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THE VALIDITY OF SELF- VERSUS OTHER REPORTS OF ADHD SYMPTOMS IN COLLEGE STUDENTS: COGNITIVE AND ACADEMIC ACHIEVEMENT OUTCOMES

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The Validity of Self- versus Informant Reports of ADHD Symptoms in College Students: Cognitive and Academic Achievement Outcomes

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Abstract

Despite the abundance of studies investigating Attention-Deficit Hyperactivity Disorder in children and adults, little research has focused on ADHD and comorbid learning disabilities (LD) in college students. The dearth of research in this population is becoming increasingly important given that ADHD and LD are the two most commonly reported and diagnosed disabilities in higher academic institutions (National Center for Education Statistics, 2011). As a result, clinicians' are continually faced with the difficult task of determining sensitive and valid assessment measures to use with this population. While some overlap exists between college students and younger and older counterparts, research has shown that this subpopulation represents a distinct subgroup of young adults further complicating diagnostic decisions and, ultimately, subsequent accommodation and intervention recommendations based on assessment results (Frazier, Youngstrom, Glutting, & Watkins, 2007).

Little is known about the degree of concordance between self- and other reports of ADHD symptoms, both of which are commonly used in diagnostic decisions. This study was designed to investigate the relationship between self- and other reports of childhood/current ADHD symptoms and neurocognitive and academic achievement performance. Data for this study is based on students at-risk for learning and/or attention disorders that sought a comprehensive psychological evaluation at the University of Georgia Regents' Center for Learning Disorders. The sample (N = 347) was comprised of three groups: (1) ADHD; (2) LD; and, (3) ADHD+LD. Participants were classified into three groups based on the results of the evaluation process and clinical diagnoses. Assessments utilized in this study included criterion- and norm-referenced ADHD measures, academic achievement, IQ, verbal memory, working memory, and processing speed tests. Results suggest that the relationship between self- and other ratings is strongest within scales regardless of time (childhood, current) or type of informant (self, parent). ADHD behaviors, as rated by self- and other report, were weakly correlated with neurocognitive measures and moderately associated with academic achievement test. Measures most sensitive to group differences were academic achievement tests; by in large, neurocognitive tests did not differentiate groups. Implications for future research are discussed.

Keywords: ADHD, LD, college students, comorbid disorders, neuropsychological assessment, academic achievement, measures of ADHD, measures of LD, inter-rater reliability, behavior rating scale, neurodevelopmental disorders.

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Chapter 1

Introduction to the Study

The field of psychology has long been interested in gaining a better understanding of the neurocognitive underpinnings and behavioral traits of Attention-Deficit Hyperactivity Disorder (ADHD). This interest has made ADHD one of the most frequently investigated disorders in the past century. Nevertheless, a group of individuals with ADHD has been largely ignored; that is, college students with ADHD represent a subsample of young adults that has received far less attention than younger and older counterparts, a revelation given the prevalence of ADHD in higher education institutions. The dearth of research examining neurocognitive and behavioral characteristics, as well as the functional impact of ADHD in college students, has become increasingly problematic as more and more students with ADHD are attending higher education institutions. This problem is further exacerbated by the very likely possibility that many college students with ADHD, previously diagnosed or not, may not be receiving appropriate accommodations and efficacious interventions. In addition, diagnostic decision making in this population is increasingly complex given the prescription medication epidemic in the U.S.; namely, stimulant medications are increasingly being sought out and abused by young adults as a recreational drug.

The most commonly used assessment measures in ADHD evaluations include self- and other report, information typically gathered via behavior rating scales. Although it is generally agreed upon that the use of multiple informants in ADHD evaluations with college students is best practice, the degree of concordance between informants in this subpopulation of young adults is relatively unknown. The significance of this missing knowledge becomes apparent when professionals are tasked with making clinical decisions of how to weight self- vs. other ratings on ADHD symptom scales. For example, discordant self- and other ratings of childhood and current ADHD symptoms pose a significant issue for clinicians that are required to make dichotomous diagnostic decisions. A further complication for clinicians is the uncertainty that revolves around using downward (children) and upward (adults) extensions in the ADHD literature to guide assessment, diagnostic, accommodation, and intervention decisions and recommendations. Important to this study is the fact that some researchers contend that college students with ADHD represent a distinct subset of adults with ADHD due to better developed compensatory mechanisms, increased feigning of symptoms (Harrison, Edwards, & Parker, 2007) for secondary gains (e.g. high-stakes testing accommodations, access to prescription medication, etc.), and higher ability levels than adults with ADHD from the general population (Frazier, Youngstrom, Glutting, & Watkins, 2007).

Therefore, the present study uses a sample largely comprised of college students to examine the concordance rates between self- and other reports of childhood and current ADHD symptomatology across three ADHD rating scales. This study further extends the literature by examining two groups of college participants in addition to the group of participants with ADHD; one group with learning disabilities (LD) and a second group with comorbid ADHD and LD. It is imperative to understand potential cognitive and academic achievement differences between these disability groups given the prevalence of college students with LD, ADHD, and both conditions. Not only has this subpopulation of young adults with ADHD and learning problems received minimal attention in the literature, little is known about how young adults planning to attend college, or those currently attending college, perform on academic, neurocognitive, and behavioral functioning measures. Even less is known about diagnostic differences on behavior rating scales that may emerge as a result of using scales with different normative samples; that is, the normative scales in which behavior scales are derived from may affect the degree of concordance between self and other ratings of childhood and current symptomatology.

In general, the use of data from multiple respondents is considered best practice; however, this information holds little value without a better understanding of concordance estimates between raters and the degree of relationship between ratings and outcomes such as academic achievement, especially as it pertains to the understudied population of college-aged students. As a result, the current study also investigates the relationship between respondents' reports and cognitive functioning and academic achievement outcomes as a means for explicating the validity and utility of different assessment measures. This extension of the research becomes increasingly important given the difficulty of extrapolating findings from downward (children) and upward extensions (older adults) of research investigating attentional disorders because both represent a distinct neurodevelopmental population of individuals. Given that ADHD is accepted as a neurodevelopmental disorder, and categorized as such in the *DSM-5* (American Psychiatric Association, 2013), considerations about the neurodevelopmental consistency between such comparisons become imperative and necessary before one can make valid conclusions and determinations about the functional impact of ADHD at a higher education level.

This investigation aims to contribute to existing knowledge by improving clinicians understanding of ADHD symptomatology and subsequent diagnostic decisions in college students through the explication of concordance estimates between self- and other ratings using multiple behavior rating scales. A second component of the study further extends the literature by investigating the relationship between behavioral symptomatology and functional impairments. For example, poor academic performance is among the most prominent features associated with ADHD. It is not, therefore, surprising that many college students with ADHD have comorbid learning problems (Frazier et al., 2007; Mayes, Calhoun, & Crowell, 2000; McGillivray & Baker, 2009). The origin of learning difficulties in college students with ADHD, however, may differ from those commonly found in college students with LD. It may be tenable to posit that learning problems associated with ADHD in college students result primarily from executive dysfunction or poor attention rather than, for example, impaired basic reading skills in students with reading disabilities or poor procedural mathematics knowledge in students with math disabilities. This distinction would suggest an additive versus interactive disability model. Prospective findings have potential theoretical as well as functional implications that, in turn, guide education planning. From a theoretical standpoint, college students with ADHD may demonstrate lower academic performance as a result of different underlying neurocognitive deficits from those commonly found in students with LD. Thus, the difference between college students with ADHD and LD may best be explained by performance vs. functional deficits despite ostensibly similar profiles. Additional information about how these groups are similar and different has implications not only for the student, but also for higher academic institutions faced with funding issues and limited disability student services.

Chapter 2

Literature Review

History of ADHD

Attention-deficit hyperactivity disorder (ADHD) is characterized by developmentally inappropriate levels of inattention, impulsivity, and hyperactivity (i.e., extreme degree of motor activity) (American Psychiatric Association, APA, 2000). ADHD is a commonly diagnosed childhood disorder that begins early in life (i.e., before age 7) and, in most individuals, perseveres throughout their lifespan (Barkley, 2006). A recent prospective longitudinal study demonstrated that up to 80% of children with ADHD continue to display symptoms into late adolescence (Willoughby, 2003), whereas persistence rates in adulthood vary widely from 4% to 70% and also fluctuate significantly across U.S. geographical regions and rural-urban settings (Faraone & Biederman, 2005). These authors explain that this wide variance is due to the heterogeneity of samples in research studies examining ADHD across the lifespan rather than any evidence of persistence.

Children described with characteristics of ADHD date back to the 1800's and a German physician, Heinrich Hoffman, who wrote about a child named Fidgety Phil. The appropriately named child exhibited traits consistent with what is now commonly recognized as ADHD (Lange, Reichl, Lange, Tucha, & Tucha, 2010). In the early 20th century ADHD was described as a disorder of children with disruptive and hyperactive behavior more commonly found in boys. Shortly thereafter, attentional problems and conduct disorder related behaviors were noted in children, particularly children with early brain damage. One of the primary investigators was

Tredgold, who in 1908 established a correlation between early brain damage caused by, for example, birth defect or perinatal anoxia that manifested as encephalitis symptoms (Tredgold 1908, as cited in Rothenberger & Neumärker, 2005). Laufer, Denhoof, and Solomons (2011) explain that in 1957 reports emerged of children without evidence of etiological trauma or infection that presented with characteristics of the ADHD syndrome, leading the authors to suggest the earliest examples of functional versus structural disturbances. This led to a variety of ADHD terminology in the 20th century, which included hyperkinetic disease of infancy (Kramer & Pollnow, 1932) and minimum brain dysfunction (Clements, 1966), not to be confused with minimal brain damage. In 1980 the *Diagnostic and Statistical Manual of Mental Disorders, Third Edition* (DSM-III; American Psychiatric Association, 1980) first classified the ADHD syndrome as a disorder in children that could be designated as either or both ADD and ADHD. Surprisingly, it wasn't until 1987 when the DSM-III-R noted that adults may also exhibit traits consistent with ADD/ADHD. The DSM-IV (American Psychiatric Association, 1994) and DSM-IV-TR (American Psychiatric Association, 2000) endorsed this terminology, but added that ADHD must begin in childhood.

Prevalence data research suggests that 2% to 5% of the general population continue to display appreciable ADHD symptoms into adult life (Barkley, 2006). According to the DSM-IV, prevalence estimates of ADHD range from 3% to 7% for children and youth. With regards to gender differences, ADHD is thought to be more frequent in males than in females regardless of age. The ADHD gender discrepancy, however, greatly diminishes across the developmental lifespan. Among children with ADHD, the ratio ranges from 2:1 to 9:1, depending on the subtype (DuPaul, Power, Anastopoulos, Reid, McGoey, et al., 1997; DuPaul, Anastopoulos, Power, Reid, Ikeda, et al., 1998; Greydanus, Pratt, & Patel, 2007) and whether the data come from a clinical-based (6:1) or random sample (3.4:1; American Psychiatric Association, 2000; Garland, Hough, McCabe, Yeh, Wood, et al., 2001). On the other hand, adult males are 1.7 times more likely to display clinically significant ADHD symptoms in comparison to adult females (Kessler, Adler, Barkley, Biederman, Conners, et al., 2006). It seems tenable to suggest that gender ratio differences in ADHD from childhood to adulthood may, in part, reflect a superficial finding stemming from parents' propensity to focus on hyperactive symptoms in young boys more so than girls.

Prevalence rates of ADHD and co-morbid conditions cannot be interpreted in isolation. Base rates of ADHD across different populations need to account for various factors such as: the type of assessment methods included in the battery (behavior rating scales, cognitive processing tests, etc.), type of informant, sample type (e.g., college), rate of attrition in the sample, and developmental age of interest (Barkley, Fischer, Smallish, & Fletcher, 2002; Mannuzza, Klein, & Moulton, 2003). Prevalence estimates of ADHD vary because of these factors as well as a lack of consensus for how ADHD is defined, which directly affects diagnostic criteria and measurement. Nevertheless, it has been established that ADHD is not simply a childhood disorder, speaking to the neurobiological origin of this disorder. The interaction between genetic predisposition to attentional and/or hyperactive-impulsive behavior and environmental factors likely contribute to the heterogeneous nature of ADHD symptoms when viewed from an etiological perspective. In fact, a meta-analysis of studies consisting of adults with ADHD found that the largest effect sizes across non-executive function and executive function measures were accompanied by significant *Q* values, a measurement of the false discovery rate commonly used in meta-analyses, indicating heterogeneity in results (Boonstra, Oosterlaan, Sergeant, & Buitelaar, 2005). Clearly there is a need to better measure neurocognitive and behavioral correlates of ADHD, as it provides a mean for more clearly understanding factors that contribute to the heterogeneity found in individuals with ADHD.

Genetic and Environmental Basis of ADHD

ADHD has strong genetic ties, as denoted by studies investigating familial transmission rates. Parents of children with ADHD have a 2 to 8 fold increase in the risk for ADHD (Faraone & Biederman, 1998). Not only does ADHD show familiality, it is also highly heritable with genetic contribution seen regardless of ADHD terminology (i.e., categorical, continuum of symptoms, or latent class analysis) (Wallis, Russell, & Muenke, 2008). Heritability estimates of ADHD are generally derived from twin studies, which across several countries have an average concordance rate of 0.76, denoting genetics contributes roughly 70-80% to ADHD and environment 20-30% (Biederman & Faraone, 2005). Farone and Biederman (1998) reported that genetic contribution to ADHD ranges from moderate to large effect sizes, generally exceeding 0.60, and were estimated to be 0.80 across six twin studies of ADHD or related traits. Most researchers agree that, given the complexity of traits underlying ADHD, multiple genes probably contribute to the neurological phenotype of ADHD, each accounting for a relatively small proportion of variance in ADHD symptoms. Molecular genetic studies have identified a minimum of 8-13 candidate genes such as thyroid receptor-b genes (GRTH), dopamine D2 receptor gene, dopamine transporter (DAT), serotonin receptor 1B, SNAP-25, and D4 dopamine receptor (DRD4) that might increase susceptibility to ADHD (Bidwell, Willcutt, DeFries, & Pennington, 2007; Coghill & Banaschewski, 2009; Faraone & Biederman, 1998; Turic, Swanson, & Sonuga-barke, 2010; Wallis, Russell, & Muenke, 2008). Overall, the etiology of ADHD may derive from different combinations of several interacting genes, as well as other factors such as environmental influences and gene x environment interactions.

In respect to environmental influences, a seminal study by Rutter and colleagues (1975) revealed six risk factors within the family environment that correlated significantly with childhood mental disturbances: a) severe marital discord; b) low socioeconomic status; c) large family size; d) paternal criminality; e) maternal mental disorder; and, f) foster placement. Their conclusion was that a collection of adversity factors, rather than the presence of any single one factor, coalesces to negatively impact development. Nonetheless, these risk factors do not merely relate to psychosocial adversity for ADHD; they are universal predictors of children's maladaptive functioning and emotional health.

Neurobiology of ADHD

Theoretical models of ADHD. Many theoretical models of ADHD have been proposed with varying constructs; nonetheless, most include some aspect of executive function contributing to the core behavioral symptomatology in individuals with ADHD. Barkley's (1997b) proposed theory of ADHD is centered around disinhibition, which disrupts supplementary functioning in areas such as working memory, motor control and fluency-syntax, self-regulation, behavior analysis and synthesis (rule-governed behavior), and internalization of speech. This pattern of deficits is consistent with frontal dysfunction, often found in children and adults with ADHD, impacting subcortical projections. Others have further delineated specific executive functions in the construct of ADHD including cognitive fluency, planning, working memory, inhibition, and set shifting or flexibility, with the primary deficits seated in behavioral inhibition (Pennington & Ozonoff, 1996). A meta-analytic review conducted by Boonstra et al. (2005) did not find support for either Pennington's or Barkley's theory in respect to adults; rather, they posit that general cognitive slowing better explains the muted neuropsychological profile of ADHD in adults when compared to children.

Researchers examining the neural basis of ADHD have consistently reported findings of frontostriatal dysfunction. A recent quantitative meta-analysis of 16 neuroimaging studies in ADHD found significant patterns of hypofunction in frontal regions, thalamus, basal ganglia, and to a lesser extent in some parietal regions (Dickstein, Bannon, Castellanos, & Milham, 2006). The frontostriatal circuitry includes the dorsolateral prefrontal cortex (DLPFC), ventrolateral prefrontal cortex (VLPFC), dorsal anterior cingulate cortex (ACC), as well as the caudate nucleus and putamen. Notably, the frontosubcortical systems that aid in the control of attention and motor behavior are often opulent in catecholamines (Smith, Johnstone, & Barry, 2004). Thus, the frontosubcortical circuitry plays a prominent role in regulation of dopamine (DA) and, given the importance of DA in executive control, it seems tenable to assume that differences in the DA rich areas of the brain, such as the prefrontal cortex and subcortical projections, may in part explain the pathophysiology of ADHD. However, more recent research, as discussed below, has shown that the pathophysiology of ADHD may extend beyond executive dysfunction and the frontostriatal circuitry. The additional brain regions include the cerebellum, and parietal and temporal lobes. This would suggest that individuals with ADHD may have broader deficits above and beyond those associated with executive functions.

