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The Relation between Executive Functions and Written Expression in College Students with Attention Deficit Hyperactivity Disorder

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The Relation between Executive Functions and Written Expression in College Students with Attention Deficit Hyperactivity Disorder

by

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DEDICATION

I dedicate this project to my uncle, Tom Mixon, who gave me my first exposure to the field of psychology through his work and who encouraged me to pursue this degree. I dedicate this to my parents for giving me opportunities that they never had, for supporting me throughout my education, and for giving me the feeling that I can accomplish anything. I also dedicate this to my big brother, Lane, who has, in so many ways, paved the way for me, consistently encouraged me throughout my life, and whose giftedness continues to inspire me.

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The Relation between Executive Functions and Written Expression in College Students with Attention Deficit Hyperactivity Disorder

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Attention deficit hyperactivity disorder (ADHD) is the second most common disability affecting college students today. According to the DSM-IV, ADHD symptoms include a persistent pattern of inattention and/or hyperactivity-impulsivity markedly more frequent and severe than individuals at a comparable level of development. Moreover, ADHD symptoms involve impairment in executive function including planning, organization, inhibition, and integration of cognitive processes.

ADHD has been linked to academic difficulty in children, adolescents, and more recently, college students. Written expression is especially important in college as students encounter required courses that involve a major writing component. Because written expression involves many of the neuropsychological abilities compromised for

those with ADHD, specifically executive functions, it was hypothesized that college students with ADHD would experience difficulty with educational tasks involving writing.

The present study examined the relation between executive function and written expression. Two groups of undergraduate students, aged 19 to 28 years, were recruited. Group one consisted of 31 students diagnosed with ADHD and group two consisted of 27 controls. Four measures of executive function and a measure of written expression were administered. The majority of those ADHD participants on medication went off their medication on the day of the study.

A one-way between-groups multivariate analysis of variance (MANOVA) was conducted to investigate differences in executive function and written expression abilities between the ADHD and control groups. No differences were found. A standard multiple regression model including executive function measures, verbal aptitude, and ADHD symptoms was not significant for predicting the SATA Writing Quotient. Exploratory analyses were conducted to examine the individual components of the SATA Writing Quotient. Results showed that the model was not significant for predicting SATA Writing Composition; however, the model was significant for predicting SATA Writing Mechanics. In addition, a measure of inhibition was found to make a statistically significant contribution to the prediction of SATA Writing Mechanics in this model. Findings from the study provide important information about the link between specific executive function abilities and written expression in college students. Limitations of the study and implications for future research and practice are discussed.

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CHAPTER 1

Introduction

Attention deficit hyperactivity disorder (ADHD) is reported to be the second most common disability affecting college students today (Barkley et al., 1991; Shekim et al., 1990). In fact, it is estimated that 1% to 5% of the college population meets criteria for ADHD (DuPaul, 2001; Heilgenstein et al., 1998). College students with ADHD have been entering institutions of higher education in record numbers (Latham, 1995; Richard, 1995). This increase in numbers is thought to be, in part, a result of the Americans with Disabilities Act of 1990, which mandates support services for college students with disabilities.

ADHD is the most common and most studied neurodevelopmental disorder of childhood (Rowland, Lesesne, & Abramowitz, 2002). ADHD was previously thought to be solely a disorder of childhood; however, researchers and clinicians have begun to recognize that ADHD symptoms persist into adulthood (Barkley, et al., 1990; Barkley, 1998; Klein & Mannuzza, 1989; Klein & Mannuzza, 1991; Weiss & Hechtman, 1993). Adult ADHD studies show that symptoms include impairment in executive function which includes planning, organization, inhibition, and integration of cognitive processes (Woods, Lovejoy, & Ball, 2002). Other scholars have suggested that executive function problems tend to increase in adulthood (Wasserstein, Wasserstein, & Wolf, 2001). Anatomical studies suggest the role of frontal lobes in the mediation of executive function (Barkley, 1997; Castellanos et al., 1994; Giedd et al., 1994; Matochik et al., 1994; Monastra et al., 1999).

ADHD in adulthood has been linked to an increased risk for academic failure, psychological disorders, relationship conflicts, and accidents (Barkley et al., 1993; Biederman et al., 1993; Fischer et al., 1990; Seidman et al., 1998; Weiss & Hetchman, 1993; Wender, 1995). Heiligenstein and colleagues (1999) found that college students with ADHD are more likely to have a lower grade point average, be on academic probation, and in general, have more academic problems as compared to non-disabled peers. These findings are likely related to the simultaneous increase in academic requirements and personal responsibilities and decrease in social and educational support, which occur during the transition from the K-12 to the college environment (Eaton & Coull, 1998).

While past research has established that college students with ADHD are more likely to experience learning problems and academic underachievement, little is yet known about the specific academic functional impact of the disorder. The present study aimed to begin addressing this question by examining the link between executive functions and written expression abilities among college students with and without ADHD. The academic domain of written expression was the primary focus because college students encounter an increase in writing assignments (Eaton & Coull, 1998) and are required to take courses which involve a major writing component. Moreover, written expression has been conceptualized to involve many of the neuropsychological abilities compromised for those with ADHD, specifically executive functions (Denckla, 1996; Pennington, 1997). Thus, it was hypothesized that college students with ADHD would experience difficulty with educational tasks involving written expression. This research will contribute to the development of a neuropsychological profile of college

students with ADHD. Additionally, the findings of the present study will serve to inform support services in higher education by providing a more in depth understanding of the academic functional impact of ADHD.

CHAPTER 2

Review of the Literature

Synthesizing previous work of scholars who study Attention-Deficit Hyperactivity Disorder (ADHD) and written expression creates a foundation for exciting research possibilities. The integration of these two areas is particularly important for the college student with ADHD given the deficits associated with the disorder and that the transition from high school to higher education involves adapting to a new, more rigorous curriculum, which emphasizes writing. This literature review is organized into six main sections. First, to set a framework for the present study, the higher education context for students with disabilities is discussed. This section includes the transition to college, higher education disability law, and requirements and responsibilities of college students with disabilities. Second, an overview of the ADHD literature is provided. Because literature in this specified area is limited, child and adolescent literature is integrated as well. Third, the neuropsychological underpinnings of ADHD, with an emphasis on executive functions, are presented. Fourth, literature on written expression is presented including major models of the writing process and associated neuropsychological constructs. Next, a summary of the research and statement of the problem is presented. In the final section, the present study is described.

Higher Education Context for Students with Disabilities

Transition to College

It is especially important to consider the transition to college when studying college students with disabilities, as the move from high school to college entails many major changes. The transition to college is a unique and challenging experience for all

students, particularly those with disabilities (Eaton & Coull, 1998). Students experience an array of feelings and frustrations as they conclude one phase of life, high school, and embark on another, college (Smith, English, & Vasek, 2002). Students with disabilities typically experience four difficulties as they transition into college: (1) a decrease in teacher-student contact; (2) an increase in academic competition; (3) a change in personal support networks; and (4) a loss of the protective public school environment, which is largely determined by the legal mandates present in K-12 education (Rosenthal, 1989).

The law surrounding students with disabilities changes significantly from high school to college. Students with disabilities in high school are in a protective environment: The school is responsible for identifying students with disabilities as well as providing services to them. In contrast, college students with disabilities must seek out the office which provides support services, provide documentation of their disability, and request accommodations (Fairweather & Shaver, 1990). The K-12 and higher education systems are therefore quite different. In K-12, student advocates include parents, school psychologists, and teachers. In higher education, students with disabilities are their own advocates. Disability law is discussed in more depth below.

To provide a framework for facilitating college transition for college-bound students, Gartin, Rumrill, & Serebreni (1996) propose the Higher Education Transition Model. This model has been applied for use with students with disabilities. Within the model is a three-part framework which includes: (a) psychosocial adjustment; (b) academic development; and (c) college and community orientation. Psychosocial adjustment is essential for all students, with or without disabilities. Meeting new people,

as well as forming friendships and a social network are important aspects of making the college transition.

The second essential element of higher education transition is academic development. Students must develop academic skills necessary to meet the challenges of a college curriculum. Courses are generally more demanding, as the course content is more challenging and professors tend to assign more reading and writing. The tasks associated with academic development include establishing effective study and time management strategies, acquainting oneself with course requirements and professors' expectations, and choosing fields of study as well as career paths. Students must become more independent as they manage their new lives away from the highly structured environment of the K-12 academic setting.

The third and final element of higher education transition is college and community orientation. Students must become aware of their new college environment and resources as it will be their second home for the next four years. An awareness of campus resources and a willingness to pursue and use the resources is of particular importance for students with disabilities. For example, since the law regarding students with disabilities is different in a higher education setting, students must learn about the services provided on their campus and how to go about accessing them. Further, it is important for students to also be aware of other resources such as health care facilities, transportation systems, cultural activities and recreational facilities. Each aspect of the Higher Education Transition Model involves tasks which are essential for achieving a successful transition to a higher education setting. These parts must all interact to facilitate the transition to college (Gartin, Rumrill, & Serebreni, 1996).

Disability Law

The greatest increase in college students with disabilities has been seen in students with cognitive disabilities such as learning disabilities, psychiatric disorders, and ADHD (Wolf, 2001). Because individuals with ADHD have entered college in record and growing numbers, institutions of post-secondary education have struggled to serve this burgeoning population (Latham, 1995; Richard, 1995). Research suggests that 1% to 4% of the college population meet criteria for ADHD (DuPaul et al., 2001; Heilgenstein et al., 1998). As a result, ADHD has begun to receive significantly more attention on college campuses (Glutting et al., 2002). This new focus and increase in numbers is believed to be, in part, a consequence of the Americans with Disabilities Act (ADA), which mandates support services for post-secondary students with ADHD. This provision is an extension of requirements for children under Section 504 of the Rehabilitation Act of 1973 (Nadeau, 1995).

A disability is defined by Section 504 and ADA as a "physical or mental impairment that (1) substantially limits one or more of the major life activities of such individual; (2) a record of such impairment; (3) or being regarded as having such an impairment" (42 U.S.C. Sec. 12102(2)). Moreover, the functional limitation(s) or manifestation of a disability must be documented in order to provide an understanding of the nature of a student's disability. This understanding assists higher education administrators in determining the most appropriate accommodations to meet the student's individual needs. Thus, gaining a greater understanding of the functional limitations of ADHD is critical for understanding the most effective ways to support students with the disorder in a higher education setting.

Requirements and Responsibilities of Students

All students with disabilities admitted to institutions of higher education must be otherwise qualified (Section 504 of the Rehabilitation Act, 1973). That is, disability status does not play a role in the admissions process, as they must meet the same admissions requirements as their non-disabled counterparts. Moreover, because universities maintain academic integrity, college students with disabilities must complete the same work and meet the same course requirements as non-disabled students. Work for students with disabilities may not be modified or changed in any way. Rather, students with disabilities may be provided with academic accommodations (e.g., extra time to complete exams), in an effort to even the playing field. These standards differ from those of the K-12 system in which students with disabilities are often provided with modified work. For example, a student with a math disability may be required to complete only half of the math problems assigned to the rest of the class.

Another major difference between the K-12 and higher education systems is the process of identifying students with disabilities (Schwiebert, Sealander, & Dennison, 2002). In the K-12 system, school faculty and staff are required by law to seek out students who are experiencing difficulty and determine through assessment if they are, in fact, disabled. In contrast, college students with disabilities are responsible for self-identifying and pursuing and paying for an assessment, if necessary. Thus, the student, not the university, is responsible for seeking out services and providing appropriate documentation of his or her disability in order to be approved for academic accommodations. Once approved, the student must coordinate individually with instructors to receive their accommodations. Unlike the K-12 system, within the

university system, the burden is placed on the student to ensure that accommodations will be provided (Schwiebert et al., 1998).

In conclusion, there are many challenges associated with the legal, systemic, and personal aspects of the transition to college. These challenges exist for all students but particularly for students with disabilities (Eaton & Coull, 1998). Moreover, due to the deficits associated with ADHD, it seems particularly important to consider the educational context under which students with the disorder learn. As a result of compromised executive and planning abilities, which are discussed below, the transition from the supportive familial environment and highly structured K-12 educational setting to an unstructured college life presents significant challenges for college students with ADHD (Wasserstein, Wasserstein, & Wolf, 2001).

