidman CPT correct responses $t(256) = 3.06$, $p = .002$, late responses $t(256) = -2.54$, $p = .01$, omissions $t(254) = -2.34$, $p = .02$, ROCF copy organization score $t(242) = 2.18$, $p = .03$ and delay organization score, $t(242) = 2.50$, $p = .02$, WRAT-R reading $t(256) = 5.68$, $p < .001$ and WRAT-R arithmetic score $t(258) = 6.02$, $p < .001$. The three neuropsychological variables that did not differ between the ADHD group and the control group of girls were Seidman CPT false alarms, CVLT List A T-Score, and WCST Non-perseverative errors.

Clear differences also emerged between the girls with ADHD and the control girls in terms of the assessments of subjective clinician and parent rating scales, including clinician-rated GAF, $t(260) = 15.15$, $p < .001$, FES Conflict, $t(253) = -3.47$, $p = .001$, FES Cohesion, $t(253) = 4.03$, $p < .001$, CBCL Competence, $t(207) = 4.20$, $p < .001$, CBCL School, $t(203) = 11.21$, $p < .001$, CBCL Social, $t(206) = 6.15$, $p < .001$, and CBCL Activities T-Score $t(206) = 2.89$, $p = .004$. The only variable that did not differ between the two groups was FES expressiveness, $p = .61$. The two groups of girls also differed on all six subscales of the SAICA: school behavior problems, $t(239) = 12.36$, $p < .001$; spare time problems, $t(239) = 8.92$, $p < .001$; problems with peers, $t(239) = 8.58$, $p < .001$; problems with the opposite sex, $t(128) = 3.33$, $p = .001$; problems with siblings, $t(213) = 5.27$, $p < .001$; and problems with parents, $t(239) = 7.79$, $p < .001$. See Table 2 for means and standard deviations between the two groups of girls.

Summary. In conclusion, during childhood for girls, the ADHD group performed worse than the control group on seven out of the ten neuropsychological tests and both academic achievement measures, but there were no group differences on Seidman False Alarms, WCST Nonperseverative Errors, and CVLT List A. The ADHD group was rated to have worse functioning on all of the parent and clinician subjective rating scales except for FES expressiveness.

Adolescence. For the adolescent girls, Seidman CPT scores were not available; however, the remainder of the neuropsychological variables were present. The girls with ADHD and the control girls differed significantly in their performance on the following neuropsychological tests: ROCF copy organization score, $t(205) = 2.14$, $p = .03$, WCST perseverative errors $t(195) = 2.67$, $p = .01$, and Stroop Color-Word T-Score, $t(215) = 3.56$, $p < .001$. The two groups of adolescent girls did not differ on ROCF delay organization score, CVLT List A T-Score, or

WCST Nonperseverative Errors. On tests of academic achievement, the adolescent girls differed significantly on both WRAT-R Reading, $t(216) = 4.97$, $p < .001$, and WRAT-R Arithmetic, $t(215) = 7.16$, $p < .001$.

Among the subjective rating scales present for the girls, clear differences emerged in terms of clinician-rated GAF, $t(240) = 16.58$, $p < .001$ and CBCL School, $t(168) = 7.28$, $p < .001$. CBCL Social and Activities were both not significantly different between groups, $p = .32$ and .75, respectively. The adolescent girls also differed significantly on SAICA school behavior problems, $t(23) = 3.37$, $p = .003$, spare time problems, $t(23) = 3.31$, $p = .003$, problems with peers, $t(23) = 2.32$, $p = .03$, and problems with siblings, $t(23) = 2.87$, $p = .009$. SAICA problems with parents was only marginally different between the groups, $t(23) = 1.90$, $p = .07$. CBCL Competence T-Score was not present during this wave, and the adolescent girls did not differ on SAICA problems with the opposite sex, $p < .05$. See Table 3 for means and standard deviations between the two groups of adolescent girls with and without ADHD.

Summary. The differences between groups declined from childhood to adolescence in the girl's sample. During adolescence for girls, out of the six present neuropsychological data points, three were significantly different between groups, with the ADHD group showing worse performance in three measures: ROCF Copy, Stroop Color-Word T-Score, and WCST Perseverative Errors, which tap into the domains of organization and fluency. On tests of achievement, the groups in adolescence continued to differ significantly on both academic achievement domains. Out of the 13 functional variables present, the adolescent groups differed significantly on eight variables. Overall, from childhood to adolescence, the ADHD group differed significantly from the control group of girls on the majority of neuropsychological assessments, academic achievement, and subjective rating scales although the differences were less prominent in neuropsychological data in adolescence.

Group Differences Between ADHD and Control Adolescent Boys Across Waves.

Adolescence. During adolescence for the boys with and without ADHD, all of the neuropsychological and functional data were present, and clear group differences emerged in the majority of the neuropsychological tests and tests of academic achievement between the control and ADHD groups, including on ROCF Copy Score, $t(211) = 4.41$, $p < .001$, ROCF Delay Score, $t(199) = 2.82$, $p = .005$, Seidman CPT Correct Responses, $t(219) = 2.42$, $p = .02$, Seidman CPT Omissions, $t(219) = - 2.80$, $p = .006$, Stroop T-Score, $t(215) = 4.65$, $p < .001$, WCST Perseverative Errors, $t(212) = -3.87$, $p < .001$, WCST Nonperseverative Errors, $t(212) = - 4.34$, $p < .001$, WRAT-R Reading, $t(205) = 5.19$, $p < .001$, and WRAT-R Arithmetic $t(205) = 6.78$, $p < .001$. Seidman CPT False Alarms were marginally different between groups, $t(219) = - 1.68$, $p = .10$, and Seidman Late Responses were not different between groups, $p = .318$. CVLT List A T-Score was similarly not different between groups, $p = .62$.

Among the subjective rating scales, many significant differences also arose between the groups, including on clinician-rated GAF, $t(235) = 15.01$, $p < .001$, FES Conflict, $t(206) = -4.57$, $p <.001$, FES Cohesion, $t(206) = 4.11$, $p < .001$, and CBCL School T-Score, $t(175) = 2.90$, $p = .004$. The control and ADHD groups also differed significantly on SAICA school behavior problems, $t(166) = 9.85$, $p < .001$, SAICA spare time problems, $t(167) = 6.13$, $p < .001$, SAICA problems with peers, $t(167) = 6.73$, $p < .001$, SAICA problems with siblings, $t(149) = 4.50$, $p < .001$, and SAICA problems with parents, $t(167) = 6.12$, $p < .001$. The two groups only did not differ on SAICA problems with the opposite sex, $t(125) = 0.76$, $p = .45$. During this wave, CBCL total competence, Social, and Activities did not differ between groups, $p = .59$, .66, and .57

respectively. Also, FES Expression did not differ between groups $p = .51$. See Table 4 for means and standard deviations between the two groups of boys with and without ADHD.

Summary. During adolescence for boys, the ADHD group performed worse than controls on seven out of the ten neuropsychological assessments and both academic achievement measures, but not on Seidman CPT Late Reponses or False Alarms or on the CVLT List A. Furthermore, the ADHD group was rated lower on nine out of 14 parent and clinician subjective rating scales compared to the control group of boys.

Young Adulthood. During early adulthood for the young adult men with and without ADHD, the Seidman CPT data were missing. However, the rest of the neuropsychological data were present and there were significant group differences on CVLT List A Total T-Score, $t(160) = 4.05$, $p < .001$, Stroop T-Score, $t(158) = 3.23$, $p = .002$, WCST Perseverative Errors, $t(137) = -2.50$, $p = .01$, Nonperseverative Errors, $t(137) = -2.21$, $p = .03$, WRAT-R Reading $t(161) = 3.88$, $p < .001$, and WRAT-R Arithmetic $t(161) = 5.36$, $p < .001$.

All of the functional data were present except CBCL Competence and the six SAICA subscales. Among these data, significant group differences were found in GAF, $t(214) = 7.83$, $p < .001$, FES Conflict, $t(130) = -3.02$, $p = .003$, FES Cohesion, $t(130) = 2.93$, $p = .004$, CBCL School T-Score, $t(24) = 3.19$, $p = .004$, Social, $t(25) = 3.41$, $p = .002$, and Activities T-Score, $t(28) = 2.33$, $p = .03$. See Table 5 for means and standard deviations between the two groups of young adult men with and without ADHD.

Summary. During early adulthood, out of the six neuropsychological assessments present, the two groups of young men differed on four. They did not differ on the two subscales of ROCF. However, on tests of achievement, the groups continued to show significant differences on both WRAT-R Reading and Arithmetic, with the ADHD group performing worse on both compared to the control group. In parent and clinician subjective rating scales, the young adult groups differed on the majority of the assessments that were present (six out of seven). Overall, the ADHD group differed significantly from the control group on the majority of neuropsychological assessments, academic achievement, and subjective clinician and parent rating scales and these differences were maintained over time from adolescence to early adulthood in the boys group.

Hypothesis 1b

To test whether subjective clinician and parent rating scales (e.g., CBCL, GAF, FES, SAICA) have higher discriminatory accuracy than performance-based assessments (neuropsychological tests and tests of academic achievement), a series of ROC curves and binary logistic regressions were conducted separately by gender at each wave with ADHD status as the dependent test variable (categorical outcome) and each neuropsychological and functional assessment entered as the independent variable. In the binary logistic regressions, age was entered as a covariate, since the mean ages of the groups were significantly different. See Tables 2-7 for a summary of each test's sensitivity and specificity by gender across each wave. The diagnostic accuracy of the various measures is also summarized below.

Diagnostic Accuracy of Functional and Neuropsychological Assessments for ADHD Across Waves in the Girls' Samples.

Childhood Neuropsychological Assessments. The neuropsychological assessments administered to girls with and without ADHD (Table 2) either failed to differentiate the group of girls with versus the girls without ADHD, or performed poorly, with AUCs ranging from .53-.69. The two tests with the highest AUC values came from the tests of academic achievement, and were WRAT-R Reading and WRAT-R Arithmetic Scaled Score (both AUCs = .69).

Sensitivity of the individual neuropsychological assessments was quite poor, ranging from 0% to 2%, while specificity was high, ranging from 84% to 100%. See Table 2 for full sensitivity and specificity, data for girls.

Childhood Clinician and Parent Subjective Rating Scales. Overall the subjective clinician and parent rating scales administered to girls during childhood performed better than the neuropsychological tests, with AUCs ranging from .53-.92. The tests with the highest AUC values were clinician rated GAF (AUC = .92) and CBCL School T-Score (AUC = .86). Sensitivity of the individual clinician and parent rating scales was better than that of the neuropsychological tests, but still poor, ranging from 0% to 58%. Specificity ranged from 56% to 100%.

Adolescent Girls Neuropsychological Assessments. For adolescent girls, no Seidman CPT data were present. Overall, the neuropsychological assessments and tests of academic achievement administered to girls with and without ADHD during adolescence (Table 3) also showed poor discriminatory value in differentiating girls with versus without ADHD. AUC's ranged from 0.52 to 0.75, with WRAT-R Arithmetic again showing the highest AUC. Sensitivity remained poor, ranging from 0% to 1%. Specificity ranged from 80% to 100%. See Table 3 for full sensitivity and specificity, data for girls during adolescence.

Adolescent Girls Clinician and Parent Subjective Rating Scales. Overall, the subjective rating scales administered to adolescent girls performed better than the neuropsychological assessments and showed higher discriminatory value in differentiating adolescent girls with and without ADHD. AUCs ranged from 0.52 to 0.84. The tests with the highest AUC values were once again current GAF and CBCL School T-Score. Sensitivity remained poor, but was still higher than the neuropsychological assessments, ranging from 0% to 10%. Specificity ranged from 68% to 100%.

Summary. During childhood for girls, none of the AUC's for the neuropsychological or academic achievement data were greater than .70, the minimum acceptable AUC for a fair test, yet several measures from the subjective clinician and parent rating scales achieved AUCs greater than .70; these included clinician-rated GAF, CBCL Competence, CBCL School, CBCL Social, SAICA School Behavior Problems, Spare Time Problems, Problems with Peers, and Problems with Parents. During adolescence for girls, again, none of the AUC's for the neuropsychological test data achieved an AUC greater than .70. However, the WRAT-R Arithmetic Scaled Score demonstrated an AUC of 0.75. Among the clinician and parent rating scales, clinician-rated GAF, CBCL School, CBCL Social, SAICA School Behavior Problems, Spare Time Problems, Problems with Peers, and Problems with Siblings all achieved AUCs greater than .70. Notably, clinician-rated GAF, school-related (i.e., CBCL School, SAICA School Behavior Problems), and interpersonally-related (i.e., CBCL Social, SAICA Problems with Peers) measures remained predictive from childhood to adolescence.

Diagnostic Accuracy of Functional and Neuropsychological Assessments for ADHD across Waves in the Boys' Samples.

Adolescent Boys Neuropsychological Assessments. All of the neuropsychological test data were present for the boys' groups. In line with the results from the girl's data, the discriminatory power of these individual tests was poor, with AUCs ranging from .52 to .75, with WRAT-R Arithmetic showing the highest AUC at .75. Sensitivity was poor, ranging from 0% to 4%, again with WRAT-R Arithmetic showing the highest sensitivity (4%). Specificity was moderate to high, ranging from 80% to 100%.See Table 4 for full results on sensitivity and specificity, for boys.

Adolescent Boys Clinician and Parent Subjective Rating Scales. All of the functional assessment test data were present for the boys groups during adolescence. Consistent with the girls' data, the AUC values were higher for the subjective rating scales than the neuropsychological assessments, with AUC values ranging from 0.52 to 0.92, with clinician rated GAF showing the highest AUC. Sensitivity was poor, ranging from 0% to 12%, with clinician rated GAF showing the highest sensitivity, and specificity was high, ranging from 84% to 100%.

Young Adulthood Neuropsychological Assessments. All of the neuropsychological data were present except for the Seidman CPT test data for young men. Overall, the AUC's for the neuropsychological tests failed to discriminate or showed poor discrimination, with areas ranging from 0.53 to 0.73, with WRAT-R Arithmetic showing the highest AUC among the neuropsychological variables. Sensitivity was poor, ranging from 0% to 3%, with WRAT-R Arithmetic showing the highest sensitivity, and specificity was high, ranging from 80% to 100%. See Table 5 for full results on sensitivity and specificity.

Young Adulthood Clinician and Parent Subjective Rating Scales. All of the functional assessment test data were present for the young men with and without ADHD except for the six SAICA subscales. Consistent with the data from adolescence, the AUC values of the subjective rating scales were overall higher than the AUC values of the neuropsychological test data in early adulthood. AUC's ranged from 0.60 to 0.85, with CBCL Social T-Score showing the highest AUC. Sensitivity was poor, ranging from 0% to 11%, again with CBCL Social T-Score showing the highest sensitivity. Specificity was moderate to high, ranging from 65% to 100%. See Table 5.

Summary. During adolescence for boys, the pattern of results was similar to the pattern of results for the girls: none of the AUC's for the neuropsychological test data achieved an AUC greater than .70. However, both of the measures of academic achievement, WRAT-R Reading and Arithmetic, demonstrated AUC's greater than .70. Of the subjective rating scales, clinician-rated GAF, CBCL School T-Score, SAICA School Behavior Problems Spare Time problems, Problems with Peers, and Problems with Parents all achieved AUC's greater than .70. During young adulthood for boys, again, none of the AUC's for the neuropsychological test data achieved an AUC greater than .70. Of the academic achievement assessments, only WRAT-R Arithmetic achieved an AUC greater than .70. Of the subjective rating scales, CBCL School, CBCL Social, and CBCL Activities all demonstrated AUCs greater than .70. Notably, the impairment in the school and social, interpersonal domains continued to be discriminating factors from adolescence to young adulthood in the boys group.

Hypothesis 1c

To test if diagnostic accuracy was higher in pediatrically referred samples (i.e., the samples acquired through Harvard Pilgrim Healthcare pediatric HMO referrals) compared to psychiatrically referred samples (i.e., the samples acquired through MGH psychiatry clinic referrals) the analyses summarized in the following section were conducted separately for the two referral settings, and separately by sex, with age entered as a control variable at each stage.

First, independent samples t-tests were conducted to detect any group performance differences; then, the AUC of the ROC curve, sensitivity and specificity were calculated. Binary logistic regressions were conducted separately for each measure for both boys and girls at each wave with ADHD status as the dependent test variable and age entered in the first block for independent variable and each neuropsychological and parent and clinician subjective rating scales entered as the independent variable. See Tables 6-9 for a summary of sensitivity and specificity, for the girls' sample, and see Tables 10-13 for summaries of the aforementioned analyses for the boys' sample. Results in this section should be interpreted with more caution due to the relatively smaller samples that resulted from this additional parsing of the populations (i.e., not only by gender, but also by referral source).

Diagnostic Accuracy in Psychiatrically Referred Girls Versus Pediatrically Referred Girls in Childhood.

Childhood Psychiatrically Referred Girls Neuropsychological Assessments. Among the psychiatrically referred girls with ADHD (n = 61) and girls without ADHD (n = 55), the only group differences that emerged on the neuropsychological test variables were on three measures: the Stroop T-Score, $t(112) = 2.37$, $p = .02$, WRAT-R Reading, $t(115) = 2.17$, $p = .03$, and WRAT-R Arithmetic, $t(115) = 2.22$, $p = .03$. All other neuropsychological test performances were statistically comparable between groups. In the psychiatrically referred girls group, none of the neuropsychological or academic achievement assessments yielded AUCs higher than .80.