Structural imagining studies. Structural abnormalities in individuals with ADHD should be discussed in the context of typical brain development, which follows the trajectory of an overall increase in grey matter volume from childhood to puberty, followed by reductions in adolescence (Giedd et al., 1999). This reduction is based on developmental synaptic pruning conducive to appropriate brain maturation. Thus, a delay in grey matter thinning for brain regions implicated in ADHD may be interpreted as structural abnormalities that are believed to be involved in the phenotypic expression, as measured by behavior rating scales and neurocognitive tests of aberrant observed behavioral characteristics. The causality of changes in grey matter is difficult to determine because developmentally normed volumes of grey matter density for a certain age is not known, limiting the ability to interpret findings in individuals with ADHD (Vaidya, 2011). Structural and functional findings, therefore, should be interpreted comparatively to the population of interest until a more valid normative base is developed through ongoing neuroimaging research.

Structural imaging findings in children with ADHD include smaller total brain volumes and reduced volumes in the right frontal lobe, caudate nucleus, the cerebellar hemispheres, and posterior inferior lobules of the cerebellar vermis after adjusting for differences in total cerebral volume (Castellanos et al., 2002). Despite the convergence across age for volumetric caudate growth trajectories, differences did not persist into adolescence as caudate volumes decreased less rapidly across age in children with ADHD than in typical development. Castellanos and colleagues also found correlations between parent and teacher ratings of ADHD symptoms and temporal grey matter volume. There is also some support for cerebellar volume loss in ADHD into adolescence (Mackie et al., 2007). In addition, structural imaging studies have reported decreases in temporal lobe total volume (Castellanos et al., 2002), grey matter volume (Brieber et al., 2007), and cortical thickness (Shaw et al., 2007). Findings regarding parietal volume reduction, grey matter, white matter, and cortical thickness have varied (Cherkasova & Hechtman, 2009). Overall, reported cortex volume and cortical thickness reductions tend to cluster in multimodal association cortices such as the prefrontal cortex and projecting substrates, premotor cortex, posterior cingulate, anterior and medial temporal lobes, cerebellar lobules, and basal ganglia structures (Seidman, Valera, & Makris, 2005; Vaidya, 2011). What is less clear is the degree to which these structural abnormalities correlate with frequently used neurocognitive measures and manifestations of behavioral symptomatology.

Functional imagining studies. Research investigating the underlying neurological circuitry of ADHD and associations with performance on neurocognitive tasks has used functional neuroimaging approaches (e.g., fMRI). Functional neuroimaging studies differ from structural investigations in that the focus of study is on white matter tracts versus grey matter and structural abnormalities. In addition, functional neuroimaging includes the monitoring and measuring of neuronal functioning at a resting state and while actively engaged in a cognitive task. Many studies have investigated functional activity via variations of the Stoop task. Overall, consistent findings have implicated reduced activation of frontal and anterior cingulate activity. A voxel-wise quantitative meta-analysis of fMRI studies found consistent hypoactivation in three primary prefrontal cortex regions: anterior cingulate cortex, dorsolateral prefrontal cortex, and inferior prefrontal cortex (Durston, Mulder, Casey, Ziermans, & van Engeland, 2006). Differences have been reported, however, between cognitive tasks; for example, some studies have found minimal striatal, ACC, and frontal activity during short-term memory, inference control, and response completion tasks (Cherkasoa & Hechtman, 2009).

Cerebellar activity has also been investigated in individuals with ADHD. In general, studies have found decreased cerebellar activity, particularly in the left cerebellum and cerebellum projections to the frontostriatal regions (Berquin, Giedd, Jacobsen, Hamburger, Krain, et al., 1998; Seidman, Valera, & Makris, 2005). Another study found that methylphenidate medication improved performance on a go-no go task in familial ADHD, in both parents and their children (Epstein, Case, Tonev, Davidson, Reiss, et al., 2007). Taken together, cerebellum dysfunction may be heritable and underlie the impaired ability of people with ADHD to predict event occurrence, leading some researchers to extrapolate these findings to explain poor behavioral adjustment in the framework of poor rule-governed behavior and expectations (Cherkasoa & Hechtman, 2009).

Parietal activity in ADHD has been associated with frontostriatal circuitry and anterior attentional control, as well as temporoparietal activity. There is some evidence of reductions in parietal volume and cortical thickness in ADHD. Task-based activation studies have implicated changes in parietal activity underlying various attention-related functions including inhibition, spatial WM, response switching, selective attention, attention allocation, alertness, episodic memory, and motor function (Cherkasoa & Hechtman, 2009). In turn, reduced parietal activity in ADHD may negatively impact monitoring and attention allocation networks making adjustments for future decision difficult. Overall, hyperperfusion of the somatosensory areas may lead to sensory disinhibiiton and sensory hyperarousal.

Involvement of temporal regions and connections in children and adults with ADHD has also been studied. Findings include hypoperfusion in the right middle temporal gyrus (Kim, Lee, Shin, Cho, & Lee, 2002), hyperactivation of the left temporal gyrus (Tamm, Menon, Ringel, & Reiss, 2004) and occipotemporal regions related to higher visual processing areas in children (Lee, Kim, Kang, Lee, Kim, et al., 2005). In addition, research has found impaired recruitment of the middle temporal gyrus during a divided attention cross-modal task, which is linked to mediating attentional processing of verbal auditory information (Shafritz, Marchione, Gore, Shaywitz, & Shaywitz, 2004). This finding is concurrent with another research finding of reduced cerebral glucose metabolism in the temporal region (Ernst, Zametkin, Matochik, Schmidt, Jons, et al., 1997). Subjects reported an increased ability to ignore auditory distractors of the attention task after dextroamphetamine, a medication that inhibits the transporter proteins for monoamine neurotransmitters (namely serotonin, norepinephrine, and dopamine transporters). The authors concluded that dextroamphetamine was effective at dampening background noise by way of more effective inhibition of temporal neural activity subserving auditory processing. Contralateral effects involving the left temporal lobe, including the left hippocampal gyrus and insula, have been found on a decision-making task requiring short-term rewards versus long-term losses and response switching tasks (Ernst, Kimes, London, Matochik, Eldreth, et al., 2003). Some studies, however, have shown an increased activation of the left middle and superior temporal gyri during similar tasks (e.g., go-no-go task) in spite of performance deficits and hypoactivation of the anterior-mid-cingulate cortex spreading to the supplementary motor area (Tamm, Menon, Ringel, & Reiss, 2004). The authors explained this difference by way of verbally mediated strategies such as verbal rehearsal. In turn, there appears to be evidence of both hypoperfusion and hyperperfusion of the middle temporal gyrus and occiptotemporal regions and the compensatory use of temporal lobes in ADHD. Castellanos and colleagues (2006) have conceptualized ADHD from the framework of an integrative model, emphasizing interactions between parallel processing and nonreciprocal pathways consisting of striato-nigral-striatal and thalamo-cortico-thalamic networks.

In summary, a variety of brain regions and specific anatomical structures have been connected to ADHD across the developmental lifespan. Contemporary research has found a number of brain regions and substrates extending beyond the frontal lobe, all of which help explain overt behavioral symptoms. For example, the aforementioned functional neuroimaging studies have found that individuals with ADHD exhibit functional abnormalities that extend to the cerebellum, temporal, frontal, and parietal lobes, as well as several cross-modal connection areas. It is, therefore, not surprising that ADHD commonly co-occurs with other disorders such as learning disabilities. The attentional system ultimately serves as a precursor to numerous neurological functions, which partially explains the connection between lower order and higher order cognitive functions such as intellectual reasoning and academic aptitude. Ultimately, neuroimaging research has laid the groundwork for a better understanding of behavioral and cognitive dysfunction in children and adults with ADHD. This type of information is important given the frequency in which neuropsychological tests are used with students suspected of having ADHD and/or LD. The current study was designed with these considerations in mind as potential differences on neurocognitive and academic measures in students with ADHD, LD and comorbid attention and learning problems are investigated.

Neurocognitive and Academic Functioning in ADHD

A continual challenge for clinicians is determining which assessments differentiate inattentive and hyperactive/impulsive problems in ADHD from normal fluctuations in attention, concentration, and self-regulation, not to mention other comorbid conditions (oppositional defiance disorder, learning disorders). Unfortunately, no reliable diagnostic test exists to deconstruct attention, concentration, and self-regulation problems in ADHD from normal fluctuations in attention and self-regulation. Further, clinicians' are tasked with determining the validity of retrospective accounts of distal childhood events that may not be accurate, as ADHD is one of a few disorders that requires symptom presentation to begin in early childhood. Results from a study investigating the accuracy of adult recollection of childhood ADHD symptoms found that in general population surveys, adult self-reports of childhood behavior were weakly related to a valid diagnosis (Mannuzza, Klein, Klein, Bessler, & Shrout, 2002). Additional research has reported more positive findings. For example, Murphy and Schachar (2000) found large correlations (.69 to .79) between current self-ratings and retrospective parent ratings of childhood ADHD symptoms. Barkley et al. (2002) found participants diagnosed with ADHD in childhood underreported their childhood symptoms in young adulthood. Magnusson and colleagues (2006) found good consistency in ratings on corresponding measures across time frames (childhood/adulthood), moderate support for divergent validity on corresponding measures, and predictive validity supported by the fact that self- and other ratings were related to interview-based diagnoses with a high degree of sensitivity and specificity. It is, therefore, not surprising that comprehensive assessments are preferred over single informant reports or single assessments because they permit a more deep understanding of the client's difficulties and help provide important information to guide rule-in and rule-out decisions. Interview-based assessment approaches are almost exclusively dependent on the perceptions of others. In addition, adults with ADHD have been reported to demonstrate inconsistent attention and performance in a one-to-one testing setting (Barkley, 1998).

Cognitive and neuropsychological assessment battery approaches is one possible means for differentiating profiles amongst individuals with ADHD. Objective psychometric tests help elucidate ADHD symptoms useful for making diagnostic decisions, in part because they share minimal variance with other assessment measures such as behavior rating scales. Moreover, cognitive tests are not reliant and thus susceptible to the influences of recall biases, to a lesser extent malingering, halo effects, as well as other hypothetically confounding factors (e.g., medical condition, psychological disturbances). Understanding different neuropsychological profiles in subtypes of ADHD has the potential to increase the delivery of services, determine what services are beneficial, and identify underlying neurocognitive impairments contributing to core symptom presentations and functional impacts. However, few studies have found consistent neuropsychological profile differences between inattentive and combined-type groups (Chhabildas, Pennington, & Willcut, 2001; Fischer, Barkely, Edelbrock, and Smallfish, 1990). Barkley (1997b) contends that different patterns of neuropsychological deficits exists; that is, the inattentive subtype is posited to be related to deficits in focused or selective attention and speed of information processing, while impaired sustained attention, behavioral disinhibition, and affect-motivation-arousal dysregulation best characterizes the hyperactive-impulsive subtype. The present theory contends that inattention in ADHD is a secondary symptom, the consequence of insufficient behavioral inhibition and interference control mediated through the constructs of working memory and additional executive functions. Overall, most individuals with ADHD present with difficulties in varying domains of attentional and neuropsychological functions, such as problem solving, orienting, alerting, planning, cognitive flexibility, response inhibition, working memory, and cognitive switching (Curatolo, 2005).

Woods, Lovejoy, and Ball (2002) investigated measures that reliably differentiate adults with ADHD from healthy controls and found subtle impairments on divided and sustained attention, verbal fluency, auditory-verbal list learning, planning/organization, behavioral inhibition/impulsivity, cognitive flexibility, and speed of information processing. The most reliable tests that distinguished ADHD from non-ADHD adults were Stroop tasks, verbal letter fluency, auditory verbal list learning, and continuous performance tests (CPT). Nonetheless, neuropsychological assessment procedures demonstrate limited utility and predictive validity in studies that attempted to distinguish ADHD from other psychiatric or neurologic conditions. A separate meta-analytic review made more specific distinctions between performance on Stroop tasks; namely, when controlling for performance on the Color card, effect sizes for the inference task failed to reach statistical significance (Boonstra, Oosterlaan, Sergeant, & Buitelaar, 2005). Based on their findings, the authors could not support the conclusion that adults with ADHD show poor selective visual attention and/or prepotent response inhibition. Results revealed a mean effect size of 0.40 for executive function variables and a mean effect size of 0.43 for variables in the non-executive function domain. Thus, the findings do not suggest a *specific* deficit in the executive function realm for adults with ADHD.

Both significant and negligible effects in overall IQ have been reported in individuals with ADHD (see Frazier, Demaree, & Youngstrom, 2004, for a review). A recent meta-analysis of studies examining intellectual and neuropsychological test performance in children, adolescents, college-age students, and adults with ADHD (Frazier, Demaree, & Youngstrom, 2004) found that ADHD groups displayed significantly lower Full Scale IQ (FSIQ) scores relative to control groups. The authors concluded that Full Scale, Verbal, and Performance IQs were also significantly sensitive to ADHD, especially for studies using clinical samples and interview-based diagnoses with multiple sources of information. No differences in FSIQ were found between ADHD subtypes. A closer inspection of Cohen's *d* effect sizes for studies included in the meta-analysis with participants between the ages of 20 and 30 revealed significantly smaller effect sizes, which may be related to more participants attending higher academic institutions in this age band. Given that college students with ADHD are likely to have higher ability levels, superior compensatory skills, and greater primary and secondary academic success than individuals with ADHD from the general population (Frazier, Youngstrom, Glutting,

& Watkins, 2007), it is not surprising that meta-analytic differences on neurocognitive measures were found between age groups. In general, neuropsychological measures were sensitive to ADHD. Effect sizes varied considerably across measures, however. Nonexecutive cognitive abilities such as the Peabody Picture Vocabulary Test (PPVT), Block Design, Rey Copy and Recall, Vocabulary, and Similarities produced significantly smaller weighted mean effect sizes. All CPT measures were significant, as were Processing Speed, Stop Signal Task-Probability of Inhibition, Stroop Interference, Freedom from Distractibility, and Letter Fluency measures. The largest effect sizes reported across studies included in the meta-analysis were for spelling and arithmetic academic achievement measures, as well as correct responses (i.e., hits) on CPTs. All academic achievement measures produced significant effect sizes; in fact, effect sizes for FSIQ were significantly smaller than those from spelling and arithmetic achievement tests. Verbal fluency and language measures did not significantly differ from FSIQ. Interestingly, measures of executive function were only equivalent or significantly smaller than FSIQ. This finding may be related to the type of executive function tasks included in effect size analyses. Frazier and colleagues posited that more specific impairment of executive function might account for difference in general ability.

Murphy (2002) found that adult ADHD subjects who completed the Tower of Hanoi, a measure of cognitive planning, were less efficient at problem solving than were the normal controls, as indicated by a significantly greater number or moves to solve the puzzle. ADHD subjects also took significantly longer complete Trails A and B, a measure of visual attention, scanning, and cognitive switching and flexibility. The author attributed poor performance on these tasks to a problem in planning rather than impulsiveness, and that difficulties in search strategy or focus negatively impacted scores on Trails more so than a problem in switching. It should be noted that this study only included male adult subjects limiting the generalizability of findings. Adults with ADHD also have difficulty learning verbal information (Seidman, Biederman, Weber, Hatch, & Faraone, 1998). Results indicated that adults with ADHD learned significantly fewer words and used fewer semantic clusters. Rate of forgetting was not significantly different from control subjects, suggesting impaired encoding of information and/or retrieval problems. Finally, working memory deficits have been found across studies (Boonstra, Oosterlaan, Sergeant, & Buitelaar, 2005; Kofler, Alderson, Raiker, Bolden, Sarver, et al., 2014; Quinlan & Brown, 2003).

Background of ADHD in Higher Academic Institutions

College students with ADHD. Despite the current research on children and adults with ADHD, research using a college-age sample has drawn significantly less attention. The passage of the Americans with Disabilities Act (ADA) in 1990 and Americans with Disabilities Act Amendments Act of 2008; the Individuals with Disabilities Education Act (IDEA) of 1975; Higher Education Opportunity Act of 2008; and, Section 504 of the Rehabilitation Act of 1973 mandated that primary, secondary, and post-secondary students with disabilities receive appropriate education services and accommodations, further accelerating the need for additional research with this population of students. The aforementioned federal mandates have led to an increased focus on primary and secondary education identifiers for students with ADHD and subsequent intervention support, thus increasing the number of adolescents with ADHD attending college. As a result, more and more students with disabilities are, and will be, attending higher academic institutions (Wolf, 2001). According to the National Center for Education Statistics report (2011) of 2-year and 4-year degree-granting post-secondary institutions conducted during the 2008–2009 academic year, approximately 707,000 students with disabilities enrolled at post-secondary institutions. Among these institutions, students with specific learning disabilities (SLD; 31%) and ADHD (15%) comprised the two largest subpopulations of students with a disability attending college.