Attention-Deficit/Hyperactivity Disorder in Adults

Diagnostic Criteria and Subtypes of ADHD

ADHD refers to a behavioral condition characterized by developmentally inappropriate degrees of inattentiveness, hyperactivity, and impulsivity that arise in childhood (before age 7 years). These behavioral conditions must be present in two or more settings, and relatively chronic in nature (American Psychiatric Association, 1994). The most widely used criteria for diagnosing ADHD and the most widely used classification system for documenting ADHD across universities (Gregg & Scott, 2000) is that of the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV; American Psychiatric Association, 1994). The DSM-IV includes three types of ADHD: ADHD Predominantly Hyperactive Impulsive Type, characterized by motor and impulse control problems; ADHD Predominantly Inattentive Type, characterized by

problems in attention or arousal; and ADHD Combined Type, characterized by symptoms in both areas. Although these groups do not differ in terms of cognitive, social, or psychosomatic problems, individuals in the predominantly inattentive group exhibit lower levels of delinquency, aggression, and conduct disorder compared to the predominantly hyperactive impulsive type or combined type (Faraone et al., 1999).

Diagnostic Issues for College Students with ADHD

DuPaul and colleagues (2001) provide a relevant discussion of the current state of affairs with regard to diagnosing university students with ADHD. They assert that what is lacking is basic epidemiological information regarding the symptomatology of ADHD at this specific developmental stage. Moreover, they discuss the need for empirically validated assessment methods for diagnosing and treating ADHD among college students. Presently, adult ADHD is commonly diagnosed based on clinical interview and self-report behavioral checklists and the clinician's diagnosis is therefore largely dependent upon others' perceptions (Woods, Lovejoy, & Ball, 2002). Thus, it is important to gain empirical support for standardized measures which will discriminate between ADHD and non-ADHD groups in order to assist clinicians in the assessment and diagnosis of ADHD. Finally, DuPaul and colleagues (2001) emphasize the importance of gaining information on the presentation of ADHD at this developmental stage as the current diagnostic criteria calls for the practitioner to determine the extent to which symptoms are presented as developmentally inappropriate.

Another concern expressed by Smith and Johnson (1998) is related to the diagnostic criteria available to practitioners and researchers. The DSM-IV criteria for ADHD came from research with 380 clinic-referred children. These children were

evaluated with a battery of tests and structured interviews. The oldest participants were 17-year-old males. College students were not included in this research and yet, the criteria for ADHD are applied to them for the purposes of diagnosis.

Prevalence, Etiology, and Comorbid Conditions

ADHD is one of the most frequently diagnosed disorders of childhood with an estimated prevalence of 3% to 7% (Barkley et al., 1990; Szatmari, 1992). In fact, ADHD is the most common neurodevelopmental disorder of childhood and the most studied (Rowland, Lesesne, & Abramowitz, 2002). ADHD was previously conceptualized solely as a disorder of childhood with symptoms subsiding throughout development; however, longitudinal studies have shown that for up to 70% of children who suffer from ADHD, symptoms of the disorder continue into adolescence and adulthood (Barkley, et al., 1990; Barkley, 1998; Klein & Mannuzza, 1989; Klein & Mannuzza, 1991; Weiss & Hechtman, 1993). The prevalence of ADHD in the college student age group is estimated to be between 3% and 5% (Faigel, 1995). These estimates are approximately the same in the K-12 school-aged population (American Psychiatric Association, 1994).

Although the etiology of ADHD is unknown, many studies suggest both genetic and environmental links (e.g., preterm delivery). Cognitive and behavioral problems are often seen in individuals with ADHD but are believed to be based on different genetic mechanisms (Farone et al., 1993). Family, twin, and adoption studies have shown genetics to be a primary cause of ADHD in many families (Eaves et al., 1997; Farone & Biederman, 1994). ADHD is more common in the first-degree biological relatives of children with ADHD (American Psychiatric Association, 1994).

Mood and anxiety disorders, antisocial personality disorder, substance-related disorders and learning disorders frequently co-occur with ADHD (American Psychiatric Association, 1994). For example, 20% to 30% of children and adolescents with ADHD also meet criteria for one or more learning disabilities (Semrud-Clikeman et al., 1992). Adults diagnosed with ADHD are at risk for comorbid psychiatric and psychosocial problems, as approximately 60% of adults with ADHD receive a comorbid psychiatric diagnosis (Spencer et al., 1998). Moreover, college students with ADHD have been found to be at greater risk for academic difficulty and underachievement as compared to peers without ADHD (Heiligenstein et al., 1999).

Gender Differences

ADHD literature has focused almost exclusively on males (Sharp et al., 1999). Male-female ratios have been reported from 4:1 to 9:1 (American Psychiatric Association, 1994) while other studies have found male-female ratios as low as 2.1:1 (Szatmari, 1992). The cause of sex differences in the prevalence of ADHD remain unclear (Levy & Hay, 2001). Many researchers have examined this difference which has resulted in inconsistent findings. Researchers have found that females with ADHD show more cognitive impairment than do their male counterparts (Berry, Shaywitz, & Shaywitz, 1985; Brown, Madan-Swain, & Baldwin, 1991; Gaub & Carlson, 1997); males with ADHD tend to exhibit more behavioral problems (De Hass & Young, 1984; Berry, Shaywitz, & Shaywitz, 1985). Other researchers have not found statistically significant gender differences on cognitive abilities (Breen, 1989; De Hass & Young, 1984) or behavioral problems (Befera & Barkley, 1985; Breen, 1989).

Limitations of Research on Adults with ADHD

Research on ADHD has focused largely on school-age children and adolescents and thus, information regarding university students with ADHD is limited. Current research on adults with ADHD is helpful to begin to understand this population; however, methodological issues limit its use for understanding college students with ADHD (Heiligenstein et al., 1999). For instance, according to Murphy and Barkley (1996), because data is often collected in mental health clinics, research with college students with ADHD is lacking. Moreover, because participants in many of these studies have co-morbid conditions, it is difficult to know if outcomes are directly related to symptoms of ADHD or are a result of the symptoms other conditions (Biederman, Faraone, & Spencer, 1993).

Biological Bases of ADHD

A number of hypotheses exist regarding the neuroanatomical dysfunction associated with ADHD; however, neurobehavioral studies regarding the frontal lobes and associated systems have shown the most consistent findings (Hynd et al., 1991). Both structural and functional neuroimaging studies have implicated dysfunction in the frontal and subcortical regions of the brain as contributing to ADHD symptoms (Barkley, 1997; Castellanos et al., 1994; Giedd et al., 1994; Matochik et al., 1994; Monastra et al., 1999). The study of individuals with frontal lobe lesions, particularly the orbital-frontal regions and caudate nucleus, has helped researchers understand the neurobiological underpinnings of behavioral symptoms associated with ADHD (Benton, 1991; Heilman, Voeller & Nadeau, 1991; Mattes, 1980). Specifically, the frontal lobes are thought to play a major role in executive functions, discussed in more depth below, including

planning, impulse control, inhibition, working memory, and organization (Stuss & Benson, 1984).

Neuropsychological Underpinnings of ADHD

The majority of research on neuropsychological functioning in individuals with ADHD has focused on children and adolescents (Hervey, Epstein, & Curry, 2004). For example, over the past 22 years, only approximately 30 empirical studies on the neuropsychological performance of adults with ADHD have been published with the majority of these published since 1997 (see Figure 1). Hervey, Epstein, and Curry (2004) published a meta-analysis of empirical studies, which compared the neuropsychological performance of adults with ADHD to a comparison group. They point out the lack of consensus regarding the neuropsychological profile of adults with ADHD. Thus, their goal was to determine what neuropsychological deficits appear to be most commonly and strongly associated with adult ADHD, which will allow future studies to test and confirm hypotheses on the neuropsychology of adult ADHD. They found that compared to adults without ADHD, adults with ADHD exhibited deficits in multiple domains with prominent impairment in attention, behavioral inhibition, and memory.

In general, findings on the cognitive impairment in adults with ADHD are similar to cognitive impairments found in children with ADHD; however, research suggests that hyperactivity declines with age (Barkley, 1998). Moreover, while impairment in attention, information processing speed, executive functioning, learning, and memory remains fairly constant throughout development (Epstein, et al., 1997; Epstein, et al., 1998; Jenkins et al., 1998; Murphy, Barkley, & Bush, 2001), executive function problems tend to increase in adulthood (Wasserstein, Wasserstein, & Wolf, 2001). Thus, it is

important for researchers to focus on the area of executive functions in adults to contribute to the construction of a neuropsychological profile of adult ADHD.

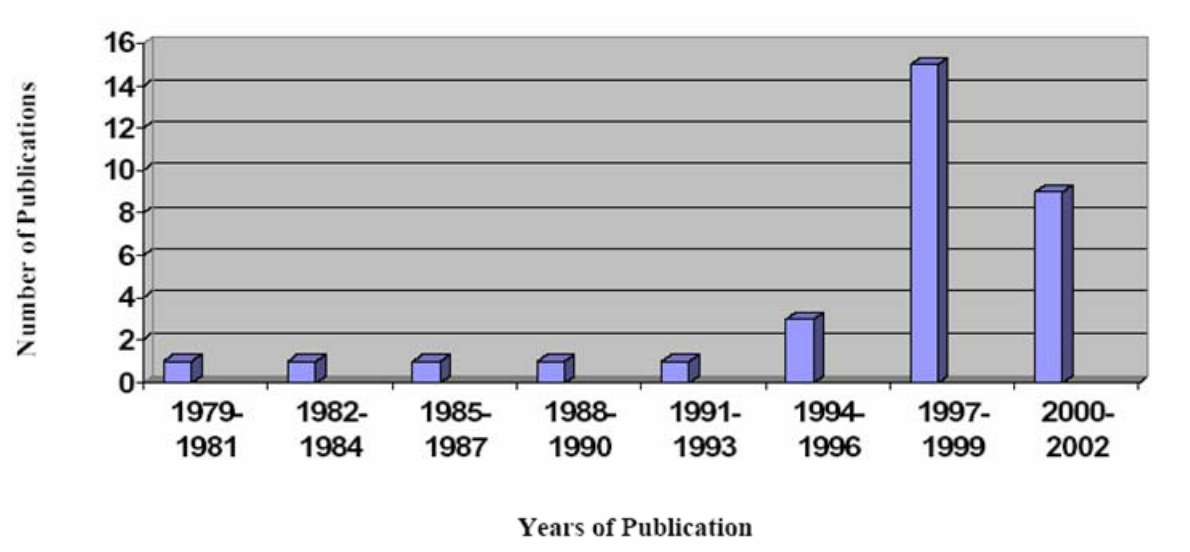

Figure 1. Number of Empirical studies (by years of publication) comparing neuropsychological performance in adults with attention-deficit/hyperactivity disorder with a comparison group. Adpated from Hervey, A., Epstein, N., & Curry, J. , "Neuropsychology of Adults with Attention-Deficit/Hyperactivity Disorder: A Meta-Analytic Review," in *Neuropsychology*. Copyright 2004 by American Psychological Association.

Executive Functions

Executive function is a complex construct which includes planning, attention, organization, self-regulation, abstract reasoning, and problem-solving for which there is no single measure and no simple definition (Homack & Riccio, 2004). Welsh (1994) describes executive function as an overarching concept that exceeds traditional categories of cognition (e.g., attention, memory, language) and regulates, integrates, and coordinates them for goal-directed behavior. In their review of adult ADHD neuropsychological studies, Woods, Lovejoy, and Ball (2002) employed a broad definition of executive functioning that "reflects a multidimensional neurocognitive construct comprised of a

variety of higher-order processes including tests of attention/concentration, concept formation, planning, impulsivity, and cognitive flexibility" (p. 13). For the purposes of this study, four main categories of cognition, subsumed under the construct of executive function were measured: attention and inhibition, verbal fluency, memory, and planning.

Attention and inhibition. The neuropsychological domains most strongly linked to ADHD are attention and inhibition (Douglas & Peters, 1979). Recently, researchers have discovered that, while symptoms of ADHD such as hyperactivity and impulsivity may diminish throughout development, symptoms of inattention are more likely to persist over time (Biederman, Mick, & Faraone, 2000). In their meta-analysis, Hervey, Epstein, and Curry (2004) found that tasks of attention and inhibition such as the Conners Continuous Performance Test (CPT) and the Stroop Color-Word Interference Test consistently distinguished adults with ADHD from adults without ADHD. In a comprehensive review of neuropsychological assessment of adults with ADHD, 92% of studies that included a CPT reported significant differences between adults with ADHD and controls on at least one CPT variable (Woods, Lovejoy, & Ball, 2002). In the same review, consistent performance differences on Stroop tasks were found between adults with ADHD and healthy controls suggesting poor selective visual attention and/or difficulty with response inhibition associated with adult ADHD.