Childhood Psychiatrically Referred Girls Clinician and Parent Subjective Rating Scales. With regard to functional measures, there were significant group differences in all of the subjective rating scales except for FES Expressiveness T-Score and CBCL Activities T-Score. These group differences between control and ADHD emerged on measures including GAF, $t(116) = -10.36$, $p < .001$, FES Conflict, $t(112) = 2.75$, $p = .007$, FES cohesion $t(112) = -3.14$, $p = .002$, CBCL Total Competence T-Score, $t(94) = -3.80$, $p < .001$, CBCL School T-Score, $t(94) = -7.06$, $p < .001$, and CBCL Social T-Score, $t(95) = -3.13$, $p = .002$. Each of the six domains of the SAICA also yielded significant group differences between the two groups of psychiatrically referred girls, including problems with school, $t(105) = 9.27$, $p < .001$, problems during spare time, $t(105) = 5.81$, $p < .001$, problems with same sex peers, $t(105) = 6.20$, $p < .001$, problems with the opposite sex, $t(51) = 2.62$, $p = .01$, problems with siblings, $t(96) = 4.57$, $p < .001$), and problems with parents, $t(105) = 5.61$, $p < .001$). The subjective rating scales with AUCs > .80 were clinician rated GAF (AUC = .93), CBCL School T-Score (AUC = .84), SAICA School Behavior Problems (AUC = .87). For clinician rated GAF, the cut score that yielded a minimum value of .80 for both sensitivity and 1-specificity was GAF = 73.50. For CBCL School T-Score, the cut score was T=46.00. For SAICA School Behavior Problems, the cut score was 2.50. See Table 6 for full results of the sensitivity, specificity, and AUCs across all measures for psychiatrically referred girls.

Summary. Consistent with previous analyses, subjective rating scales like the CBCL and the SAICA scales yielded greater differences between ADHD and control as well as higher AUCs than the neuropsychological assessments, which generally failed to discriminate between those with and without ADHD in this psychiatrically referred sample. Of note, out of the 10 neuropsychological tests administered, the ADHD and control groups' performance differed significantly on only one test.

Childhood Pediatrically Referred Girls Neuropsychological Assessments. Among the pediatrically referred girls in with ADHD ($n = 77$) and without ADHD ($n = 67$), there were group differences in most of the neuropsychological assessment data, including ROCF Copy Score, $t(132) =3.29$, $p = .001$, ROCF Delay Score, $t(132) = 2.89$ p = .005, Seidman CPT Correct Responses, $t(141) = 4.38$, $p < .001$, Seidman CPT Omissions, t(139) = -3.00, $p = .003$, Stroop T-Score, $t(140) = 3.13$, $p = .002$, WCST Perseverative Errors, $t(108) = -2.33$, p = .02, and WCST

Nonperseverative Errors, $t(108) = -2.33$, $p = .03$; WRAT-R Reading Scaled Score, $t(139) = 5.71$, $p < .001$, and WRAT-R Arithmetic Scaled Score, $t(141) = 6.08$, $p < .001$. The neuropsychological assessment variables that did not differ between groups were Seidman CPT False Alarms, and CVLT List A T-Score. None of the neuropsychological or performance based measures yielded AUCs > .80.

Childhood Pediatrically Referred Girls Clinician and Parent Subjective Rating Scales. Group differences emerged on all subjective rating scales, except for FES Expressiveness T-Score. These group differences included GAF, $t(142) = 11.1$, $p < .001$, FES Conflict, $t(139) = -2.18$, $p = .03$, FES Cohesion, $t(139) = 2.54$, $p = .01$, CBCL Total Competence T-Score $t(111) = 2.54$, $p = .01$, CBCL School T-Score $t(107) = 8.72$, $p < .001$, CBCL Social T-Score (T(109) = 5.73, $p < .001$, and CBCL Activities T-Score $t(111) = 2.34$, $p = .02$. Among the SAICA subscales, group differences between ADHD and control emerged on all of six subscales, including SAICA School Behavior Problems, $t(132) = 8.26$, $p < .001$, SAICA Spare Time Problems, $t(132) = 6.73$, $p < .001$, SAICA Problems with Peers, $t(132) = 5.89$, $p < .001$, SAICA Problems with the Opposite Sex, $t(75) = 2.17$, $p = .03$, SAICA Problems with Siblings, $t(115) = 2.95$, $p = .004$, and SAICA Problems with Parents, $t(132) = 5.38$, $p < .001$.

The subjective rating scales with AUCs > .80 were clinician rated GAF (AUC = .91), CBCL School T-Score (AUC = .87), and SAICA School Behavior Problems (AUC = .82). For clinician rated GAF, the cut score that yielded a minimum value of .80 for both sensitivity and 1-specificity was GAF=74.50. For CBCL School T-Score, the cut score was T=56.00. For SAICA School Behavior Problems, the cut score was 2.50. See Table 7 for full results of the sensitivity, specificity, and AUCs across all measures for pediatrically referred girls.

*Summary***.** Among pediatrically referred girls, functional and neuropsychological performance based assessments both discriminated between control and ADHD, yet subjective rating scales yielded higher AUCs than the neuropsychological assessments. When comparing the two referral sites, the pediatrically referred groups showed the anticipated findings of group differences between ADHD and control on neuropsychological test performance, academic achievement, and subjective rating scales, and the psychiatrically referred groups showed the expected group differences on academic achievement and subjective rating scales, but almost no differences between ADHD and control on neuropsychological test performance those measures. When comparing the two referral sites, neuropsychological and academic achievement tests performed better diagnostically in the pediatric site compared to the psychiatric referrals, but performed comparably on the subjective rating scales in childhood.

Diagnostic Accuracy in Psychiatrically Referred Girls Versus Pediatrically Referred Girls in Adolescence.

Adolescent Psychiatrically Referred Girls Neuropsychological Assessments. Among the psychiatrically referred adolescent girls with and without ADHD, there were no group differences among the neuropsychological assessment data, which is consistent with the results from the childhood wave. Among the academic achievement data, The WRAT-R Arithmetic Scaled Score differed between groups, $t(91) = 3.55$, $p = .001$, but the WRAT-R Reading Scaled Score did not differ between groups, $p > .05$. Seidman CPT data and CBCL Competence T-Score data were not present for this group. With regard to diagnostic accuracy, none of the neuropsychological or performance based measures yielded AUCs > .80. The highest AUC achieved was the WRAT-R Arithmetic Scaled Score, AUC = .70.

Adolescent Psychiatrically Referred Girls Clinician and Parent Subjective Rating Scales. Among the subjective rating scales, significant group differences arose in Current GAF, $t(101) = 6.93$, $p < .001$, FES Conflict T-Score, $t(38) = -4.05$, $p < .001$, FES Cohesion T-Score, $t(39) = 2.94$, $p = .005$, and CBCL School-T-Score, $t(41) = 3.90$, $p < .001$. Less data were available for the SAICA subscales in this population; likely due to these very small samples (df = 9), no statistically significant differences emerged between the ADHD and Control group of psychiatrically referred girls. However, when examining the means, the ADHD group scored higher on all six subscales of the SAICA compared with the Control Group. The subjective rating scales with AUC > .80 were clinician rated GAF (AUC = .86) and FES Cohesion T-Score (AUC = .83). For clinician rated GAF, the cut score that yielded a minimum value of .80 for both sensitivity and 1-specificity was GAF = 74.50. For FES Cohesion T-Score, the cut score was T = 31.00. See Table 8 for full results of the sensitivity, specificity, and AUCs across all measures for psychiatrically referred adolescent girls.

*Summary***.** Overall, a trend from childhood to adolescence among the psychiatrically referred girls group is the decrease in the number of significant group differences between the ADHD and control groups in both neuropsychological and subjective rating scales. With regard to the classification statistics, domains of social and school functioning (e.g., CBCL School and Social T-Score, FES Conflict, SAICA Problems with Siblings, Problems with Parents, School Behavior Problems) performed the best, while the neuropsychological test data failed to discriminate between the groups, which was to be expected, since there were few significant group mean differences on neuropsychological test data to begin with during childhood and adolescence among the psychiatrically referred girls.

Adolescent Pediatrically Referred Girls Neuropsychological Assessments. Among the pediatrically referred adolescent girls, there were several group differences on neuropsychological assessments, including on the Stroop Color-Word score, $t(121) = 3.07$, $p = .003$, WCST Perseverative Errors, $t(110) = -3.47$, $p < .001$, WCST Nonperseverative Errors, $t(110) = -2.11$, $p = .04$, WRAT-R Reading Scaled Score, $t(122) = 5.35$, $p < .001$, and WRAT-R Arithmetic, $t(122) = 6.47$, $p < .001$. However, even with these group differences between ADHD and control, none of the neuropsychological or performance based measures yielded AUCs > .80. The highest neuropsychological assessment AUC was WRAT-R Arithmetic Scaled Score, AUC = .79.

Adolescent Psychiatrically Referred Girls Clinician and Parent Subjective Rating Scales. Among the general subjective rating scales, there were group differences in Current GAF, $t(131) = 7.53$, $p < .001$, CBCL School T-Score, $t(30) = 4.89$, $p < .001$, and CBCL Social T-Score $t(51) = 5.12$, $p < .001$. Significant differences also emerged between the ADHD and Control groups of pediatrically referred girls on the SAICA subscales, including SAICA School Behavior Problems, $t(12) = 3.54$, $p = .004$, SAICA Spare Time Problems, $t(12) = 2.45$, $p = .03$, and SAICA Problems with Siblings, $t(12) = 2.52$, $p = .03$. Notably, none of the subscales of the Family Environment Scale (FES) revealed any group differences between ADHD and Control groups; however, this result should be interpreted with some caution, as the samples were smaller, ADHD ($n = 21$), Control ($n = 30$). The subjective rating scales with AUC > .80 were clinician rated GAF (AUC = .84), CBCL School T-Score, (AUC = .83), CBCL Social T-Score, (AUC = .84), and SAICA School Behavior Problems, (AUC = .86). For clinician rated GAF, the cut score that yielded a minimum value of .80 for both sensitivity and 1-specificity was GAF = 70.50. For CBCL School T-Score the cut score was T=56.00, and for CBCL Social T-Score it was also 56.00. For SAICA School Behavior Problems, the cut score was 1.50. See Table 9 for full results of the sensitivity, specificity, and AUCs across all measures for pediatrically referred adolescent girls.

*Summary***.** Again, as in the childhood wave of pediatrically referred girls, the functional and neuropsychological performance based assessments comparably discriminated between control and ADHD in adolescence, yet subjective rating scales yielded higher AUCs than the neuropsychological assessments. Subjective rating scales in the school domain consistently produced AUCs > .80.

Diagnostic Accuracy in Psychiatrically Referred Boys Versus Pediatrically Referred Boys in Adolescence.

Adolescent Psychiatrically Referred Boys Neuropsychological Assessments. Among the psychiatrically referred boys with (n = 70) and without ADHD (n = 33), there were no group differences among any of the neuropsychological assessment data. All of the neuropsychological data were present for this group. None of the neuropsychological or performance based measures yielded AUCs > .80. The highest performance based assessment AUC was the WRAT-R Arithmetic Scaled Score, AUC = .62.

Adolescent Psychiatrically Referred Boys Clinician and Parent Subjective Rating Scales. Among the subjective rating scales, significant group differences only arose in Current GAF, $t(101) = 8.58$, $p < .001$, and FES Conflict T-Score, $t(85) = -2.60$, $p = .01$. Notably, none of the CBCL T-Scores yielded group differences. The ADHD group and Control group of psychiatrically referred boys differed on the following four SAICA subscales: SAICA School Behavior Problems, $t(71) = 6.58$, $p < .001$, SAICA Spare Time Problems, $t(71) = 4.99$, $p < .001$, SAICA Problems with Peers, $t(71) = 5.19$, $p < .001$, and SAICA Problems with Parents, $t(71)$ =

3.99, $p < .001$. There were no group differences in SAICA problems with the opposite sex or problems with siblings. The only functional assessment with AUC > .80 were clinician rated GAF (AUC = .91), SAICA School Behavior Problems (AUC = .85) and SAICA Problems with Peers (AUC = .82). For clinician rated GAF, the cut score that yielded a minimum value of .80 for both sensitivity and 1-specificity was GAF=74.50. For SAICA School Behavior Problems and Problems with Peers, the cut score was 1.50. See Table 10 for full results of the sensitivity, specificity, and AUCs across all measures for psychiatrically referred boys in young adulthood.

*Summary***.** Consistent with the data from the girls in childhood and adolescence, there were little to no group differences on the neuropsychological test data among psychiatrically referred adolescent boys. With regard to the classification statistics, subjective rating scales in the school, family, and interpersonal domains performed the best. The neuropsychological test data failed to discriminate between the groups, which was to be expected, since there were few significant group mean differences on neuropsychological test data to begin with during childhood and adolescence among the psychiatrically referred boys.

Adolescent Pediatrically Referred Boys Neuropsychological Assessments. Among the pediatrically referred boys with ADHD (n = 54) and without ADHD (n = 76), all of the neuropsychological assessments were present; however, in contrast to the psychiatric group, there were significant group differences between the control and ADHD pediatric groups on the majority of the neuropsychological assessments, including ROCF Copy Score, $t(114) = 4.33$, $p < .001$, ROCF Delay Score, $t(110) = 2.21$, $p = .03$, Seidman CPT Correct Responses, $t(120) = 2.42$, $p = .02$, Seidman CPT Omissions, $t(120) = - 2.40$, $p = .03$, Stroop Color-Word T-Score, $t(119) = 4.29$, $p < .001$, WCST Perseverative Errors, $t(115) = 3.60$, $p < .001$, and WCST Non-Perseverative Errors, $t(115) = 3.56$, $p < .001$. On tests of academic achievement, there were also significant group differences: WRAT-R Arithmetic, $t(113) = 6.51$, $p < .001$, WRAT-R Reading $t(113) = 5.39$, $p < .001$. None of the neuropsychological or performance based measures yielded AUCs > .80.

Adolescent Pediatrically Referred Boys Clinician and Parent Subjective Rating Scales. There were group differences in all of the subjective rating scales except FES Expressiveness and the CBCL T-Scores. These group differences emerged on the GAF, $t(132) = 11.52$, $p < .001$, FES Conflict, $t(119) = -4.28$, $p < .001$, FES Cohesion, $t(119) = 3.26$, $p < .001$, and on five domains of the SAICA, including problems with school behavior, $t(93) = 8.31$, $p < .001$, problems during spare time, $t(94) = 6.36$, $p < .001$, problems with peers, $t(94) = 5.57$, $p < .001$, problems with siblings, $t(88) = 3.91$, $p < .001$, and problems with parents, $t(94) = 7.32$, $p < .001$). There were no group differences in SAICA problems with the opposite sex, $p > .05$. The subjective rating scales with AUC > .80 were clinician rated GAF (AUC = .93) and SAICA School Behavior Problems (AUC = .83). For clinician rated GAF, the cut score that yielded a minimum value of .80 for both sensitivity and 1-specificity was GAF=77.50. For SAICA School Behavior Problems, the cut score was 2.50. See Table 11 for full results of the sensitivity, specificity, and AUCs across all measures for the pediatrically referred group of adolescent boys.

*Summary***.** In general, the degree of group differences on the neuropsychological, academic achievement, and subjective rating scales between the pediatrically and psychiatrically referred groups was notable, with the pediatrically referred group showing greater differences between control and ADHD groups on nearly all of the measures. Thus, during adolescence, more group differences between ADHD and control emerged in the pediatric group compared to the psychiatric group. With regard to the classification statistics, domains of social and school functioning performed the best, and when comparing the two referral sites, diagnostic accuracy tended to be higher more often in the pediatrically referred group compared to the psychiatrically referred group (e.g., 12 measures achieved AUCs >.70 in the pediatrically referred group, while only six measures achieved that minimum in the psychiatrically referred group) of adolescent boys.

Diagnostic Accuracy in Psychiatrically Referred Boys Versus Pediatrically Referred Boys in Young Adulthood.

***Young Adulthood Psychiatrically Referred Boys Neuropsychological Assessments*.** Among the psychiatrically referred young men with and without ADHD with (n = 59) and without ADHD (n = 21), there were no group differences among any of the neuropsychological assessment data, of which all data were present except for Seidman CPT data. Furthermore, there were no group differences on tests of academic achievement. Accordingly, none of the neuropsychological or performance based measures yielded group differences or AUCs > .80.

Young Adulthood Psychiatrically Referred Boys Clinician and Parent Subjective Rating Scales. Among the subjective rating scales, significant group differences only arose in Current GAF, $t(87) = 4.71$, $p < .001$, and FES Conflict, $t(56) = -2.33$, $p = .02$. Notably, none of the CBCL T-Scores yielded group differences; this is almost certainly due to small samples (ADHD group n = 9; control group n = 6). SAICA data were not present during this wave. The only functional assessment with AUC > .80 was clinician rated GAF (AUC = .81). For clinician rated GAF, the cut score that yielded a minimum value of .80 for both sensitivity and 1-specificity was GAF=74.50. See Table 12 for full results of the sensitivity, specificity, and AUCs across all measures for the psychiatrically referred young men.