As more and more students with ADHD and other disabilities (e.g., learning disability, internalizing disorders, etc.) pursue higher education, research is needed to clarify the construct of ADHD in college students, develop empirically validated assessment methods for diagnostic decisions, and, ultimately, develop and explicate efficacious intervention methods and cost effective ways to deliver support services. Although there is limited research examining college students and young adults with ADHD, several studies have investigated the prevalence rates of ADHD in college samples using various ADHD scales and diagnostic criteria (see Weyandt & DuPaul, 2006, for a review). This is a particularly important step since the general consensus is college students with ADHD comprise an adult subgroup that differs from other adults with ADHD who do not attend college (Heiligenstein & Keeling, 1995; Lee, Oakland, Jackson, & Glutting, 2008). In general, the prevalence of ADHD among college students is thought to be less than prevalence estimates in adulthood (Wolf, 2001). Weyandt, Linterman, and Rice (1995) conducted one of the first empirical investigations of self-reported ADHD symptoms with a sample of college students. The sample consisted of 770 college students who completed two ADHD symptom questionnaires (Adult Rating Scale, ARS; Weyandt et al., 1995; and the Wender Utah Rating Scale, WURS, Ward, Wender, & Reimherr, 1993). The study applied two diagnostic cutoff criteria (1.5 *SD* and 2.0 *SD* greater than the sample mean) across both questionnaires. Prevalence estimates varied across assessment measures and stringency of diagnostic cutoff criteria. Approximately 7% and 8% of the sample self-reported significant

ADHD symptoms (scores greater than or equal to 1.5 *SD*) on the ARS and WURS, respectively, with 2.5% endorsing significant symptoms on both scales. Prevalence estimates fell to 4% (ARS), 3.8% (WURS), and .05% (both scales) after applying a more rigorous criterion (i.e., 2 *SD*). No significant gender differences were found.

Using a *DSM-IV*- based rating scale (Murphy & Barkley, 1995) with a sample of 468 college students from a Midwest university, Heiligensteing, Conyers, Berns, and Smith (1998) found moderate rates of ADHD symptomatology in their sample. Overall, 4% of the sample met the *DSM-IV* threshold for diagnosis of ADHD. In respect to the students meeting the ADHD diagnosis threshold, the majority of students (56%) were identified as predominantly inattentive type and the remainder met the criteria for hyperactive–impulsive (22%) or combined type (22%). Heiligenstein et al. (1998) reported a negative trend between age and hyperactive-impulsive symptoms. Older students endorsed fewer hyperactive-impulsive symptoms than younger students. This finding led to the further examination of ADHD symptomology using a 4-symptom age-adjusted criterion, in line with the belief that older individuals with ADHD exhibit fewer ADHD behaviors than children, yet these behaviors continue to cause a clinically significant impairment. The resulting prevalence estimates increased to 11% for the entire sample. Furthermore, the distribution of subtypes became more equally distributed with 34% meeting the inattentive type, 36% hyperactive-impulsive type, and 30% combined type.

To date there has been only one large cross-cultural study of self-reported ADHD symptoms. DuPaul, Schaughency, Weyandt, Tripp, and colleagues (2001) obtained self-report ratings on a *DSM-IV* criteria-based rating scale from 1209 college students in three countries (i.e., New Zealand, United States, and Italy). Participants were classified as having ADHD inattentive subtype if they endorsed six or more inattentive symptoms and less than six hyperactive-impulsive symptoms. The opposite criterion was used for classifying hyperactive-impulsive subtype. ADHD combined was defined as reporting six or more symptoms in both categories. Results revealed that male students from Italy (7.4%) and New Zealand (8.1%) were more likely to meet *DSM-IV* criteria for ADHD compared to male students from the United States (2.9%). The hyperactive-impulsive subtype was most prevalent for males across all three countries. Female students endorsed fewer ADHD symptoms; however, considerable variation was reported across countries (United States = 3.9%; Italy = 0%; New Zealand = 1.7%). Similar to males, female students across countries were more likely to report hyperactive-impulsive symptoms. When DuPaul and colleagues applied an age-adjusted criterion of at least three symptoms, prevalence rates rose considerably to 27.4% for men and 24.6% for women in the United States.

Two more recent studies have investigated ADHD symptoms in college students using a college-normed ADHD scale (Comprehensive ADHD Response Evaluation [CARE]; Glutting, Sheslow, & Adams, 2002). McKee (2008) used a norm-based and criterion-based approach to discern the prevalence of ADHD in a sample of 1096 college students. Results exposed a discrepancy in prevalence rates that was dependent on the method (normative vs. criterion) and cutoffs employed. Using a 1.5 *SD* or greater than the sample mean criterion-based approach, 8.47% to 14.42% of the students reported at-risk symptoms of ADHD. Prevalence rates decreased to 3.15% to 6.75% when a 2.0 *SD* cutoff level was applied. Corresponding gender-based normative cutoff levels on the CARE (i.e., 92^{nd} and 97^{th} percentile) increased the percentage of students meeting those cutoffs by 2 to 4 times. However, the hyperactivity factor score had a similar percentage across the two diagnostic methods. Gender differences were found on various subscales as well. McKee concluded that norms associated with the CARE yield higher prevalence estimates than those found with a *DSM-IV* criterion-based approach. This finding was especially applicable when identifying students with extreme attentional difficulties.

Only one study has investigated ADHD symptomology in college students using both self- and parent report across time, with parents retrospectively reporting childhood symptoms and students providing information pertaining to current symptoms. The use of multiple respondents has significant practical implications and is considered best practice for identifying ADHD across childhood and young adulthood (Barkley, 2006). Lee et al. (2008) used a matched sample of college freshman (n = 956) and their parents (n = 956) to investigate ADHD prevalence rates and group differences across respondents. Self-report identified 1.2% of male and 4.6% of female students as meeting or exceeding the *DSM-IV* threshold for ADHD. Conversely, parent report identified 5.6% of males and 1.6% of females as meeting the clinically significant symptoms in childhood. Ethnicity differences were also found between self- and parent report. Parent report lowered ADHD prevalence rates for African Americans, while self-report increased the endorsement of ADHD symptoms. The opposite relationship trend was discovered for Caucasian students. The combination of self- and parent ratings significantly decreased prevalence estimates for males (0.4%) and females (0%). When a less stringent age-adjusted criterion was used (i.e., 3 symptoms), prevalence estimates increased significantly and ranged from 12.6% to 38%.

Collectively, there is a considerable amount of variation across research studies investigating the prevalence of ADHD in college students. This variability is, in large part, the result of different ADHD diagnostic criteria, varying assessment measures, and lack of multiple respondent scores. Nevertheless, these five studies suggest that the 2% to 8% of college students' self-report clinically significant ADHD symptoms and nearly twice as many meet "at-risk" criteria (1.5 *SD* or 92nd percentile).

Self- and other report of ADHD symptoms. Although it is generally agreed upon that the use of multiple informants in an ADHD evaluation with college students is best practice, the degree of concordance between informants in this subpopulation of adults is relatively unknown. The significance of this missing knowledge becomes evident when making a clinical decision of how to weight self- vs. informant report scores on ADHD symptom scales. For example, Barkley et al. (2002) examined the persistence of ADHD into young adulthood as a function of reporting source and definition of disorder. The sample included 158 children (ages 4-12) diagnosed as hyperactive in childhood and a matched community control group (n = 71). The majority of participants were re-evaluated eight years later. Barkley and colleagues developed two separate structured interviews using the *DSM-III-R* symptoms list, a structured interview for disruptive behavior disorders (i.e., young adult), and parent interview of ADHD symptoms. In addition, all parents completed the Conners' Parent Rating Scale-Revised (Goyette, Conners, & Ulrich, 1978) and Werry-Weiss-Peters Activity Rating Scale (see Barkley, 1981). Results indicated that parent reported information classified substantially more hyperactive group members as currently having ADHD by *DSM-III-R* criteria (i.e., 8 of 14 symptoms) than did self-reported information (46% vs. 5%). When a developmentally referenced criterion (see Barkley et al., 2002, for a review) was employed, parent report resulted in a five-fold increase in the hyperactive group compared to self-report. Overall, there was no significant correlation between self- and parent reports (r = .16) and low diagnosis concordance rate (κ = .073). Only 10% of the hyperactive group defined as having ADHD by parent report also endorsed clinically significant symptoms in self-report. In addition, the validity of self- versus parent reports of ADHD symptoms in young adulthood was examined using a regression model and eight outcome variables (e.g., education, high school GPA, number of arrests, job performance, etc.). Of the eight outcome variables, self-reported ADHD symptoms only contributed significantly to two of the eight outcome variables (i.e., employer ratings of ADHD and job performance). In contrast, parent report of ADHD symptoms added significant predictive validity to all eight outcomes after controlling for age and level of self-rated symptoms. Finally, only moderate correlations were found for self-reports of childhood ADHD symptoms and actual parent rating scales collected at during childhood evaluations.

Similar findings have been reported in a meta-analysis that preliminarily examined 51,000 articles published over 10 years to determine the degree of concordance between self-reports and other reports of psychopathology (Achenbach, Krukowski, Dumenci, & Ivanova, 2005). Cross-informant correlations revealed no significant effects for interview versus questionnaires; however, the use of parallel instruments resulted in significantly larger cross-informant correlations (.453 versus .304). Achenbach and colleagues concluded that self-reports may provide different pictures of adults' functioning than other reports. Moreover, only 108 (0.2%) of all studies reviewed in the meta-analysis reported multi-informant information, speaking to the paucity of research using what is widely considered to be an important component in the evaluation of ADHD symptomatology.

Limited research has investigated the level of agreement between self- and other ratings using a sample of college students who presented with academic difficulties. Zucker and collaborators (2002) used the ADHD Behavior Checklist for Adults (Barkley, 1995a) to examine the concordance rates between self- and other ratings and found a high degree of correlation between self-rating of childhood and current symptoms (*r* = .75 for Inattention; *r* = .74 for Hyperactive-Impulsive). Comparable intra-rater agreement was reported for parent ratings of childhood and current ADHD symptoms (*r* = .59 for Inattention; *r* = .65 for Hyperactive-Impulsive) and two different respondents (*r* = .56 for Inattention; *r* = .62 for Hyperactive-Impulsive). Furthermore, other ratings were significantly higher for current inattention than participants themselves, but self- and other ratings of current hyperactive-impulsive symptoms did not differ significantly. This pattern was found regardless of group affiliation (i.e., ADHD or non-ADHD). The investigators reported the same pattern of results for childhood symptoms. Interestingly, the level of agreement between self- and other childhood ratings was stronger for females than males across both subtypes of ADHD symptoms. Their finding adds validity to the assertion that a more severe impairment is needed for parents to acknowledge ADHD symptoms in females during childhood; or, perhaps, it reflects higher prevalence rates of at-risk ADHD symptoms in boys during childhood. In any case, it is very possible that parents more commonly misperceive young boys ADHD symptoms as more severe. Findings from this study should be interpreted with caution due to the lack of known psychometric data (i.e., internal consistency, test-retest reliability, and validity data).

Evaluation of college students with ADHD symptoms. The vexing problem of discordant self- and other ratings of childhood and current ADHD symptoms poses a significant issue for diagnostic assessment that requires dichotomous decisions about diagnosing ADHD in college students. Some contend that college students with ADHD represent a distinct subset of adults with ADHD due to better developed compensatory mechanisms, increased feigning (Harrison, Edwards, & Parker, 2007) for secondary gains (e.g. high-stakes testing accommodations, access to prescription medication, etc.), and higher ability levels than adults with ADHD from the general population (Frazier, Youngstrom, Glutting, & Watkins, 2007). Complicating this matter further is the fact that no gold standard exists with regards to the validity of self- versus other ratings in diagnostic decisions concerning ADHD. Previous research has resulted in equivocal conclusions about the validity of self-reported ADHD behaviors in both adolescents and adults (DuPaul et al., 1997; DuPaul et al., 1998; Zucker et al., 2002; Barkley et al., 2002; Achenbach et al., 2005). In turn, the question arises as to which assessment method is more accurate when conducting a comprehensive psychological evaluation. This question, however, is contingent on the purpose of the assessment and prediction of impairment in cognitive functioning and major life activities such as academic or occupational performance. Therefore, the present study examines this issue by comparing the degree of concordance between self- and other reports of childhood (retrospectively) and current ADHD symptoms with several commonly used ADHD measures. Consequentially, the study will examine the relationship of self- and other report to cognitive processing (e.g., working memory, cognitive fluency, etc.) and academic achievement outcomes.

An additional quandary commonly encountered in ADHD evaluations with college students is determining the appropriate diagnostic criterion to employ when making diagnostic decisions. As previously stated, this problem is especially relevant to college students because they are believed to constitute a subgroup of adults with ADHD that differ from other adults with ADHD who do not attend college. Consequently, the use of ADHD ratings scales lacking a college-age normative sample may produce erroneous and inconsistent findings. This matter is of particular importance when one considers the conceptualization of ADHD as a developmental disability stemming from genetic and neurobiological factors. This, in turn, would imply it is a disorder because associated symptoms must occur to a degree that is developmentally inappropriate and, as a result, cause impairment in major life activities (Mash & Wolfe, 2005). From this perspective, ADHD symptoms at any stage in life must be partially determined by using not only age-relative thresholds for diagnostic decisions, but also careful consideration of normative populations from which the scale was normed. When these factors are taken into consideration with findings that ADHD symptoms decline substantially in normal populations with age (Smith, Barkley, & Shapiro, 2006), a fixed criterion and declining symptom trend make ADHD rarer with age (Barkley et al., 2002; Greydanus et al., 2007). The individual with ADHD, however, does not chronologically outgrow their disorder. Conversely, they have outgrown the criteria by which the disorder is widely diagnosed (Barkley, 2006). It also seems reasonable to attribute a decrease in ADHD symptomology across the lifespan to an increase in compensatory strategies, which may mitigate the severity of symptoms and, accordingly, lessen the adverse impact on major life activities, cognitive abilities, and academic performance.

In an effort to address a specific element of this matter, we propose to investigate the differences between ADHD scales developed from different normative samples and constructional formats (criterion vs. normative). Specifically, the current study examines the relationship between the CARE, CAARS, and a *DSM-IV* based ADHD questionnaire as well as their respective relationships with academic achievement and cognitive functioning outcome measures. The overriding goal of this investigation is to add empirical research that will improve diagnostic accuracy. For example, poor academic performance is among the most prominent features associated with ADHD. One method to elucidate the validity of self- versus other ratings of ADHD symptoms is to measure the degree correlation with associated characteristics (e.g., poor academic achievement) of ADHD. A meta-analysis conducted by Frazier, Youngstrom, Glutting, and Watkins (2007) found moderate to large discrepancies between individuals with and without ADHD on standardized achievement tests, with reading measures resulting in the largest effect sizes (weighted d = .71) across the lifespan when compared to executive function, memory, and other assessments. Nevertheless, objective measures (GPA, years of education) and behavior rating scales also produced moderate to large effect sizes, followed by medium effect sizes for nominal scales such as dropping out of school or repeating a grade. The results suggest that ADHD symptoms continue to be significantly correlated with academic deficits at the college level. Taken together, the findings support that poor academic performance extends beyond standardized tests. Other research has demonstrated an inverse relationship between college students' self-ratings of impulsivity and objective academic performance in a college course (Spinella & Miley, 2003). This relationship remained after controlling for the influences of age, sex, and years. Self-ratings of impulsivity explained between 20% and 38% of the variance in grades. Similar findings have been reported in children, including the same inverse relationship between ADHD symptoms and academic performance (Mayes, Calhoun, & Crowell, 2000). In general, standardized achievement tests may be sensitive to the general effects of ADHD symptoms on learning, attention, and particular effects of ADHD symptoms on test performance. It is, therefore, not unexpected to see a significant portion of college students with ADHD also present with comorbid learning disabilities (Frazier et al., 2007; Mayes, Calhoun, & Crowell, 2000; McGillivray & Baker, 2009).

The relationship between attentional difficulties and learning problems has been exhaustively studied in children; however, little information is available about cognitive processing deficits in college students with ADHD. The rationale for using cognitive and academic achievement tests as assessment components in a comprehensive ADHD evaluations is derived from neuropsychological research and brain imaging, which suggests that executive function systems may be impaired causing deleterious results on cognitive and academic aptitude testing. Unfortunately, the minimal research that does exist using a sample of college students with ADHD does not appear to parallel some research findings in children and adults. In fact, college students with ADHD tend to perform comparably to non-ADHD controls on a variety of neuropsychological tests (DuPaul, Weyandt, O'Dell, & Varejao, 2009). One of the very few studies to demonstrate differences on neuropsychological testing was conducted by Buchsbaum, Haier, Sostek, Weigarner, Zahn and colleagues (1985) who found college students reporting high levels of ADHD symptoms performed lower on serial learning and memory tasks. This relationship did not hold true for the low-symptom group suggesting that neuropsychological testing may only be sensitive to more severe attentional and/or hyperactive/impulsive behavior. A recent preliminary study by Gropper and Tannock (2009) also found significant differences in verbal working memory performance between college students with ADHD and controls. The ADHD group showed significant impairment on three out of four verbal working memory measures. Working memory dysfunction was also significantly related to academic performance (i.e., GPA) at the university level.

Rationale for the Present Study

The limited research and inconsistent findings due to variably defined symptoms and different assessment methods in college age students with attentional and learning problems provides the rationale for the present study. Undoubtedly the need to identify and understand the kinds of interventions, accommodations, and supports that best afford opportunity for college students with ADHD, LD or ADHD+LD to succeed is not only ethically important, it also has potential legal ramifications. The questions that stand in the forefront for examination encompass the utility of assessments presently used with college students, prospective differences between college students with isolated attentional or learning problems and those individuals with deficits in both, and the validity of self- versus other report of ADHD symptoms as measured by multiple rating scales at multiple points in time.