Verbal fluency. Measures of verbal fluency typically require participants to generate words which begin with a certain letter or belong to a specified semantic category. Performance is based on how many words a person can generate in a given length of time. These tasks measure speeded lexical production and the efficiency of lexical organization (Dunn, Gomes et al., 1996). This type of task has shown variable

results in the identification of children with ADHD (Barkley, Grodzinsky, & DuPaul, 1992); however, across adult neuropsychological studies, the task showed a generally reliable sensitivity in discriminating between adults with ADHD and healthy controls (Hervey, Epstein, & Curry, 2004; Woods, Lovejoy, & Ball, 2002).

Memory. Auditory-verbal list learning task deficits are common in adults with ADHD and are the most commonly explored area of learning and memory in this population (Woods, Lovejoy, & Ball, 2002). Notable performance difference between the adult ADHD and non-ADHD groups on the California Verbal Learning Test (CVLT) have been found across adult ADHD studies (Hervey, Epstein, & Curry, 2004). Other measures of memory have not shown the same discrimination. For example, adults with ADHD tended not to show impairment on memory tasks when they had visual stimuli in the form of a figure such as on the Visual Reproduction subtest of the Wechsler Memory Scale and the Rey-Osterrieth Complex Figure Test. Baldo and colleagues (2002) examined patients with focal frontal lesions using the CVLT. They found that these patients exhibited deficits on this task including poorer recall, greater number of intrusions, reduced semantic clustering, and impaired recognition.

Planning. Tower tests such as the Tower of Hanoi and Tower of London are thought to measure executive functions such as planning and working memory. These tests require the participant to move disks from one formation to another using the fewest moves possible while following a set of specified rules. Deficits in these tasks have been found among children with ADHD (Pennington, Groisser, & Welsh, 1993). Across studies, on Tower tasks which required advanced planning and complex, nonverbal,

series of steps, adults with ADHD performed more poorly than did non-ADHD adult controls (Hervey, Epstein, & Curry, 2004).

Functional Impact of Neuropsychological Deficits for Adults with ADHD

As emphasized previously, little research has focused on ADHD in adulthood and thus, less is understood about the functional impact of ADHD in adulthood (Heiligenstein & Keeling, 1995; Heiligenstein et al., 1999). Adults with ADHD have been reported to be at increased risk for academic failure, depression, low self-esteem, substance abuse, occupational difficulties, legal problems, automobile accidents, and relationship conflicts (Barkley et al., 1993; Biederman, Faraone, & Spencer, 1993; Faigel, 1995; Fischer et al., 1990; Seidman et al., 1998; Weiss & Hechtman, 1993; Wender, 1995). With regard to academic functioning, Heiligenstein and colleagues (1999) found that college students with ADHD, compared to non-ADHD controls, had a significantly lower mean grade point average, were more likely to be on academic probation, and reported significantly more academic problems. Written expression has been identified as an area of particular difficulty to students with cognitive disabilities including learning disabilities and ADHD (Gregg, 1986; Smith, 1993); yet, the area of research on the basic writing abilities of college students with these disorders is underrepresented in the literature (Gregg et al., 2002).

Previous research has established that individuals with ADHD are more likely to experience learning problems and academic underachievement. Moreover, as students with ADHD make the transition from high school to college, academic demands increase. College students are expected to read and write more than was necessary in high school. Courses which have a major writing component are mandatory at the college level.

Services for students with disabilities provide accommodations (e.g, extra time to complete exams, a reduced distraction environment) to support students with ADHD; however, research has not established how the functional impact of ADHD specifically affects academic skills such as writing. Because writing becomes increasingly important from high school to college, it is important to investigate the extent to which ADHD symptoms affect college students' abilities in this essential academic domain.

Written Expression

Research in the area of written expression is well behind areas such as reading, particularly with respect to understanding the development of writing skills as well as the neurocognitive underpinnings of written expression (Hooper et al., 2002). In this section, the developmental context of writing acquisition, gender differences with regard to written expression, and the neuropsychology of writing are discussed. Further, a model of the writing process is presented. The Hayes and Flower (1980) model of the writing process is the most influential of the cognitive models of writing (Abbott & Berninger, 1993). For the purposes of this study, the writing process model of skilled writers (Hayes & Flower, 1980; Hayes, 1996) was examined, as it is the most relevant to college-level writers, as opposed to writers in earlier developmental stages as described by Berninger and Swanson (1994).

Developmental Process of Writing Acquisition

Written language acquisition, or language by hand, has a longer developmental trajectory compared to language by ear, mouth, or eye (Berninger & Richards, 2002). Many systems are called upon throughout the developmental process of writing acquisition, which begins in the preschool years (Gregg, 1991). Among them are systems

required for the component parts of writing including handwriting, spelling, and composing (Abbott & Berninger, 1993). Berninger and Richards (2002) provide the following discussion of each of the components necessary for writing acquisition within a developmental context.

The beginning of the writing acquisition process involves learning to scribble or write which draws on visual-motor systems for planning and producing written output (e.g., lines, letters). In addition, visual-spatial abilities are necessary to manage the size and relative position of written output. As the beginning writer develops, typically in the primary grades, handwriting becomes an increasingly automatic process. The brain systems necessary for beginning writers, such as grapho-motor and language systems, are served by regions of the brain which myelinate during early childhood in contrast to higher order cognitive systems such as planning that emerge later in development. At this point, however, the ability to spell continues to rely on more controlled processing. At this early stage of writing acquisition, the three best predictors for written composition were found to be measures of orthographic coding, fine motor planning and coordination, and speeded orthographic-motor integration (Berninger & Fuller, 1992).

In the intermediate grades, letter and word production become more automatic, which consequently, frees up the limited capacity in working memory (McCutchen, 1996). This automaticity allows writers the capacity for higher-level tasks of writing including planning and self-regulation (Harris & Graham, 1996). These abilities are thought to be facilitated by the increased myelination of frontal areas of the brain which support the executive processes of working memory. In the junior high years, a greater connection between all of the cognitive systems used for writing, mentioned previously,

and working memory emerges. Additionally, a capacity to review and revise emerges. At this stage, the written products of these writers begin to resemble those of adult or more skilled writers. Increased myelination of the frontal areas of the brain are approaching adult levels which support higher order executive processes such as working memory, planning, and reviewing.

Gender differences have been shown at the beginning stages of writing acquisition (Berninger & Fuller, 1992). In primary grades, boys outperformed girls on oral verbal fluency in terms of semantic retrieval (e.g., confrontation naming, generation of words from semantic categories); girls outperformed boys on orthographic fluency and number of words and number of clauses produced in a composition or compositional fluency. In the intermediate grades, girls continued to outperform boys in these areas but the gender effect for verbal fluency disappeared (Berninger & Swanson, 1994). In junior high grades, when accounting for number of words produced, gender differences in composition were related to differences in written fluency, likely due to differences in speeded orthographic-motor integration, rather than the quality of the composition.

Neuropsychology of Writing

The ability to write involves many neurocognitive systems, as it evolves from all other language systems and draws on nonlanguage systems as well (Berninger & Richards, 2002). Writing is a controlled process which involves attention, planning (Wilson & Proctor, 2002), memory, graphomotor abilities, higher order cognition, language, and visual-spatial abilities (Gregg, 1991). Researchers have begun to hone in on many of these neurocognitive systems which are subsumed by control processes known as executive functions discussed above. These processes have been linked to the

prefrontal regions of the brain though other regions of the brain are involved as well (Denkla, 1994).

Currently, evidence of a consensus regarding the role of executive functions within the writing process is lacking in the written expression literature. Thus, executive function has begun to receive more attention in this domain (Hooper et al., 2002). Studies have found executive functions such as planning, self-regulation, inhibition, working memory, and sustained mental attention to be important factors in the writing process (Denckla, 1996; Pennington, 1997). These findings have begun to highlight the importance of executive functions in writing (Graham, 1997).

One area of executive functioning, known as working memory, has emerged as a theme in the writing literature (Berninger, 1999). Working memory is important for the writing process because it allows the writer to engage in multiple cognitive tasks (e.g., retrieval of information from memory, maintenance of multiple ideas) at once (Swanson & Berninger, 1994) and its capacity is believed to increase with development (McCutchen, 1996). Because working memory allows the writer to manage multiple, simultaneous processes, a compromise in this system would likely cause problems with written expression (Lea & Levy, 1999; Levy & Marek, 1999).

Self-regulation is thought to be another important function in the writing process (Graham & Harris, 2000). Self-regulatory mechanisms include planning, monitoring, evaluating, and revising which allow the writer to effectively accomplish the writing task and ultimately improve the written product (Scardamalia & Bereiter, 1985). Skilled writing requires continuous self-regulation and attentional control which allows the writer to manage the multiple environmental aspects of writing as well as the processes

necessary for composing (Kellogg, 1987; Ransdell & Levy, 1996; Scardamalia & Bereiter, 1986).

Another important area of executive function related to self-regulation documented in the writing literature is planning (Hayes & Flower, 1980; McCutchen, 1996). Researchers have commonly found that a major difference between novice writers and skilled adult writers is the ability to plan throughout the writing process (De La Paz & Graham, 1997; Hayes & Flower, 1980; McCutchen, 1988; Scardamalia & Bereiter, 1986). Planning allows the writer to simplify or manage the multiple constraints of a composition (Hayes & Flower, 1980). These aspects of the writing process are discussed in more depth below.

Hayes and Flower's Model of the Writing Process

Previously, research on writing has focused primarily on the final written product. More recently, the focus has shifted to exploring the writing process. Hayes and Flower (1980) proposed a cognitive model for the writing process of competent adult writers (See Figure 2). The unique features of the model are 1) It identifies the organization of subprocesses of the composing process; 2) It allows for individual differences in composing styles. Hayes and Flower divide the model into three major parts including the task environment and the writer's long-term memory, both of which are contextual components in which the third part, the writing process, takes place.

Contextual components. The task environment includes everything outside the writer that influences task performance. For example, the writing assignment itself would be considered a part of the task environment. As the writing project develops, the text that has been produced so far is also part of the task environment, as the writer will

refer to this information throughout the remainder of the writing process. The writer's long-term memory is an important contextual piece, as it provides information to the writer about potential topics, the writer's audience, and even a structure or guiding questions (e.g., who, what, where, when, why?) he or she has learned to facilitate the writing process.

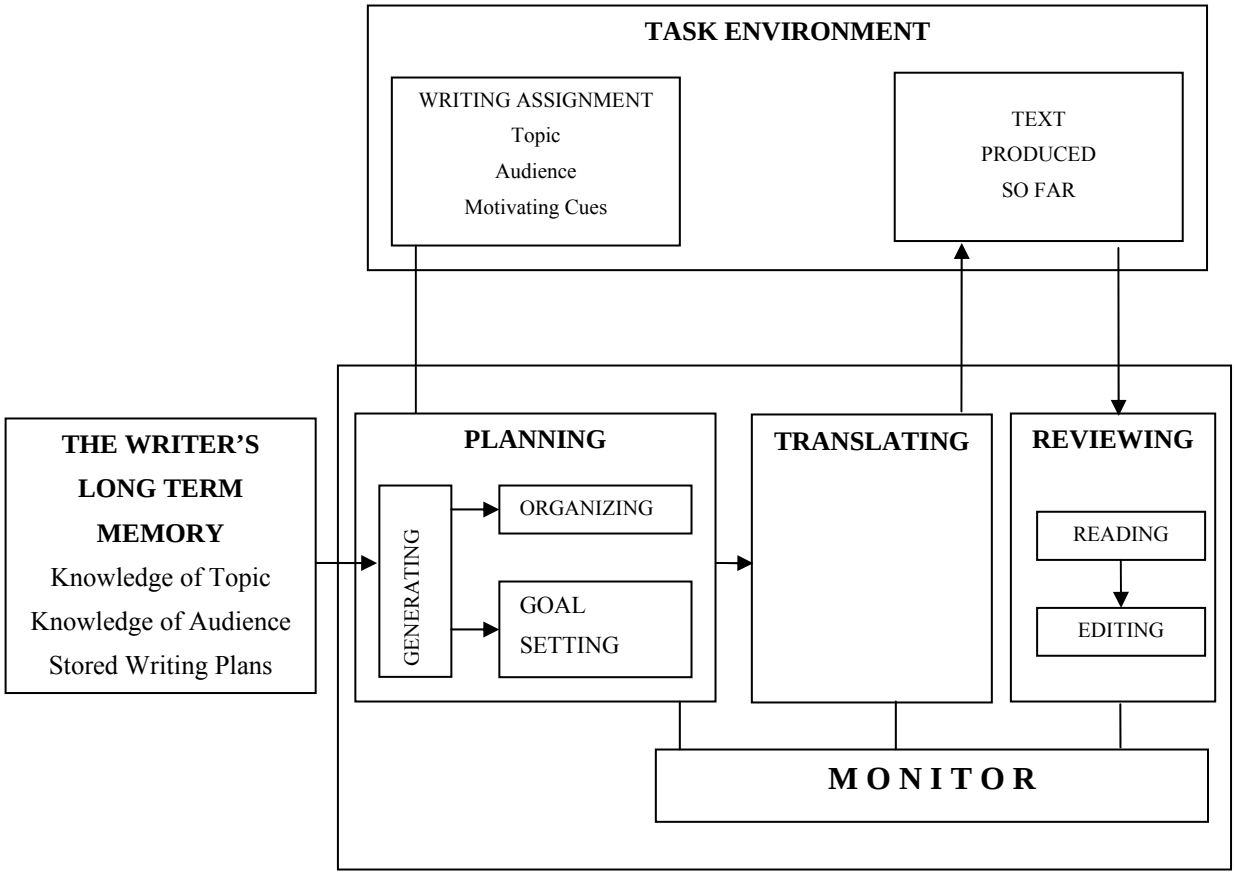

Figure 2. Hayes and Flower's writing process model. Adapted from "Identifying the Organization of Writing Processes," by J.R. Hayes and L.S. Flower, *Cognitive Processes of Writing,* p. 11. Copyright 1980 by Erlbaum.