*Summary***.** Overall, a trend from psychiatrically referred boys from adolescence to young adulthood is the decline in significant group differences between the ADHD and control groups in the functional and neuropsychological assessments. For example, although all of the CBCL data were present for both waves, and group differences between ADHD and control were present on three separate CBCL T-Scores (Total Competence, School, and Social T-Score) in adolescence, there were no group differences between ADHD and control in young adulthood among the psychiatrically referred young men. Only current GAF and FES Conflict remained significantly different between groups in young adulthood, with the ADHD group evincing lower GAF and higher FES conflict. No group differences emerged on the neuropsychological data in young adulthood, also consistent with the past two waves of psychiatrically referred boys, although appreciable levels of missing data limit the inferences that can be made. With regard to the classification statistics, only current GAF, CBCL Social and CBCL Activities T-Scores showed AUCs > .70. None of the neuropsychological test data achieved an AUC > .70.

Young Adulthood Pediatrically Referred Boys Neuropsychological Assessments. Among the pediatrically referred young men with ADHD (n = 53) and without ADHD (n = 46), all of the neuropsychological assessments were present except for Seidman CPT; however, in contrast to the psychiatric group which showed no group differences, there were significant group differences between the control and ADHD pediatric groups in several neuropsychological assessments, including on CVLT List A T-Score, $t(90) = 4.27$, $p < .001$, Stroop T Score, $t(90) = 3.36$, $p < .001$, and on both tests of academic achievement: WRAT-R reading, $t(91) = 3.55$, $p = .001$, and WRAT-R arithmetic, $t(91) = 5.88$, $p < .001$. However, none of the neuropsychological or performance based measures yielded AUCs > .80.

Young Adulthood Pediatrically Referred Boys Clinician and Parent Subjective Rating Scales. There were group differences on several subjective rating scales in the pediatric group, including on clinician-rated GAF, $t(125) = 5.51$, $p < .001$, FES Conflict, $t(72) = -2.15$, $p < .001$;

CBCL School T-Score, $t(12) = 9.25$, $p < .001$, and CBCL Social T-Score, $t(12) = 3.99$, $p < .001$. SAICA data were not collected for the pediatric group in young adulthood. The small samples and low power at this time point warrant cautious interpretation. The functional assessment with AUCs> .80 were CBCL School T-Score (AUC = .98). For CBCL School T-Score, the cut score that yielded a minimum value of .80 for both sensitivity and 1-specificity was 56, and for CBCL Social T-Score the cut score was also 56. See Table 13 for full results of the sensitivity, specificity, and AUCs across all measures for the pediatrically referred group in early adulthood.

*Summary***.** Overall, during adolescence and young adulthood for pediatrically referred boys, none of the neuropsychological tests showed an AUC > .80, while both CBCL School and SAICA School Problems maintained an AUC > .80. With regard to group differences between ADHD and control, there were far more significant group differences on neuropsychological and academic achievement test data among the pediatrically referred group compared to the psychiatrically referred group. The pattern of results, i.e., pediatric versus psychiatric differences, is consistent with the girls group.

Ancillary Analyses. To better understand the properties of the best performing category of measures – the subjective clinician and parent rating scales, cut points at optimal levels of sensitivity (90%) and specificity (90%) were calculated, and the proportion correctly classified was also reported for boys and girls across time. Please see Tables 18-21.

Furthermore, to better understand the hypothesis 1c findings which were in the opposite direction from what was hypothesized, a series of analyses comparing the two control groups was conducted.

Comparing Control Participants from Pediatric and Psychiatrically Referred Clinics. To determine whether the two control groups of participants (pediatric versus psychiatric) differed on the study variables of interest, a series of independent t-tests were conducted, treating control group referral source (Pediatric Control, Psychiatric Control) as between-subject variables and the neuropsychological, academic achievement, and subjective rating scales measures as dependent variables.

Childhood - Girls. During the childhood wave for girls, pediatric and psychiatric controls did not differ significantly in age. Furthermore, none of the independent t-tests yielded significant results on the neuropsychological tests except for modest differences on two measures: ROCF Copy Organization Score, $t(110) = 2.20$, $p = .03$, and Seidman CPT late responses, $t(118) = 2.11$, $p = .04$. Among tests of academic achievement, pediatric control girls scored higher than psychiatric controls on WRAT-R Reading scores, $t(119) = 4.57$, $p = .02$, but there were no differences in WRAT-R Arithmetic scores. Among subjective rating scales, pediatric and psychiatric control girls did not differ significantly on any measure.

Adolescent - Girls. During the adolescent wave for girls, pediatric and psychiatric controls did not differ on any neuropsychological tests. On tests of academic achievement, pediatric controls scored significantly higher on the WRAT-R Reading Scaled Score, t(102) = 2.58, p = .01. Among subjective rating scales, pediatric and psychiatric control adolescent girls differed on CBCL Social T-Score t(46) = 2.06, p = .05, with pediatric controls demonstrating higher t-scores than psychiatric controls.

Adolescent - Boys. During the adolescent wave for boys, pediatric and psychiatric controls also did not differ significantly in age. However, among the neuropsychological test data, pediatric and psychiatric control boys differed on several measures, with pediatric controls demonstrating more Seidman CPT correct responses, t(99) 2.65, p = .01, fewer Seidman late responses(99) = -2.67, p = .009, higher Stroop Scores, t(97) = 2.29, p = .02, lower

Perseverative, t(96) =-2.73, p = .008, and Non-perseverative Errors, t(96) = -2.57, p = .01. On tests of academic achievement, the control group of pediatrically referred control boys scored higher than psychiatrically referred controls on WRAT-R Reading, t(95) = 2.28, p = .02) and Arithmetic Scaled Scores, t(95) = 2.54, p = .001). On parent and clinician subjective rating scales, the two groups of control boys did not differ significantly on any measures.

Young Adult - Boys. During the young adulthood wave for boys, pediatric and psychiatric controls did not differ on any of the present neuropsychological tests (ROCF, CVLT, Stroop, WCST). The two control groups did differ on WRAT-R Reading Score, t(70) = 2.00, p = .05, and WRAT-R Arithmetic Score, t(70) = 3.63, p = .001), with the pediatric control group scoring higher than the psychiatric control group on both tests of academic achievement. Among the clinician and parent subjective rating scales, the two groups did not differ on current GAF or FES variables, but did differ on CBCL School T-Score, t(11) = 2.44, p = .03, and CBCL Social T-Score, t(11) = 2.61, p = .024, with the pediatric control group scoring higher on each measure. Given the smaller samples these results should be interpreted cautiously.

Summary. For girls, pediatric and psychiatric controls did not differ significantly on the majority of neuropsychological tests, but pediatric control girls scored significantly higher on academic achievement tests in reading in childhood and adolescence than psychiatric control girls. While there were no differences in parent and clinician subjective rating scales during childhood, pediatric control girls showing better social functioning in adolescence compared to psychiatric controls.

For boys, there were numerous differences between pediatric and psychiatric controls in neuropsychological test data, with pediatric boys showing better performance on the Seidman CPT, WCST, and Stroop. These differences disappeared by young adulthood. During both adolescence and young adulthood, pediatric controls showed higher scores on reading and arithmetic academic achievement tests. Thus, some group differences distinguished the pediatric versus psychiatric control populations, with the pediatric controls exhibiting slightly to moderately better performance than psychiatric controls.

Discussion

While the diagnosis of ADHD has one of the highest levels of diagnostic reliability in the DSM-IV (Regier et al., 2003), how ADHD is diagnosed and the frequency with which the disorder is diagnosed can vary considerably from setting to setting, despite the general consensus around what are best practices (Bukstein, 2010; Hechtman, 2000; Pelham, Fabiano, & Massetti, 2005; Pliszka, 2007a; Rapport, Chung, Shore, Denney, & Isaacs, 2000; Seixas, Weiss, & Muller, 2012; Sibley et al., 2012). Indeed, ADHD has been decried as both over- (Visser et al., 2014, Bruchmuller, Margraf, & Schneider, 2002) and under-diagnosed (Ginsberg et al., 2014) and there is evidence that clinicians may be inappropriately diagnosing ADHD as the result of implicit biases stemming from patient characteristics (Chan, Hopkins, Perrin, Herrerias, & Homer, 2005; Epstein et al., 2008; Wolraich, 1999). Furthermore, relatively little is presently known about the diagnostic efficiency of the various instruments used in the diagnosis of ADHD at different developmental time points (i.e., childhood versus adolescence).

With these issues in mind, the overall aim of the present study was to aid clinicians in selecting an efficient diagnostic assessment battery for ADHD during different developmental time points across the lifespan for boys and girls. This study investigated the diagnostic predictive abilities of common diagnostic tools of ADHD (e.g., stop signal tasks, working memory tests, continuous performance tests, clinician and parent rated subjective rating scales) across different developmental periods including childhood, adolescence, and young adulthood.

Sensitivity, specificity, and receiver operating characteristic (ROC) curve analysis were examined at each time point separately by gender. The predictive abilities of these assessment tools differed were also examined by referral setting—psychiatric versus pediatric clinics—since research is still emerging about the differences in the presentation and assessment of ADHD in psychiatric versus pediatric clinical settings.

Hypothesis 1a – Group Differences in Neuropsychological and Tests of Academic Achievement and Clinician and Parent Subjective Rating Scales

The data largely supported Hypothesis 1a, in that the ADHD group differed significantly from the control group in childhood, adolescence, and young adulthood on neuropsychological assessments, tests of academic achievement, and on clinician and parent subjective rating scales for both boys and girls. During childhood and adolescence for girls, the ADHD group performed worse than controls on the majority of neuropsychological assessments, tests of academic achievement, and subjective rating scales. A similar pattern was found for the boys during adolescence and also into early adulthood. This is consistent with decades of research demonstrating significant impairment in multiple domains across multiple environments for both boys and girls diagnosed with ADHD (for reviews, see Wehmeier, Schacht, & Barkley, 2010; Seidman, 2006; Spencer, Biederman, & Mick, 2007).

While current practice guidelines generally do not advocate for the use of cognitive testing or academic achievement testing in the diagnosis of ADHD (Bukstein, 2010; Seixas, Weiss, & Muller, 2012), the present study found that differences in academic achievement between control and ADHD groups was the most robust and stable finding across time. Boys and girls with ADHD consistently performed worse on tests of math and reading achievement compared to controls over time. While the differences between ADHD and control participants on performance-based neuropsychological tests are likely muted given the test administration environment (one-on-one testing environment; structured, discrete, tasks that last only several minutes, etc.), the test administration environment possibly exerts less of an impact on the results of academic achievement tests which measure prior learning. Thus, to both help differentiate ADHD from non-ADHD as well as understand the individuals academic abilities, clinicians diagnosing ADHD may wish to make use of existing academic achievement data or consider collecting this information either through testing or through teacher collateral contact.

Gender and Development. The overall findings of the present study indicate many similarities between boys and girls with ADHD compared to control boys and girls, with regard to the robustness of the tests of academic achievement and subjective rating scales over neuropsychological test performance, but some differences also emerged.

A notable gender difference occurred over time with regard to the stability of group differences in the neuropsychological test data; group differences in neuropsychological test performance were maintained over time in the boy's sample, but these differences in neuropsychological test performance and clinician and parent rating scales of functioning decreased over time between the ADHD and control girls. A meta-analytic review (Hasson & Fine, 2012) found a similar pattern when comparing boys and girls with ADHD to same-sex controls on several psychological tests including continuous performance tests: the difference between ADHD and control boys was significantly larger than the differences between ADHD and control girls in performance on continuous performance tests. Hasson and Fine (2012) argued that this finding may have been due to within-sex biases in the evaluation of ADHD and study sample selection biases.

For the present study, one possible explanation for these within- and between-sex differences may be the neurodevelopmental processes that mark the transition between developmental stages of the lifespan. In general, ADHD is characterized by a delay in cortical maturation, especially in areas of the prefrontal cortex, known to be involved in controlling cognitive processes involving attention, executive functioning, and motor planning (Shaw et al., 2007). Since the present study examined the girls in their transition from childhood to adolescence, and the boys from adolescence to young adulthood, it is plausible that the two groups would have been undergoing different stages of cortical maturation, wherein the ADHD girls may have been "catching up" in cortical maturation to the control girls from childhood to adolescence, whereas the ADHD boys in the transition from adolescence to adulthood may have already passed the period of cortical thinning and maturation that characterizes adolescence (Shaw et al., 2007). Thus, these gender differences may have emerged as a function of the age of the participants and the processes of neuropsychological development that are presumed to occur in ADHD across the lifespan.

Hypothesis 1b – Diagnostic Classification

The results also supported Hypothesis 1b, in that parent and clinician subjective rating scales (e.g., CBCL, GAF, FES, SAICA) had higher discriminatory accuracy than performance-based assessments (neuropsychological tests). Furthermore, the tests of academic achievement also showed superior diagnostic accuracy to neuropsychological tests. Indeed, the parent and clinician subjective rating scales had higher overall diagnostic accuracy than neuropsychological and performance-based test data at all time points. Despite significant group differences between ADHD and control groups, as documented in Hypothesis 1a, the neuropsychological tests uniformly had low predictive power towards an ADHD diagnosis in both girls and boys. These results are consistent with others who have questioned the use of neuropsychological instruments commonly used in the ADHD assessment process (e.g., computerized tests of attention, continuous performance tasks, executive function tasks) for failing to show adequate sensitivity and specificity to ADHD (Werry, Elkind, & Reeves, 1987; Barkley, 1991; Rapport et al., 2000; Pliszka, 2007b).

The stark underperformance of the neuropsychological test data compared to the academic achievement and parent and clinician subjective rating scales was a striking finding of the present study. While ADHD is considered a neurodevelopmental disorder with associated deficits in executive functioning (an average effect size differences of 0.59 on clinic-based objective measures) (Sonuga-Barke, 2002; Frazier et al., 2004), the utility and ecological validity of using neuropsychological tests of EF to diagnose ADHD has been called into question, especially with regard to differential diagnosis (Barkley & Murphy, 2010; McGee, Clark & Symons, 2000; Hall et al., 2016). Even though significant differences between ADHD and control groups exist across these stages - individuals with ADHD consistently show executive function deficits (e.g., relating to sustained attention, response inhibition, working memory, and processing speed) relative to non-ADHD control participants - these EF deficits, as captured by neuropsychological testing, lack of adequate discriminatory power and therefore may not be useful for diagnosing ADHD. In fact, the use of EF tests as part of the ADHD diagnostic process is generally not encouraged by practice guidelines, yet the use of neuropsychological tests to aid diagnosis continues to proliferate (Bukstein, 2010; Wolraich et al., 2010). The findings of the present study are in line with the position that subjective rating scales from parents and clinicians should be prioritized over neuropsychological tests in the ADHD diagnostic process (Barkley, 2006).

In contrast, many of the parent and clinician subjective rating scales achieved minimal standards of an acceptable test (i.e., AUC > .70) while the neuropsychological tests rarely met this standard. In addition, the AUCs of subjective rating scales related to school (e.g., CBCL School, SAICA School Behavior Problems) consistently had the highest AUC's, next to clinician-rated GAF, over time from for both boys and girls, regardless of developmental stage. These findings are consistent with the literature, which document that individuals with ADHD are often impaired in the school and social domains throughout early development and into adulthood (Wehmeier, Schacht & Barkley, 2010; DuPaul, McGoey, Eckert & Vanbrakle; Strine et al., 2006). While the finding regarding the clinician-rated GAF may be subject to the flaw of having common method variance (i.e., the same clinician who is interviewing the parents about the symptoms is also the clinician rating the GAF) and symptoms are taken into account in determining the GAF, the findings regarding the usefulness of the CBCL School and SAICA School Behavior Problems scales both underscore the usefulness of assessing impairment when diagnosing ADHD.

However, at present, impairment is not always considered in the diagnostic picture and guidelines for assessing impairment associated with ADHD have only recently begun to be developed (Lewandowski, Lovett, & Gordon, 2016). In the past, impairment has often been commingled with measuring the number and frequency of inattentive or hyperactive symptoms in various settings, with a higher symptom count presumed to be linked to greater impairment, yet this has been shown to not be the case (Gordon et al., 2006). In fact, Gordon and colleagues (2006) demonstrated that ADHD symptoms only account for, at most, 25% of the variance in impairment.

Despite this research suggesting the importance of considering impairment in an ADHD diagnosis, the latest edition of the DSM (DSM-5) removed the impairment-based criterion (Criterion D, in DSM-IV) as a requirement to diagnose ADHD, replacing impairment with softer language stating that ADHD symptoms should “interfere with or reduce the quality of functioning” (APA, 2013). The results of the present study suggests that however clinicians define functional interference or quality reduction, given the stark superiority of parent and clinician subjective rating scales in aiding with a diagnosis of ADHD, compared to other performance-based tests, clinicians should rely heavily upon subjective rating scales of different functional domains into their diagnostic battery. Future research should also strive to provide clearer guidelines in determining how best to quantify functional interference or quality reduction (e.g., relative to what standard).