Chapter 3

Research Methodology

Research Questions and Hypotheses

Research question 1. What are the concordance rates between self- and other ratings of both childhood (retrospective) and current ADHD symptoms across three commonly used ADHD scales (i.e., CARE, CAARS, and a *DSM-IV* ADHD Rating Scale – see methodology section) in a sample of clinically diagnosed students with ADHD, LD or ADHD+LD who received a comprehensive evaluation at an on-campus clinic?

Hypothesis 1. It is hypothesized that lower within scale correlations between self and other reports of ADHD symptoms will be found on the CARE. The CARE requires informants to rate childhood ADHD symptoms while the client (student) provides a self-account of current ADHD symptoms. Moderate to large inter-rater agreement is anticipated for responses on the *DSM-IV* measure. This hypothesis is partially derived from the restricted range of items on the DSM-IV scale (i.e., 18 questions) in comparison to the CARE (Self-Report Inventory = 59 items; Parent Inventory = 46 items) and CAARS (66 items). Further, the CARE factor structure separates the constructs of hyperactivity and impulsivity for self-report; likewise, the CAARS is also constructed in such a manner that hyperactivity and impulsivity are represented as distinct factors in the construct of ADHD. Alterations have been made to the construct of ADHD throughout the last three versions of the *DSM*. In short, the *DSM-III* separated ADHD into three distinct factors, while the *DSM-III-Revised* collapsed all factors due to the belief that all three factors were highly interrelated. Conversely, the *DSM-IV* portrays ADHD as two-dimensional

(Inattention and Hyperactivity/Impulsivity). The ever-shifting construct of ADHD has led some (e.g., Barkley, 1998) to criticize the *DSM–IV* criteria for not being developmentally sensitive to heterogeneity that takes place with ADHD among adolescents and adults. Similar inconsistencies have been found between self- and other ratings on ADHD behavior scales (DuPaul et al. 2001; Glutting, Youngstrom, & Watkins, 2005; Smith & Johnson, 1998; Span, Earleywine, & Strybel, 2002). Like the factor structure variability seen across *DSM* versions, these studies also came to different conclusions regarding the factor structure of ADHD in college students. Given the collapsing of constructs in the *DSM-IV-TR*, a moderate to large association between self- and other ratings of ADHD symptoms is anticipated on the *DSM-IV* measure.

In regards to comparisons between scales, we expect to see a similar relationship between ratings on the *DSM-IV*, CARE, and CAARS scales due the fact that the CARE and CAARS encapsulate the same 18 *DSM-IV* based ADHD symptomology questions. On average, we do not expect strong correlations between the CARE and other scales because roughly half the CARE items tap into specific college-related milieu and experiences (e.g., doing homework, sitting through lectures, taking exams, etc.). Instead, we expect to find a moderate degree of correlation between others' ratings of ADHD symptoms on the CARE and *DSM-IV* measure. Low to moderate between rater correlations on the *DSM-IV* and the CAARS is expected. This hypothesis is primarily based on previous research that suggests college students with ADHD constitute a different subpopulation of young adults with ADHD. The construct of the CAARS was designed to measure ADHD behaviors in a wide age range of adults and, therefore, is unlikely to capture the constellation of ADHD symptoms the CARE purports to measure.

Finally, it is hypothesized that moderate to large inter- and intra-rater agreement will be found on the *DSM-IV*-based rating scale. Previous research investigating correlation ranges between raters for externalizing and internalizing behaviors revealed low inter-rater agreement (Achenbach et al., 2005; Barkley et al., 2002). Nevertheless, a paucity of research has included multi-informant reports with this population of students, making it difficult to discern an expected magnitude of agreement between self- and other ratings of ADHD symptoms. Nevertheless, it is hypothesized that self- and other ratings at corresponding times will result in stronger associations than ratings of symptoms at incongruent (childhood vs. current) times. Retrospective accounts require mental time travel (MTT), which is dependent upon two systems of declarative memory, episodic memory and semantic memory (Roberts & Feeney, 2009). The ability to autobiographically remember specific behaviors subsumed within different personal experiences requires an integrative and constructive process. It is, therefore, postulated that some degree of correlation will exist because participants could remember a history of attentional problems by integrating recollections of past episodes with semantic information provided by parents. Conversely, as time goes by, parents' recollection of their child's ADHD symptoms may become increasingly influenced by semantic information provided by their child.

Research question 2. Are self- and other ratings of childhood and/or current ADHD symptoms related to academic achievement and cognitive processing deficits associated with ADHD?

Hypothesis 2. It is expected that low to moderate correlations between self and other ratings of ADHD symptoms and outcome variables will be found. Specifically, it is hypothesized that the largest correlation coefficients will be found for self-reports of current ADHD symptoms and reading performance, followed by other measures of academic achievement (i.e., math and written expression). Current ratings of ADHD symptoms are expected to correlate more strongly with academic achievement measures given the temporal proximity of current ratings to academic test performance. Moderate to large discrepancies between individuals with ADHD and individuals without ADHD (weighted $d = .73$) on reading measures in standardized achievement tests have been found (Frazier et al., 2007). Comparable effect sizes were reported for mathematics ($d = .67$) and spelling ($d = .55$). Weak but statistically significant correlations between self- and other ratings of ADHD symptoms and cognitive processing outcome variables are expected. We hypothesize that working memory will correlate more highly with self- and other ratings of ADHD than will cognitive fluency, IQ, and verbal immediate memory measures. As previously mentioned, college students with ADHD have been found to exhibit deficits on working memory tasks. Moreover, it is well documented that students with LD and/or ADHD display executive function deficits such as working memory impairments, slow cognitive processing, and, consequentially, lower academic achievement performance (Cutting & Denckla, 2003; Frazier, Demaree, & Youngstrom, 2004).

Research question 3. Are there significant between group differences (ADHD, LD, ADHD/LD) on neurocognitive and academic achievement measures?

Hypothesis 3. The LD group is expected to perform worse than the ADHD group on measures of academic achievement, with the ADHD+LD group demonstrating more severe academic achievement deficits than either single deficit group. Given the frequency of working memory deficits found in individuals with LD and ADHD, no significant difference is anticipated. In contrast, a significant processing speed performance difference is expected between LD and ADHD groups, with the ADHD group performing significantly worse than the LD group. In addition, it is hypothesized that the comorbid LD and ADHD group will exhibit weaker processing speed skills than either single deficit group. Based on inconsistent findings reported in a review by Frazier et al. (2004), no significant group differences in general intellectual ability is expected.

Research question 4. Do concordance estimates vary by ADHD subscales (i.e., Inattention, Hyperactivity-Impulsivity, Total Symptoms)?

Hypothesis 4. It is hypothesized that both within and between rater correlation coefficients will be largest for the hyperactive-impulsive cluster on all scales. Previous research has found that the hyperactive-impulsive subtype is most prevalent in college-aged students; a finding that remained regardless of gender and country of origin (DuPaul, Schaughency, Weyandt, et al., 2001). Heiligenstein et al. (1998), however, reported a negative trend between age and hyperactive-impulsive symptoms, which may lessen the degree of relatedness between childhood and current ratings of hyperactive-impulsive symptoms. Taking this finding into account, we expect within and between rater correlation coefficients on inattentive and hyperactive-impulsive clusters to be similar for comparisons across time. Ratings at congruent times are hypothesized to be largest for the hyperactive-impulsive cluster. It seems reasonable to assume that the degree of relatedness between self- and other ratings will be strongest for this cluster because hyperactive-impulsive behaviors are more readily observable than, at times, less apparent inattentive symptoms, especially for parents that infrequently see their children in college.

Significance of Study

This study expands previous research using a sample of understudied students with ADHD, LD and ADHD+LD. To date, no study has investigated the relationship between ratings of childhood and current ADHD symptoms within and between raters and scales with this population. This dearth of research is surprising for multiple reasons: 1) the *DSM-IV* diagnostic criteria requires that ADHD symptoms be present in childhood as well as currently; 2) use of multiple informants is widely considered best practice in the assessment of ADHD regardless of age; 3) ADHD is one of the most common disabilities reported in higher academic institutions, and 4) little is known about the degree of concordance between young adults recollection of childhood ADHD-related behavior and parents recollection of their child’s ADHD-related behavior. The practical utility of such information is particularly important because it directly informs accommodation and intervention services, which directly impact the degree of academic success a student attains at the collegiate level. This study also furthers the literature by utilizing multiple ADHD measures with different normative samples, a highly debated area in the field. The few studies that have included multiple measures with different normative samples fail to include ratings across time.

In addition, this study investigates the relationship between self- and other reports of ADHD symptoms and neurocognitive and academic achievement outcome variables. Very few studies have examined the relationship between ADHD behaviors and functional performance on psychometric tests using a college-age sample of participants; that is, previous research has over utilized proximal measures of academic achievement such as GPA in place of norm-referenced academic achievement tests. Moreover, little to no studies have extrapolated findings to investigate performance differences on neuropsychological assessments between college students diagnosed with ADHD or LD, nor college students with comorbid ADHD and LD.

Methods

Participants. Participants are students (N=347) who sought comprehensive psychological evaluations at a university-based clinic staffed by licensed psychologists and/or clinicians supervised by licensed psychologists. Participants presented with mixed complaints, but most were concerned about potential learning and/or attention deficits. All participants from the clinical groups were assessed at the University of Georgia Regents' Center for Learning Disorders (UGA RCLD). The sample ranged from juniors and seniors in high school to undergraduates (see Table 1); however, the preponderance of participants was college students (85%). The study is based on a convenience sample of all individuals assessed at the clinic between 2005 and 2010 who met the study inclusion criteria discussed below. Gender representation of the sample is almost equal: 51.3% male (*n* =178) and 48.7% female (*n* =169). Ethnic representation of the sample is: 89% Anglo (*n* = 310), 4% African American (*n* = 12), 2% Hispanic (*n* = 8), 1% Asian (*n* = 3), and 3% Other or Mixed (*n* = 14). The participants' ages ranged from 16 to 53 years old (*M* = 19.86 years, *SD* = 3.4). Only 2% of the sample was older than age 30. Average year in school is 3.28, or the equivalent of a freshman in college.

Three inclusion criteria were used to select the participants. First, all participants had to be diagnosed with ADHD, LD, or comorbid ADHD and LD using *DSM-IV-TR* (diagnostic procedures discussed below) criteria. Second, participants were required to have completed at least one self-report ADHD behavior rating scale; in addition, a parent or other person in a close relationship with the participant (both referred to as "other" in the study) was required to complete the other informant version of the scale. Third, participants were required to have completed a battery of neurocognitive and academic achievement tests at the UGA RCLD. Participants with psychosis, developmental delay (IQ < 70), chronic medical or neurological condition, schizophrenia, pervasive developmental disorder, tic disorder, or uncorrected sensory impairment were excluded from the study. All participants were native speakers of English.

Participants were diagnosed through use of a comprehensive psychological evaluation. Average evaluation completion time was approximately 10 hours, over the course of two days. A licensed doctoral-level psychologist or a master's-level clinician conducted all evaluations. Master's-level clinicians completed evaluations under the supervision and with participation of a licensed doctoral-level psychologist.

Evaluations included qualitative (case histories, clinical intake interviews, previous record review, behavioral observations) and quantitative (standardized tests and informal measures) information. Commonly used norm-referenced tests included measures of general cognitive ability, specific cognitive abilities (e.g., working memory), oral language, academic achievement, and social-emotional and behavioral functioning. Assessment instruments were chosen on the basis of their psychometric properties and clinical usefulness with young adult, college, and adult population. Clinicians independently selected the specific instruments that would aid in the identification of idiosyncratic patterns of strengths and weaknesses based on the referral concerns. Assessment batteries were designed to meet the presenting concerns of each participant; nonetheless, assessment batteries included measures from all aforementioned areas. Likewise, interviews were developed by clinical staff and included assessment of each participant's presenting concerns, background information, and symptoms of psychopathology.

The content of the clinical interviews was similar across psychologists; however, the specific manner in which the interviews were administered varied based on the approach of each psychologist. Overall, clinical interviews consisted of similar content across psychologists. A comprehensive assessment approach permitted the identification of comorbid disorders. Differential diagnosis was stressed to rule out other explanations for behavioral and learning symptomatology.

Table 1

Participants by Year in School (n = 347)

Grade	Frequency	Percent
High School (junior/senior)	52	15.0
Incoming/Current College Freshman	157	45.3
College Sophomores	70	20.2
College Juniors	40	11.5
College Seniors	25	7.2
Transitioning College Graduates	3	.9

Procedure. Approval to conduct the study was obtained through the University of Montana and University of Georgia Human Subjects Internal Review Boards. Participants of legal age gave informed consent to participate in the study, while informed consent was obtained from parents of non-legal age participants who subsequently gave informed assent. Participants as well as one of their parents or, on an occasion, another person in a significant relationship with the participant, completed behavior rating scales as part of a comprehensive evaluation at the clinic. Neurocognitive and academic tests were completed at the clinic, as were self-report rating scales. Parents or significant others who accompanied the study participant to the evaluation completed the parent/other report rating scale while at the clinic. Those who were unable to accompany the participant were telephoned and asked to complete the rating scale. Written informed consent was obtained from all “other” participants who completed the other informant version of the scale.

Grouping criteria. The sample of participants were exclusively grouped into one of three groups for purposes of examining functional differences; ADHD only, LD only and ADHD+LD

ADHD group. All participants with ADHD (35%, *n* = 121) met both the USG (See Appendix B, #2) and the *DSM-IV-TR* diagnostic criteria for attention disorders. Participants described their symptoms during the clinical interview, which was ascertained through a developmental history, generality of symptoms across multiple settings, and functional impairment. Participants were required to report or have a caretaker report that symptoms were present during childhood and continued to be experienced across at least two settings. Confirmation of self-reported current symptoms by an outside observer, usually a parent, was also required. This requirement is not included in the *DSM-IV-TR*, but considered best practice in the field. In addition, they and one of their parents or acquaintance completed at least one of the following norm-referenced ADHD rating scales: Conners, Adult ADHD Rating Scales—Self-Report: Long Version (CAARS-S:L; Conners, Erhardt, & Sparrow, 1999b); CAARS—Observer: Long Version (CAARS-O:L; Conners, Erhardt, & Sparrow, 1999a); College ADHD Response Evaluation—Student Response Inventory (CARE:S; Glutting, Sheslow, & Adams, 2002b);

College ADHD Response Evaluation—Parent Response Inventory (CARE:P; Glutting, Sheslow, & Adams, 2002a). Clinician preference determined the specific scales used for each participant. Each psychologist made an independent determination when weighing the data from each method of assessment and additional information to determine whether UGA and *DSM-IV-TR* criteria were met; specifically, particular cutoff scores on the rating scales were not used to make diagnoses. Although neuropsychological testing (e.g., working memory, executive function, continuous performance tests) is not required by *DSM-IV-TR* criteria, it was used in most cases to aid in diagnostic decisions; however, deficits on neuropsychological tests was not required in order for a ADHD diagnosis to be made.

LD group. All participants diagnosed with LD (40%, *n* = 139) met the diagnostic criteria established by the University Systems of Georgia (USG) for determining LD. The assessments critical to the diagnosis of a learning disability included standardized measures of academic achievement and cognitive processing abilities that have age-appropriate normative data for high school/college students or older adult non-traditional students. USG criteria for LD are provided in Appendix B, #1 and may also be found at http://rcld.uga.edu.

ADHD+LD group. This group consisted of participants who met the criteria for both LD and ADHD (25%, *n* = 87) as described above.

Instruments

Cognitive functioning. All participants were assessed with the *Reynolds Intellectual Assessment Scale* (RIAS; Reynolds & Kamphaus, 2003), an individually administered measure of verbal, nonverbal, and general intelligence for people in the age group of 3 to 94. For the purpose of this study only the Composite Intelligence Index score was used. Psychometric properties for the RIAS are sound, with all Cronbach's Alpha across the normative group $\geq .94$. Test-retest stability estimates were .86 or greater across Indices.

Processing speed. Two different tasks from the *Woodcock Johnson-III Tests of Cognitive Abilities* (WJ-COG: Woodcock, McGrew, & Mather, 2001) were used to create a composite score of processing speed: Visual Matching and Decision Speed. The former is a measure of participants' abilities to perform automatic cognitive tasks and is a good estimate of cognitive efficiency. The Decision Speed subtest requires participants to locate quickly two pictures that are most similar conceptually. This test has a 3-minute time limit. Visual Matching 2 was utilized as a second measure of processing speed, specifically perceptual speed. The second version was given to all participants. On this test, the participant is asked to locate and circle the two identical numbers in a row of six numbers, with task difficulty increasing from single-digit numbers to triple-digit numbers. This task also has a 3-minute time limit. The Processing Speed Composite has median reliabilities of .92 in the age 5 to 19 and .95 in the adult range.

Verbal memory. The *Wechsler Memory Scale—Third Edition* (WMS-III: Wechsler, 1997) Verbal Memory Index was used as a measure of immediate auditory memory. The Immediate Memory Index is comprised of the Logical Memory I and Verbal Paired Associates subtests. In the Logical Memory subtest participants are tasked with immediately recalling two paragraphs read aloud by the examiner. The Verbal Paired Associates subtest tasked participants with recalling words from a list of word pairs. The examiner read a list of word pairs and then the participant was read one word and asked to provide the word that went with it. Four trials of the list were presented. The Immediate Memory Index has a median reliability of .93 and test-retest estimate of .85.