Writing process. In their model, Hayes and Flower (1980) proposed that writing consists of three major processes: planning, translating, and reviewing. Within the

planning process, the task of the generating process is to retrieve relevant information from the long-term memory. Then, the organizing process allows the writer to choose the most useful information and create a writing plan, while the function of the goal-setting process is to identify and remember information (e.g., specific criteria for the writing project) to use later during the editing process. Within the translating process, the writer expresses concepts, relations, and attributes through complete sentences. Next, the reviewing process involves the tasks of reading and editing to improve the quality of the written text. Through review of the written material, the writer is able to systemically evaluate the text in relation to the writing goals and/or assignment criteria. The authors highlight that this model is not a linear one. Rather, it is recursive and allows for the complex and varying intermingling of processes.

Hayes' New Model of the Writing Process

Hayes (1996) elaborated on the 1980 Hayes and Flower model of the writing process. The new model updates the 1980 model, as according to Hayes, the new one is informed by empirical findings from the past 15 years. He acknowledges that this model is not intended to encompass and explain all aspects of writing in detail but rather, he expresses that, "it is like a building that is being designed and constructed at the same time" (p. 1). Although certain components have undergone several stages of development, others have just emerged from recent empirical findings and may be elaborated upon in the future. Hayes expresses that one of his objectives in presenting the new model is to provide a framework for researchers to utilize as they explore the process of writing.

Hayes discusses several differences in the models, but asserts that the most important difference between the two models is the new emphasis on the fundamental role of working memory in the writing process. Also, the abundance of visual-spatial and linguistic information present in many forms of literature has accounted for another important difference in the models. According to Hayes, the ability to understand visual-spatial components of literature is important for facilitating an understanding of the text. Another difference between the models is in the addition of the role of the writer's motivation and affect in the writing process. Finally, the cognitive process section has undergone major revision as explained below.

The new model (see Figure 3) has two major components: the task environment and the individual. Within the task environment are the social and physical environments. Hayes describes writing as a social activity as it serves as communication between people. The audience is highlighted as an important aspect of writing as it provides a context for writers and in many ways dictates how writers develop their composition. In addition, O'Donnell and colleagues (1985) demonstrated that current or previous writing collaboration can lead to improvement in subsequent individual writing performance (as cited in Hayes, 1980). The physical environment includes the text that has been produced by the writer so far and the writing medium (e.g., word processor). As the writer develops a composition, he or she re-reads what has been written so far to shape what will be written next. In addition, the writing medium is important to consider, as it compromises or promotes many of the processes involved in writing. Hayes offers the example that, while one medium is not necessarily better than the other, it is much easier to sketch out an idea if the writer is using the pen and paper medium versus a word

processor; however, word processors make it easier for the writer to move text, check spelling, and change spacing as compared to the pen and paper method.

The motivation and affect component are new to the model and according to Hayes, are affected by the writer's individual goals, predispositions, beliefs and attitudes, and cost/benefit estimate. There are a number of studies which examine the role of motivation and affect in the writing process (e.g., Bruning & Horn, 2000); however, for the purposes of this study, these were not explored. Finally, Hayes renamed the cognitive processes of planning, translating, and reviewing to text interpretation, reflection, and text production. Text interpretation allows the writer to take in information through reading, listening, or visually scanning in order to create an internal representation of the information. Reflection involves the writer making internal representations from other internal representations through problem-solving, inference, and decision-making. Last, text production involves moving internal representations to written, spoken, or graphic form.

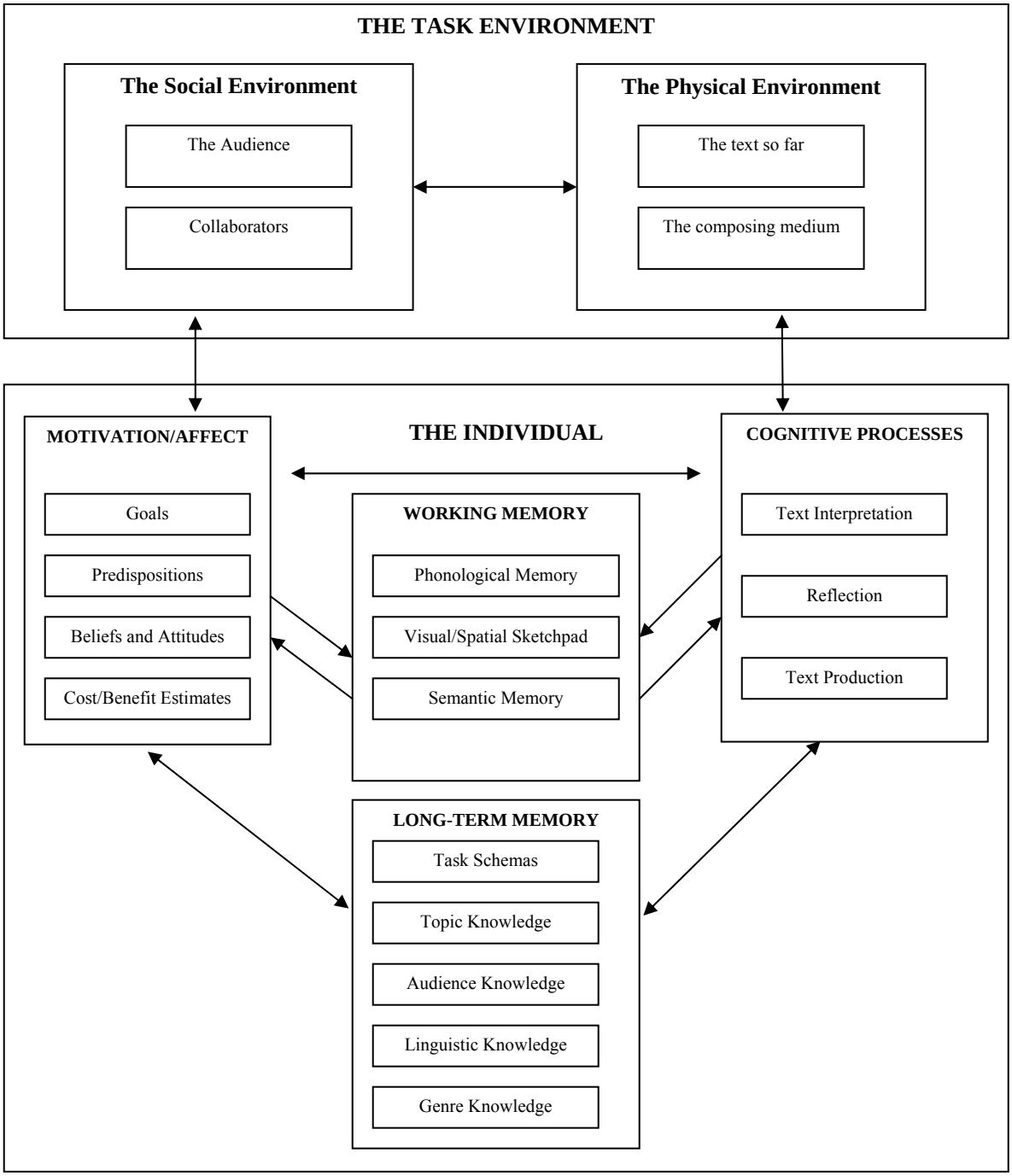

Figure 3. Hayes' new writing process model. Adapted from "A new framework for understanding cognition and affect in writing" by J.R. Hayes. In C.M. Levy & S. Ransdell (Eds.), *The Science of Writing: Theories, Methods, Individual Differences, and Applications.* Copyright 1996 by Erlbaum.

Summary of Research and Statement of the Problem

Research in the areas of ADHD and written expression highlight executive function as playing a central role in each. This research provides a foundation for which to explore empirically the link between ADHD and written expression. More specifically, how do the deficits in executive function associated with ADHD impact the writing abilities of college students? Research has not yet answered this question; however, related research provides a starting point for the present study.

Executive function has been found to be impaired in individuals with ADHD. Several measures of executive function discriminated consistently across studies comparing adults with ADHD and adults without ADHD. When considering the models of the writing process from both cognitive and neuropsychology perspectives, the consistent emphasis of executive function in this process is striking. It follows, then, that for individuals with reduced abilities in executive function (e.g., those with ADHD), writing abilities would be compromised. Because writing skills are increasingly emphasized throughout education, it is important to look at how college students with ADHD perform on an academic task that calls on executive processes, written expression. Although the aforementioned findings provide a foundation for research, these studies have limitations that are important to consider as research progresses in this area.

The majority of research in the neuropsychology of ADHD has focused on children and adolescents; however, more recently, there has been an increase in studies that focus on adults. Unfortunately, most of these studies utilized clinically-referred samples and as a result, less is understood about the ADHD college population. Thus,

research on the ADHD college population is warranted. In addition, many studies have included ADHD participants diagnosed with comorbid conditions which have made it difficult to understand the underlying condition which contributed to observed behavioral manifestations. As mentioned previously in this chapter, more than half of adults with ADHD have also received a comorbid psychiatric diagnosis such as a mood disorder, anxiety disorder, substance use disorder, learning disorder, or behavior disorder (Spencer et al., 1998). Also, it is estimated that 35% to 50% of individuals diagnosed with ADHD are also diagnosed with a learning disability (Barkley, 1998). Research samples should include ADHD participants without co-morbid conditions. Additionally, the presentation of ADHD is heterogeneous and individuals may experience different symptoms of the disorder (Rowland, Lesesne, & Abramowitz, 2002). Most research looking at ADHD involves a dichotomous variable (e.g., ADHD or non-ADHD). Research should consider the symptoms present for each participant including the number, frequency, and nature of symptoms and how those relate to variables under investigation.

Description of Present Study

The present study explored the relation between executive functions and writing abilities among college-level writers with the purpose of answering the following: Do executive function deficits associated with ADHD compromise written expression abilities at this developmental stage? College students with and without ADHD were recruited to participate in the study. Exclusionary criteria for the ADHD sample included the presence of severe psychopathology, learning disability, or history of traumatic brain injury. Participants in the ADHD group who were on medication were asked to go off of their medication the day of the study. Each participant completed four

neuropsychological measures of executive function which purport to measure planning, inhibition, working memory, and verbal fluency. In addition, participants were tested on written expression abilities. Participants also completed a self-report checklist of ADHD symptoms which provided a continuous, rather than a dichotomous, variable in order to account for the number and frequency of each participant's symptoms. The ADHD and non-ADHD groups were compared on performance on executive function and written expression measures. Additionally, performance on executive function measures was used to predict written expression abilities.

CHAPTER 3

Method

Participants

Participants for the present study were drawn from a large state-supported university in the southwest with comprehensive undergraduate, graduate, and professional programs. Approximately 50,000 students are enrolled each year. Participants recruited for the study included 58 undergraduate university students, 20 males and 38 females. Two groups of students, ages 19 to 28 years, were recruited for this study. Group one consisted of 31 students, including 21 students registered for disabilities services through the Services for Students with Disabilities (SSD) office with documentation of an attention deficit hyperactivity disorder (ADHD) and 10 students with a self-reported diagnosis of ADHD recruited through the Educational Psychology Department subject pool. Exclusionary criteria included students with co-morbid ADHD and learning disability, with the exception of a learning disability in written expression, history of head injury, and/or severe psychopathology (e.g., major depression, anxiety disorder).