A departure from this pattern of clinician and parent subjective rating scales showing superiority over test-based data was the performance of the assessments of academic achievement (WRAT-R Arithmetic and Reading). The WRAT-R subscales were more predictive towards a diagnosis of ADHD than the neuropsychological tests and showed stable differences between the ADHD and control groups for both boys and girls over time. This may be because standardized tests of academic achievement may be more sensitive to the general effects of ADHD symptoms on learning and retention as well as the more specific effects of ADHD symptoms on actual test performance (Frazier et al., 2007), especially when compared to neuropsychological or EF tests, which are typically narrower in scope. This finding bolsters the case for considering including standardized tests of achievement in an ADHD assessment, especially if there are academic impairments as noted by either parents or teachers. One significant limitation of the present study is that data from teachers (e.g., rating scales, symptom inventories) were not collected. Since impairment in the school domain and lower academic achievement is almost ubiquitous for children with ADHD (Barbaresi et al., 2007), clinicians should endeavor to solicit observations from teachers regarding academic achievement when trying to establish a diagnosis of ADHD, as currently recommended by both the *AAP* and *AACAP* (Pliszka, 2007a; Subcommittee on Attention-Deficit/Hyperactivity Disorder, 2011).

Hypothesis 1c – Impact of Ascertainment Site

The data did not support Hypothesis 1c*,* that diagnostic accuracy of the assessments would be higher in psychiatrically referred samples compared to pediatrically referred sample; instead, rather surprisingly, there were far fewer significant neuropsychological test differences between the ADHD and control groups from the *psychiatric* referral setting for both boys and girls. Within the psychiatrically referred girls group, only one out of the 10 neuropsychological tests were significantly different between ADHD and control in childhood; in adolescence, none of the six present tests were significantly different between ADHD and control. The pattern was similar for the psychiatrically referred boys groups: the ADHD and control groups did not differ on any of the neuropsychological in childhood or adolescence.

In contrast, among the pediatrically referred groups for both boys and girls, differences in neuropsychological test data emerged between ADHD and control (e.g., differences in 13 out of 14 tests for girls in childhood and eight out of 14 tests for boys in adolescence). These differences declined over time (e.g., differences in three out of six tests available for girls in adolescence and differences in two out of six for boys in young adulthood). Overall, parent and clinician subjective rating scales had higher AUCs than neuropsychological tests and tests of academic achievement for both boys and girls, and for both pediatric and psychiatrically-referred groups. However, here again, the AUC’s of the parent and clinician subjective rating scales were overall higher in the pediatric group compared to the psychiatric group, and more measures achieved AUCs greater than .80 in the pediatric group compared with the psychiatric group for both boys and girls across time. Thus, these results provide further information on differences regarding the presentation of ADHD in pediatric versus psychiatric clinic settings and complicate the already inconsistent existing literature.

Within the literature, mixed findings have been reported regarding the severity of the ADHD presentations in pediatric versus psychiatric clinics. It seems intuitive to suggest that patients referred from pediatric and primary care clinics for ADHD assessment will represent less severe cases compared to patients referred from psychiatric clinics. This was shown not to be the case by Busch et al. (2002) who found nearly identical levels of ADHD symptomatology, comorbidities, and impairments between the groups (Busch et al., 2002). Similar findings of comparability between treatment settings have been reported by other researchers (Rothe et al., 2016; Zima et al., 2010). However, other researchers have reported differences between psychiatric and pediatric clinics in terms of the presentation of ADHD therein (Kolar, Hechtman, Francoeur & Pateterson, 2012; Rothe et al., 2016), highlighting more severe ADHD in psychiatric clinics.

In the present study, the reverse pattern was found, with regard to neuropsychological performance and assessments of socioemotional and school and family functioning: boys and girls with ADHD referred from *psychiatric* settings overall did *not* differ significantly in performance from control children and adolescents on the majority of neuropsychological tests. In contrast, children from referred from pediatric settings demonstrated the anticipated group differences over time. Furthermore, parent rating scales of functioning (e.g., CBCL, SAICA) also demonstrated better diagnostic accuracy in the pediatric population compared to the psychiatric population.

Several mechanisms may explain this unexpected pattern of results. First, the characteristics of patients seen in pediatric versus psychiatric clinics can vary significantly, and the roles of pediatricians and other primary care physicians (e.g., family practice doctors) versus child psychiatrists are increasingly overlapping in the mental health treatment of children and adolescents. For example, given the documented shortage of child psychiatrists in the United States (Thomas & Holzer, 2006), the relatively high prevalence rates of childhood ADHD and the limited mental health resources for children and adolescents (Olfson, Blanco, Wang, Laje, & Correll, 2014), pediatricians and other primary care physicians have been required to play a larger role in their care of youth with ADHD (Brown et al., 2001; Olfson, Blanco, Wang, Laje, & Correll, 2014; Subcommittee on Attention-Deficit/Hyperactivity Disorder, Steering Committee on Quality Improvement and Management, 2011). Thus, ADHD managed in pediatric clinics may constitute a relatively more severe constellation of symptoms compared to the other common presenting problems, whereas ADHD in psychiatric clinics may constitute a relatively *less* severe presenting problem (e.g., relative to pediatric bipolar disorder, conduct disorder, etc.), therefore, partially explaining the greater diagnostic accuracy in pediatric compared to psychiatric referrals.

Another potential explanation for why classification rates were poorer in the psychiatrically referred group is that the control group participants in both settings were allowed, at baseline, to have coexisting psychiatric disorders (yet not ADHD). The same was allowed for the pediatrically referred control group, which would provide theoretically equivalent samples; however, the control group patient populations of the two referral settings differed significantly.

As an example, analyses revealed that the pediatric girls in this study had better academic achievement and better social functioning than the psychiatric control girls during the childhood period, and pediatric boys in this study had better neuropsychological test data and academic achievement than psychiatric boys during the adolescent period.

Lastly, these results should also be understood in light of the comparability of the two control groups. In some ways, the pediatric control group represented "supernormal" controls. For instance, the mean WRAT-R Reading Score for pediatrically referred control girls was nearly one standard deviation above the population mean. Thus, group differences between the two control populations may have contributed to the better diagnostic accuracy rates in the pediatric compared to psychiatric referral sources, since the pediatric controls exhibited slightly to moderately better scores on neuropsychological tests, tests of academic achievement, and parent and clinician subjective rating scales than psychiatric controls.

Limitations and Future Directions

Confounds Arising from Naturalistic Design. Since this study was a naturalistic, longitudinal study, treatments were not assigned to the subjects and were not a factor in recruitment and study participation. Treatment status varied freely at baseline among the children diagnosed with ADHD: approximately half of the children received pharmacological treatment, some received psychosocial interventions (e.g., behavioral therapy), others received a combined treatment approach, and some remained untreated over time (e.g., never entered pharmacological or psychosocial treatment). Because of this, we cannot fully account for the effect of treatment(s), either positive or negative, given the limited information that was known about the nature and course of treatment. For example, data were not collected on whether or not the study participants had taken any medication on the day of testing that may have affected testing results.

It is also possible that the parent and clinician subjective rating scales may have been affected by treatment and medication status (potentially improving the performance of the ADHD participants). If accurate, this would imply that the differences between groups might have been even greater if the children were untreated (Shaw et al., 2012). In any case, future research is needed to parse the effects of both treated and untreated populations of ADHD across time and to understand the effects of treatment on diagnostic classification metrics for neuropsychological tests and measure of functioning.

Comorbidities. Another limitation of the study due to its naturalistic design was the fact that a portion of the sample of both the control groups as well as the ADHD groups was also diagnosed with other psychiatric disorders (e.g., anxiety, depression, learning disorders). Thus, it may be possible that the psychiatric comorbidities may have influenced the study findings. However, this limitation is somewhat ameliorated by the fact that the lifetime prevalence of experiencing psychiatric comorbidities seems to be the norm, rather than the exception, especially for ADHD (Brassett-Harknett & Butler, 2007), and that excluding participants with comorbidities would have led to lower ecological validity. Indeed, a recent nationally representative survey of N= 10,123 adolescents aged 13-18, showed that 40% of adolescents with one class of psychiatric disorder (e.g., anxiety disorders) also met criteria for another class, e.g., mood, behavior, or substance use disorders, (Brassett-Harknett & Butler, 2007). Thus, future research in this area should take comorbidities into account since they are highly prevalent in the clinical picture of ADHD.

Confounds Arising from Participant Selection. Given the participant characteristics selected for at baseline (e.g., race, SES, IQ), the results of this study may not generalize to other populations since the full range of ADHD was not examined. For example, children with intellectual delays or intellectual disabilities were excluded from this study. Furthermore, children from lower SES echelons were also excluded from this study, truncating the full picture of ADHD across socioeconomic strata. More research is needed to broaden the scope of our understanding of ADHD in non-white ethnic groups, in lower SES strata, and in children with intellectual delays.

Test Selection. Since the present study made use of an existing dataset to explore hypotheses, the tests and measures were fixed and therefore not comprehensive to the full range of tests that may comprise a diagnostic evaluation for ADHD. Attempts were made to choose representative measures from neuropsychological, academic achievement, and parent and clinician subjective rating scales within the dataset, however the classification metrics may have been affected by the tests selected, and the results may have been different had other measures been included.

Limited Age Range. The present study also did not examine the full range of development (e.g., preschool, middle and older adulthood). Given the neurodevelopmental roots of ADHD, examining development during the preschool years is an especially worthy task for future research. Similarly, examining neuropsychological differences between ADHD and controls later in the lifespan may also help to provide clinically useful information. Currently, the literature is very sparse with regard to knowledge on the impact of ADHD on functioning in senescence, but the existing research points to decrements in quality of life from the accumulative impact of ADHD over the lifespan, including, poorer social functioning, greater emotional and social loneliness and a smaller social support network (Brod, Schmitt, Goodwin, Hodgkins, & Niebler, 2011; Michielsen et al., 2013).

Rater Bias. Another limitation of this study is that the majority of the parent and clinician subjective rating scales (e.g., CBCL, SAICA, FES) as well as the diagnostic interviews were completed by one parent, and in all cases, the mothers of the participants were the ones providing the information. Furthermore, diagnostic interviews (e.g., SCID) were only administered to the participants themselves if they were over the age of 18; otherwise, the KSADS-PL interview was administered to the mothers of the participants. Observations and rating scales from teachers and/or fathers/other parents and caregivers were not collected at any time point. This overreliance on one parent's report introduces the possibility of rater bias. In a similar vein, the usage of the GAF as a rating scale of functioning represents another possible introduction of rater bias, as the GAF was completed by only the clinician. An additional problem with using the GAF is that it conflates impairment with the number of symptoms, i.e., symptoms are taken into consideration when deciding a GAF score (Aas, 2010), when research has shown that ADHD symptoms are not necessarily highly correlated with impairment (Gordon, Antshel, & Faraone, 2006; Gathje, Lewandowski, & Gordon, 2008).

Limitations Arising from Statistical Analyses and Missing Data. The results of the present study are also limited by the missing data across developmental periods in neuropsychological data as well as parent and clinician subjective rating scales. Thus, the study may have been underpowered to detect significance, and Type II errors are possible. On the other hand, the present study also made use of multiple between- and within-group analyses, without statistical corrections for multiple comparisons, and therefore the study results may also be at increased risk for Type I errors.

No consideration of ADHD diagnostic continuation. In the present study, participants with ADHD were classified at baseline, and whether or not they continued to meet diagnostic criteria for ADHD was not considered at follow-up; in other words, ADHD and control status was determined at baseline and these classifications were maintained at follow-up. It is possible that some of the children from the control group may have been diagnosed with ADHD at follow-up; similarly, it is also possible that children from the ADHD group may have "outgrown" their ADHD diagnosis by adolescence or young adulthood. The literature on the persistence versus remittance of ADHD is complex and contested depending on the definition of persistence, the criteria required (DSM versus ICD), and the informant (e.g., self- versus parent), among other factors. Estimates of the persistence of ADHD range from 29% to approximately 79% for both boys and girls (Guelzow, Loya, & Hinshaw, 2016; Cheung et al., 2015), yet despite the remittance of the ADHD diagnostic label, research has also shown that functional impairments remain even without the ADHD diagnosis (Miller, Ho, & Hinshaw, 2012; McAuley, Crosbie, Charach & Schachar, 2013). Thus, these data are still informative and useful towards understanding developmental differences in participants who were diagnosed with ADHD in childhood, compared to controls, even if they no longer meet the criteria later in life. Further research, however, is needed to parse the differences between persistent and remittent ADHD across the lifespan and how this may affect the diagnostic accuracies of various measures.

Conclusions

In conclusion, the present study contributes to our understanding of neuropsychological test performance, tests of academic achievement, and parent and clinician subjective rating scales in different domains for both boys and girls in childhood, adolescence, and young adulthood, and the utility of these tests in different referral settings. Overall, neuropsychological tests and tests of academic achievement show less diagnostic accuracy than parent and clinician subjective rating scales, particularly in the school and social domains, when diagnosing ADHD. In choosing an assessment or diagnostic battery, regardless of the age of the individual, clinicians should prioritize rating scales of school and social functioning. These functional domains may also demonstrate better diagnostic accuracy in the pediatric population compared to the psychiatric population, but more research is needed to understand these differences.

Table 1.
Sample Characteristics of All Participants Across All Waves

	ADHD Girls Study				ADHD Boys Study			
	Age of Participants During Waves							
Age of Participants	Childhood **		Adolescence		Adolescence *		Young Adulthood *	
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N
ADHD	11.24 (3.37)	140	16.35 (3.74)	123	14.55 (3.02)	130	21.63 (3.33)	112
Control	12.22 (2.96)	120	17.08 (3.02)	112	15.50 (3.72)	113	22.75 (3.97)	105

Note. Significant age differences between the ADHD and Control group are indicated by asterisks at each developmental stage.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2.
Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning Administered to Girls with and without ADHD

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	8.62 (3.50)	7.57 (3.94) *	242	0.58	.51 - .65	0%	100%
Delay Score	7.43 (4.35)	6.14 (3.89) *	242	0.58	.51 - .65	0%	100%
Seidman CPT							
Correct Responses	25.01 (4.81)	22.98 (5.74) **	256	0.60	.54 - .67	1%	99%
Omissions	2.48 (3.29)	3.52 (3.76)*	254	0.59	.52 - .65	0%	100%
Late Responses	2.54 (2.47)	3.49 (3.41)*	256	0.56	.50 - .63	0%	99%
False Alarms	0.13 (0.38)	0.21 (0.49)	252	0.53	.46 - .60	0%	100%
CVLT List A T-Score	36.91 (15.04)	32.64 (15.18)	23	0.59	.36 - .83	0%	100%
Stroop Color-Word T-Score	49.30 (7.19)	45.66 (7.73)***	254	0.65	.58 - .72	2%	91%
WCST							
Perseverative Errors	15.80 (10.75)	19.62 (13.83)*	203	0.57	.49 - .65	0%	100%
Nonperseverative Errors	16.04 (10.23)	18.31 (13.55)	203	0.53	.45 - .61	0%	100%
WRAT-R Scaled Score							
Reading	109.60 (10.88)	100.12 (15.25)***	256	0.69	.63 - .76	0%	84%
Arithmetic	106.12 (15.23)	95.47 (13.32)***	258	0.69	.63 - .76	1%	91%
GAF - Current	69.45 (4.71)	58.83 (6.37)***	260	0.92	.88 - .95	13%	56%
FES T-Score							
Expressiveness	50.32 (13.40)	49.50 (12.07)	253	0.53	.46 - .60	0%	100%
Conflict	49.84 (11.76)	54.92 (11.55)**	253	0.65	.59 - .72	2%	92%
Cohesion	56.61 (13.43)	49.01 (16.35)***	253	0.62	.55 - .69	0%	99%
CBCL T-Score							
Competence	53.45 (15.71)	44.04 (16.72)***	207	0.75	.69 - .82	3%	96%
School	50.42 (6.16)	38.15 (9.31)***	203	0.86	.81 - .91	51%	95%
Social	50.43 (6.32)	43.97 (8.65)***	206	0.74	.67 - .81	2%	86%
Activities	49.19 (5.72)	46.47 (7.85)**	210	0.60	.53 - .68	0%	96%
SAICA							
School Behavior Problems	1.48 (0.58)	2.60 (0.79)***	239	0.85	.80 - .90	58%	96%
Spare Time Problems	1.37 (0.58)	2.14 (0.78)***	239	0.77	.71 - .83	29%	98%
Problems with Peers	1.34 (0.53)	2.09 (0.79)***	239	0.76	.70 - .82	28%	97%
Problems with the Opposite Sex	1.22 (0.55)	1.62 (0.79)**	12	0.64	.54 - .74	10%	98%
Problems with Siblings	1.48 (0.61)	1.97 (0.71)***	213	0.68	.61 - .76	21%	96%
Problems with Parents	1.30 (0.48)	1.98 (0.48)***	239	0.74	.67 - .80	24%	99%

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3.

Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning Administered to Adolescent Girls with and without ADHD

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	11.66 (13.72)	8.69 (3.56)*	204	0.64	.56 - .71	0%	100%
Delay Score	9.01 (3.65)	8.13 (3.89)	204	0.56	.49 - .64	0%	100%
Seidman CPT							
Correct Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Omissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Late Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
False Alarms	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CVLT List A T-Score	48.53 (13.00)	47.08 (15.76)	214	0.52	.44 - .59	0%	100%
Stroop Color-Word T-Score	45.97 (7.11)	42.18 (8.11)***	214	0.63	.56 - .71	0%	97%
WCST							
Perseverative Errors	8.24 (5.04)	11.85 (9.66)**	195	0.62	.54 - .70	1%	90%
Nonperseverative Errors	9.81 (11.39)	11.90 (10.35)	195	0.61	.54 - .69	0%	100%
WRAT-R stroopScaled Score							
Reading	108.62 (8.75)	101.68 (12.41)***	215	0.67	.60 - .74	1%	88%
Arithmetic	108.10 (12.04)	95.79 (12.95)***	214	0.75	.69 - .81	1%	80%
GAF - Current	66.31 (5.53)	57.23 (7.59)***	233	0.84	.80 - .89	8%	68%
FES T-Score							
Expressiveness	57.29 (11.90)	56.45 (12.36)	90	0.52	.40 - .64	0%	100%
Conflict	44.37 (11.01)	51.52 (11.20)**	89	0.59	.47 - .71	0%	93%
Cohesion	58.93 (11.48)	53.53 (16.45)	90	0.69	.58 - .80	4%	87%
CBCL T-Score							
Competence	N/A	N/A	N/A	N/A	N/A	N/A	N/A
School	50.42 (5.84)	39.28 (9.55)***	73	0.82	.72 - .93	10%	76%
Social	50.69 (4.75)	44.06 (8.73)***	99	0.72	.62 - .82	0%	75%
Activities	46.90 (6.58)	45.72 (7.06)	102	0.55	.44 - .66	0%	100%
SAICA							
School Behavior Problems	1.69 (0.86)	2.83 (0.84)**	23	0.81	.64 - .98	17%	100%
Spare Time Problems	1.38 (0.51)	2.42 (0.99)**	23	0.79	.61 - .98	50%	100%
Problems with Peers	1.62 (0.65)	2.33 (0.89)*	23	0.73	.53 - .93	17%	100%
Problems with the Opposite Sex	1.08 (0.28)	1.33 (0.49)	23	0.63	.40 - .85	17%	100%
Problems with Siblings	1.23 (0.44)	2.00 (0.85)**	23	0.76	.56 - .95	33%	100%
Problems with Parents	1.38 (0.51)	2.00 (1.04)	23	0.66	.44 - .88	25%	100%

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
**p* < .05. ***p* < .01. ****p* < .001.

Table 4.
Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning Administered to Adolescent Boys with and without ADHD

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	10.90 (3.01)	8.75 (3.94)***	211	0.66	.59 - .74	0%	96%
Delay Score	9.38 (4.03)	7.69 (4.41)**	199	0.61	.53 - .68	0%	100%
Seidman CPT							
Correct Responses	26.86 (3.26)	25.66 (4.00)*	219	0.60	.52 - .67	0%	98%
Omissions	1.39 (2.01)	2.33 (2.83)**	219	0.61	.53 - .68	0%	96%
Late Responses	1.75 (2.06)	2.02 (1.86)	219	0.57	.49 - .64	0%	100%
False Alarms	0.11 (0.31)	0.29 (1.06)	219	0.53	.46 - .61	0%	97%
CVLT List A T-Score	47.51 (13.36)	45.82 (15.67)	73	0.52	.38 - .65	0%	100%
Stroop Color-Word T-Score	47.37 (6.99)	42.66 (7.79)***	215	0.66	.59 - .73	1%	88%
WCST							
Perseverative Errors	10.28 (7.51)	15.54 (11.19)***	212	0.67	.59 - .74	2%	89%
Nonperseverative Errors	10.54 (7.30)	17.09 (13.32)***	212	0.66	.58 - .73	3%	87%
WRAT-R Scaled Score							
Reading	111.76 (10.00)	101.83 (16.35)***	205	0.70	.63 - .77	0%	88%
Arithmetic	109.41 (15.47)	93.49 (18.02)***	205	0.75	.68 - .81	4%	80%
GAF - Current	69.48 (5.94)	56.20 (7.43)***	235	0.92	.89 - .96	12%	55%
FES T-Score							
Expressiveness	54.90 (12.81)	53.71 (13.00)	205	0.52	.45 - .60	0%	100%
Conflict	47.47 (11.45)	54.74 (11.45)***	206	0.65	.58 - .73	4%	84%
Cohesion	58.80 (12.73)	49.60 (18.63)***	206	0.67	.60 - .74	0%	96%
CBCL T-Score							
Competence	57.46 (13.91)	55.74 (24.09)	175	0.65	.57 - .73	0%	100%
School	50.61 (6.21)	44.70 (16.39)**	175	0.78	.71 - .85	0%	99%
Social	53.99 (13.42)	52.69 (22.55)	175	0.64	.56 - .72	0%	100%
Activities	51.07 (7.43)	50.02 (14.17)	175	0.59	.50 - .67	0%	100%
SAICA							
School Behavior Problems	1.69 (0.69)	2.75 (0.69)***	166	0.84	.78 - .90	67%	87%
Spare Time Problems	1.44 (0.63)	2.12 (0.78)***	167	0.74	.77 - .82	27%	93%
Problems with Peers	1.46 (0.56)	2.18 (0.76)***	167	0.75	.68 - .83	32%	97%
Problems with the Opposite Sex	1.40 (0.58)	1.50 (0.75)	125	0.52	.41 - .62	0%	100%
Problems with Siblings	1.55 (0.69)	2.13 (0.84)***	149	0.69	.61 - .78	23%	91%
Problems with Parents	1.28 (0.48)	1.93 (0.79)***	167	0.73	.66 - .81	19%	98%

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 5.

Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning Administered to Young Adult Men with and without ADHD

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	10.86 (2.81)	10.04 (3.12)	158	0.59	.50 - .68	0%	100%
Delay Score	9.76 (3.69)	9.58 (3.60)	158	0.53	.44 - .62	0%	100%
Seidman CPT							
Correct Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Omissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Late Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
False Alarms	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CVLT List A T-Score	48.22 (13.12)	38.23 (17.36)***	160	0.66	.58 - .75	0%	84%
Stroop Color-Word T-Score	48.29 (8.15)	43.83 (9.03)**	158	0.64	.55 - .72	0%	95%
WCST							
Perseverative Errors	8.00 (5.94)	10.90 (7.63)*	137	0.66	.56 - .75	1%	96%
Nonperseverative Errors	8.13 (7.38)	11.35 (9.58)*	137	0.63	.53 - .72	1%	96%
WRAT-R Scaled Score							
Reading	111.36 (7.87)	104.10 (14.23)***	161	0.67	.58 - .75	1%	88%
Arithmetic	108.60 (12.96)	95.95 (16.39)***	161	0.73	.65 - .81	3%	80%
GAF - Current	66.40 (6.07)	59.08 (7.53)***	214	0.79	.73 - .85	5%	75%
FES T-Score							
Expressiveness	52.21 (14.32)	52.08 (13.87)	130	0.51	.41 - .61	0%	100%
Conflict	43.21 (10.44)	49.20 (12.37)**	130	0.60	.50 - .70	0%	94%
Cohesion	58.32 (13.25)	49.11 (22.06)**	130	0.64	.55 - .74	0%	99%
CBCL T-Score							
Competence	N/A	N/A	N/A	N/A	N/A	N/A	N/A
School	48.46 (6.44)	39.00 (8.55)**	24	0.83	.65 - 1.00	0%	68%
Social	50.15 (6.73)	39.36 (9.37)**	25	0.85	.70 - 1.00	11%	67%
Activities	45.38 (7.85)	37.82 (9.47)*	28	0.73	.55 - .91	0%	65%
SAICA							
School Behavior Problems	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spare Time Problems	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with Peers	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with the Opposite Sex	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with Siblings	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with Parents	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
**p* < .05. ***p* < .01. ****p* < .001.

Table 6.
Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning– Psychiatrically Referred Girls in Childhood

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	7.85 (3.23)	8.14 (3.93)	108	0.48	.37 - .59	0%	100%
Delay Score	6.60 (3.81)	6.26 (4.06)	108	0.53	.42 - .64	0%	100%
Seidman CPT							
Correct Responses	24.29 (5.26)	24.42 (5.50)	113	0.48	.37 - .59	0%	99%
Omissions	2.64 (3.62)	2.70 (3.22)	113	0.51	.41 - .62	0%	100%
Late Responses	3.05 (2.73)	2.88 (3.26)	113	0.45	.34 - .56	0%	99%
False Alarms	0.13 (0.34)	0.22 (0.56)	113	0.52	.41 - .62	0%	100%
CVLT List A T-Score	45.33 (4.93)	36.60 (19.88)	6	0.53	.11 - .96	0%	100%
Stroop Color-Word T-Score	49.31 (7.35)	45.66 (8.97)*	112	0.62	.52 - .72	2%	91%
WCST							
Perseverative Errors	17.56 (11.34)	19.27 (13.34)	93	0.52	.40 - .63	0%	100%
Nonperseverative Errors	17.88 (11.99)	16.98 (11.95)	93	0.47	.35 - .59	0%	100%
WRAT-R Scaled Score							
Reading	107.11 (10.13)	101.89 (15.10)*	115	0.60	.50 - .71	0%	84%
Arithmetic	104.49 (13.70)	98.95 (13.29)*	115	0.61	.51 - .72	1%	91%
GAF - Current	69.60 (4.80)	58.02 (6.98)***	116	0.93	.88 - .97	13%	56%
FES T-Score							
Expressiveness	50.36 (14.27)	48.87 (13.12)	112	0.55	.44 - .65	0%	100%
Conflict	49.92 (11.08)	56.02 (12.38)**	112	0.68	.58 - .78	2%	92%
Cohesion	57.30 (14.07)	47.92 (17.39)**	112	0.64	.54 - .74	0%	99%
CBCL T-Score							
Competence	54.81 (14.07)	44.75 (11.75)***	94	0.76	.66 - .85	3%	96%
School	49.79 (6.98)	37.88 (9.38)***	94	0.84	.76 - .92	9%	67%
Social	49.51 (7.32)	44.18 (9.27)**	95	0.69	.59 - .80	2%	86%
Activities	49.82 (5.33)	47.70 (6.50)	97	0.60	.49 - .71	0%	96%
SAICA							
School Behavior Problems	1.36 (0.52)	2.63 (0.85)***	105	0.87	.80 - .94	61%	98%
Spare Time Problems	1.28 (0.46)	2.00 (0.78)***	105	0.76	.66 - .85	26%	100%
Problems with Peers	1.26 (0.45)	2.07 (0.84)***	105	0.78	.69 - .86	28%	100%
Problems with the Opposite Sex	1.15 (0.46)	1.62 (0.80)*	51	0.67	.53 - .82	0%	100%
Problems with Siblings	1.46 (0.55)	2.10 (0.80)***	96	0.72	.62 - .82	33%	98%
Problems with Parents	1.26 (0.45)	2.00 (0.85)***	105	0.75	.65 - .84	0%	100%

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 7.
Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning– Pediatrically Referred Girls in Childhood

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	9.28 (3.61)	7.12 (3.91)**	132	0.65	.56 - .74	0%	98%
Delay Score	8.15 (4.67)	6.04 (3.79)**	132	0.63	.53 - .72	0%	100%
Seidman CPT							
Correct Responses	25.60 (4.36)	21.84 (5.71)***	141	0.71	.62 - .79	4%	85%
Omissions	2.35 (3.01)	4.17 (4.03)**	139	0.65	.55 - .74	3%	93%
Late Responses	2.12 (2.16)	3.97 (3.46)***	141	0.66	.57 - .75	1%	88%
False Alarms	0.13 (0.42)	0.21 (0.44)	137	0.55	.45 - .64	0%	100%
CVLT List A T-Score	33.75 (16.56)	30.44 (12.72)	15	0.60	.32 - .89	0%	80%
Stroop Color-Word T-Score	49.28 (7.10)	45.67 (6.65)**	140	0.68	.59 - .76	3%	81%
WCST							
Perseverative Errors	14.45 (10.16)	19.96 (14.40)*	108	0.62	.51 - .72	0%	95%
Nonperseverative Errors	14.63 (8.49)	19.59 (14.92)*	108	0.57	.47 - .68	0%	97%
WRAT-R Scaled Score							
Reading	111.68 (11.12)	98.65 (15.32)***	139	0.75	.67 - .83	4%	74%
Arithmetic	107.46 (16.36)	92.63 (12.75)***	141	0.76	.68 - .84	5%	74%
GAF - Current	69.33 (4.68)	59.49 (5.79)***	142	0.91	.86 - .96	11%	55%
FES T-Score							
Expressiveness	50.29 (12.78)	50.01 (11.22)	139	0.52	.42 - .61	0%	100%
Conflict	49.77 (12.37)	54.03 (10.83)*	139	0.63	.53 - .72	4%	91%
Cohesion	56.05 (12.97)	49.89 (15.51)*	139	0.61	.51 - .70	0%	99%
CBCL T-Score							
Competence	52.33 (16.98)	43.42 (20.17)*	111	0.75	.66 - .85	0%	98%
School	50.95 (5.40)	38.41 (9.32)***	107	0.87	.81 - .94	7%	68%
Social	51.19 (5.30)	43.78 (8.12)***	109	0.78	.70 - .87	5%	79%
Activities	48.66 (6.03)	45.35 (8.81)*	111	0.60	.50 - .71	0%	98%
SAICA							
School Behavior Problems	1.59 (0.62)	2.58 (0.74)***	132	0.82	.75 - .89.	49%	96%
Spare Time Problems	1.44 (0.56)	2.25 (0.78)***	132	0.78	.70 - .86	52%	93%
Problems with Peers	1.41 (0.59)	2.11 (0.76)***	132	0.75	.67 - .83	32%	95%
Problems with the Opposite Sex	1.28 (0.60)	1.62 (0.79)*	75	0.62	.49 - .74	0%	97%
Problems with Siblings	1.51 (0.67)	1.86 (0.61)**	115	0.66	.56 - .76	6%	96%
Problems with Parents	1.33 (0.51)	1.96 (0.79)***	132	0.73	.64 - .81	26%	98%

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
*p < .05. **p < .01. ***p < .001.

Table 8.
Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning– Psychiatrically Referred Girls in Adolescence

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	9.63 (2.98)	8.93 (3.58)	87	0.54	.42 - .66	0%	100%
Delay Score	8.19 (3.71)	7.93 (4.02)	87	0.51	.39 - .64	0%	100%
Seidman CPT							
Correct Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Omissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Late Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
False Alarms	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CVLT List A T-Score	47.91 (13.16)	47.73 (14.55)	91	0.50	.39 - .62	0%	100%
Stroop Color-Word T-Score	45.27 (6.78)	42.33 (8.28)	92	0.59	.48 - .71	0%	100%
WCST							
Perseverative Errors	9.33 (6.55)	11.91 (10.78)	84	0.58	.46 - .71	0%	98%
Nonperseverative Errors	11.69 (12.10)	10.77 (7.78)	84	0.55	.42 - .67	0%	100%
WRAT-R Scaled Score							
Reading	106.11 (9.20)	103.82 (11.63)	92	0.56	.44 - .67	0%	100%
Arithmetic	106.76 (12.35)	97.08 (13.79)**	91	0.70	.59 - .80	0%	88%
GAF - Current	66.39 (5.59)	56.56 (8.39)***	101	0.86	.78 - .93	7%	64%
FES T-Score							
Expressiveness	59.35 (9.93)	54.10 (15.18)	39	0.59	.41 - .77	0%	100%
Conflict	44.15 (9.89)	57.55 (11.01)***	38	0.71	.55 - .88	0%	77%
Cohesion	62.90 (5.64)	49.81 (19.15)**	39	0.83	.70 - .95	13%	72%
CBCL T-Score							
Competence	N/A	N/A	N/A	N/A	N/A	N/A	N/A
School	49.00 (5.74)	40.50 (8.26)***	41	0.79	.66 - .93	7%	71%
Social	49.26 (5.01)	45.64 (9.17)	46	0.58	.41 - .75	0%	96%
Activities	47.04 (5.54)	46.16 (5.92)	50	0.56	.40 - .71	0%	94%
SAICA							
School Behavior Problems	2.17 (0.75)	2.80 (0.84)	9	.70	.38 - 1.00	20%	100%
Spare Time Problems	1.50 (0.55)	2.40 (0.89)	9	.79	.51 - 1.00	60%	100%
Problems with Peers	1.67 (0.82)	2.20 (0.84)	9	.68	.35 - 1.00	0%	100%
Problems with the Opposite Sex	1.17 (0.41)	1.40 (0.55)	9	.62	.27 - .97	0%	100%
Problems with Siblings	1.33 (0.52)	2.00 (1.00)	9	.70	.36 - 1.00	20%	100%
Problems with Parents	1.67 (0.52)	2.20 (1.30)	9	.60	.22 - .98	0%	100%

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
**p* < .05. ***p* < .01. ****p* < .001.

Table 9.

Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning– Pediatrically Referred Girls in Adolescence

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	13.13 (17.90)	8.52 (3.57)	116	0.70	.61 - .80	2%	85%
Delay Score	9.57 (3.53)	8.27 (3.82)	116	0.61	.50 - .71	0%	100%
Seidman CPT							
Correct Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Omissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Late Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
False Alarms	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CVLT List A T-Score	49.31 (13.06)	46.60 (16.69)	122	0.53	.43 - .63	0%	97%
Stroop Color-Word T-Score	46.36 (7.41)	42.06 (8.04)**	121	0.67	.57 - .76	2%	90%
WCST							
Perseverative Errors	7.38 (3.13)	11.81 (8.84)***	110	0.65	.55 - .75	2%	81%
Nonperseverative Errors	8.25 (10.57)	12.75 (11.91)**	110	0.66	.56 - .76	4%	93%
WRAT-R Scaled Score							
Reading	110.44 (7.92)	100.08 (12.82)***	122	0.75	.67 - .84	2%	78%
Arithmetic	108.90 (11.84)	94.83 (12.32)***	122	0.79	.71 - .87	5%	67%
GAF - Current	66.06 (5.67)	57.74 (6.92)***	131	0.84	.77 - .90	9%	68%
FES T-Score							
Expressiveness	55.33 (13.47)	58.10 (9.88)	49	0.46	.29 - .63	3%	91%
Conflict	44.57 (12.22)	47.50 (9.52)	49	0.48	.32 - .64	0%	91%
Cohesion	55.14 (14.22)	56.13 (14.02)	49	0.61	.45 - .77	0%	84%
CBCL T-Score							
Competence	N/A	N/A	N/A	N/A	N/A	N/A	N/A
School	51.77 (5.74)	36.60 (11.97)***	30	0.83	.64 - 1.00	0%	81%
Social	52.00 (4.18)	42.64 (8.23)***	51	0.84	.73 - .95	8%	60%
Activities	46.76 (7.60)	45.34 (8.01)	52	0.56	.40 - .71	0%	100%
SAICA							
School Behavior Problems	1.29 (0.76)	2.86 (0.90)**	12	0.86	.66 - 1.00	86%	86%
Spare Time Problems	1.29 (0.49)	2.43 (1.13)*	12	0.79	.54 - 1.00	57%	100%
Problems with Peers	1.57 (0.54)	2.43 (0.98)	12	0.77	.51 - 1.00	42%	100%
Problems with the Opposite Sex	1.00 (0.00)	1.29 (049)	12	0.64	.33 - .94	29%	100%
Problems with Siblings	1.14 (0.38)	2.00 (0.82)*	12	0.79	.56 - 1.00	57%	86%
Problems with Parents	1.14 (0.38)	1.86 (0.90)	12	0.74	.46 - 1.00	43%	100%

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
**p* < .05. ***p* < .01. ****p* < .001.

Table 10.

Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning– Psychiatrically Referred Boys in Adolescence

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	10.33 (3.63)	8.97 (3.83)	95	0.63	.51 - .75	0%	94%
Delay Score	8.63 (4.17)	7.42 (4.49)	87	0.57	.45 - .69	0%	100%
Seidman CPT							
Correct Responses	25.67 (3.85)	25.47 (3.80)	97	0.52	.40 - .64	0%	100%
Omissions	1.82 (2.43)	2.50 (2.84)	97	0.58	.46 - .70	2%	91%
Late Responses	2.52 (2.35)	2.03 (1.78)	97	0.46	.33 - .59	0%	100%
False Alarms	0.09 (0.29)	0.35 (1.27)	97	0.56	.45 - .68	5%	68%
CVLT List A T-Score	47.91 (11.64)	44.76 (17.23)	26	0.54	.32 - .75	10%	56%
Stroop Color-Word T-Score	45.09 (5.32)	42.61 (8.35)	94	0.58	.47 - .70	0%	89%
WCST							
Perseverative Errors	13.16 (9.58)	16.85 (12.49)	95	0.59	.47 - .72	2%	84%
Nonperseverative Errors	13.19 (8.45)	18.00 (13.28)	95	0.60	.48 - .71	0%	80%
WRAT-R Scaled Score							
Reading	108.37 (12.03)	102.55 (16.83)	90	0.60	.48 - .72	0%	86%
Arithmetic	101.57 (16.56)	93.29 (18.37)*	90	0.62	.50 - .74	5%	75%
GAF - Current	68.73 (6.79)	55.66 (7.41)***	101	0.91	.84 - .98	18%	36%
FES T-Score							
Expressiveness	56.17 (14.58)	53.68 (12.10)	85	0.59	.46 - .72	2%	100%
Conflict	45.90 (10.80)	52.58 (11.70)*	85	0.62	.50 - .74	4%	70%
Cohesion	55.97 (14.54)	48.09 (19.29)	85	0.67	.55 - .79	6%	68%
CBCL T-Score							
Competence	55.91 (15.15)	56.14 (23.24)	79	0.62	.49 - .74	8%	58%
School	49.00 (8.17)	43.83 (13.18)	79	0.74	.61 - .87	9%	51%
Social	54.74 (14.56)	51.95 (21.84)	79	0.66	.54 - .77	9%	53%
Activities	49.35 (5.47)	49.64 (12.18)	79	0.49	.36 - .62	7%	54%
SAICA							
School Behavior Problems	1.51 (0.72)	2.74 (0.66)***	71	0.85	.75 - .95	66%	87%
Spare Time Problems	1.26 (0.54)	2.10 (0.81)***	71	0.79	.69 - .91	70%	78%
Problems with Peers	1.35 (0.49)	2.30 (0.81)***	71	0.82	.72 - .92	60%	87%
Problems with the Opposite Sex	1.31 (0.48)	1.47 (0.69)	46	0.55	.37 - .72	32%	77%
Problems with Siblings	1.71(0.78)	2.08 (0.76)	56	0.62	.47 - .78	23%	95%
Problems with Parents	1.22 (0.42)	1.98 (0.87)***	71	0.76	.65 - .87	58%	87%

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
**p* < .05. ***p* < .01. ****p* < .001.

Table 11.
Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning– Pediatrically Referred Boys in Adolescence

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	11.18 (2.63)	8.47 (4.10)***	114	0.68	.58 - .78	0%	97%
Delay Score	9.73 (3.94)	8.00 (4.33)*	110	0.62	.51 - .72	0%	100%
Seidman CPT							
Correct Responses	27.44 (2.78)	25.89 (4.27)*	120	0.62	.52 - .72	0%	97%
Omissions	1.18 (1.74)	2.11 (2.83)*	120	0.61	.51 - .71	0%	97%
Late Responses	1.38 (1.81)	2.00 (1.97)	120	0.61	.51 - .71	0%	100%
False Alarms	0.12 (0.33)	0.22 (0.72)	120	0.51	.40 - .61	0%	100%
CVLT List A T-Score	47.37 (14.12)	46.88 (14.40)	45	0.49	.31 - .66	0%	100%
Stroop Color-Word T-Score	48.46 (7.45)	42.72 (7.14)***	119	0.70	.60 - .79	0%	93%
WCST							
Perseverative Errors	8.88 (5.85)	13.88 (9.15)***	115	0.70	.60 - .79	2%	92%
Nonperseverative Errors	9.26 (6.35)	15.92 (13.42)**	115	0.67	.57 - .77	2%	93%
WRAT-R Scaled Score							
Reading	113.28 (8.61)	100.90 (15.85)***	113	0.76	.67 - .85	0%	88%
Arithmetic	112.93 (13.67)	93.75 (17.76)***	113	0.79	.72 - .89	3%	86%
GAF - Current	69.80 (5.55)	56.84 (7.47)***	132	0.93	.88 - .97	10%	70%
FES T-Score							
Expressiveness	54.33 (12.00)	53.74 (14.02)	118	0.49	.39 - .60	0%	100%
Conflict	48.16 (11.73)	57.06 (10.81)***	119	0.67	.57 - .76	4%	94%
Cohesion	60.04 (11.75)	51.23 (17.94)**	119	0.70	.61 - .79	0%	97%
CBCL T-Score							
Competence	58.21 (13.37)	55.25 (25.31)	94	0.68	.56 - .79	0%	100%
School	51.38 (4.92)	45.75 (19.67)	94	0.80	.70 - .90	0%	100%
Social	53.63 (12.98)	53.58 (23.59)	94	0.62	.51 - .74	0%	100%
Activities	51.90 (8.13)	50.48 (16.38)	94	0.65	.54 - .76	0%	100%
SAICA							
School Behavior Problems	1.73 (0.68)	2.77 (0.73)***	93	0.83	.75 - .91	49%	90%
Spare Time Problems	1.52 (0.65)	2.15 (0.74)***	94	0.72	.62 - .83	17%	92%
Problems with Peers	1.52 (0.58)	2.06 (0.70)***	94	0.71	.60 - .81	27%	96%
Problems with the Opposite Sex	1.44 (0.61)	1.52 (0.80)	74	0.51	.38 - .64	2%	100%
Problems with Siblings	1.48 (0.63)	2.17 (0.90)***	88	0.72	.61 - .82	24%	93%
Problems with Parents	1.31 (0.51)	1.88 (0.70)***	94	0.72	.62 - .82	19%	98%

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
**p* < .05. ***p* < .01. ****p* < .001.

Table 12.
Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning– Psychiatrically Referred Sample Young Men

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	10.57 (3.25)	10.10 (2.62)	67	0.58	.43 - .73	0%	100%
Delay Score	9.14 (4.03)	9.54 (3.20)	67	0.49	.34 - .65	0%	100%
Seidman CPT							
Correct Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Omissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Late Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
False Alarms	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CVLT List A T-Score	44.29 (15.80)	39.04 (18.15)	68	0.57	.42 - .71	2%	83%
Stroop Color-Word T-Score	45.95 (7.30)	44.31 (9.54)	66	0.54	.39 - .69	2%	86%
WCST							
Perseverative Errors	8.74 (4.42)	12.09 (8.71)	52	0.61	.45 - .76	3%	78%
Nonperseverative Errors	9.63 (6.11)	13.03 (9.93)	52	0.59	.43 - .75	3%	82%
WRAT-R Scaled Score							
Reading	108.52 (9.52)	103.45 (14.95)	68	0.59	.45 - .73	2%	71%
Arithmetic	100.62 (12.82)	96.12 (17.75)	68	0.57	.44 - .71	0%	88%
GAF - Current	65.97 (7.11)	57.71 (8.15)***	87	0.81	.70 - .91	14%	47%
FES T-Score							
Expressiveness	52.90 (15.34)	52.54 (12.91)	56	0.54	.38 - .70	0%	100%
Conflict	41.29 (9.18)	48.68 (12.79)*	56	0.58	.44 - .73	0%	72%
Cohesion	56.86 (14.60)	46.69 (25.22)	55	0.67	.53 - .81	4%	65%
CBCL T-Score							
Competence	N/A	N/A	N/A	N/A	N/A	N/A	N/A
School	44.50 (6.98)	42.67 (11.67)	10	0.58	.22 - .95	0%	86%
Social	45.83 (7.68)	37.71 (10.86)	11	0.71	.42 - 1.00	0%	67%
Activities	41.83 (8.04)	35.22 (9.04)	13	0.75	.50 - 1.00	0%	55%
SAICA							
School Behavior Problems	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spare Time Problems	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with Peers	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with the Opposite Sex	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with Siblings	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with Parents	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
*p < .05. **p < .01. ***p < .001.

Table 13

Means, Standard Deviations, and Area Under the Curve (AUC) Calculations of Neuropsychological Tests and Tests of Functioning– Pediatrically Referred Young Men

	Control	ADHD	df	AUC	(95% CI)	SE	SP
ROCF							
Copy Score	10.98 (2.62)	9.98 (3.66)	89	0.58	.46 - .70	0%	100%
Delay Score	10.02 (3.54)	9.63 (4.05)	89	0.54	.42 - .66	0%	100%
Seidman CPT							
Correct Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Omissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Late Responses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
False Alarms	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CVLT List A T-Score	49.84 (11.64)	37.27 (16.54)***	90	0.72	.62 - .83	3%	88%
Stroop Color-Word T-Score	49.22 (8.35)	43.29 (8.50)***	90	0.69	.58 - .80	0%	98%
WCST							
Perseverative Errors	7.71 (6.45)	9.75 (6.33)	83	0.64	.52 - .77	0%	100%
Nonperseverative Errors	7.55 (7.79)	9.72 (9.07)	83	0.60	.48 - .72	0%	100%
WRAT-R Scaled Score							
Reading	112.53 (6.85)	104.86 (13.49)**	91	0.69	.59 - .80	0%	89%
Arithmetic	111.88 (11.62)	95.74 (14.86)***	91	0.78	.72 - .90	6%	80%
GAF - Current	66.58 (5.65)	60.60 (6.52)***	125	0.76	.67 - .84	2%	94%
FES T-Score							
Expressiveness	51.89 (13.99)	51.46 (15.28)	72	0.50	.36 - .64	0%	100%
Conflict	44.06 (10.93)	49.93 (11.97)*	72	0.62	.48 - .75	0%	100%
Cohesion	58.98 (12.72)	52.21 (17.13)	73	0.65	.52 - .78	0%	100%
CBCL T-Score							
Competence	N/A	N/A	N/A	N/A	N/A	N/A	N/A
School	51.86 (3.63)	35.86 (2.80)***	12	1.00	1.00 - 1.00	0%	50%
Social	53.86 (2.61)	41.00 (8.12)**	12	0.98	.92 - 1.00	0%	54%
Activities	48.43 (6.78)	40.75 (9.65)	13	0.72	.46 - .99	0%	70%
School Behavior Problems	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spare Time Problems	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with Peers	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with the Opposite Sex	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with Siblings	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Problems with Parents	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. SAICA = Social Adjustment Inventory for Children and Adolescents WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. AUC = Area Under the Curve. SE = Sensitivity. SP = Specificity.
A Cut-off value of .80 was used. N/A = missing data
*p < .05. **p < .01. ***p < .001.

Table 14
Pearson Correlations Among Neuropsychological, Academic Achievement, and Functioning Data for ADHD Girls during Childhood

Neuropsychological and Academic Achievement Variables	*r* 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1.ROCF Copy Organization Score	1											
2.ROCF Delay Organization Score	.60***	1										
3.Seidman CPT Correct Responses	.44***	.33***	1									
4.Seidman CPT Omissions	-.36***	-.28***	-.82***	1								
5.Seidman CPT Late Responses	-.33***	-.25**	-.78***	.28***	1							
6.Seidman CPT False Alarms	-.08	-.10	-.14	.14	.08	1						
7.CVLT List A T-Score	.36	.67*	.23	-.13	-.29	.29	1					
8. Stroop Color-Word T-Score	-.02	-.07	-.01	-.06	.08	.21	.37	1				
9. WCST Perseverative Errors	-.33**	-.30**	-.39***	.43***	.19	.15	-.48	-.14	1			
10. WCST Nonperseverative Errors	-.32***	-.30**	-.28**	.21*	.25*	.11	-.14	.03	.47***	1		
11. WRAT Reading Scaled Score	.34***	.14	.27**	-.29***	-.14	-.05	.61*	.39***	-.22*	-.14	1	
12. WRAT Arithmetic Scaled Score	.16	.16	.23**	-.19*	-.18	-.05	.59*	.23**	-.17	-.24*	.55***	1

Clinician and Parent Subjective Rating Scales	*r* 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1.Current GAF	1													
2.FES Expressiveness	.16	1												
3.FES Conflict	-.14	-.16	1											
4.FES Cohesion	.34***	.40***	-.36***	1										
5.CBCL Competence T-Score	.12	-.00	.25*	-.15	1									
6.CBCL School T-Score	.22*	.14	-.13	.12	.22*	1								
7.CBCL Social T-Score	.20*	.19	-.04	..15	.56***	.14	1							
8.CBCL Activities T-Score	.29**	.02	.11	.04	.25*	.08	.09	1						
9. SAICA School Behavior Problems	-.47***	.01	.14	-.18	-.05	-.22*	-.32**	-.20	1					
10.SAICA Spare Time Problems	-.45***	-.13	.09	-.13	.01	-.18	-.25*	-.27**	.48***	1				
11.SAICA Problems with Peers	-.46***	-.09	.03	-.08	-.15	-.27*	-.25*	-.20*	.54***	.45***	1			
12.SAICA Problems with the Opposite Sex	-.43***	-.22	.17	-.42**	.17	-.11	-.06	-.16	.27*	.31*	.28*	1		
13.SAICA Problems with Siblings	-.35***	-.05	.24*	-.14	.08	-.14	-.22*	.08	.27**	.24**	.24*	.36**	1	
14.SAICA Problems with Parents	-.38***	-.15	.27**	-.24**	-.06	-.25*	-.18	.02	.42***	.44***	.36***	.37**	.29**	1

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. SAICA = Social Adjustment Inventory for Children and Adolescents
**p* < .05. ***p* < .01. ****p* < .001.