Working memory. The WMS-III Working Memory Index is a measure of complex or high-level attentional tasks. The Index purports to measure the ability to attend to information, to hold, process, and manipulate that information in memory, and to formulate a response based on that information. The Working Memory Index is composed of the Letter–Number Sequencing and Spatial Span subtests. For the Letter–Number Sequencing subtest, the examiner reads a list consisting of a combination of numbers and letters. The participant is then asked to recite them back, numbers first in ascending order, and then letters in alphabetic order. For the Spatial Span subtest, the examinee watches the examiner tap numbers on raised blocks randomly positioned on a three-dimensional board. The examinee must repeat the sequence in either a forward or backward order. The Working Memory Index has a median reliability of .80 in adults.

Reading. Two different tasks from the *Woodcock-Johnson III Test of Academic Achievement (*WJ-III; McGrew & Woodcock, 2001) were used to create a composite score of basic reading skills; Work Attack and Word Identification. Participants were tasked with reading select whole words that become increasingly difficult (words appear less and less frequently in written English), as well as nonsense words that required the participant to apply phonic and structural analysis skills to the pronunciation of unfamiliar printed words. Letter-Word Identification has median reliability of .91 in the age 5 to 19 and .94 in the adult range; Word Attack has a median reliability of .87 in the age 5 to 19 range and .87 in the adult range.

Reading comprehension. The *Nelson Denny Reading Comprehension Test, Part II,* is a reading 20-minute survey test used with high school and college students (Brown, Fishco, &

Hanna, 1993). It is a measure of passage reading rate and comprehension. Comprehension passages are drawn from widely used, current high school and college texts. Part I (Vocabulary) is a fifteen-minute timed test; Part II (Comprehension and Rate) is a twenty-minute test. The first minute of the Comprehension test is used to determine reading rate, including the time needed to distribute materials, complete information grids, and deliver directions. This test was individually administered to all participants. Participants were instructed to silently read five short passages and to respond to 38 multiple-choice questions about the content of these passages. Approximately half of the multiple-choice questions relate to specific factual content, while the other half are more inferential in nature.

Math. This cluster is an aggregate measure of computational skills and automaticity with basic math facts derived from two separate math calculation tests; Calculation and Math Fluency. The WJ-III Calculation subtest is a non-timed measure of mathematical computations. Initial items in this task require the participant to write single numbers. The remaining items include addition, subtraction, multiplication, division, and combinations of these basic operations, as well as some geometric, trigonometric, logarithmic, and calculus operations. Calculations also involve negative numbers, percentages, decimals, fractions, and whole numbers. Calculation problems are presented in a traditional format; no decisions about what operations to use or what data to include is needed. The timed Math Fluency subtest measures the ability to solve simple addition, subtraction, and multiplication facts quickly. In this task the participant is presented a series of simple arithmetic problems in the Participant Response Booklet. Participants were given 3 minutes to complete this task. The Calculation test has a median reliability of .90 in the age 5 to 19 range and .94 in the adult range; the Math Fluency has a median reliability of .89 in the age 7 to 19 range and .92 in the adult range.

Writing. This WJ-III cluster is a combination of Spelling and Editing untimed subtests and provides a measure of basic writing skills in both isolated and contextually based formats. It is an aggregate measure of spelling single-word responses and identifying and correcting errors in spelling, punctuation, capitalization, and word usage. Basic Writing has a median reliability of .94 in the age 5 to 19 range and .96 in the adult range.

The Conners' Adult ADHD Rating Scales (CAARS). *The Conners' Adult ADHD Rating Scales* is a multimodal measure constructed to aid in the diagnosis of ADHD in adults age 18 and above (Conners, Erhardt, & Sparrow, 1999). The CAARS provides two sources of information, a Self-Report measure and an Observer checklist, completed by a close acquaintance. Informants rated symptoms on a 4-point Likert-type scale indicating frequency of problems with Inattention/Memory Problems, Hyperactivity/Restlessness, Impulsivity/Emotional Lability, and Problems with Self-Concept. The *DSM-IV* symptom subscales are Inattentive Symptoms, Hyperactive-Impulsive Symptoms, and Total ADHD Symptoms. In addition, an ADHD Index is produced to identify individuals 'at risk" for ADHD. Each item is identical in content across the two forms of the CAARS except for different pronouns and slightly different wording to account for the perspective of the informant. Total sample internal consistency estimates for the Self-Report measure ranges from .66 to .90, with Observer measure's ranging from .81 to .92. Test-retest coefficient estimates of the CAARS for both the self-report (1-month interval) and observer (2-week interval) versions were excellent (e.g., r = .80 to .95). For both CAARS forms, the test authors also provided validity evidence from confirmatory factor analyses indicating separate factors within their larger models inclusive of ADHD symptomatology. In addition, the measure is highly correlated with other self-report ADHD measures and has sound sensitivity and specificity data in initial studies of diagnostic accuracy for adult ADHD (Erhardt, Epstein, Conners, Parker, & Sitarenios, 1999).

The College ADHD Response Evaluation (CARE*)*. The *College ADHD Response Evaluation* (Glutting, Sheslow, & Adams, 2002) is an assessment system designed to screen for ADHD symptoms in a college-age population. The CARE has two forms: a 59-item Student Response Inventory (SRI) and a 46-item Parent Response Inventory (PRI). The SRI includes four empirical scales (Inattention, Hyperactivity, Impulsivity, and Total Score) and two clinical scales (*DSM-IV* Inattentive and *DSM-IV* Hyperactive-Impulsive), whereas the PRI includes three empirical scales (Inattention, Hyperactivity, and Total Score) and the two *DSM-IV* clinical scales. Participants indicated the degree to which statements such as “I am forgetful in daily activities” described them during the past several months using 3-point scales (0 = *disagree,* 1 = *undecided,* 2 = agree). Higher numbers indicate greater ADHD symptomatology. Internal consistency estimates for the SRI ranged from a low of .63 to a high of .90 for the Total Score. For the PRI, coefficients ranged from .74 to .89. Results were consistent across males, females and the total sample. Test-retest reliability coefficients ranged from a low of .77 for the Impulsivity scale to a high of .91 for the Combined Score (Glutting, Sheslow, & Adams, 2002).

DSM-IV-TR ADHD Rating Scale (DSM-IV*)*. The *DSM-IV* ADHD Rating Scale is an 18-item, paper and pencil questionnaire designed to identify behaviors that would align with *DSM-IV-TR* criteria. Items are rated on a 4-point Likert-based scale. On this scale, symptoms are rated as not a problem by the participant/parent (score = 1), sometimes a problem (score = 2), often a problem (score = 3), or very often a problem (score = 4). A total score for inattentive or hyperactive-impulsive symptoms was derived for both respondents. This tool is intended to be used as a screening tool for ADHD, as part of a comprehensive evaluation of ADHD. There are two versions of the test (informant- and self-ratings) that measure childhood and current ADHD symptoms.

Chapter 4

Statistical Analyses and Results

Design and Analyses

Prior to analysis, variables included in the correlational and multivariate analyses were examined through Statistical Package for Social Sciences programs, Version 22 (SPSS 22), for accuracy of data entry, missing data, outliers, and univariate and multivariate normality. A mean proration method was applied to 36 *DSM-IV* cases with missing data (i.e., three or less scores). Assumptions of normality, linearity, and multicollinearity were satisfactory; however, one or two cases approached significant deviations. The observed slight deviations from normality are likely explained by a lack of participants' insight when asked to recall and rate their behaviors. Furthermore, the transformation of variables that share the same directionality of skewness has been observed to both increase and decrease coefficient correlations relative to the original data (Ramussen, 1989b). Additional studies (Dunlap, Chen, & Greer, 1994; Dunlap, Burke, & Greer, 1995) have found no consistent relationship between correlation magnitudes, degree of skew, and increase or decrease in correlation coefficients. A more recent study that empirically investigated the difference between transformed and untransformed data using Pearson product-moment correlation as the primary metric found no appreciable benefit associated with data transformation across various sample sizes (Norris & Aroian, 2004). These authors concluded that the assumption of normality is not always necessary with respect to calculations of the Pearson product-moment correlation.

Heterogeneity of error variance was found for three DV's (see correction applied below); in addition, three multivariate outliers, as measured by Mahalanobis distance statistic D^2, were removed. Pearson product-moment correlation coefficients (r) were used to measure the degree of concordance between subject and informant ratings for inattentive symptoms, hyperactive-impulsive symptoms, and total symptoms between ADHD measures and across time. Likewise, Pearson product-moment correlations were used to examine the strength of relationship between respondent ratings on different ADHD scales (childhood and current) and outcome measures (neurocognitive and academic achievement). Within and between rater correlations within and between ADHD measures were examined at overall and cluster levels. A more conservative significance criterion was applied for multiple comparisons ($p \leq .01$). Descriptive statistics by group for ADHD, academic achievement, and neurocognitive variables are presented in Tables 2 and 3.

Table 2

Descriptive Statistics for ADHD Measures by Disability Groups

	LD (n = 139)		ADHD (n = 121)		ADHD+LD (n = 87)	
Measure/Scale$_a$	*M*	*SD*	*M*	*SD*	*M*	*SD*
DSM-IV$_b$						
Self A Total	32.17	10.57	45.47	11.92	48.62	13.38
Self A Inattention	17.58	6.24	24.79	6.61	26.16	6.29
Self A H/I	14.60	5.49	20.68	7.71	22.46	8.95
Self B Total	28.41	7.98	39.98	10.50	39.82	10.82
Self B Inattention	15.44	5.06	22.20	5.92	21.96	6.17

Self B H/I	12.97	4.08	17.77	6.40	17.86	6.60
Parent A Total	31.19	10.05	44.18	12.45	47.38	12.49
Parent A Inattention	17.99	6.33	25.40	7.08	27.16	6.10
Parent A H/I	13.20	4.81	18.79	8.12	20.22	8.31
Parent B Total	27.11	7.16	40.56	9.31	39.36	10.93
Parent B Inattention	15.50	5.17	24.10	6.07	23.16	6.65
Parent B H/I	11.62	3.50	16.45	6.35	16.19	6.33
$CAARS_b$						
Self Inatt/Memory	12.15	6.07	17.76	7.75	15.12	6.18
Self Hyper/Restless	13.75	7.48	19.72	8.04	18.65	7.62
Self Imp/Emotion	6.95	4.90	12.26	5.42	10.79	5.37
Self DSM-IV Inatt	8.75	5.22	15.15	5.47	12.59	4.80
Self DSM-IV H/I	5.90	4.19	11.00	5.09	9.38	5.23
Self DSM-IV Total	14.65	8.36	26.17	9.19	22.53	7.57
Self ADHD Index	8.80	5.70	15.37	5.94	14.26	5.33
Observer Inatt/Memory	16.29	7.86	22.74	7.09	21.85	7.75
Observer Hyper/Restless	10.67	8.12	16.23	7.57	17.66	8.91
Observer Imp/Emotion	8.42	7.24	13.03	7.54	14.23	8.84
Observer DSM-IV Inatt	10.63	5.61	16.62	4.64	16.60	5.88
Observer DSM-IV H/I	4.58	4.74	9.09	5.54	10.51	6.24
Observer DSM-IV Total	16.04	8.96	25.74	7.75	28.43	13.12
Observer ADHD Index	11.83	7.41	16.87	5.07	17.55	6.56
$CARE_b$						
Self Inattention	15.82	7.41	24.76	8.27	25.30	6.29

Self Hyperactivity	10.48	6.50	14.66	5.81	15.79	5.47
Self Impulsivity	6.02	5.37	10.51	6.57	10.46	5.72
Self Total	32.00	16.66	49.80	16.34	51.43	13.23
Self DSM-IV Inattentive	6.48	3.52	10.99	4.01	11.10	3.12
Self DSM-IV H/I	6.00	4.37	8.57	4.59	9.07	4.04
Parent Inattention	18.00	10.00	24.32	8.27	24.91	6.88
Parent Hyperactivity	8.43	7.68	15.95	10.69	18.10	10.77
Parent Total	26.41	15.73	40.22	14.98	42.97	15.31
Parent DSM-IV Inattentive	9.78	5.37	13.24	4.21	13.49	3.44
Parent DSM-IV H/I	3.74	4.16	7.69	6.05	8.75	5.96

Note. LD = Learning Disorder; ADHD = Attention Deficit/Hyperactivity Disorder; ADHD+LD = Attention Deficit/Hyperactivity Disorder + Learning Disorder.
[a] DSM-IV = DSM-IV ADHD Rating Scale; CAARS = Conners' Adult ADHD Rating Scale; CARE = College ADHD Response Evaluation; DSM-IV A = childhood ratings; DSM-IV B = current ratings; Inatt = Inattention; H/I = Hyperactive-Impulsive; Hyper = Hyperactivity; Imp = Impulsivity
[b] Raw scores

Table 3

Descriptive Statistics for Cognitive and Academic Achievement Measures by Disability Groups

	LD		ADHD		ADHD+LD	
	(n = 139)		(n = 121)		(n = 87)	
Measures[a]	*M*	*SD*	*M*	*SD*	*M*	*SD*
IQ	102.45	8.83	105.79	10.11	105.47	8.15
IM	97.47	11.81	97.62	13.86	101.18	11.66

WM	97.69	9.58	99.87	11.85	98.32	10.61
PS	92.36	12.16	95.08	14.06	91.81	13.28
Reading	84.17	11.05	98.03	7.83	87.02	7.26
Math	88.00	12.38	95.53	13.65	89.37	13.78
Writing	86.28	11.13	100.04	9.44	90.30	8.67
Reading Comp	182.66	24.23	201.18	22.94	190.77	23.56

[a] IQ=RIAS Intelligence Composite; IM=WMS-III Auditory Immediate Memory; WM=WMS-III Working Memory; PS=WJ-Cog Processing Speed; Reading=WJ-III Reading; Math=WJ-III Basic Math; Writing=WJ-III Basic Writing; Reading Comp=Nelson Denny Reading Comprehension.

Correlation coefficient magnitude interpretation. Cohen (1988) provided the most commonly known and used guidelines for interpreting the magnitude of correlation coefficients. A correlation coefficient of .10 is commonly interpreted to represent a small or weak association; a correlation coefficient of .30 is considered moderate; and a correlation coefficient of .50 or larger is believed to constitute a strong or large correlation. The basis of these guidelines, however, is not empirically derived, but rather based on Cohen's familiarity with effect sizes and correlation coefficients. Despite the ubiquitous usage of correlation coefficients as a key index of effect size in behavioral sciences, very few empirical interpretation guidelines exist. Fortunately, Hemphill (2003) addressed this issue by examining two large meta-analytic reviews involving psychological assessment (Meyer, Finn, Eyde, Kay, Moreland, et al., 2001) and treatment (Lipsey & Wilson, 1993). Correlation coefficients were sorted in terms of their magnitudes and divided into three approximately equal groups. Hemphill found that Cohen's guideline for a large correlation coefficient occurs infrequently, a finding corroborated by another meta-analytic review (Anderson, Lindsay, Bushman, 1999) of applied and laboratory research findings in a variety of areas of social psychology (i.e., fewer than 3%). Overall, results from the 78 meta-analytic studies concerning psychological assessment resulted in a correlation coefficient range of .02 to .21 for the lower third (low); a correlation coefficient range of .21 to .33 for middle third (moderate); and a correlation coefficient range of .35 to .78 for the upper third (large). Given the purpose of this study and similarity to aforementioned empirical meta-analyses of studies using correlation analyses in psychological assessment, all correlations were interpreted using the Hemphill guidelines.

Correlational Results

ADHD within scale correlations. For self and other ratings on the *DSM-IV,* all correlations were statistically significant at $p < .01$ (see Table 4). Self-childhood and self-current rating correlations were large and ranged from $r = .60$ to .72 ($M = .65$). Other-childhood and other-current rating correlations were also large and ranged from $r = .68$ to .76 ($M = .71$). Correlations between self and other raters were large and significant at concurrent times: other-current and self-current ranged from $r = .61$ to .71 ($M = .67$); self-childhood and other-childhood ranged from $r = .71$ to .76 ($M = .74$). Overall, results suggest large and statistically significant associations within and between informants on the *DSM-IV* rating scale across time (i.e., childhood, current). In addition, a slightly lower but still large and statistically significant correlation ($r = .44$ to .50, $M = .47$) between raters at different time points was found. For current self- and other ratings on the CAARS, correlations ranged from moderate to large ($r = .26$ to .44, $M = .32$). Inter-rater correlations on the CARE were also moderate to large and ranged from $r =$ .25 to .46 ($M = .34$). Concordance strength was largest for between and within informant ratings on the *DSM-IV* compared to norm-referenced assessment measure (CAARS and CARE). The stronger association held true when rater and time comparisons were matched (CARE: other-childhood/self-current vs. *DSM-IV*: other childhood/self-current; CAARS: other-current/self-current vs. *DSM-IV*: other-current/self-current).

ADHD between scale correlations. Between ADHD scales concordance estimates are reported for self- and other ratings on the *DSM-IV* and CARE followed by *DSM-IV* and CAARS correlation ranges, and finally correlation ranges between subscales on the CARE and CAARS (see Table 5).