Group two consisted of 27 students recruited through the Educational Psychology Department subject pool. Students from the subject pool were enrolled in an Educational Psychology course in which they receive course credit for participating in a research study. Group two was limited to students with no history of head injury, attention deficit hyperactivity disorder, learning disability, or severe psychopathology (e.g., major depression, anxiety disorder). Students were screened through a series of questions required for participation in departmental research. English was the primary language for

all participants. Demographic information for the sample is presented by group in Table 1 and includes sex, age, ethnicity, classification, years in college, academic probation history, Services for Students with Disabilities (SSD) registration, and medication status.

Table 1

Sample Population Demographic Data by Group (N = 58)

Demographic	ADHD (n = 31)	Control (n = 27)
	n (%)	
Sex		
Male	14 (45.2)	6 (22.2)
Female	17 (54.8)	21 (77.8)
Age		
19	3 (9.7)	1 (3.7)
20	4 (12.9)	4 (14.8)
21	14 (45.2)	12 (44.4)
22	7 (22.6)	8 (29.6)
23	2 (6.5)	1 (3.7)
24	0 (0.0)	1 (3.7)
28	1 (3.2)	0 (0.0)
Ethnicity		
White	26 (83.9)	19 (70.4)
African American	3 (9.7)	5 (18.5)
Latino	1 (3.2)	3 (11.1)
Asian American	1 (3.2)	0 (0.0)

Classification		
Sophomore	5 (16.1)	1 (3.7)
Junior	6 (19.4)	8 (29.6)
Senior	20 (64.5)	18 (66.7)
Years in College		
2	4 (12.9)	1 (3.7)
3	11 (35.5)	11 (40.7)
4	13 (41.9)	11 (40.7)
5	2 (6.5)	4 (14.8)
6	1 (3.2)	0 (0.0)
Academic Probation History		
Yes	6 (19.4)	4 (14.8)
No	25 (80.6)	23 (85.2)
SSD Registration		
Yes	21 (67.7)	0 (0.0)
No	10 (32.3)	27 (100.0)
Medication		
Yes	23 (74.2)	0 (0.0)
No	8 (25.8)	27 (100.0)
Medication Day of Study		
Yes	6 (19.4)	0 (0.0)
No	17 (54.8)	27 (100.0)

Measures

Delis-Kaplan Executive Function System Tower Test

The Delis-Kaplan Executive Function System (D-KEFS; Psychological Corporation, 2001) Tower Test was administered to participants to measure planning and problem-solving ability. This test was modeled after previous measures (e.g., Tower of Hanoi, Tower of London). The test includes five disks that range in size and a wooden base with three vertical pegs. Subjects are asked to build towers displayed in a diagram of the tower by using the fewest moves possible, moving only one disk at a time, and avoiding placing a larger disk on top of a smaller one. Raw scores are based on the total number of moves used to build the series of towers. These scores were converted to scaled scores. Low scores on this measure may indicate poor planning. Split-half reliability was found to be .60 for the 16-19 year age group and .62 for the 20-29 year age group.

Delis-Kaplan Executive Function System Color-Word Interference Test

The Delis-Kaplan Executive Function System (D-KEFS; Psychological Corporation, 2001) Color-Word Interference Test was administered to participants to measure the executive function of response inhibition. This test was modeled after the Stroop Word-Color Naming Test (Golden, 1978). This task requires the subject to quickly name the ink colors of printed words which are the names of colors other than the color of the printed text. For example, the word "blue" may be written in red text. The subject must resist reading the word, "blue" and give the response "red" to indicate the color of the text. Scores are calculated based on the number of correct responses within a certain time limit. The overall test-retest reliability was found to be .75.

Controlled Oral Word Association

The Controlled Oral Word Association (COWA; Benton & Hamsher, 1976) test was administered to measure verbal fluency or speeded lexical production. This test provides information about the efficiency of the participant's lexical organization (Dunn, Gomes et al., 1996). Additionally, this task requires additional aspects of executive function such as inhibition, self-monitoring, initiation, and shifting abilities (Mahone, Cirino et al. 2002). This measure evaluates the spontaneous production of words beginning with a given letter within a limited amount of time. The subject is asked to produce orally as many words as possible which begin with a given letter. Three letters are given in the measure and they receive one minute per letter to orally produce the words. This test takes approximately 5 to 10 minutes to administer. Scores are calculated by adding all admissible words for the three letters. Retest reliability in adults after 19 to 42 days was found to be .88.

California Verbal Learning Test

The purpose of the California Verbal Learning Test (CVLT; Delis et al., 1987) is to measure strategies and processes involved in the learning and memory of verbal material. Subjects are asked to recall a list of 16 stimulus words over 5 trials. The examiner then presents the subject with an interference list which is followed by a free recall of the first list. Then, there is a 20 minute delay after which the subject is asked to recall the 16 stimulus words from the first list. Multiple scores are yielded on this measure; however, for the purposes of this study the t-score for the first five trials was used, as it has been shown in the literature to discriminate between adult ADHD and non-ADHD groups (Hervey, Epstein, & Curry, 2004). Alternate form reliability coefficients

for the traditional recall measures of the CVLT were robust (e.g., List A Total Trials 1-5 index r = .84).

Scholastic Abilities Test for Adults – Writing Mechanics & Writing Composition

The Scholastic Abilities Test for Adults (SATA; Bryant, Patton, & Dunn, 1991) is an academic achievement test for adults. The Writing Mechanics subtest assesses skills in spelling, capitalization, and punctuation. The Writing Composition subtest requires the subject to write a creative story based on a set of pictures. The composition is checked for both vocabulary and thematic content. These two subtests make up a composite score called the Writing Quotient which was used for the purposes of this study. Test-retest reliability for the Writing Mechanics subtest was .88 while the test-retest reliability for the Writing Composition subtest was .66. The overall Writing Quotient test-retest reliability was found to be .85.

Scholastic Aptitude Test

The Scholastic Aptitude Test (SAT I; College Entrance Examination Board, 2002) is a measure of aptitude accepted by more than 80% of U.S. colleges and universities. The SAT I is a three-hour test that measures verbal and mathematical reasoning skills. The verbal section assesses abilities in passage-comprehension, vocabulary, understanding analogies, and sentence completion. The math section measures mathematical problem solving and includes arithmetic, algebra and geometry problems. Generally, the measure contains items which require critical thinking and problem-solving skills necessary for higher education curriculum. Scores for the SAT I range from 200 to 800 for each section. Typical internal consistency reliability coefficients were found to exceed .90. The SAT Verbal score was used to control for the

verbal aptitude of participants. For students who took the ACT only, a concordance table was used to predict the SAT Verbal score from the ACT English and Reading scores (Dorans, 1999). This procedure was applied for 2 participants (6.9%) in the current study.

Adult ADHD Self-Report Scale (ASRS) Symptom Checklist

The Adult ADHD Self-Report Scale (ASRS; Adler, Kessler, & Spencer, 2003) is an 18-item rating scale created for adults from the DSM-IV symptom list for ADHD. Nine of the items reflect criteria for ADHD – Predominately Inattentive Type and nine of the items reflect criteria for ADHD – Predominately Hyperactive Type. Each of the items is rated on a 0 to 4 scale. The 5-point scale includes the choices never, rarely, sometimes, often, or very often. Scores are added individually for inattentive items, hyperactive items, and total items. These scores reflect the number and frequency of symptoms.

Procedure

Approval by the Human Subjects Committee

This study was in adherence with the ethics and standards of research presented by the American Psychological Association and the University of Texas at Austin. A research proposal and appropriate materials were submitted to the Department Review Committee within the Department of Educational Psychology and the Institutional Review Board of the University of Texas at Austin. Also, the primary researcher completed the certification training required by the Institutional Review Board.

Approval by the Services for Students with Disabilities Office

This study followed the Services for Students with Disabilities office's rules and guidelines concerning this type of research. Prior to the recruitment of participants and collection of data, the research proposal was submitted for approval by Student Affairs Administrators. Once the study was approved, the primary researcher coordinated with the Services for Students with Disabilities' Assistant Dean of Students to recruit participants and collect data.

Recruitment of Participants

To recruit members for the ADHD group, a recruitment letter (see appendix A) was sent via email to students registered with the Services for Students with Disabilities Office who are diagnosed with ADHD. The letter described the study and invited students to participate. The letter also explained that the student's decision to participate or not in no way influenced or compromised his or her relationship with the Services for Students with Disabilities office. Compensation for participation was described. Participants in the ADHD group recruited from the Services for Students with Disabilities office received $10.00 in cash. The letter instructed those who chose to participate to contact the primary researcher by either email or telephone. At the time of initial contact, the primary researcher asked students to respond to brief screening questions to determine if they met criteria for participation. Additionally, participants were asked if they were currently taking medication to treat symptoms of ADHD. The primary researcher requested that those students on medication go off their medication on the day of the study. Frequency data regarding medication status can be found in Table 1 above.

For students who met criteria, a one time, one-hour appointment was scheduled for study participation. Additional members of the ADHD group and the non-ADHD control group were recruited through the Department of Educational Psychology subject pool. Participants from the subject pool received course credit in an educational psychology course.

Data Collection

Data collection took place on the university's campus at the George I. Sanchez Building. The primary researcher conducted all assessment measures throughout the study. Once the appropriate consent forms (see Appendix B, Appendix C, and Appendix D) were collected, the primary researcher administered the battery of tests for this study. Executive function and written expression achievement measures were individually administered to participants. Testing lasted approximately one hour for each participant.

Participants were given the opportunity to authorize the primary researcher to access SAT scores either through the Services for Students with Disabilities office or the Office of the Registrar. The majority of participants provided authorization; however, some participants chose to self report scores. Scores for students who transferred to the University from another college or university could not be accessed in any university record, as they are not required for university admission. These participants also provided self report of scores. Five participants (16.6%) provided self report of SAT scores. For students who had taken the ACT only, a concordance table was used to predict SAT Verbal and Mathematics scores from participants' individual ACT scores (Dorans, 1999). Students who had not taken either the ACT or SAT were excluded from the study.

Data Analyses

Hypothesis 1

Hypothesis 1a. College students with ADHD will have significantly lower scores than students without ADHD on all four measures of executive functions.

Hypothesis 1b. College students with ADHD will have significantly lower scores than students without ADHD on a measure of written expression.

Rationale. Research has established that adults with ADHD experience difficulty in tasks which involve executive functions (Hervey, Epstein, and Curry, 2004), which researchers conceptualize as necessary for the successful progression through the writing process (Hayes, 1996; Kellogg, 1996; McCutchen, 1996). Moreover, individuals with ADHD have been found to be at greater risk for academic underachievement (Faigel, 1995). Difficulty in written expression has been found to be common among individuals with cognitive disabilities including learning disabilities and ADHD (Gregg, 1986; Smith, 1993).

Data Analysis. A multivariate analysis of variance (MANOVA) was used to determine if there was a statistically significant difference between the ADHD and non-ADHD groups on executive function measures (D-KEFS Tower Test, D-KEFS Color-Word Interference Test, COWA, and CVLT) and/or performance on a measure of written expression (SATA Writing Quotient). These scores were compared between groups. The results of the MANOVA were examined to determine if there were statistically significant differences between groups.

Hypothesis 2

Executive functioning tasks (e.g., inhibition, planning, working memory, and verbal fluency) will account for a significant portion of the variance of written expression as measured by the SATA writing quotient for both groups while controlling for aptitude and disability status.

Rationale. Many researchers theorize that executive functions such as planning, attention, organization, and self-regulation play an essential role in the process of writing (Hayes, 1996; Kellogg, 1996; McCutchen, 1996). Research has shown that individuals with compromised executive functions have difficulty with written expression (Gregg, 1986; Smith, 1993). Thus, it is hypothesized that performance on executive function tasks would significantly predict writing ability.

Data Analysis. A standard multiple regression analysis was conducted to determine how much of the variance in written expression is explained by executive function tasks when controlling for verbal aptitude and ADHD status. The variables, D-KEFS Tower Test, D-KEFS Color-Word Interference Test, COWA, CVLT, ASRS Checklist, and SAT Verbal score, were simultaneously entered into the multiple regression equation as predictors of the SATA Writing Quotient. Standardized regression coefficients for each variable were examined to determine the contribution of each variable within the model.

CHAPTER 4

Results

The present study was developed to investigate the link between executive functions and written expression abilities among college students. The present research will also contribute to the existing literature related to the construction of a neuropsychological profile of adult ADHD. Additionally, the study provides a step toward a more in depth understanding of the academic functional impact of ADHD to inform intervention and support services for college students with ADHD. This study examined the relation between college students' performance on executive function tasks and a written expression measure. This section details the findings of the analyses presented in the previous chapter. Descriptive statistics are presented first, followed by preliminary analyses. The next section includes the results for each hypothesis and exploratory analyses. The final section summarizes of the results.