Table 15

Pearson Correlations Among Neuropsychological, Academic Achievement, and Functioning Data for Control Girls during Childhood

Neuropsychological and Academic Achievement Variables	*r* 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1.ROCF Copy Organization Score	1											
2.ROCF Delay Organization Score	.47***	1										
3.Seidman CPT Correct Responses	.32**	.13	1									
4.Seidman CPT Omissions	-.27**	-.15	-.88***	1								
5.Seidman CPT Late Responses	-.27**	-.06	-.78***	.38***	1							
6.Seidman CPT False Alarms	-.03	-.16	-.27**	.26**	.18	1						
7.CVLT List A T-Score	-.28	-.20	.23	-.13	-.23	N/A	1					
8. Stroop Color-Word T-Score	-.19*	-.18	-.31***	.29**	.23*	.16	-.06	1				
9. WCST Perseverative Errors	-.04	-.20	-.13	.21*	.01	-.06	-.80**	.18	1			
10. WCST Nonperseverative Errors	-.10	-.21*	-.25*	.27**	.11	-.12	-.81***	.12	.74***	1		
11. WRAT Reading Scaled Score	.05	.07	-.01	.06	-.03	.02	.08	.16	-.04	-.12	1	
12. WRAT Arithmetic Scaled Score	.10	.24*	.04	-.07	.02	-.12	.36	.14	-.15	-.16	.41***	1

Clinician and Parent Subjective Rating Scales	*r* 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1.Current GAF	1													
2.FES Expressiveness	.17	1												
3.FES Conflict	-.10	-.06	1											
4.FES Cohesion	.23*	.45***	-.38***	1										
5.CBCL Competence T-Score	.09	.16	-.11	.33**	1									
6.CBCL School T-Score	.24*	-.01	-.06	.24*	.45***	1								
7.CBCL Social T-Score	-.07	.04	-.11	.15	.44***	.23*	1							
8.CBCL Activities T-Score	.02	.20*	.04	.13	.59***	.20*	.24*	1						
9. SAICA School Behavior Problems	-.36***	-.07	-.01	-.24*	-.17	-.25*	-.07	-.22*	1					
10.SAICA Spare Time Problems	-.27**	-.03	-.05	-.17	-.15	-.20*	-.08	-.11	.43***	1				
11.SAICA Problems with Peers	-.24*	.23*	.09	-.07	.02	-.22*	-.05	.07	.36***	.34***	1			
12.SAICA Problems with the Opposite Sex	-.05	-.07	-.20	.02	-.09	-.00	-.06	.01	.19	.39**	.21	1		
13.SAICA Problems with Siblings	-.31**	-.10	.18	-.17	-.24*	-.11	-.22*	-.18	.27**	.21*	.34**	.27*	1	
14.SAICA Problems with Parents	-.27**	-.24*	.33***	-.45***	.06	-.16	.03	.07	.24*	.44***	.29**	.09	.29**	1

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. SAICA = Social Adjustment Inventory for Children and Adolescents

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 16

Pearson Correlations Among Neuropsychological, Academic Achievement, and Functioning Data For ADHD Boys during Adolescence

Neuropsychological and Academic Achievement Variables	*r*											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1.ROCF Copy Organization Score	1											
2.ROCF Delay Organization Score	.59***	1										
3.Seidman CPT Correct Responses	.36***	.39***	1									
4.Seidman CPT Omissions	-.36***	-.40***	-.91***	1								
5.Seidman CPT Late Responses	-.22*	-.23*	-.77***	.43***	1							
6.Seidman CPT False Alarms	.04	-.06	-.12	.24*	-.09	1						
7.CVLT List A T-Score	.41*	.21	.43*	-.41*	-.32	-.31	1					
8. Stroop Color-Word T-Score	.06	.03	.12	-.16	-.02	-.01	.42*	1				
9. WCST Perseverative Errors	-.23*	-.32**	-.36***	.41***	.14	-.08	-.02	-.07	1			
10. WCST Nonperseverative Errors	-.21*	-.26**	-.27**	.26**	.20*	-.10	-.06	-.03	.59***	1		
11. WRAT Reading Scaled Score	.28**	.22*	.20*	-.26**	-.03	.02	.48**	.65***	.20*	-.17	1	
12. WRAT Arithmetic Scaled Score	.32**	.34***	.28**	-.31***	-.13	-.11	.44*	.45***	-.36***	-.26**	.61***	1

Clinician and Parent Subjective Rating Scales	*r*													
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1.Current GAF	1													
2.FES Expressiveness	.26**	1												
3.FES Conflict	-.24*	-.23*	1											
4.FES Cohesion	.43***	.61***	.51***	1										
5.CBCL Competence T-Score	-.19	-.04	-.03	-.09	1									
6.CBCL School T-Score	-.09	-.05	.10	-.11	.43***	1								
7.CBCL Social T-Score	-.11	-.06	-.02	-.08	.82***	.07	1							
8.CBCL Activities T-Score	-.02	.01	-.16	.22*	.40***	.13	.13	1						
9. SAICA School Behavior Problems	-.49***	-.19	.24*	-.32**	.01	-.12	.05	-.07	1					
10.SAICA Spare Time Problems	-.50***	-.24*	.30**	-.42***	-.08	-.06	-.08	-.11	.51***	1				
11.SAICA Problems with Peers	-.46***	-.06	.21*	-.25*	-.10	-.03	-.14	-.04	.40***	.55****	1			
12.SAICA Problems with the Opposite Sex	-.43***	-.19	.13	-.30**	.19	.22	.14	.08	.18	.24*	.36**	1		
13.SAICA Problems with Siblings	-.27*	-.16	.43***	-.39***	-.09	.13	-.09	-.13	.35***	.31**	.37**	.28*	1	
14.SAICA Problems with Parents	-.27**	-.12	.30**	-.38***	-.14	-.04	-.11	-.16	.39***	.40***	.38***	-.01	.32**	1

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. SAICA = Social Adjustment Inventory for Children and Adolescents

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 17

Pearson Correlations Among Neuropsychological, Academic Achievement, and Functioning Data for Control Boys during Adolescence

Neuropsychological and Academic Achievement Variables	r											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1.ROCF Copy Organization Score	1											
2.ROCF Delay Organization Score	.58***	1										
3.Seidman CPT Correct Responses	.48***	.38***	1									
4.Seidman CPT Omissions	-.46***	-.29**	-.79***	1								
5.Seidman CPT Late Responses	-.32**	-.31**	-.81***	.28**	1							
6.Seidman CPT False Alarms	.01	.05	-.06	-.06	.14	1						
7.CVLT List A T-Score	.11	.08	-.03	-.11	.17	.00	1					
8. Stroop Color-Word T-Score	.01	.02	.06	-.13	.03	.13	-.14	1				
9. WCST Perseverative Errors	-.14	-.08	-.25*	.20	.21*	-.08	-.14	.07	1			
10. WCST Nonperseverative Errors	-.20*	-.07	-.39***	.36***	.27**	-.05	-.14	-.01	.79***	1		
11. WRAT Reading Scaled Score	.20	12	.13	-.04	.15	.00	.28	.41***	-.02	-.07	1	
12. WRAT Arithmetic Scaled Score	.07	.08	.00	-.04	.04	.05	.20	.34**	-.23	-.19	.42***	1

Clinician and Parent Subjective Rating Scales	r													
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1.Current GAF	1													
2.FES Expressiveness	.39***	1												
3.FES Conflict	-.15	.01	1											
4.FES Cohesion	.47***	.15***	-.20*	1										
5.CBCL Competence T-Score	.18	.04	-.08	.24*	1									
6.CBCL School T-Score	.37**	.09	-.09	.08	.35**	1								
7.CBCL Social T-Score	.03	.03	-.12	.17	.93***	.18	1							
8.CBCL Activities T-Score	.18	-.04	-.08	.12	.53***	.09	.44***	1						
9. SAICA School Behavior Problems	-.63***	-.22	.15	-.23	-.05	-.43***	.04	.03	1					
10.SAICA Spare Time Problems	-.37**	-.16	.09	-.21	-.18	-.21	-.13	-.01	.38***	1				
11.SAICA Problems with Peers	-.54***	-.18	.28*	-.30*	-.01	-.04	-.01	.04	.49***	.35**	1			
12.SAICA Problems with the Opposite Sex	-.42***	-.13	.12	-.34*	-.03	-.16	-.00	.09	.3***	.32*	.42**	1		
13.SAICA Problems with Siblings	-.31*	-.14	.16	-.35**	-.15	-.13	-.07	-.28*	.27*	.33**	.15	.21	1	
14.SAICA Problems with Parents	-.43***	.06	.28*	-.23	.08	-.04	.13	-.16	.31**	.25*	.25*	.29*	.29*	1

Note. ROCF = Rey-Osterrieth Complex Figure. CPT = Continuous Performance Task. CVLT = California Verbal Learning Test. WCST = Wisconsin Card Sort Task. WRAT-R= Wide Range Achievement Test. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. SAICA = Social Adjustment Inventory for Children and Adolescents

**p* < .05. ***p* < .01. ****p* < .001.

Table 18

Optimal Sensitivity and Specificity Thresholds and Cut Scores of Subjective Clinician and Parent Rating Scales for Girls in Childhood

	Cut Score
1.Current GAF	
Optimal Sensitivity	≤ 67.50
Optimal Specificity	≤ 64.50
2.FES Expressiveness	
Optimal Sensitivity	≥ 69.50
Optimal Specificity	≥ 37.50
3.FES Conflict	
Optimal Sensitivity	≥ 40.50
Optimal Specificity	≥ 62.00
4.FES Cohesion	
Optimal Sensitivity	≥64.00
Optimal Specificity	≥ 42.00
5.CBCL Competence T-Score	
Optimal Sensitivity	≤ 59.50
Optimal Specificity	≤ 41.50
6.CBCL School T-Score	
Optimal Sensitivity	≤ 51.50
Optimal Specificity	≤ 43.50
7.CBCL Social T-Score	
Optimal Sensitivity	≤ 54.50
Optimal Specificity	≤ 40.50
8.CBCL Activities T-Score	
Optimal Sensitivity	≤ 54.00
Optimal Specificity	≤ 41.50
9. SAICA School Behavior Problems	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50
10.SAICA Spare Time Problems	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50
11.SAICA Problems with Peers	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50
12.SAICA Problems with the Opposite Sex	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50
13.SAICA Problems with Siblings	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50
14.SAICA Problems with Parents	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50

Note. Optimal Sensitivity = .90. Optimal Specificity = .90. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. SAICA = Social Adjustment Inventory for Children and Adolescents.

Table 19

Optimal Sensitivity and Specificity Thresholds and Cut Scores of Subjective Clinician and Parent Rating Scales for Girls in Adolescence

	Cut Score
1.Current GAF	
Optimal Sensitivity	≤ 65.50
Optimal Specificity	≤ 61.00
2.FES Expressiveness	
Optimal Sensitivity	≥ 69.50
Optimal Specificity	≥ 37.50
3.FES Conflict	
Optimal Sensitivity	≥ 35.00
Optimal Specificity	≥ 62.00
4.FES Cohesion	
Optimal Sensitivity	≥ 64.00
Optimal Specificity	≥ 49.50
5.CBCL Competence T-Score	
Optimal Sensitivity	≤ 59.50
Optimal Specificity	≤ 41.50
6.CBCL School T-Score	
Optimal Sensitivity	≤ 51.50
Optimal Specificity	≤ 43.50
7.CBCL Social T-Score	
Optimal Sensitivity	≤ 54.50
Optimal Specificity	≤ 43.50
8.CBCL Activities T-Score	
Optimal Sensitivity	≤ 54.00
Optimal Specificity	≤ 38.00
9. SAICA School Behavior Problems	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 2.50
10.SAICA Spare Time Problems	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50
11.SAICA Problems with Peers	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 2.50
12.SAICA Problems with the Opposite Sex	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50
13.SAICA Problems with Siblings	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50
14.SAICA Problems with Parents	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50

Note. Optimal Sensitivity = .90. Optimal Specificity = .90. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. SAICA = Social Adjustment Inventory for Children and Adolescents

Table 20

Optimal Sensitivity and Specificity Thresholds and Cut Scores of Subjective Clinician and Parent Rating Scales for Boys in Adolescence

	Cut Score
1.Current GAF	
Optimal Sensitivity	≤ 66.00
Optimal Specificity	≤ 60.50
2.FES Expressiveness	
Optimal Sensitivity	≥ 69.50
Optimal Specificity	≥ 37.50
3.FES Conflict	
Optimal Sensitivity	≥ 40.50
Optimal Specificity	≥ 62.00
4.FES Cohesion	
Optimal Sensitivity	≥ 66.00
Optimal Specificity	≥ 42.00
5.CBCL Competence T-Score	
Optimal Sensitivity	≤ 88.00
Optimal Specificity	≤ 46.50
6.CBCL School T-Score	
Optimal Sensitivity	≤ 52.00
Optimal Specificity	≤ 43.50
7.CBCL Social T-Score	
Optimal Sensitivity	≤ 77.00
Optimal Specificity	≤ 44.00
8.CBCL Activities T-Score	
Optimal Sensitivity	≤ 77.00
Optimal Specificity	≤ 41.00
9. SAICA School Behavior Problems	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 2.50
10.SAICA Spare Time Problems	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 2.50
11.SAICA Problems with Peers	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 2.50
12.SAICA Problems with the Opposite Sex	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50
13.SAICA Problems with Siblings	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 2.50
14.SAICA Problems with Parents	
Optimal Sensitivity	≥ 1.50
Optimal Specificity	≥ 1.50

Note. Optimal Sensitivity = .90. Optimal Specificity = .90. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. SAICA = Social Adjustment Inventory for Children and Adolescents.

Table 21
Optimal Sensitivity and Specificity Thresholds and Cut Scores of Subjective Clinician and Parent Rating Scales for Boys in Young Adulthood

	Cut Score
1.Current GAF	
Optimal Sensitivity	≤ 69.60
Optimal Specificity	≤ 55.50
2.FES Expressiveness	
Optimal Sensitivity	≤ 69.50
Optimal Specificity	≤ 31.00
3.FES Conflict	
Optimal Sensitivity	≥ 35.00
Optimal Specificity	≥ 56.50
4.FES Cohesion	
Optimal Sensitivity	≤ 64.00
Optimal Specificity	≤ 42.00
5.CBCL Competence T-Score	
Optimal Sensitivity	N/A
Optimal Specificity	N/A
6.CBCL School T-Score	
Optimal Sensitivity	≤ 54.00
Optimal Specificity	≤ 41.50
7.CBCL Social T-Score	
Optimal Sensitivity	≤ 50.00
Optimal Specificity	≤ 44.50
8.CBCL Activities T-Score	
Optimal Sensitivity	≤ 54.00
Optimal Specificity	≤ 36.50
9. SAICA School Behavior Problems	
Optimal Sensitivity	N/A
Optimal Specificity	N/A
10.SAICA Spare Time Problems	
Optimal Sensitivity	N/A
Optimal Specificity	N/A
11.SAICA Problems with Peers	
Optimal Sensitivity	N/A
Optimal Specificity	N/A
12.SAICA Problems with the Opposite Sex	
Optimal Sensitivity	N/A
Optimal Specificity	N/A
13.SAICA Problems with Siblings	
Optimal Sensitivity	N/A
Optimal Specificity	N/A
14.SAICA Problems with Parents	
Optimal Sensitivity	N/A
Optimal Specificity	N/A

Note. Optimal Sensitivity = .90. Optimal Specificity = .90. GAF = Global Assessment of Functioning. FES = Family Environment Scale. CBCL = Child Behavior Checklist. SAICA = Social Adjustment Inventory for Children and Adolescents. N/A = Missing Data

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Curriculum Vitae

Education

In Progress (Expected 8/17)	**Ph.D. Clinical Psychology**, Syracuse University Primary Advisor: Kevin M. Antshel, Ph.D. Dissertation: Improving the Longitudinal Assessment of ADHD in Pediatrically and Psychiatrically Referred Samples.
2014	**M.S. Clinical Psychology**, Syracuse University Primary Advisor: Craig K. Ewart, Ph.D. Master's thesis: Investigating the Role of Social Environmental Stress and Implicit Motives in Predicting Salivary Alpha-Amylase Reactivity to the Social Competence Interview.
2011	**B.A. Psychology**, minor in Business Administration, Brandeis University Graduated *magna cum laude*, with highest honors in psychology

Clinical Experience

2016 - 2017 **California Pacific Medical Center (CPMC),** *Pre-doctoral Intern*

The APA-Accredited pre-doctoral internship program at CPMC uses the practitioner-scholar model of training and is grounded in the integration of multiple perspectives in psychology, including psychodynamic, developmental, family systems, and cognitive behavioral models. As an intern, I attend weekly core and elective didactic classes, receive intensive weekly individual (4 hours) and group (4 hours) supervision, co-lead a process group for teenage girls, and provide individual psychotherapy to both children ages 7-16 and adults ages 25-75. In my specialty training on the Child Therapy and Assessment Track, I provide child and adolescent therapy, parent consultation, and comprehensive psychoeducational assessments at the Kalmanowitz Child Development Center, a multidisciplinary clinic serving children and adolescents with a wide array of developmental, academic, behavioral, and emotional problems.

Clinical Supervisors

Sharon Tyson, PhD; Katie Fahrner, PhD; Suzanne Giraudo, EdD; Belinda Stroud, PsyD; Joseph Gumina, PhD; Maureen Murphy, R.N., PhD, Audrey Dunn, M.S.