DSM-IV and CARE. Correlation coefficient ranges for within informant ratings at concurrent times (childhood-childhood, current-current) were large and statistically significant at $p \leq .01$: self ranged from $r = .42$ to .60 ($M = .53$); other ranged from $r = .64$ to .78 ($M = .72$). Between rater correlations at corresponding times were, on average, large, r = .33 to .50 ($M = .44$); lower, but statistically significant moderate correlation coefficient ranges were found at incongruent times ($r = .29$ to .43, $M = .34$). Lastly, within rater correlations across time ranged from $r = .32$ to .47 ($M = .38$). Results revealed a similar association between within and between rater correlations at incongruent times in which behaviors were rated. In summary, other ratings of childhood ADHD symptoms across both scales were, on average, the largest followed by self-current ratings and other and self-ratings of childhood ADHD symptoms.

DSM-IV and CAARS. Correlation coefficient ranges for within informant ratings at concurrent times were large and statistically significant: self ranged from $r = .44$ to .61 ($M = .55$); other ranged from $r = .50$ to .64 ($M = .48$). Between rater correlations at congruent times ranged from $r = .26$ to .61 ($M = .47$). Between rater correlations at incongruent times for self ranged from r = .23 to .47 (M = .37) and other ranged from r = .38 to .65 (M = .49). The overall results reveal moderate to large correlations between the *DSM-IV* and CAARS regardless of rater comparisons and time at which symptoms were rated (childhood, current); nevertheless, stronger associations at incongruent rating times were found for other ratings of ADHD symptoms.

CARE and CAARS. All correlation coefficients were statistically significant at $p \leq .01$ for CARE and CAARS correlations between raters and across time. Correlations between measures for self-ratings of current symptoms ranged from r = .52 to .80 (M = .73). Other ratings of symptoms at different points in time were large and statistically significant (r = .49 to .79, M = .61). Self-current ADHD symptom ratings were also statistically related (r = .21 to .56, M = .39). Taken together, within rater concordance estimates were larger than between rater concordance estimates regardless of informant comparisons and time at which symptoms were rated.

Table 4

Pearson's Correlation Coefficient Ranges for Within Scale Comparisons

Measure	Rater 1	Rater 2	*r* range	*M*
DSM-IV$_a$	Self—current	Self—childhood	.60 - .72	.65*
	Other—current	Other—childhood	.68 - .76	.71*
	Self—current	Other—childhood	.44 - .50	.47*
	Other—current	Self—current	.61 - .71	.67*
	Self—childhood	Other—childhood	.71 - .76	.74*
CARE$_b$	Self—current	Other—childhood	.25 - .46	.34*
CAARS$_c$	Self—current	Other—current	.26 - .44	.32*

Note. Other = parent, significant other, or guardian
$_a$ DSM-IV-TR ADHD Rating Scale

[b] College ADHD Response Scale
[c] Conners' Adult ADHD Rating Scales
* $p \leq .01$

Table 5

Pearson's Correlation Coefficient Ranges for Between ADHD Measures, Respondents, and Time

Between Measures	Rater 1	Rater 2	*r* range	*M*
DSM-IV-TR/CARE				
	Other—current	Self—current	.33 - .50	.44*
	Other—childhood	Other—childhood	.64 - .78	.72*
	Self—childhood	Other—childhood	.42 - .60	.53*
	Self—current	Self—current	.43 - .60	.54*
	Other—childhood	Self—current	.29 - .43	.34*
	Self—childhood	Self—current	.32 - .47	.38*
DSM-IV-TR/CAARS				
	Self—current	Self—current	.44 - .61	.55*
	Other—current	Other—current	.50 - .64	.48*
	Other—current	Self—current	.26 - .47	.39*
	Self—current	Other—current	.48 - .61	.55*
	Other—current	Other—current	.50 - .64	.55*
	Self—childhood	Self—current	.23 - .47	.37*
	Other—childhood	Other—current	.38 - .65	.49*
CARE/CAARS	Self—current	Self—current	.52 - .80	.73*
	Other—childhood	Other—current	.49- .79	.61*

	Self—current	Other—current	.21 - .56	.39*
* $p \leq .01$				

ADHD cluster correlations. Of particular interest was the relationship between informant ratings of childhood and current ADHD symptoms (inattentive, hyperactivity-impulsivity, total), in part because both are required to meet diagnostic criteria for ADHD. Overall, correlation coefficient ranges were largest for the hyperactive-impulsive cluster at congruent (r = .36 to .76, M = .61) and incongruent (r = .27 to .72, M = .52) times, followed by the total symptoms cluster and, finally, the inattentive symptoms cluster. This relationship held true regardless of the rater combination (self-self, other-other, self-other) or measure combinations (see Table 6). Overall, the vast majority of cluster comparisons within and across rater, time, and scales were statistically significant ($p \leq .01$).

ADHD, neurocognitive, and academic achievement correlations. The association between ADHD symptoms, as measured by the *DSM-IV*, CARE, and CAARS, and neurocognitive and academic achievement measures was investigated to elucidate the relationship between ADHD-related behaviors and the underlying theoretical and empirical constructs of ADHD. Only statistically significant correlations are described below (see Table 7 for complete results). Reading was significantly related to all three ADHD scales (*DSM-IV* Self and Other*:* r = .09 to .29; CARE Self: r = .12 to 29; CAARS Self: r = .01 to .31), but varied by rater and ADHD subscale. Math was significantly related to *DSM-IV* Other (r = .09 to .22) and CARE Self (r = .15 to .27). Writing was significantly related to all ADHD scales (*DSM-IV* Self and Other*:* r = .09 to .30; CARE Self: r = .24 to 35; CAARS Self: r = .09 - .31). Reading comprehension was significantly related *DSM-IV* Self and Other (r = .06 to .21) and CARE Self (r = .15 to .24).

Conversely, IQ was only significantly related to CARE Self (r = .18 to .30). All other neurocognitive measures failed to reach statistical significance with ADHD measures; although, several approached statistical significance. In general, correlation coefficients between ADHD measures and neurocognitive and academic achievement variables were low to moderate. It was confirmed that ADHD symptoms have stronger associations with academic achievement measures than neurocognitive measures.

As expected, nearly all neurocognitive and academic achievement measures were statistically significant $p \leq .01$ and moderate to large in magnitude (see Table 8). The one exception was a low and insignificant correlation between immediate verbal memory and academic achievement measures excluding reading comprehension (r = .05 to .11, $p \leq .01$); a moderate and statistically significant correlation between immediate verbal memory and reading comprehension was found (r = .29).

Table 6

Pearson's Correlation Coefficients for ADHD Clusters

Measure	Rater 1	Rater 2	ADHD Cluster		
Within Scale			Inattention	H/I	Total
DSM-IV	Self—current	Self—childhood	.597**	.715**	.646**
	Other—current	Other—childhood	.676**	.764**	.699**
	Self—current	Other—childhood	.442**	.495**	.458**
	Other—current	Self—current	.706**	.611**	.690**
	Self—childhood	Other—childhood	.713**	.758**	.759**
CARE	Self—current	Other—childhood	.245**	.458**	.335**

CAARS	Self—current	Other—current	.289*	.359**	.283*
Between Scales	DSM-IV	CARE$_a$			
DSM-IV/CARE	Self—current	Self—current	.582**	.552**	.591**
	Other—current	Other—childhood	.345**	.553**	.406**
	Self—childhood	Other—childhood	.421**	.591**	.555**
	Other—childhood	Self—current	.286**	.434**	.342**
	DSM-IV	CAARS$_b$			
DSM-IV/ CAARS	Self—current	Self—current	.582**	.610**	.605**
	Other—current	Other—current	.595**	.637**	.498**
	Self—childhood	Self—current	.282**	.465**	.394**
	Other—childhood	Other—current	.415**	.649**	.436**
	Other—childhood	Self—current	.081	.272**	.165
	CARE	CAARS			
CARE/CAARS$_c$	Self—current	Self—current	.762**	.751**	.773**
	Other—childhood	Other—current	.524**	.742**	.570**
	Other—childhood	Self—current	-.048	.207	.018

** $p \leq .01$

Table 7

Pearson's Correlation Coefficient Ranges for ADHD Behavior Rating Scales, Neurocognitive, and Academic Achievement Measures

	DSM-IV		CARE		CAARS	
Measure	Self	Other	Self	Other	Self	Other

IQ	.07 - .14*	.01 - .14*	18 - .30**	.05 - .10	-.13 - .01	-.04 - .14
IM	.01 - .14*	.07 - .14*	-.01 -.16*	.00 - .05	-.09 - .06	-.14 - .06
WM	-.06 - .06	-.08 - .03	.05 - .15*	-.08 - .00	-.05 - .05	-.10 - .07
PS	-.05 - .06	-.08 - .08	.01 - .16*	-.01 - .12	-.05 - .06	-.10 - .27*
Reading	.09 - .22**	.11 - .29**	.12 - .29**	-.02 - .05	.01 - .31**	-.30 - .14
Math	-.03 - .09	-.06 - .15**	.15 - .27**	-.04 - .11	-.01 - .25*	.08 - .19*
Writing	.11 - .28**	.09 - .30**	.24 - .35**	.24 - .35**	-.07 - .06	.09 - .31**
Reading Comp	.06 - .15**	.08 - .21**	.15 - .24**	.08 - .11	-.08 - .14	-.04 - .17*

Note. IQ = RIAS Composite Intelligence Index; IM = WMS-III Verbal Memory Index; WM = WMS-III Working Memory Index; PS = Woodcock Johnson-III Tests of Cognitive Abilities Cognitive Efficiency Composite; Reading = Woodcock Johnson-III Tests of Academic Achievement; Math = Woodcock Johnson-III Tests of Academic Achievement; Writing = Woodcock Johnson-III Tests of Academic Achievement; Reading Comp = Nelson Denny Reading Comprehension Test.
* $p \leq .05$
** $p \leq .01$

Multivariate Results

A 3 x 8 MANOVA was conducted with group condition (LD, ADHD, ADHD+LD) as the independent variable. Eight dependent variables (DV's) were included in the analysis: IQ, immediate verbal memory, working memory, processing speed, reading, math, written expression (writing), and reading comprehension. Correlation coefficient analyses on DV's were conducted prior to multivariate analyses. A statistically insignificant Box's *M* test (p = .099) indicated acceptable variance-covariance matrices of the dependent variables. There were no significant between group differences on demographic variables (age, gender, and years in school); as a result, these variables were dropped from subsequent analyses.

Using Pillai's trace criterion the composite dependent variate was significantly affected by group membership (V = .417, F [16, 500] = 8.23, p = .000, partial η^2 = .208). Follow-up univariate tests were carried out on each dependent measure to determine the locus of statistically significant multivariate effects. A Bonferroni correction to the operational alpha level (.05/8 = .006) was applied to reduce the possibility of Type I error. As can be seen from an inspection of Table 9, group membership significantly affected performance on all four academic achievement DV's: Reading (F [2, 256] = 62.41, p = .000, partial η^2 = .328); Math (F [2, 256] = 8.03, p = .000, partial η^2 = .059); Writing (F [2, 256] = 55.43, p = .000, partial η^2 = .302); and, Reading Comprehension (F [2, 256] = 134.59, p = .000, partial η^2 = .102). Effects of group membership failed to reach the conservative statistical significance alpha level on all neurocognitive DV's.

Post hoc analysis was carried out using multiple comparison tests. Hochberg GT2 multiple comparison test was used for DV's with acceptable homogeneity of variance statistics to correct for multiple comparisons with unequal group sizes. For DV's with heterogeneity of variance, Tamhane's T2 multiple comparison test was used.

Table 8

Correlation Matrix for Neurocognitive and Academic Achievement Variables

Measure	1	2	3	4	5	6	7	8
1. IQ	1	-						
2. IM		1	-					
3. WM		.196**	1	-				
4. PS		.086	.302**	1	-			

5. Reading	.046	.282**	.132*	1	-		
6. Math	.064	.405**	.375**	.408**	1	-	
7. Writing	.105	.402**	.246**	.787**	.515**	1	-
8. Reading Comp	.288**	.324**	.339**	.508**	.345**	.585**	1

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

Table 9

Summary of MANOVA, ANOVA, and Post-Hoc Results for Neurocognitive and Academic Achievement Variables (n=344)

Effect	*F*	*df*	*p*	*partial* η^2
Disability group	8.23	16	.000*	.21

Univariate Tests of Between Subjects Effects

DV	*F*	*df*	*p*	partial η^2	Post Hoc$_a$
Group					
IQ	3.35	2	.036	.026	
Imm Memory	1.47	2	.233	.011	
WM	3.72	2	.026	.028	
PS	1.07	2	.344	.008	
Reading	62.41	2	.000*	.328	1< 2, | 3 < 2
Math	8.03	2	.000*	.059	1< 2, | 3 < 2

Writing	55.43	2	.000*	.302	1< 2
Reading Comp	14.59	2	.000*	.102	1< 2, | 3 < 2

Note. * Significant result - A Bonferroni correction of .006 was applied for multiple comparisons on univariate tests.
[a]Hochberg GT2 multiple comparison test was used for reading comprehension. Tamhane's T2 multiple comparison test was used on reading, math, and written expression measures. Corrected statistically significant ($p < .05$) post hoc mean comparison differences are reported.
1 = LD; 2 = ADHD; 3 = ADHD+LD

Neurocognitive tests. Post-hoc comparisons between groups failed to reach statistical significance at the .006 criterion for IQ, immediate verbal memory, and processing speed, suggesting similar performance between groups on these neurocognitive measures. However, in respect to the working memory composite, LD participants (M = 97.17, SD = 9.47) had significantly lower scores than did ADHD participants (M = 100.89, SD = 11.71).

Academic performance. Significant group differences were also found on measures of reading, math and writing academic performance.

Reading. The LD (M = 84.40, SD = 11.20) and ADHD+LD (M = 86.94, SD = 7.45) groups had significantly lower reading scores than the ADHD group (M = 98.51, SD = 7.63). No significant differences between the LD and ADHD+LD were found. Significant differences between groups on the reading comprehension measure were found; the LD group (M = 182.93, SD = 24.26) performed significantly lower than the ADHD group (M = 200.76, SD = 23.33) and the ADHD+LD group (M = 188.14, SD = 24.49) performed significantly lower than the ADHD group.

Math. Participants in the LD (*M* = 88.42, *SD* = 12.37) and ADHD+LD (*M* = 89.42, *SD* = 14.62) groups had significantly lower scores on the math composite than did participants in the ADHD group (*M* = 95.78, *SD* = 13.83). Participants in the LD and ADHD+LD groups performed comparably to one another on this measure.

Writing. Significant differences were found between all groups on the writing composite. The LD group (*M* = 86.43, *SD* = 10.82) had significantly lower scores than the ADHD (*M* = 100.50, *SD* = 8.97) and ADHD+LD (*M* = 89.92, *SD* = 8.00) groups and the ADHD+LD group had significantly lower scores than the ADHD group.

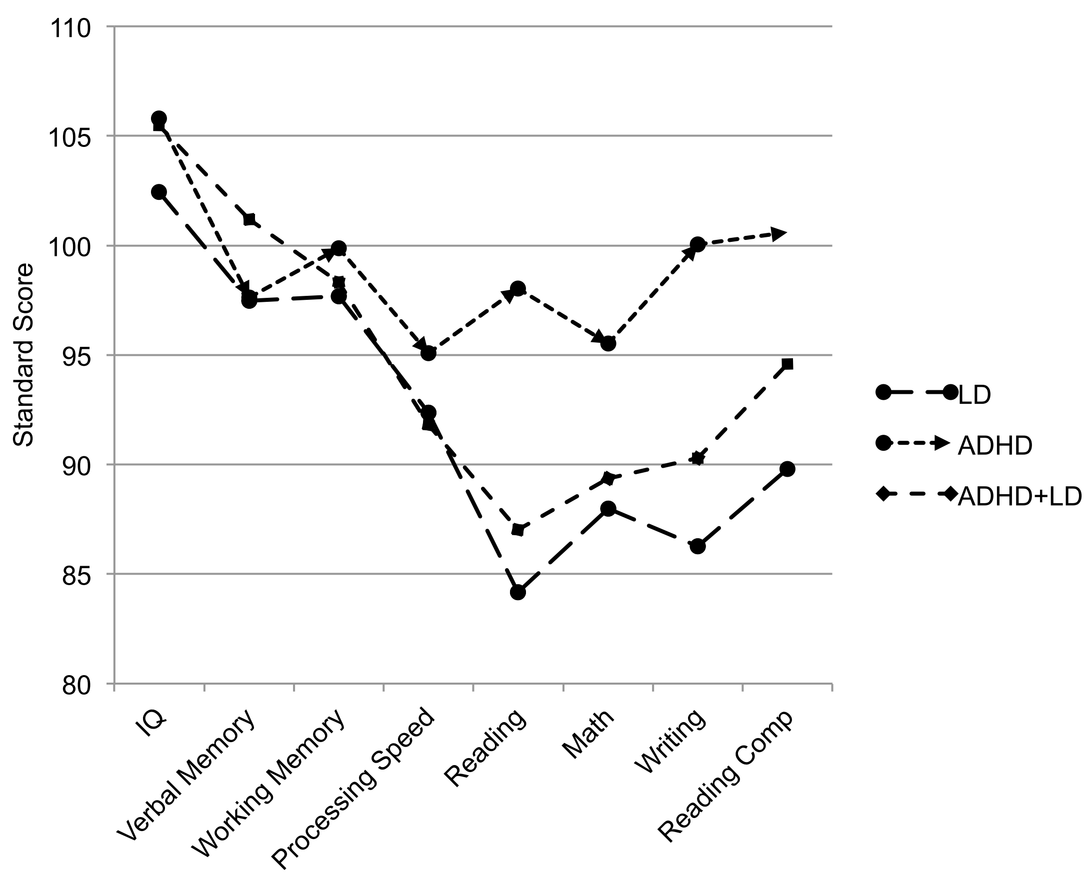

Figure 1. Neurocognitive and academic achievement profiles by disability group.