Descriptive Statistics

Descriptive statistics are presented by group in Table 2 and include means and standard deviations for each measure. Statistics are presented for the Controlled Oral Word Association (COWA), California Verbal Learning Test (CVLT), Delis Kaplan Executive Function System Color-Word Interference Test Condition 3 (DKEFS CWI 3), Delis Kaplan Executive Function System Tower (DKEFS Tower), Scholastic Abilities Test for Adults Writing Mechanics (SATA WM), Writing Composition (SATA WC) and Writing Quotient (SATA WQ), Scholastic Aptitude Test (SAT), Verbal and Mathematics, and Adult ADHD Self Report Scale (ASRS) Symptom Checklist.

Table 2

Means and Standard Deviations of Measures by Group (N = 58)

Measure	ADHD (n = 31)		Control (n = 27)	
	M	SD	M	SD
COWA[a]	-0.71	.75	-0.81	.75
CVLT[b]	50.6	11.4	46.1	8.7
DKEFS CWI 3[c]*	12		11	
DKEFS Tower[d]	11.5	2.3	10.6	2.5
SATA WM[e]	10.23	2.0	9.89	2.19
SATA WC[f]	9.4	2.6	10.6	2.7
SATA WQ[g]	98.7	11.9	101.6	12.8
SAT Verbal	574.8	84.6	559.3	62.1
SAT Mathematics	612.3	63.7	547.4	69.3
ASRS Checklist[h]	41.6	9.1	25.7	6.4

[a]Controlled Oral Word Association
[b]California Verbal Learning Test-II
[c]Delis-Kaplan Executive Function System Tower Test
[d]Delis-Kaplan Executive Function System Color-Word Interference Test Condition 3
[e]Scholastic Abilities Test for Adults Writing Mechanics
[f]Scholastic Abilities Test for Adults Writing Composition
[g]Scholastic Abilities Test for Adults Writing Quotient
[h]Adult ADHD Self Report Scale Symptom Checklist
* Medians reported for skewed variable

Preliminary Analyses

Individual t-tests were used to determine if there were significant differences present between participants in mean performance of executive function tasks, written expression measures, SAT Verbal, and SAT Mathematics based on sex. Significant mean differences were found between male and female participants on the SAT Mathematics score with males outperforming females on this measure (mean difference [95% C.I.] = 61.0 [23.4, 98.5], $p = .002$). No other significant differences were found across executive function measures, written expression measures, or SAT Verbal based on sex.

Individual t-tests were used to test for differences between groups on normally distributed variables (SAT Verbal, SAT Mathematics, DKEFS Tower, COWA, CVLT, SATA Writing Mechanics, SATA Writing Composition, SATA Quotient, and ASRS Checklist). The ADHD group had significantly higher SAT Mathematics scores than the control group (mean difference [95% C.I.] = 64.9 [29.9, 99.8], $p \leq .0001$). Individual t-tests were also used to compare SAT Verbal and SAT Mathematics scores with SAT scores that were converted from ACT scores. No significant mean differences were found. In addition, the ADHD group had significantly higher ADHD self-report scores, reflecting number and frequency of ADHD symptoms, than the control group (mean difference [95 C.I.] = 15.9 [11.7, 20.1], $p = \leq.0001$). The ADHD group had marginally significantly lower SATA Writing Composition scores than the control group (mean difference [95% C.I.] = -1.24 [-2.64, 0.17], $p = .08$). There were no other significant mean differences found in the other continuous variables between ADHD and control groups. For the skewed variable, DKEFS CWI 3, non parametric tests (e.g., Mann

Whitney) were used to compare median differences. Results showed no significant median differences on this variable. A quadratic formation was conducted on the DKEFS CWI 3 variable to fulfill the assumption of normality for conducting the multivariate analysis of variance (MANOVA).

Due to small expected frequencies, Fisher's Exact Tests were used to test for differences in categorical variables (sex, ethnicity, classification, history of academic probation, and SAT self-report) between the ADHD and control groups. Fisher's exact probabilities indicated no significant relationships between sex (p = .10), ethnicity (p = .33), classification (p = .27), history of academic probation (p = .74), and SAT self-report (p = .36) and group. Additionally, an individual t-test did not show significant differences in years of college based on group.

Results of Test of Hypotheses

Hypothesis 1a and 1b

Hypothesis 1a predicted that college students with ADHD will have significantly lower scores than students without ADHD on all four measures of executive functions (DKEFS Tower, DKEFS CWI 3, COWA, and CVLT). Hypothesis 1b predicted that college students with ADHD will have significantly lower scores than students without ADHD on a measure of written expression (SATA Writing Quotient). A one-way between-groups multivariate analysis of variance (MANOVA) was conducted to investigate differences in written expression and executive function abilities between the ADHD and control groups. Five dependent variables were used: DKEFS Tower, COWA, DKEFS CWI 3, CVLT and SATA Writing Quotient. The independent measure was group (e.g., ADHD or control). Preliminary assumption testing was conducted. The

variable DKEFS CWI 3 was found to be skewed and thus, violates the assumption of normality. A quadratic transformation was used to fulfill the assumption of normality. The results of the one-way between-groups MANOVA showed no statistically significant differences between groups on the combined dependent variables, multivariate $F(5, 52) = 1.19$, $p = .33$. Therefore, this hypothesis was not confirmed.

Hypothesis 2

It was predicted that executive function tasks would account for a significant portion of the variance of written expression as measured by the SATA Writing Quotient for both groups when controlling for aptitude and disability status. The variables DKEFS CWI 3, COWA, CVLT, DKEFS Tower, SAT Verbal, and ASRS Checklist score were entered simultaneously as predictors of the SATA Writing Quotient in a multiple regression equation. The overall equation for the model was not significant for predicting the SATA Writing Quotient for this sample (F (6, 51) = 1.607, $p = .164$). Data are presented in Table 3. The t- tests of the standardized multiple regression coefficients were not significant for DKEFS CWI 3 ($B = .249$, $t = 1.696$) COWA ($B = .188$, $t = 1.188$), CVLT ($B = -.083$, $t = -.592$), DKEFS Tower ($B = .037$, $t = .270$), SAT Verbal ($B = .091$, $t = .577$), and ASRS Checklist ($B = -.080$, $t = -.608$). The variables in the model accounted for 15.9% of the variance in the SATA Writing Quotient. Thus, this hypothesis was not confirmed.

Table 3

Simultaneous Regression for Variables Predicting the SATA Writing Quotient

Predictor	*B*	SEB	Beta	*t*	*p*
DKEFS CWI 3	1.156	.682	.249	1.696	.096
COWA	3.114	2.621	.188	1.188	.240
CVLT	-.099	.166	-.083	-.592	.556
DKEFS Tower	.189	.701	.037	.270	.788
SAT Verbal	.015	.026	.091	.577	.566
ASRS Checklist	-.088	.144	-.080	-.608	.546

Note: $R^2 = .159$

Exploratory Analyses

Additional analyses were run to attempt to more fully understand the results reported above. These analyses were utilized to create a distinction between the individual components of the SATA Writing Quotient, Writing Mechanics and Writing Composition. Caution is required in their interpretation, as running additional analyses increases the chance of a Type I error, or falsely rejecting the null hypothesis (Miles & Shevlin, 2001).

The variables DKEFS CWI 3, COWA, CVLT, DKEFS Tower, SAT Verbal, and ASRS Checklist were entered simultaneously in a multiple regression equation as predictors of the SATA Writing Composition. The overall equation for the model was not significant for predicting SATA Writing Composition for this sample (F (6, 51) = .702, p = .649). Data are presented in Table 4. The t- tests of the standardized multiple

regression coefficients were not significant for DKEFS CWI 3 (B = .161, t = 1.047) COWA (B = .126, t = .756), CVLT (B = -.080, t = -.544), DKEFS Tower (B = -.079, t = -.544), SAT Verbal (B = .013, t = .081), and ASRS Checklist (B = -.158, t = -1.144). The variables in the model accounted for 7.6% of the variance in SATA Writing Composition.

Table 4

Simultaneous Regression for Variables Predicting the SATA Writing Composition

Predictor	*B*	SEB	Beta	*t*	*p*
DKEFS CWI 3	.165	.158	.161	1.047	.300
COWA	.458	.606	.126	.756	.453
CVLT	-.021	.038	-.080	-.544	.589
DKEFS Tower	-.088	.162	-.079	-.544	.589
SAT Verbal	.000	.006	.013	.081	.936
ASRS Checklist	-.038	.033	-.158	-1.144	.258

Note: R^2 = .076

Finally, the variables DKEFS CWI 3, COWA, CVLT, DKEFS Tower, SAT Verbal, and ASRS Checklist score were entered simultaneously as predictors of SATA Writing Mechanics in a multiple regression equation. The overall equation for the model was significant for predicting SATA Writing Mechanics for this sample (F (6, 51) = 3.616, p = .005). Data are presented in Table 5. The t- test of the standardized multiple regression coefficients was significant for the variable DKEFS CWI 3 (B = .285, t = 2.127). Thus, the variable, DKEFS CWI 3, makes a statistically significant unique

contribution to the prediction of SATA Writing Mechanics within this model. The t-tests of the standardized multiple regression coefficients were not significant for COWA (*B* = .200, *t* = 1.383), CVLT (*B* = -.072, *t* = -.564), DKEFS Tower (*B* = .168, *t* = 1.336), SAT Verbal (*B* = .167, *t* = 1.160), and ASRS Checklist (*B* = .064, *t* = .528). The variables in the model accounted for 29.8% of the variance in the SATA Writing Mechanics scores.

Table 5

Simultaneous Regression for Variables Predicting the SATA Writing Mechanics

Predictor	*B*	SEB	Beta	*t*	*p*
DKEFS CWI 3	.223	.105	.285	2.127	.038
COWA	.559	.404	.200	1.383	.173
CVLT	-.014	.026	-.072	-.564	.575
DKEFS Tower	.144	.108	.168	1.336	.188
SAT Verbal	.005	.004	.167	1.160	.252
ASRS Checklist	.012	.022	.064	.528	.600

Note: $R^2 = .298$

Summary

The purpose of the present study was to investigate the relation between executive functions and written expression in college students with ADHD. Results from preliminary analyses showed significant mean differences between male and female participants within the ADHD group on the SAT Mathematics score with males outperforming females on this measure (mean difference [95% C.I.] = 61.0 [23.4, 98.5], *p* = .002). Additionally, the ADHD group had significantly higher SAT Mathematics

scores than the control group (mean difference [95% C.I.] = 64.9 [29.9, 99.8], $\underline{p} \leq .0001$). The ADHD group had marginally significant lower SATA Writing Composition scores than the control group (mean difference [95% C.I.] = -1.24 [-2.64, 0.17], $\underline{p} = .08$). Results showed that student self report of ADHD symptoms was strongly associated with ADHD group (mean difference [95 C.I.] = 15.9 [11.7, 20.1], $\underline{p} = \leq .0001$).

Testing of hypotheses 1a and 1b showed no significant differences between groups on measures of executive function (DKEFS CWI 3, DKEFS Tower, COWA, and FAS) or the SATA Writing Quotient ($F(5, 52) = 1.19$, $p = .33$). Investigation of hypothesis 2 showed that the model for predicting the SATA Writing Quotient was not significant. Additionally, t-tests of the standardized multiple regression coefficients were not significant.

To more fully understand the relationship between executive functions and written expression, additional exploratory analyses were run which separated the SATA Writing Quotient into its individual parts, Writing Composition and Writing Mechanics. Results showed that executive function measures, SAT Verbal, and ADHD self-report were not significant for predicting the SATA Writing Composition scores (F (6, 51) = .702, $p = .649$). The t-tests of the standardized multiple regression coefficients were not significant. Executive function measures, SAT Verbal, and ASRS Checklist were significant for predicting the Writing Mechanics scores (F (6, 51) = 3.616, $p = .005$). The t-tests for the standardized multiple regression coefficients were significant for only executive function measure, DKEFS CWI 3 ($B = .285$, $t = 2.127$). This variable makes a statistically significant unique contribution to explaining the variance in the SATA Writing Mechanics scores within the model.

CHAPTER 5

Discussion

The results and implications of the present study are discussed in detail in this chapter. The chapter begins with a presentation of the results of the study organized by hypothesis. This section includes additional findings of the study which were not part of the hypotheses. Findings are discussed in the context of past literature. Next, implications for research, methodology, and practice are discussed. Finally, limitations of the present study and directions for future research are presented.