2013-2016 **Syracuse University**, *Neuropsychological Assessment Consultant*, Psychological Services Center (PSC)

The Psychological Services Center (PSC) provides neuropsychological evaluations for students, faculty, and staff at Syracuse University as well members from the community. I conducted clinical and diagnostic interviews for ADHD, specific learning disorders, and dementia. I

administered symptom inventories, measures of executive functioning, attention, memory, intelligence, spatial organization to both children and adults. I prepared reports and conduct feedback sessions with clients to provide diagnostic impressions, recommendations, and additional referrals as needed. I also consulted with school psychologists and primary care physicians in the community as well as campus resources (e.g., Office of Disability Services, University Health Services) regarding diagnosis and treatment plans.
Clinical Practicum Supervisors
Kevin M. Antshel, PhD; Larry M. Lewandowski, PhD

2014-2015 **SUNY-Upstate Medical University**, *Student Clinician*, Pediatric ADHD Clinic

The SUNY-Upstate Attention Deficit / Hyperactivity Disorders Program is a nationally recognized center for the assessment and treatment of ADHD. Children and adolescents referred to this program for evaluation have a comprehensive protocol of behavior rating scales, child and parent interviews, and psychological testing. As part of a multidisciplinary team (psychiatry, psychology and pediatrics), I tested children and adolescents and interviewed parents about socioemotional functioning.
Clinical Practicum Supervisors
Kevin M. Antshel, PhD; George Starr, MD

2014 - 2016 **Syracuse University,** *Group Co-Facilitator*, Social Skills Training group (SST)

The Social Skills Training group (SST) at Syracuse University is a 10-week CBT intervention that focuses on conversation skills and social problem solving skills for children with autism spectrum disorders (ASDs) and common comorbid disorders. I co-facilitated the children's group and led the parent group.
Clinical Practicum Supervisors
Kevin M. Antshel, PhD; Amy Olszewski, PhD

2013- 2014 **Syracuse University,** *Group Co-Facilitator*, CBT for ADHD Group

The CBT for ADHD group at Syracuse University is a semester-long manualized CBT intervention for college and graduate students that targets executive dysfunction through a variety of modules, including psychoeducation about ADHD, skills training in time management, organization and planning, and overcoming procrastination.
Clinical Practicum Supervisor
Kevin M. Antshel, PhD

2013-2016 **Syracuse University**, *Student Therapist*, Psychological Services Center

The Psychological Services Center (PSC) provides assessment and counseling services for students, faculty, and staff at Syracuse University as well community members from greater Syracuse. I provide brief and long-term therapy to children, adolescents and adults with a wide range of presenting problems. I conducted clinical and diagnostic interviews for intake evaluations, administer symptom inventories, provide short- and long-term outpatient individual psychotherapy, implemented interventions from an eclectic range of theoretical perspectives, including cognitive-behavioral

therapy, interpersonal therapy, and psychodynamic therapy; I also prepared case reports and case presentations and received weekly individual and group supervision and participated in staffing meetings and case conferences.
Clinical Practicum Supervisors
Afton Kapuscinski, PhD; Joseph Himmelsbach, PhD; Steve Maisto, PhD; Thomas Krisher, PsyD; Robbi Saletsky, PhD; Deborah Pollack, PhD; Kevin M. Antshel, PhD

2013-2014 **SUNY Upstate Medical University**, *Assessment, Consultation & Liaison Consultant*, Adult Inpatient Psychiatric Unit

Within a 48-hour turn around time, I provided neuropsychological and psychodiagnostic assessments and prepared reports for adolescents and adults on the inpatient psychiatric unit who were referred for psychological testing. In this practicum experience, I gained valuable knowledge on differential diagnoses for individuals with serious mental illness (SMI) and valuable experience in consultation and liaison with allied mental health providers in psychiatry and primary care.
Clinical Practicum Supervisor
Kevin M. Antshel, PhD

2010 (Summer) **Spring Harbor Hospital**, *Psychiatric Technician*, Glickman Family Center for Child and Adolescent Psychiatry

Spring Harbor Hospital provides inpatient services for children and adolescents experiencing acute mental illness. I trained in crisis intervention, de-escalation, and physical containment techniques. I engaged with adolescents who were in crisis and practiced maintaining a supportive and structured milieu by implementing treatment plans and facilitating group therapy and community meetings. I also shadowed psychiatrists and social workers during intake interviews with both adolescents and adult patients and attended treatment team meetings.
Clinical Practicum Supervisors
Mary Jane Krebs, APRN, BC; Jennifer Hunt-MacLearn, RN

Administrative Experience

2016-Present ***Chief Intern***, California Pacific Medical Center (CPMC) Predoctoral Training Program
As the Chief Intern at CPMC, my responsibilities include monitoring intern caseloads, completing program development/evaluation projects, functioning as a liaison between the intern group and the training directors, representing the intern class in staff meetings of the outpatient department of psychiatry, and leading the effort to develop a collegial and constructive working relationship among interns. I also spearheaded the effort to streamline the interview process and am involved in reviewing applications in the selection process for the incoming intern class and interviewing candidates.

2015-2016 ***Co-President***, Psychology Department Graduate Student Organization (GSO) at Syracuse University

As the Co-President of the Psychology Department GSO, my responsibilities included leading department-wide graduate student meetings designed to keep students informed about developments in the department, acting as a liaison between students and administration, managing a budget of $2,000, and planning professional development and social events.

2014-2015 ***Administrative TA***, Undergraduate Enrichment Program at Syracuse University
As an Administrative TA in the Psychology Department, I advised and mentored undergraduate students in career planning, evaluated undergraduate research proposals for undergraduate research grants, interviewed students for undergraduate clinical internship placement sites, and helped plan and facilitate the Psychology Department Poster Session. I held office hours and prepared undergraduate seminars on topics like preparing for the GREs, personal statement workshops, and careers in psychology.

Supervision Experience

2015- 2016 **Syracuse University,** *Peer Supervisor*, Psychological Services Center (PSC)
I provided weekly, direct, one-on-one clinical supervision to school psychology and clinical psychology doctoral students in both assessment and therapy cases. I discussed and reviewed intake reports, assessment batteries, and testing results; I also reviewed and edited psychological assessment reports, progress notes, and treatment plans. This practicum was a tiered supervised experience wherein I also received weekly supervision and didactic training on supervision from licensed clinical psychologists.
Supervision Practicum Supervisors
Afton Kapuscinski, PhD; Kevin M. Antshel, PhD

Teaching Experience

Summer 2013 **Syracuse University**, *Instructor*, PSY 395: Abnormal Psychology
Advanced undergraduate course on psychology with an attached recitation section. I led a small advanced seminar course in abnormal psychology. I was responsible for constructing a syllabus, selecting a textbook, assigning readings, updating Blackboard, preparing lectures, and grading all coursework.

Spring 2013 **Syracuse University**, *TA*, PSY 495: Advanced Research Experience Credit in Clinical Health Psychology.
Advanced undergraduate course in research experience. I supervised and mentored 6 undergraduate students working on research addressing the relationships between stress hormones, coping strategies, and health outcomes. I also helped my students successfully apply for several undergraduate research grants (for a total of $5800).

Fall 2012 **Syracuse University**, *TA*, PSY 295: Research Experience in Clinical Health Psychology

Undergraduate course in research experience. I supervised and mentored 4 undergraduate students in the Ewart lab, all of whom were first generation college students and/or members of traditionally underrepresented minority groups.

Fall 2011 **Syracuse University**, *TA*, PSY 205: Foundations of Human Behavior. Undergraduate course on psychology with an attached recitation section. I led 4 weekly sections of 20 students each in gaining an understanding of the broad study of psychology. I was responsible for constructing a syllabus, prepping for exams, grading all coursework, and managing a grade book for 80 students.

Spring 2011 **Brandeis University**, *TA*, PSY 34: Adolescence and the Transition to Maturity.

Fall 2010 **Brandeis University**, *TA*, PSY 205: Statistics for the Psychological Sciences.

Scholarly Contributions

Publications:

He, J.A., Antshel, K.M. (2016). Cognitive behavioral therapy for Attention Deficit / Hyperactivity Disorder (ADHD) in college students: A critical review of the literature. *Cognitive and Behavioral Practice*. Advance online publication

He, J.A., Antshel, K.M., Biederman, J., & Faraone, S.V. (2016). Do personality traits predict functional impairment and quality of life in adult ADHD? A controlled study. *Journal of Attention Disorders*. Advance online publication. doi: 10.1177/1087054715613440

He, J.A., Sense, F., & Antshel, KM. (2015). Developing a university-wide primary prevention intervention for prescription stimulant misuse and diversion in college students. *The ADHD Report,* 23(1), 1-8

Manuscripts In Preparation or Under Review:

Fiksdal, A.S., Thoma, M.V., **He, J.A.**, Gianferante, D., & Rohleder, N. (Under review at *Biological Psychology*). Threat appraisals predict cortisol responses to repeated psychosocial stress in low but not high subjective social status individuals.

Ewart, C.K., **He, J.A**., LaFont, S.R., Gump, B. (In preparation). Measuring experiences of social exclusion and devaluation in multiracial populations: The social rejection and denigration scales.

Presentations:

He, J.A., Wagner, K.S., Antshel, K.M., Biederman, J., & Faraone, S.V. (2015). Functional impairment in ADHD: What matters more, symptoms or personality? *American Professional Society of ADHD and Related Disorders*, Washington, D.C. ***Poster Award Finalist***.

He, J.A., Raj, M., Talamantes, J.U., Koo, K.Y., Canavatchel, A.R., Franco, D.J., & Ewart, C.K. (2014). Childhood exposure to violence and the salivary alpha amylase response to the social competence interview. *American Psychosomatic Society*, San Francisco, CA. *Poster.*

Elder, G.J., Parekh, M., **He, J.A.**, Schoolman, J.H., LaFont, S.R., Fitzgerald, S.T., & Ewart, C.K. (2014). Social support and cardiovascular stress: the positive perception of social support buffers against stress of negative interactions

with support providers in the natural environment. *American Psychosomatic Society*, San Francisco, CA. *Citation Poster Award.*

Schoolman, J.H., Elder, G.J., Velasquez, H.A., Parekh, M., **He, J.A.**, LaFont, S.R., Fitzgerald, S.T., & Ewart, C.K. (2014). Self-Reported Depressive Symptoms Predict Metabolic Syndrome in Adults. *American Psychosomatic Society*, San Francisco, CA. *Poster.*

Parekh, M.,Elder, G.J., **He, J.A.**, Schoolman, J.H., S.R. LaFont, Fitzgerald, S.T., & Ewart, C.K. (2014). Does transcendence striving buffer the cardiovascular stress of social interaction in persons with hypertension? *American Psychosomatic Society*, San Francisco, CA. *Poster.*

Lafont, S.R., Elder, G.J., Parekh, M., Schoolman, J.H., **He, J.A.**, Fitzgerald, S.T., & Ewart, C.K. (2014) Dissipated striving predicts increased hypertension risk in persons with symptoms of depression. *American Psychosomatic Society*, San Francisco, CA. *Poster.*

Devine, J.K., Grey, S.J., **He, J.A.**, & Wolf, J.M. (2013). Can napping protect against negative inflammatory and health effects of poor sleep? *Psychoneuroimmunology International Society*, Stockholm, Sweden. *Poster.*

Devine, J.K., Grey, S.J., **He, J.A.**, & Wolf, J.M. (2013). Why Do You Nap? Influences of Sleep Behavior and Napping on Mental and Physical Health. *International Society for Psychoneuroendocrinology*, Leiden, Netherlands. *Poster.*

He, J.A., Velasquez, H.A., Fitzgerald, S.T., Raj, M., Elder, G.J., Parekh, M., Schoolman, J.H., & Ewart, C.K. (2013). Higher Perceived Neighborhood Disorder and Lower Subjective SES Predict Higher Metabolic Syndrome Risk. *American Psychosomatic Society*, Miami, Florida. *Poster.*

Elder, G.J., Parekh, M., Schoolman, J.H., **He, J.A.**, & Ewart, C.K. (2013). Implicit Agonistic Motives Moderate the Strength of the Longitudinal Relationship between Diastolic Reactivity in Youth and Adulthood. *American Psychosomatic Society*, Miami, Florida. ***Citation Poster.***

He, J.A., Thoma, M.V., Fiksdal, A., Geiger, A., Lerman, M., & Rohleder, N. (2012). Beyond the SES Health Gradient: Subjective Social Status Predicts a Higher IL-6 Response to Acute Stress. *Society for Psychophysiological Research*, New Orleans, Louisiana. *Poster.*

He, J.A., Thoma, M.V., Fiksdal, A., Lerman, M., & Rohleder, N. (2012). Lower subjective social status predicts increased acute stress-induced inflammatory disinhibition. *American Psychosomatic Society*, Athens, Greece. ***Paper Talk***.

He, J.A., Elder, G.J., Schoolman, J.H., Parekh, M., & Ewart, C.K. (2012). Adverse Cardiovascular Effects of Exposure to Neighborhood Disorder and Violence are Increased by Agonistic Striving. *Society for Behavioral Medicine*, New Orleans, Louisiana. *Meritorious Poster Award.*

Fiksdal, A.S., **He, J.A.**, Johnson, J. Rene, K., Thoma, M.V., & Rohleder, N. (2012). Threat appraisals predict cortisol responses to an acute psychosocial stressor in low but not high subjective social status individuals. *American Psychosomatic Society*, Athens, Greece. ***Citation Poster***.

He, J.A., Wolf, J.M., Robsman, L., Wong, J., Ellman, R., & Rohleder, N. (2011). Inverse association of subjective social status with peripheral inflammation in female, but not male college students. *American Psychosomatic Society*, San Antonio, TX. *Poster.*

Thoma, M.V., Berman, E.R., Gray, S.J., **He, J.A.**, Lerman, M., Nichols, K.M., Specker,

M.F., Wang, D., Wolf, J.M., & Rohleder, N. (2011). Relationship of the diurnal rhythm of heart rate variability with plasma interleukin-6 and salivary alpha-amylase. *American Psychosomatic Society*, San Antonio, TX. *Poster.*

Research Experience

2015- 2016 **Syracuse University**, *Syracuse Lead Study*
Research Supervisors: Craig K. Ewart, PhD; Brooks B. Gump, PhD
The Syracuse Lead Study is an NIH funded R01 project that aims to examine the impact that environmental toxicants (i.e., lead) have on the health of predominantly low income school age children who live in the Syracuse community. I conducted standardized, semi-structured qualitative interviews with primary caregivers and their children about chronic stressors and coping strategies. I also contributed to grant writing, data cleaning, data analysis, and manuscript preparation.

2014- 2016 **Syracuse University**, *Developmental Psychopathology Clinical Research Center*
Research Supervisor: Kevin M. Antshel, PhD
The Developmental Psychopathology Clinical Research Center aims to investigate and understand the heterogeneity of Attention deficit / hyperactivity disorder (ADHD) and Autism Spectrum Disorders (ASD) across the lifespan. I worked on research projects related the heterogeneity of ADHD to further explore mediators and moderators of treatment outcomes.

2014- 2015 **Syracuse VA Medical Center,** *Center for Integrated Health (CIH)*
Research Supervisors: Jennifer Funderburk, PhD; Stephen Maisto, PhD.
Addressing depression and suicidality in veterans is a principal goal of many psychiatric and psychotherapeutic treatment plans at the VA. As a Health Science Specialist at the Syracuse VA Medical Center, I applied my clinical and assessment skills to a randomized controlled trial of behavioral activation for depression and suicidality in the VA primary care setting.

2011- 2014 **Syracuse University**, *Project Heart*
Research Supervisor: Craig K. Ewart, PhD.
Through a series of NIH-funded longitudinal studies (Project Heart) spanning over 20 years, the Ewart lab has been studying determinants of CVD risk in low-income, largely minority populations. We examined relationships between biomarkers of health and development of metabolic syndrome and other indices of risk for CVD. I supervised a team of 6 undergraduate research assistants in implementing my master's project, an exploration of how perceived neighborhood disorder and exposure to violence during childhood affects the sympathetic adrenal medullary (SAM) axis response to stress, by assessing the biomarkers cortisol and amylase before, during, and after a standardized stress interview.

2009- 2011	**Brandeis University**, *Health and Aging Study* Research Supervisor: Nicolas Rohleder, PhD. The Brandeis Health Study, supported by a grant from the American Federation of Aging Research, aimed to elucidate the relationship between stress and health and the specific pathways that link acute or chronic stress to detrimental health outcomes. I received intensive experimental training in psychoneuroimmunology and endocrinology lab techniques for saliva and plasma assays of in-vitro hormone and immune responses, and the Trier Social Stress Test (TSST) paradigm. My honors thesis, "Looking beyond the SES-Health gradient: does subjective social status play a role in acute stress-induced peripheral inflammation?" earned me the distinction of receiving the Elliot Aronson Prize for Excellence in Psychological Research, given to the best undergraduate honors thesis of the year

Fellowships & Awards

2015	Graduate Student Organization (GSO) Travel Grant - $450
2014	Psychology Department Conference Travel Award - $400
2013	Psychology Department Conference Travel Award - $400
2012	Graduate Student Organization (GSO) Travel Grant - $450
2012	Psychology Department Award for Master's Thesis Research - $1,000
2011	Elliot Aronson Prize for Excellence in Psychological Research - $150
2010	Jerome A. Schiff Undergraduate Research Fellowship - $2,000
2010	Hiatt Center World of Work Fellowship - $3,000

Service

2014-Present	Ad-Hoc Student Reviewer: *Journal of Adolescent Health, Psychiatry Research, Health Psychology*
2013-2016	Abstract Reviewer, American Psychosomatic Society Annual Meeting
2014	Member, Clinical Psychology Faculty Search Committee, Syracuse University
2012	Member, Curriculum Coordinator Search Committee, Syracuse University

Professional Affiliations

2015-Present	American Professional Society of ADHD and Related Disorders (APSARD)
2013-Present	American Psychological Association (APA) Division 53
2013-2015	Women in Science and Engineering (WISE) at Syracuse University
2011-2015	American Psychosomatic Society (APS)
2010-Present	Psi-Chi International Honor Society