Chapter 5

Discussion

The present study investigated the relationship between self- and other reports of childhood and current ADHD symptoms using a sample comprised largely of college students who were referred to a university–affiliated clinic for assessment of learning and attentional problems. A primary goal of the present study was to examine the concordance between self- and other ratings on three different commonly used ADHD behavior rating scales and if correlational magnitudes varied in regard to retrospective recall of childhood and current ADHD symptoms. A second goal was to investigate the relationship between multi-informant ratings on ADHD scales and performance on select neurocognitive and academic achievement measures. This investigation was meant to serve as a barometric indicator of the relationship between behavior ratings on ADHD scales and functional outcomes. Third, the present study attempted to elucidate potential group (ADHD, LD, ADHD+LD) differences on neurocognitive and academic achievement tests. Together, these aims were meant to provide clinicians with a better understanding of how to weigh self- vs. other ratings of ADHD symptoms and subsequently knowledge of how to integrate behavioral data from multiple raters with neurocognitive and academic achievement test results.

Results from the primary analysis indicate predominately significant and moderate to large correlations for self- and other ratings of symptoms at congruent and incongruent time frames (childhood, current), regardless of the ADHD behavior rating scale. However, the strength of relationship between and within raters was variable and contingent upon the specific comparison. As predicted, within scale correlations were strongest for within and between rater reports of ADHD symptoms at corresponding times. A closer examination of the data revealed that the *DSM-IV*-based ADHD scale produced the largest correlations at congruent times. In fact, self- and other ratings of current ADHD symptoms on the *DSM-IV* resulted in a mean correlation coefficient of .67, which is consistent with correlations reported elsewhere (Barkley, 1995a; Magnusson et al., 2006; Murphy & Schachar, 2000; Zucker et al., 2002). Other report of childhood and current symptoms was strongly associated (r = .68 to .76) and largely commensurate to that found for self-report (r = .60 to .72).

Conversely, Mehringer et al. (2002) found a stronger association (r = .68 to .77) for self-report of childhood and current ADHD symptoms and a weaker relationship (r = .22 to .53) for other report of childhood and current symptoms. The same discrepancy remained when they examined the relationship strength between a *DSM-IV*-based ADHD rating scale and an external gold standard semi-structured clinical interview. Stronger self-rating correlations may have resulted from the fact their sample was largely represented by relatives of individuals with ADHD participating in their study. Further, these authors did not examine between rater agreement across time frames. Another possible explanation for why comparable self- and other report correlations were found in our study is the temporal relationship that other informants, mainly parents in this case, have to college students, whereas Mehringer and colleagues included a broader spectrum of other informants who may or may not have had close proximity to the person being evaluated. Other research is generally comprised of an older adult sample that has less contact with their parents; in other cases, a partner or friend is asked to rate childhood and/or current ADHD symptoms. Thus, it appears that self- and other ratings of ADHD symptoms are equally valid in a college-age sample of students. The validity between other and self-report in the general adult population seems to be less well understood, an assertion corroborated by other research (Kooij, Boonstra, Swinkels, Bekker, De Noord, et al., 2008).

Although variability across ADHD measures was found, the criterion-referenced *DSM-IV*-based scale resulted in the most consistent and largest correlations. Consistently large and statistically significant associations were found on the *DSM-IV*-based scale, whereas substantially lower yet statistically significant correlations were found on the CAARS. In fact, self- and other ratings of current ADHD symptoms on the *DSM-IV* were, on average, twice as large as those found on the CAARS. This relationship was also true at the ADHD cluster level. A similar finding was revealed for between rater reports of symptoms at different times (self-current, other-childhood) on the CARE and *DSM-IV*, although the degree of discrepancy was less than that found between the *DSM-IV* and CAARS. The mean correlation was larger on the *DSM-IV* compared to the CARE. This finding is of particular importance given the frequency in which clinicians use other informants as raters of childhood ADHD symptoms and college students as raters of current ADHD symptoms, both of which are needed to satisfy the *DSM-IV-TR* ADHD diagnostic criteria. Current results suggest that this approach may or may not be recommended depending on the ADHD measurement tool. For example, large correlations were found between raters on the *DSM-IV*-based rating scale, while moderate correlations were found on the CARE, which may be the result of different scale types (norm-referenced vs. criterion-referenced).

An alternative explanation is the limited number of items on the *DSM-IV*-based scale. This postulation is, however, unlikely given the current finding that correlations remained larger for the *DSM-IV* scale even when correlation analyses were carried out using only the CARE and

CAARS *DSM-IV* subscales. The one exception was similar correlation coefficients between the *DSM-IV* and CARE on the Hyperactive-Impulsive cluster. As a result, we contend that the difference is more likely attributable to the current study's sample; namely, all participants and other informants were required to fill out the *DSM-IV* ADHD rating scale whereas only a circumscribed number of participants and their other informants were asked to fill out the CAARS and/or CARE. The *DSM-IV* scale was used as a screener of ADHD symptomology at this particular university-based clinic, while the CARE and CAARS served as adjunct measures to provide a more in-depth analysis of ADHD symptoms. Therefore, the *DSM-IV* correlations included a larger number of LD-only participants and, in turn, one would expect to find higher levels of agreement between raters on a Likert-based scale when fewer ADHD symptoms are present. To test this supposition, we conducted a follow-up correlational analyses excluding the LD-only group. We found statistically significant ($p \leq .01$) but lower overall within scale mean correlation coefficients (*DSM-IV*: other-current/self-current mean $r = .50$; *DSM-IV*: other-childhood/self-current mean $r = .15$; CARE other-childhood/self-current mean $r = .16$; CAARS other-current/self-current mean $r = .16$). Again, this relationship held true at the ADHD cluster level.

Other research has found similar concordance estimates between self- and other ratings (e.g., Van Voorhess, Hardy, & Kollins, 2011; Zucker et al., 2002); however, to date, no other study has investigated rater agreement between ADHD and LD in college students, young adults, or adults. A study by Ward, Wender, and Reimherr (1993) compared rater agreement on an ADHD rating scale using a normative sample of adults as well as a group of adults with ADHD. They found moderate but statistically significant correlations for both a normative sample (.49) and for adults with ADHD (.41). These correlation magnitudes are inline with those found in the current study for self- and other report of current and childhood ADHD symptoms; in addition, Ward and colleagues also reported larger concordance estimates for the non-ADHD group.

In summary, results of this study do not support the use of one particular scale over the other (*DSM-IV* vs. CARE vs. CAARS) when drawing conclusions about ADHD symptoms from within scale, self- and other ratings of ADHD symptoms at different points in time. Nevertheless, within scale effect sizes for the *DSM-IV*-based scale were superior to the CAARS for between rater reports of current ADHD symptoms speaking, perhaps, to the difference between a norm-referenced assessment based on an adult normative sample and assessment tools based on a parallel normative sample (i.e., college students) and criterion-referenced assessments.

Of equal importance to intra- and inter-rater relationships discussed above is the difference between rater reports of ADHD symptoms between scales. It is not uncommon for clinicians to use an ADHD screener followed by a more comprehensive ADHD behavior rating measure, upon which they are left to make clinical decisions about scores from different measures that purport to measure the same construct. Therefore, the current study investigated this question by comparing self- and other ratings on multiple ADHD assessment tools. In general, results revealed a strong relationship for self- and other accounts of ADHD symptoms across different measures. The average correlation coefficient between the *DSM-IV* and CARE and the CARE and CAARS were identical, followed closely by *DSM-IV* and CAARS associations. A closer inspection of individual comparisons exposed differences according to the combination of scales, time of ratings, and type of rater comparison. For example, on *DSM-IV* and CARE comparisons, other ratings of childhood symptoms on both scales resulted in a larger correlation (r = .72) than did self-ratings of current ADHD symptoms (r = .54).

The significance of these findings is the added preliminary evidence to the idea that individuals with ADHD may have more difficulty accurately recalling their childhood symptoms and validly reporting their current ADHD symptoms due to limited self-awareness of behaviors (Wender, 1995). Additional researchers (e.g., Zucker et al., 2002) have called into question the accuracy of self-report accounts of ADHD symptoms. This question is unlikely to be answered by simply comparing self- and other ratings on one particular measure and needs to be considered within the context of other variables such as sample type, demographic factors, measurement type, proximity of raters' relationships to one another, and possible comorbid conditions. Current findings both support and oppose this idea and, ultimately, depend on the measurement tools used.

For instance, current results support this idea because other report of childhood ADHD symptoms on the *DSM-IV* and CARE were greater than self-report of current ADHD symptoms; however, at the same time, results oppose this idea because comparable correlational estimates were found for self- and other ratings of childhood and current symptoms on the *DSM-IV*-based scale, as well as current ADHD symptoms on the *DSM-IV* and CAARS. A similar relationship was found between self- and other ratings of symptoms at different points in time on the *DSM-IV* and CAARS, with a slightly stronger association between other report of childhood and current ADHD symptoms. Moreover, self-ratings of current ADHD symptoms on the CARE were more strongly associated to self-ratings on the CAARS than the combination of self-ratings of current symptoms on the CARE and other ratings of current symptoms on the CAARS. The latter finding is not unexpected because different raters were asked to recall ADHD symptoms at different points in time; this finding was also found on other rater and scale comparisons. The degree of relational discrepancy was not found for identical comparisons on the *DSM-IV* and

CARE and *DSM-IV* and CAARS, however. Again, this difference may be related to different normative samples between the CARE and CAARS as both comparisons were anchored with the *DSM-IV*-based rating scale. Previous research has suggested a difference between young adults attending college and adults who do not attend college (Heiligenstein & Keeling, 1995; Lee, Oakland, Jackson, & Glutting, 2008). Further, the CAARS normative sample includes a larger number of other raters—informants that are not parents—than the CARE normative sample, as well as a greater age range than that found in the CARE normative sample.

Two additional explanations as to why discrepancies were found also seem defensible. First, differences between types of "other informants" quite likely influence ratings; for example, other ratings of their spouse's current ADHD behaviors are not influenced by retrospective accounts of childhood behavior that may be present in other ratings of current ADHD symptoms. Secondly, questions on the CARE are more specifically related to ADHD behaviors found in a collegiate setting. If the latter hypothesis were true, one would expect a stronger association between other ratings of childhood ADHD symptoms on the CARE and other ratings of current ADHD symptoms on the CAARS because it removes the potential confound of current symptoms on the CARE being related to a collegiate environment. This is, in fact, consistent with current findings; that is, mean other ratings of childhood symptoms on the CARE were strongly correlated with other ratings of current symptoms on the CAARS (r = .61). Furthermore, research has shown that the type of information a rater is asked to recall and the manner in which questions are posed can impact the accuracy of recollections (Mitchell, Cottler, & Shapiro, 1986; Olson, Shu, Ross, Pendergrass, & Robinson, 1997).

Overall, student and other accounts of both retrospective and current ADHD symptoms appear to be reliable. Research investigating similar questions with other age groups has been tasked with the same question of how to weigh self- and other ratings of ADHD behaviors across time. Current results suggest that there is no distinct advantage of tasking one informant rather than the other with rating childhood versus current ADHD symptoms. Stated another way, other ratings of childhood symptoms do not appear to be more accurate than self-ratings of childhood symptoms; the same appears to be the case for other ratings of current symptoms versus self-ratings of current symptoms. For example, self-ratings of childhood and current symptoms on the *DSM*-IV and CARE were moderate (r = .34) and largely parallel to that of other ratings of childhood symptoms on the *DSM-IV* and self-ratings of current symptoms on the CARE (r = .38). Similar findings were found for *DSM-IV* and CAARS comparisons. Moreover, self-rating (r = .65) and other ratings (r = .71) of childhood and current symptoms were nearly equivalent. Our general conclusion is that information rated and recalled from college students is as valid and accurate as that obtained from a knowledgeable informant such as a parent, which challenges assertions made Wender (1995) and Zucker and colleagues (2002). While on the surface this may lead some to believe that multi-informant ratings are not needed, the current findings only suggest that both types of informants appear to be reliable reporters of childhood and current ADHD symptoms. This finding should not detract from the fact that multi-informant accounts provide a rich and robust source of information, which validates individuals' accounts of symptoms, safeguards against malingering/feigning of symptoms for secondary gains, and likely helps differentiate between subtypes of ADHD.

At the cluster level of analysis, ratings of hyperactive-impulsive symptoms appear to be at least as reliable as inattentive and total symptoms, if not more reliable. Overall, within and between rater concordance estimates on the hyperactive-impulsive cluster were large, statistically significant, and greater than correlational coefficients found on inattentive and total symptoms clusters. This finding was true regardless of the scale or time of rating; one exception was similar correlation magnitudes between self-ratings of current inattentive and hyperactive-impulsive symptoms. Research to date has presented mixed findings in regards to within and between raters concordance on ADHD clusters (Barkley, 1995a; Frazier et al., 2007; Kooji et al., 2008; Zucker et al., 2002); in general, slightly stronger associations for hyperactive-impulsive cluster scores have been reported. Van Voorhess et al. (2011) found that self-rated *DSM-IV* hyperactive-impulsive symptoms also have strong specificity and moderate to strong sensitivity. Despite current and anecdotal findings, inattentive symptoms have been shown to predict and moderately to strongly correlate with negative outcomes (Barkley et al., 2002; Betz, 2000, Bird, Gould, Staghezza, 1992; Frazier, 2007; Schwanz, Palm, Brallier, 2007). It may be the case that hyperactive behaviors, more so than impulsivity or inattention behaviors, decline with age due to ongoing external correction over time resulting in less of an influence on negative outcomes.

While ascertaining the association amongst self- and other ratings of childhood and current symptoms on different ADHD behavior scales is undoubtedly important, it does little to elucidate the relationship between ADHD behaviors and functional outcomes such as performance on academic achievement tests. Further, it does not examine the theoretical underpinnings of ADHD (i.e., neurocognitive functioning) in college students. Research investigating the relationship between ratings of ADHD symptoms and neurocognitive and academic achievement performance of college students with ADHD and/or LD is sparse at best, and significantly lagging behind studies investigating the same question in children. The current study attempted to fill this void in the literature and hypothesized that the strongest relationship would be found between other and self-reports of current ADHD symptoms and reading performance, followed by other measures of academic achievement (i.e., math and written expression). Current results affirmed our hypothesis, as among all analyses, correlations were largest between all ADHD scales and academic achievement measures, regardless of informant type. Nevertheless, only self-ratings of ADHD symptoms and academic achievement reached the conservative statistical significance criterion on all three rating scales. In respect to other ratings, only those for the *DSM-IV* and academic achievement (reading, math, and written expression) were statistically significant, whereas CARE and CAARS ratings were not. This suggests that self-report on ADHD rating scales may be more accurate when predicting academic performance.

Previous research has reported similar associations between ADHD symptoms and academic achievement. Frazier and colleagues (2007) found that ADHD symptoms continue to be significantly associated with problems in academic functioning at the college level, particularly for reading performance. In their Study 1, the overall average effect size was .33 for two studies using a college-age sample and .27 for six studies using an adolescent sample of students; both groups were diagnosed with ADHD using *DSM*-based criteria. In their Study 2, the predictive relationship of self- and parent ratings on the CARE and first-year college GPA was investigated; overall, bivariate correlations were small (r = .10). Effect sizes from the current study are comparable to those reported in Study 2 and slightly lower than those reported in Study 1, with weak associations between self- (mean r = .17) and other ratings (mean r = .11) and academic achievement.

At first glance the discrepancy between findings in Study 1 and the current study seem noteworthy; however, a closer examination of both studies revealed differences between studies. For example, the two studies included in the Frazier and colleagues (2007) meta-analysis used GPA as a measure of academic aptitude and did not use formal norm-referenced academic achievement measures; in addition, one study (Heiligenstein, Guenther, Levy, Savino, & Fulwiler, 1999) did not directly compare rater reports of ADHD symptoms and GPA. The other study (Glutting, Sheslow, & Adams, 2002) reported lower bivariate correlations for self- and parent report of ADHD symptoms on the CARE and outcome measures (SAT scores and end-of-freshman-year GPA). Student-ratings (r = .01 to .03) and parent ratings (r = .03 to .22) were negligible to weak. Furthermore, only ratings of current ADHD symptoms were used. What this tentatively suggests is that formal norm-referenced measures of academic achievement are more valid than informal measure of academic aptitude such as GPA in comprehensive psychological evaluations of college students.