Summary of Results

Hypothesis 1a and 1b

The first hypothesis of the present study predicted that college students diagnosed with ADHD would have significantly lower scores than non-ADHD controls on four measures of executive functions. These executive function measures purport to measure verbal fluency, planning and organization, inhibition, and memory. Past research has established that adults with ADHD exhibit cognitive impairment in attention, information processing speed, executive functioning, learning and memory (Epstiein, et al., 1997; Epstein, et al., 1998; Jenkins et al., 1998; Murphy, Barkley, & Bush, 2001; Hervey, Epstein, and Curry, 2004). Moreover, according to Wasserstein and colleagues (2001), executive function problems tend to increase in adulthood.

Hypothesis 1b predicted that college students in the ADHD group would have significantly lower scores on a measure of written expression than their non-ADHD counterparts. The measure of written expression used to test this hypothesis provides a quotient score which combines students' performance on writing mechanics (e.g.,

spelling, capitalization, and punctuation) and writing composition wherein aspects of compositional writing such as vocabulary, sequencing of events, and passage length are evaluated. Previous research has established that students with cognitive disabilities, including ADHD and learning disabilities, have shown particular difficulty in the area of written expression (Gregg, 1986; Smith, 1993). Additionally, executive processes, which are compromised for individuals with ADHD, are necessary for the successful progression through the writing process (Hayes, 1996; Kellogg, 1996; McCutchen, 1996). Results showed no differences between the ADHD and non-ADHD control groups on performance of verbal fluency, planning and organization, inhibition, and memory tasks. Additionally, no differences were found between the ADHD and non-ADHD control groups on the combined performance of writing mechanics and writing composition.

Hypothesis 2

The second hypothesis predicted that, for both groups (e.g., ADHD and non-ADHD control), four measures of executive function would account for a significant portion of the variance in the combined performance on writing mechanics and writing composition, when controlling for verbal aptitude and the number and frequency of ADHD symptoms. Verbal aptitude was measured by SAT Verbal scores and the number and frequency of ADHD symptoms was measured using the Adult ADHD Self-Report Scale (ASRS) Symptom Checklist. Researchers have conceptualized the writing process to involve many executive processes such as planning, self-regulation, inhibition, working memory, and sustained attention (Denckla, 1996; Pennington, 1997). A standard multiple regression model including executive function measures, verbal aptitude, and ADHD symptoms was not significant for predicting combined writing

mechanics and writing composition. Additionally, individual measures were not significant for predicting written expression in the model.

Exploratory Analyses

Additional analyses were conducted to gain a better understanding of the results discussed above. Standard multiple regression models were used to predict each of the components which make up the SATA Writing Quotient, Writing Composition and Writing Mechanics, from executive function measures while controlling for verbal aptitude and ADHD symptoms. Results showed that the model was not significant for predicting SATA Writing Composition; however, the model was significant for predicting SATA Writing Mechanics. In addition, a measure of inhibition, Delis-Kaplan Color-Word Interference Condition 3, was found to make a statistically significant contribution to the prediction of SATA Writing Mechanics in this model.

Although a consensus on the role of executive functions in the writing process is lacking, many scholars have articulated the importance of inhibition in this process (Denckla, 1996; Pennington, 1997). Additionally, the ability to self-regulate has been highlighted as an important function of the writing process (Graham & Harris, 2000). Self-regulation involves planning, monitoring, evaluating, and revising (Scardamalia & Bereiter, 1985). Skilled writers must continuously self-regulate and maintain attentional control (Kellogg, 1987; Ransdell & Levy, 1996; Scardamalia & Bereiter, 1986). In this study, both the inhibition and writing mechanics tasks required self regulation and careful attention to detail. On the inhibition task, the participant was required to name the color of the ink rather than the more salient printed text. On the SATA Writing Mechanics task, the participant had to attend to the details of the text which provided clues for

determining the appropriate responses. For example, the participant was asked to fill in the blank of a sentence using words provided by the examiner and for several items, the spelling of the word depended on the context of the sentence. Also, the participant had to carefully read each sentence to determine the appropriate placement of capitalization and punctuation. Thus, the association found between inhibition and writing mechanics in the present study appears to be consistent with previous literature on the writing process and provides a compelling link between research on the writing process and on ADHD.

Additional Findings

The present study yielded additional findings which were not part of the hypotheses discussed above. The ADHD group had significantly higher scores on a self-report measure of ADHD. The score from this measure is based on the number and frequency of symptoms reported by participants. This finding is not surprising given that adult ADHD is commonly diagnosed based on clinical interview and self-report behavioral checklists (Woods, Lovejoy, & Ball, 2002).

Two findings from the present study were related to the SAT Mathematics scores. Differences in mean performance on the SAT Mathematics measure were found based on sex with males outperforming females. Additionally, the ADHD group had significantly higher SAT Mathematics scores than the non-ADHD group. These findings are likely a product of sex differences in performance on the SAT Mathematics, as the control group had approximately 78% females (see Table 1) and past research has documented that college bound males tend to outperform females on the SAT Mathematics (Sappington & Topolski, 2005; Mollette, 2004; Maier & Casselman, 1970).

Implications of Findings

Findings from the present study have implications for higher education support services and for professionals working with college students with ADHD. An inhibition task was found to provide a significant unique contribution to the prediction of writing mechanics. Although no differences were found between groups on performance of executive function tasks, including the Delis Kaplan Color Word Interference Condition 3 task, deficits in the neuropsychological domains of attention and inhibition have been strongly linked to and consistently identified in individuals with ADHD (Douglas & Peters, 1979; Hervey, Epstein, & Curry, 2004; Woods, Lovejoy, & Ball, 2002). Moreover, performance on Stroop Color Word Interference tasks has consistently distinguished between ADHD adults and controls across studies (Hervey, Epstein, & Curry, 2004). Thus, it is important to consider this finding when working with college students with ADHD. Therapists and/or tutors may have students engage in tasks which target inhibition and attention to promote self-regulation and attention to detail. Additionally, it may be useful to target this neuropsychological domain for intervention prior to the college years.

The findings of the current study also have implications for higher education disability services. These findings support accommodations frequently provided to college students diagnosed with ADHD. For example, these students often receive extra time to complete exams or classroom assignments. The score for the inhibition task, the Delis Kaplan Color Word Interference test, is based on the time it takes the student to complete the trial. Thus, the more time it took the student to complete the inhibition task, the poorer their score on this task. Results from the study showed that performance on

this task predicted performance on a writing mechanics task. Although no differences were found between groups on the inhibition task, given that individuals with ADHD typically show deficits in this domain (Douglas & Peters, 1979; Hervey, Epstein, & Curry, 2004; Woods, Lovejoy, & Ball, 2002), extra time for exams and/or class work, particularly those which require a significant amount of writing, are likely appropriate for students with ADHD. Moreover, difficulty with inhibition likely makes it difficult to tune out extraneous environmental stimuli in order to focus in a classroom setting. Therefore, the accommodations frequently provided to college students with ADHD, a reduced distraction environment for exams and preferential seating near the front of the classroom, are also likely appropriate for this group.

Another accommodation often provided to students with learning disabilities or ADHD allows these students to make errors in writing mechanics without losing credit on the exam or assignment. The writing mechanics measure used in this study assessed students' abilities to spell and to insert appropriate punctuation and capitalization. This task requires careful attention to detail. Impulsivity on this task typically results in multiple omissions, reducing the score. Thus, an accommodation which allows students to make errors in writing mechanics without being penalized may be appropriate for individuals with ADHD. Alternatively, an accommodation which allows students to use a word processor to benefit from grammar and writing mechanics correction (Li and Hamel, 2003) may be beneficial to students with ADHD.

Limitations and Future Directions

Several limitations of the present study are related to the sample of students recruited. Much of the existing adult ADHD literature used to build a theoretical

framework for the present study is based on findings from clinically-referred samples, as research on college students with ADHD is lacking (Murphy & Barkley, 1996). Thus, many of the findings on adult ADHD may not generalize to an ADHD college student population. For example, executive function measures administered in these studies were sensitive in detecting differences between ADHD adults and controls. These measures may not be as sensitive among the college population possibly due to differences in higher overall cognitive abilities and/or other characteristics associated with this group. Additionally, it is estimated that 25% to 35% of students with ADHD do not graduate from high school (Barkley, 1990). Thus, a large portion of the adult ADHD population has been automatically filtered when evaluating college students with ADHD. Also, participants in the clinically-referred samples often had comorbid conditions unlike participants in the present study. Research should continue to investigate the ADHD college population in order to contribute to the limited literature in this area.

Because the sample for the present study was drawn from a large, state-supported university in the southwest, it is difficult to generalize findings across university populations and geographical regions. Future research should recruit college students from a variety of universities and colleges, including state-supported universities, community colleges, and private universities. Additionally, because admissions criteria, such as performance on standardized aptitude tests and high school grade point average, vary across colleges and universities, it is important to look across university populations with varying admissions criteria. Important to note, disability status does not play a role in the admissions process. Students with disabilities such as those diagnosed with ADHD must be otherwise qualified, or meet the same admissions requirements as their non-

disabled counterparts, to be admitted to an institute of higher education (Section 504 of the Rehabilitation Act, 1973). In 2004, first-time freshman admitted to the selected university in the southwest had an average SAT Verbal score of 603 and an average SAT Mathematics score of 627, above national SAT averages which were 508 and 518, respectively (UT Austin Measurement and Evaluation Center and The College Board, 2004). It is likely that students diagnosed with ADHD who are admitted to universities with more stringent admissions criteria have higher aptitudes and have developed effective strategies for coping with symptoms of ADHD.

Though there were no significant differences between groups based on classification, the majority of the present sample, approximately 66%, were classified as seniors. Future research should recruit a broader and more evenly distributed sample of students across classification status to provide a more complete picture of university students who are likely at different levels of writing ability. Additionally, the present study's sample had a female to male sex ratio of approximately 2:1. Male to female ratio estimates in the ADHD population are inconsistent and have been reported to be from 4:1 to 9:1 (American Psychiatric Association, 1994) and as low as 2.1:1 (Szatmari, 1992). Future research should strive to recruit equal numbers of males and females.

The majority of the ADHD participants, approximately 68%, were recruited from the Services for Students with Disabilities (SSD) office. Students who register with the SSD office and access services must be effective self advocates. Additionally, to be approved for services, students must provide documentation of disability by completing an evaluation with a psychologist or psychiatrist. The majority of students registered for SSD services were on medication to treat symptoms of ADHD. It is possible that ADHD

participants registered for SSD services may have access to more resources and may be more effective self-advocates than those students who are not receiving services and/or treatment for ADHD. It is important to consider the possible ways in which the individual characteristics of participants may have contributed to the findings of the present study.

A strength of the present study was the inclusion of a self-report measure of ADHD symptoms which was used as a continuous variable to control for ADHD status rather than using a dichotomous variable (e.g., ADHD or non-ADHD). Future research should extend this idea to investigate the specific symptoms reported by students, perhaps by separating the self-report items by inattentive and hyperactive scores to determine if these are related to performance on executive function measures and written expression abilities and/or other academic domains.

Participants in this study were asked to complete writing mechanics and writing composition tasks by hand to evaluate overall writing ability. Today's college students commonly use computers and word processing programs (e.g., Microsoft Word®) to complete writing assignments. Many word processing programs provide tools to check for writing mechanics errors such as spelling and grammar errors. In Hayes' New Model of the Writing Process (1996), he highlights the importance of the writing medium for compromising or promoting many of the processes involved in writing. He discusses that word processors facilitate editing by the writer such as moving text and checking for spelling errors. Students in the present study did not have the option to use a computer. Future research should explore writing abilities by having students complete a writing

task using a word processor to more closely simulate college students' experiences engaging in the writing process.

Research on college students with ADHD should continue to investigate the academic functional impact of the condition. Research has established that college students with ADHD are more likely to have a lower grade point average, be on academic probation, and in general, have more academic problems as compared to non-disabled peers (Heiligenstein et al., 1999). In order to provide effective intervention and support services, a greater understanding of the ways in which underlying neurocognitive processes of ADHD affect students' academic performance is necessary. Thus, subsequent research should focus on linking the neuropsychological deficits associated with ADHD with performance in individual academic domains for college students with ADHD. Future research should also include college students with ADHD who are on medication during study participation in order to investigate differences in performance based on medication status, as much of the previous research on medication effects has been with children and adolescents.

Conclusions

The present study investigated the relation between executive functions and written expression in college students with ADHD. Performance on an inhibition task was found to provide a significant unique contribution in predicting performance on a writing mechanics task. Although there were no differences between the ADHD and control groups on measures of executive function, including the inhibition measure, the findings from the study provide useful information for continuing to conceptualize the writing process. In addition, because individuals with ADHD have reduced executive

function abilities, it is important for clinicians to consider the findings of the present study, as they provide a window into the academic functional impact of ADHD. Further exploration of the relation between executive function and written expression as well as other academic domains is necessary to more fully understand the functional impact of ADHD in college students and for the development of more specific and appropriate support services.