Of particular clinical utility is a potential difference in the relationship strength between raters' accounts of ADHD symptoms on differing ADHD scales and academic and neurocognitive performance, as it provides a means for determining the degree of impact ADHD symptoms have on functional outcomes. Our findings suggest that clinicians should assign more importance to self-ratings than other ratings on the basis that concordance rates between self-ratings and academic achievement were, on average, twice as strong as other ratings regardless of the academic domain or ADHD measure. The lower magnitude of effect between other ratings and academic achievement performance was unexpected given other research that has demonstrated stronger associations for parent ratings and various functional outcomes (Barkley et al., 2002). This difference is plausibly linked to dissimilar outcome measures between the two studies. Barkley and colleagues did not include norm-referenced academic achievement assessments as outcome measures; instead, they included outcome measures such as employer ratings of ADHD, number of arrests, and job performance. Moreover, the current study did not attempt to exclude individuals with LD and comorbid ADHD+LD.

Based on preliminary findings, clinicians may be better served to focus their attention on information collected from rating scales and gleaned from clinical interview when assessing for ADHD and comorbid attentional and learning problems in college students. The preponderance of concordance estimates between neurocognitive measures and ADHD rating scales were weak and insignificant. We originally hypothesized that working memory would be the one exception due to findings from a pilot study by Grooper and Tannock (2009) that found verbal and visual working memory deficits in college students diagnosed with ADHD compared to normal controls, as well as a significant relationship between working memory and academic attainment at the postsecondary level. Our postulation, however, did not prove true. While several relationships approached the conservative statistical significance criterion, only self-ratings on the CARE and IQ were statistically significant. While it is surprising that working memory and ratings on ADHD scales failed to reach statistical significance, several explanations seem reasonable. First, working memory performance and other neurocognitive abilities, as measured in a clinical setting, do not accurately reflect real-world applications of these abilities. Shaywitz, Flecthcer, and Saywitz (1995) contend that cognitive deficits examined in a laboratory setting may very well vary from behavioral and cognitive problems observed in natural settings and, thus reflect different meanings of terminology. Second, given that attentional capacity is a precursor to working memory, the setting may mitigate the impact attentional deficits have on working memory performance. Third, from a neurodevelopmental perspective it seems credible to hypothesize that college students with ADHD and/or LD develop compensatory mechanisms (e.g., chunking), which, in part, diminish the effects working memory deficits have on academic performance.

Our findings call into question the clinical utility of neurocognitive measures in the assessment of ADHD and LD in college students. Overall, current results are consistent with the extant literature in college student and adults with ADHD, LD, or concurrent ADHD and LD and extend the literature by demonstrating that this lack of association extends beyond self-ratings of current ADHD symptoms. Very few studies have empirically demonstrated appreciable neurocognitive deficits in these samples. Studies that have included formal measures of executive functioning and attention also generally failed to find significant differences between college students and adults with ADHD, LD, and controls (Advokat, Martino, Hill, & Gouvier, 2007; DuPaul, Weyandt, O'Dell, & Varejao, 2009; Linterman & Weyandt, 2001; Weyandt, Linterman, & Rice, 1995; Weyandt, Rice, Linterman, Mitzlaff, & Emert, 1998; Weyandt, Mitzlaff, & Thomas, 2002).

Additional findings from the current study further corroborate the suspect clinical utility of neurocognitive measures in the assessment of ADHD and LD in college students. Neurocognitive and academic achievement accounted for 21% of variance in between group differences. Univariate analyses revealed significantly larger effect sizes for academic achievement variables. Effect sizes were greatest for the reading and writing composites. Two neurocognitive measures reached statistical significance, working memory and IQ, but post-hoc analyses only revealed a significant difference between participants with LD and ADHD on the working memory composite. The lack of statistically significant differences between the LD and

ADHD+LD groups suggests that deficits on this measure largely stem from participants with LD. In addition, participants with LD consistently performed worse than their ADHD counterparts on all academic achievement measures, a finding that was also true for participants with comorbid attentional and learning problems. Interestingly and unexpected was the similar performance between participants with LD and ADHD+LD on academic measures. If the theoretical relationship between LD and ADHD in this sample were additive, one would expect worse academic performance for the comorbid group versus the ADHD-only group. This, however, was not the case lending preliminary evidence to an overlapping and interactive relationship between LD and ADHD in college students. Similar research has also suggested overlapping disorders in children and adolescents (Mayes et al., 2000).

Limitations of Study

This investigation has a number of limitations that should be considered. The first and most salient limitation concerns the lack of a control group. While certain academic achievement and neurocognitive measures were not found to be sensitive to differentiating ADHD from LD or comorbid ADHD and LD, performance differences on academic and neurocognitive measures may very well have been found for students with ADHD and students without attentional and/or learning deficits. There is a general consensus that college students with ADHD are at risk for poor academic achievement, less likely than non-disabled peers to complete college, and at greater risk for failure (Barkely, 1998, Frazier et al., 2007, Lewandowski et al., 2008; Wolf, 2001). Thus, it is possible that participants with ADHD would differ from college students without attentional and/or learning problems on academic achievement measures, as a subsample of college students (i.e., LD group) performed, on average, in the low average range. Other studies have also found similar academic achievement scores in college students with LD (Frazier et al., 2007; Morris & Leuenberger, 1990; Murray & Wren, 2003; Spark & Lovett, 2009). In addition, participants with ADHD and ADHD+LD performed below the general normative sample on neurocognitive measures. Again, it seems sensible to assume that a subpopulation of college student with ADHD and/or LD have isolated neurocognitive deficits that exceed those of their non-disabled college peers. An additional unknown variable is the potential effect of stimulant medication on raters' perception of their ADHD symptoms, as well as performance on neurocognitive measures.

Second, neurocognitive measures included in this study serve only as a proxy of behaviors and challenges encountered by college students with ADHD and LD in a collegiate environment. For example, organization, task initiation, and planning difficulties may negatively impact this subsample of students' ability to have successes at the postsecondary level. Future research examining the contribution of these behavioral deficits is needed to disentangle the relationship between commonly employed assessment measures and functional outcomes such as graduation rates, academic probation, and psychosocial health.

Another potential limitation is the collapsing of higher-grade high school students (*n* = 52; 15%) into the group of students accepted into a college institution and those currently enrolled in college. While it is possible that performance differences on neurocognitive and academic achievement measures exist between these two groups, to our knowledge no empirical investigation has substantiated such a postulation. Furthermore, a partial correlation analysis accounting for the effect of age did not change bivariate correlations on ADHD rating scales. Murphy and Schachar (2000) also found that age did not seem to be a significant factor in recall of childhood behavior or judgment of current ADHD behavior. Lastly, an inspection of mean performance on neurocognitive and academic achievement variables between high school/high school graduates and college student participants revealed comparable performance on neurocognitive and academic achievement tests. From a neurodevelopmental perspective, one would expect greater overlap between high school juniors and seniors and undergraduates than differences, especially as it pertains to the current measures of interest, as most critical periods of brain development happen in childhood and early adolescence.

A final set of limitations with respect to the current study is the representativeness of our sample. Participants in the current sample were largely comprised of individuals with financial means to seek such services; it is unclear how participants in this study compare to the greater populations of individuals who do not seek an evaluation. In addition, the degree in which these findings can extend to older and younger populations remains unknown, as do the extrapolation of findings to ethnic minorities and geographical regions that differ from the current sample.

Summary and Future Directions

The empirical study of ADHD in the college student population is limited compared to the vast and ever expanding body of literature concerning ADHD in children and adolescents. This problem continues to be the case for college students with LD and comorbid ADHD and LD. The current examination supports several conclusions. First, both student and other accounts of both retrospective and current ADHD symptoms appear to be reliable. Concordance was moderate to strong within and between raters on all ADHD rating scales. Nevertheless, more research is needed to fully extricate the question of whether other and self-accounts of childhood and current ADHD behaviors are equally valid representations of ADHD symptomatology.

Second, although variability across measures was found, the criterion-referenced *DSM*-IV-based scale resulted in the most consistent and largest correlations. No previous study has investigated this question on a mulit-rater, multi-scale level; as a result, future research is needed to confirm the current findings. Third, contrary to other findings, the hyperactive-impulsive cluster produced the strongest associations between and within raters at both corresponding times and incongruent time frames.

The clinical utility of these findings cannot be understated as multi-rater information is considered best practice in the evaluation of ADHD. To date, clinicians have not had empirical evidence to guide their clinical impressions when attempting to determine the reliability and validity of cross-informant accounts on multiple ADHD scales in a college population. A secondary benefit of such information is how findings from the current study aid in the identification of college students feigning ADHD symptoms for secondary gains (i.e., non-prescribed stimulant medications). For example, given the moderate to strong association between self- and other ratings, clinicians should be alert to potential dishonest responding if self-report of ADHD symptoms significantly exceed other accounts of ADHD symptoms on like scales. This growing problem in the college population has been identified in approximately 7% of college students reporting this behavior (DuPaul et al., 2009). Furthermore, the amassing collection of empirical evidence regarding neurocognitive and academic achievement performance for college student with ADHD and/or LD serves as embedded measures of effort. The increasing trend of students seeking some form of disability for secondary gains has led certain researchers to recommend the addition of symptom validity testing (Booksh, Pella, Singh, & Gouvier, 2010). Further research is needed to determine the sensitivity of formal and embedded validity and effort measures in this population.

Fourth and, finally, ADHD behavior rating scales appear to have a weak association with neurocognitive measures, and weak to moderate associations with academic achievement measures. Despite this finding, self-report of current ADHD symptoms seem to be more valid indicators of current academic achievement than other accounts of current ADHD symptoms. Based on preliminary findings, clinicians may be better served to focus their attention on information collected from rating scales and gleaned from clinical interview when assessing for ADHD and comorbid attentional and learning problems in college students. Nonetheless, future work with formal measures of attention and executive functioning in college students with ADHD and LD is needed to fully elucidate the relationship between ADHD behaviors and neurocognitive strengths and weaknesses. While weak to moderate relationships were found between ADHD symptoms and academic achievement in the current study, a better understanding of differences between disabled and non-disabled college students will help guide intervention efforts. In addition, further exploration of the potential effects medication status has on the relationship between ADHD and achievement is needed.

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Appendix A: UGA RCLD Disability Documentation

Definition of Disability

A. An individual must demonstrate that his/her condition meets the definition of a disability under the Rehabilitation Act, 1973 and/or the Americans with Disabilities Act (ADA), 1990, and its Amendment (2009). The ADA defines a disability as a physical or mental impairment that substantially limits one or more major life activities.

B. Substantially limits, under ADA, refers to significant restrictions as to the condition, manner, or duration under which an individual can perform a particular major life activity as compared to most people.

C. Whether a condition is substantially limiting to support an accommodation request is a decision made by qualified professional(s) based upon multiple sources of information.

D. A clinical diagnosis is not synonymous with a disability. The specific symptoms that are present should be stated in the documentation. Evidence that these symptoms are associated with substantial impairment in a major life activity is required for provision of accommodations. A detailed description of current substantial limitation in the academic environment is essential to identify appropriate academic accommodations, auxiliary aids, and services. Specific requests for accommodations need to be linked to the student's current functional limitations, and the rationale for each recommendation clearly stated.

General Documentation Guidelines

A. All institutions are required to have written policies and procedures for review of documentation submitted by students with disabilities. Decision-making for the provision of institutional-level accommodation is provided by the Office of Disability Services (ODS) or a designated office at an individual college or university.

B. Secondary education eligibility reports, Individualized Educational Plans, Summary of Progress reports, or previous provision of special education services may not be sufficient documentation for college-level accommodations.

C. Documentation should provide a diagnostic statement identifying the disability, describe the diagnostic criteria and methodology used to diagnose the condition, and detail the progression of the condition if its impact on the student's functioning is expected to change over time.

D. Documentation should provide an adequate representation of the student's current functional abilities. In most situations, documentation should be within three years of the student's application for services. Professional judgment, however, must be used in accepting older documentation of conditions that are permanent or non-varying, or in requiring more recent documentation for conditions for which the functional impact may change over time.

Documentation must include the names, signatures, titles, and license numbers of the appropriate evaluators, as well as the dates of testing and contact information. Evaluators must be licensed professionals whose training and licensure status is consistent with expertise in the disability for which they provide documentation.

Appendix B: UGA RCLD Disability Criteria

Specific Definition of Disability

1. **Learning disabilities**. Learning disabilities is a general term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical skills. These disorders are intrinsic to the individual, presumed to be due to central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behaviors, social perception, and social interaction may exist with learning disabilities but do not, by themselves, constitute a learning disability. Although learning disabilities may occur concomitantly with other disabilities (e.g., sensory impairment, mental retardation, serious emotional disturbance), or with extrinsic influences (such as cultural differences, insufficient or inappropriate instruction), they are not the result of those conditions or influences. (National Joint Committee on Learning Disabilities, Learning Disabilities: Issues on Definition, January, 1990.)

Specific documentation guidelines for Learning Disabilities include the following:

A. General documentation guidelines listed above.

B. Clear and specific identification of a learning disability must be stated. For example, the terms “Learning styles” or “Learning differences” are not synonymous with a learning disability.

C. Documentation of a developmental and educational history consistent with a learning disability.

D. Since the manifestations of a learning disability may change over the period of childhood and adolescence, documentation must reflect either data collected within the past three years or after the age of 18.

E. Information gained from standardized assessment instruments is one essential piece of the methodology used to diagnose learning disabilities. Therefore, documentation of learning disabilities must include standardized measures of academic achievement and cognitive processing abilities that have age-appropriate normative data for high school/college students or older adult non-traditional students. All standardized measures must be represented by standard scores and percentile ranks based on published norms.

F. Documentation of a functional limitation(s) in one or more of the following areas of academic achievement:

   i. Mathematics (calculations, math fluency, and applied reasoning)

   ii. Written Language (spelling, fluency, and written expression)

   iii. Reading (decoding, fluency, and comprehension)

G. Documentation of relative strength(s) in academic achievement in order to establish the presence of a significant discrepancy between academic domains. The presence of a significant discrepancy will typically require a difference of one standard deviation between scores. However, qualified professionals may use other widely accepted metrics for documenting a significant difference between two scores (e.g., standard error of measurement).

H. Documentation that alternative explanations for the academic limitation(s) have been considered and ruled out (e.g., low cognitive ability, lack of adequate instruction, emotional factors such as anxiety or depression).

I. Documentation of a pattern of cognitive processing weaknesses and strengths that is associated in a meaningful way with the identified area(s) of academic limitation.

J. Both processing weaknesses and processing strengths must be identified and must represent a significant discrepancy between cognitive domains. The presence of a significant discrepancy will typically require a difference of one standard deviation between scores. However, qualified professionals may document a significant difference between two scores using other widely accepted metrics (e.g., standard error of measurement).

K. Processing weaknesses and strengths must be evident on multiple measures and not based on a single discrepant score on an individual test or subtest. Cognitive Processing Skills (selection dependent upon case) include the following:

    i. Attention
    ii. Executive Functions
    iii. Fluency/Automaticity
    iv. Memory/Learning
    v. Oral Language
    vi. Phonological/Orthographic Processing

vii. Visual-Motor

viii. Visual-Perceptual/Visual-Spatial

L. Documentation that alternative explanations for the cognitive limitation(s) have been considered and ruled out (e.g., low cognitive ability, lack of adequate instruction, emotional factors such as anxiety or depression).

These guidelines are intended to guide the review of documentation and cannot substitute for the expertise and clinical judgment of a qualified professional. Failure to fully meet each of the above criteria does not automatically preclude a diagnosis of learning disabilities. In some circumstances, this diagnosis may be justified, based on an expert's integration of a student's history, test performance, and current functioning.

2. Attention-Deficit/Hyperactivity Disorder (AD/HD). AD/HD is a persistent pattern of inattention and/or hyperactivity-impulsivity that is more frequently displayed and more severe than is typically observed in individuals at a comparable level of development. The manifestations of AD/HD result in functional impairment in at least two settings (e.g., academic, occupational, social). The diagnosis of AD/HD is based on the following specific criteria included in the current version of the Diagnostic and Statistical Manual of Mental Disorders (DSM) of the American Psychiatric Association.

Specific documentation guidelines for AD/HD include the following:

M. General documentation guidelines listed in Appendix D.

N. Diagnosis and corresponding code from the most recent DSM must be included.

O. Assessment of the following diagnostic criteria is required and evaluation results must be included in the documentation:

  i. Developmental history of either inattention and/or hyperactivity-impulsivity symptoms during childhood. The specific symptoms that were present in childhood should be stated in the documentation. Corroboration of childhood symptoms should be included, and may need to be gathered from a variety of possible data sources (e.g., parent/guardian report, school records, past evaluations). Evidence that these symptoms were associated with some functional impairment in home and/or school settings also must be included.

  ii. Current symptoms of either inattention and/or hyperactivity-impulsivity must be present. The specific symptoms that are present should be stated in the documentation. Self-reported current symptoms should be corroborated by an independent informant who has been able to observe the student's recent functioning with adequate regularity to provide this type of information. Evidence that these symptoms are associated with functional impairment in academic, occupational, and/or social settings also must be included.

The frequency/severity of both childhood and current AD/HD symptoms should be documented by comparison to individuals at a similar level of development. Documentation must include the results of standardized rating scales that provide comparison to age-based normative data.