APPENDICES

Appendix A: E-mail Recruitment Letter for ADHD Group

If you fit the following criteria…

- **You are between the ages of 17 and 30**

AND

- **You have been diagnosed with ADHD**

…then keep reading!!

Title: The Relation between Executive Functions and Written Expression in College Students with Attention Deficit Hyperactivity Disorder

You are invited to participate in a project about how planning, verbal fluency, and inhibition influence writing skills. In cooperation with the University of Texas at Austin and the Services for Students with Disabilities office, we are trying to learn more about the functional impact of attention-deficit disorder (ADHD) in college students in order to most appropriately meet their higher education needs.

My name is Lana Harder and I am a graduate student at the University of Texas at Austin in the Department of Educational Psychology. This study is directly related to my school psychology program and will serve as data for my dissertation project. I will be supervised by Dr. Margaret Semrud-Clikeman, Professor of Educational Psychology. I am asking for your participation because you are a student who has a documented attention-deficit disorder. I expect to have approximately 60 participants in the study.

If you participate, I will conduct an assessment of attention, planning skills, verbal fluency, inhibition, and writing skills to determine your abilities in these areas. A graduate student from the University of Texas will administer the assessment during a one time appointment which will last approximately one hour and will take place on campus in the George I. Sanchez Building. **In exchange for your participation, you will be paid $10.00.**

Any information that is obtained in connection with this study that can be connected to you will remain confidential and will be disclosed only with your permission. Your responses will not be linked to your name in any written or verbal report of the research project. All information gained from this project can be made available to you. We welcome any questions you may have about this project.

Your decision to participate will not affect your present or future relationship with the University of Texas at Austin or the Services for Students with Disabilities office. If you have any questions about this study, please feel free to email me at lanaharder@mail.utexas.edu. If you have questions or concerns about your participation in the study, call Professor Clarke Burnham, Chair of the Unviersity of Texas at Austin Institutional Review Board for the Protection of Human Research Participants at 232-4383.

If you choose to participate, please contact me either by email: lanaharder@mail.utexas.edu or by phone: 294-9669 to set up the appointment.

Thank you!
Lana Harder
Doctoral Student
Department of Educational Psychology

Appendix B: Consent Form for ADHD Group

IRB# _____

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

The University of Texas at Austin

You are being asked to participate in a research study. This form provides you with information about the study. The Principal Investigator (the person in charge of this research) or his/her representative will provide you with a copy of this form to keep for your reference, and will also describe this study to you and answer all of your questions. Please read the information below and ask questions about anything you don't understand before deciding whether or not to take part. Your participation is entirely voluntary and you can refuse to participate without penalty or loss of benefits to which you are otherwise entitled.

Title of Research Study: The Relation between Executive Functions and Written Expression in College Students with Attention Deficit Hyperactivity Disorder

Principal Investigator(s) (include faculty sponsor), UT affiliation, and Telephone Number(s):

Lana Harder, M.A.
Graduate Student
512-294-9669

Margaret Semrud-Clikeman, Ph.D.
Professor, Department of Educational Psychology
512-471-0274

Funding source:

none

What is the purpose of this study?

The study will explore the relation between executive functions and writing abilities among college-level writers with the purpose of answering the following: Do executive function deficits associated with ADHD compromise written expression abilities at this developmental stage? Goals of the project are to examine the possible link between executive functions and written expression abilities among college students with and without ADHD, to contribute to the construction of a neuropsychological profile of adult ADHD, and to gain a more in depth understanding of the academic functional impact of ADHD among college students to inform support services in higher education.

Two groups of students will be recruited for this study. Group one consists of 30 students registered for disabilities services with documentation of an attention deficit hyperactivity disorder, any type. Group two will consist of 30 undergraduate university students enrolled in an educational psychology course in which they receive course credit for participating in a research study.

What will be done if you take part in this research study?

Data collection will take place at either the Services for Students with Disabilities office or the George I. Sanchez building. Graduate student examiners trained by the primary researcher will conduct measures throughout this study. Once the appropriate consent forms are collected, the primary researcher and examiners will administer the battery of tests for this study. Examiners will individually administer executive function and written expression achievement measures. Testing will last approximately one hour for each participant. Data collection will last approximately one hour per participant.

What are the possible discomforts and risks?

None known at this time.

What are the possible benefits to you or to others?

None known at this time.

If you choose to take part in this study, will it cost you anything?

No

Will you receive compensation for your participation in this study?
What if you are injured because of the study?

Students in the ADHD group who participate in the study will receive $10.00 in cash.

If you do not want to take part in this study, what other options are available to you?

Participation in this study is entirely voluntary. You are free to refuse to be in the study, and your refusal will not influence current or future relationships with The University of Texas at Austin and/or participating sites such as the Services for Students with Disabilities Office.

How can you withdraw from this research study and who should I call if I have questions?

If you wish to stop your participation in this research study for any reason, you should contact: Lana Harder at (512) 294-9669. You are free to withdraw your consent and stop participation in this research study at any time without penalty or loss of benefits for which you may be entitled. Throughout the study, the researchers will notify you of new information that may become available and that might affect your decision to remain in the study.

In addition, if you have questions about your rights as a research participant, or if you have complaints, concerns, or questions about the research, please contact Clarke A. Burnham, Ph.D., Chair, The University of Texas at Austin Institutional Review Board for the Protection of Human Subjects, 512/232-4383. You may also contact the Office of Research Compliance and Support at 512/471-8871.

How will your privacy and the confidentiality of your research records be protected?

Authorized persons from The University of Texas at Austin and the Institutional Review Board have the legal right to review your research records and will protect the confidentiality of those records to the extent permitted by law. If the research project is sponsored then the sponsor also have the legal right to review your research records. Otherwise, your research records will not be released without your consent unless required by law or a court order.

If the results of this research are published or presented at scientific meetings, your identity will not be disclosed.

Will the researchers benefit from your participation in this *study*?

No

Signatures:

As a representative of this study, I have explained the purpose, the procedures, the benefits, and the risks that are involved in this research study:

_____

Signature and printed name of person obtaining consent

Date

You have been informed about this study's purpose, procedures, possible benefits and risks, and you have received a copy of this Form. You have been given the opportunity to ask questions before you sign, and you have been told that you can

ask other questions at any time. You voluntarily agree to participate in this study. By signing this form, you are not waiving any of your legal rights.

_____

Printed Name of Subject **Date**

_____

Signature of Subject **Date**

_____

Signature of Principal Investigator **Date**

Appendix C: Exchange of Information Authorization for ADHD Group

EXCHANGE OF INFORMATION AUTHORIZATION

Participant's Name: _____

Address: _____

Phone: _____

I hereby authorize Lana Harder, primary research investigator to exchange information with the Services for Students with Disabilities (SSD) office at the University of Texas at Austin for the purposes of her research study entitled, "The Relation between Executive Functions and Written Expression in College Students with Attention Deficit Hyperactivity Disorder." The information to be exchanged will be limited to information from my SSD file.

I understand that I may withdraw this authorization at any time by written request. Otherwise, this permission will expire in 12 months.

Signature: _____ Date: _____

Appendix D: Consent Form for non-ADHD Control Group

IRB# _____

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

The University of Texas at Austin

You are being asked to participate in a research study. This form provides you with information about the study. The Principal Investigator (the person in charge of this research) or his/her representative will provide you with a copy of this form to keep for your reference, and will also describe this study to you and answer all of your questions. Please read the information below and ask questions about anything you don't understand before deciding whether or not to take part. Your participation is entirely voluntary and you can refuse to participate without penalty or loss of benefits to which you are otherwise entitled.

Title of Research Study: The Relation between Executive Functions and Written Expression in College Students with Attention Deficit Hyperactivity Disorder

Principal Investigator(s) (include faculty sponsor), UT affiliation, and Telephone Number(s):

Lana Harder, M.A.
Graduate Student
512-294-9669

Margaret Semrud-Clikeman, Ph.D.
Professor, Department of Educational Psychology
512-471-0274

Funding source:

n/a

What is the purpose of this study?

The study will explore the relation between executive functions and writing abilities among college-level writers with the purpose of answering the following: Do executive function deficits associated with ADHD compromise written expression abilities at this developmental stage? Goals of the project are to examine the possible link between

executive functions and written expression abilities among college students with and without ADHD, to contribute to the construction of a neuropsychological profile of adult ADHD, and to gain a more in depth understanding of the academic functional impact of ADHD among college students to inform support services in higher education.

Two groups of students will be recruited for this study. Group one consists of 30 students registered for disabilities services with documentation of an attention deficit hyperactivity disorder, any type. Group two will consist of 30 undergraduate university students enrolled in an educational psychology course in which they receive course credit for participating in a research study.

What will be done if you take part in this research study?

Data collection will take place at either the Services for Students with Disabilities office or the George I. Sanchez building. Graduate student examiners trained by the primary researcher will conduct measures throughout this study. Once the appropriate consent forms are collected, the primary researcher and examiners will administer the battery of tests for this study. Examiners will individually administer executive function and written expression achievement measures. Testing will last approximately one hour for each participant. Data collection will last approximately one hour per participant.

What are the possible discomforts and risks?

None known at this time.

What are the possible benefits to you or to others?

None known at this time.

If you choose to take part in this study, will it cost you anything?

No

Will you receive compensation for your participation in this study?
What if you are injured because of the study?

Undergraduate students recruited through the Department of Educational Psychology Subject
Pool will receive course credit in an educational psychology course.

If you do not want to take part in this study, what other options are available to you?

Participation in this study is entirely voluntary. You are free to refuse to be in the study, and your refusal will not influence current or future relationships with The University of Texas at Austin and/or participating sites such as the Department of Educational Psychology.

How can you withdraw from this research study and who should I call if I have questions?

If you wish to stop your participation in this research study for any reason, you should contact: Lana Harder at (512) 294-9669. You are free to withdraw your consent and stop participation in this research study at any time without penalty or loss of benefits for which you may be entitled. Throughout the study, the researchers will notify you of new information that may become available and that might affect your decision to remain in the study.

In addition, if you have questions about your rights as a research participant, or if you have complaints, concerns, or questions about the research, please contact Clarke A. Burnham, Ph.D., Chair, The University of Texas at Austin Institutional Review Board for the Protection of Human Subjects, 512/232-4383. You may also contact the Office of Research Compliance and Support at 512/471-8871.

How will your privacy and the confidentiality of your research records be protected?

Authorized persons from The University of Texas at Austin and the Institutional Review Board have the legal right to review your research records and will protect the confidentiality of those records to the extent permitted by law. If the research project is sponsored then the sponsor also have the legal right to review your research records. Otherwise, your research records will not be released without your consent unless required by law or a court order.

If the results of this research are published or presented at scientific meetings, your identity will not be disclosed.

Will the researchers benefit from your participation in this *study*?

No

Please check yes or no to indicate if you agree with the following: I give permission for my SAT and/or ACT scores to be accessed from my university file and reported to Lana Harder for the purposes of her study, "The Relation between Executive

Functions and Written Expression in College Students with Attention Deficit Hyperactivity Disorder."

___ YES ___ NO

Signatures:

As a representative of this study, I have explained the purpose, the procedures, the benefits, and the risks that are involved in this research study:

_____ ___

Signature and printed name of person obtaining consent **Date**

You have been informed about this study's purpose, procedures, possible benefits and risks, and you have received a copy of this Form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time. You voluntarily agree to participate in this study. By signing this form, you are not waiving any of your legal rights.

_____

Printed Name of Subject **Date**

_____

Signature of Subject **Date**

_____

Signature of Principal Investigator **Date**

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VITA

Lana Lee Harder was born in Tyler, Texas on February 14, 1978, the daughter of Carol Mixon Harder and James Byars Harder. After receiving her diploma at Mineola High School, Mineola, Texas, in 1996, she entered Southern Methodist University in Dallas, Texas. During the summer of 1998, she attended Southern Methodist University in Taos, New Mexico and during the fall of 1998, she attended Fundacion Jose Ortega y Gasset in Madrid, Spain. She graduated from Southern Methodist University in May, 2000, with a Bachelor of Arts degree in Psychology. In August, 2000, she entered the doctoral program in the School Psychology at The University of Texas at Austin. She received a Master of Arts from the University of Texas in August 2004. She will complete her internship at the Kennedy Krieger Institute and the Johns Hopkins School of Medicine in June 2006.

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This dissertation was typed by the author.