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## Visual-selective attention in young adult males with Attention-Deficit/Hyperactivity Disorder (ADHD)

Katherine Donahue  
*Northeastern University*

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Doctorate of Philosophy

Katherine Donahue, M.A.

VISUAL-SELECTIVE ATTENTION IN YOUNG ADULT MALES WITH  
ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

Emanuel Mason, Ed.D., Committee Chair

Gila Kornfeld-Jacobs, Ph.D., Committee Member

William Stone, Ph.D., Committee Member

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**ABSTRACT**

The purpose of this study was to investigate the selective attention abilities of young adults (aged 18 to 22 years), diagnosed with ADHD. The study was guided by Michael Posner's (1990) Attention Network Theory that examines three, neural systems of visual attention. The study also surveyed the domains of visual memory and visual processing speed to examine factors that might account for differences found among the participants. The sample included young adults who have been diagnosed with Attention-Deficit/Hyperactivity Disorder combined type (ADHD), a comparison group of young adults who have been diagnosed with Bipolar Disorder, and a Control group of young adults who have never been diagnosed with ADHD or Bipolar Disorder. No significant differences found among the three groups on tasks of selective visual attention, visual memory and visual processing speed. A significant difference was found, however, on a task of visual copy. Thus, the ADHD group performed worse than the Bipolar Disorder and Control group when copying a visual stimulus from a model.

## CHAPTER ONE

This chapter presents the background of the problem, the rationale and significant research, statement of the problem, the purpose of the proposed study, major research questions and potential benefits of the study.

### INTRODUCTION

#### *Background of the Problem*

Attention-Deficit/Hyperactivity Disorder (ADHD) is the most common psychiatric disorder presenting for treatment in youth (Riccio et al, 2004; Biederman, 2005; Wilens, Biederman, & Spencer, 2002) and is affecting an estimated three to five percent of the school-aged population (Barkley, 2007). ADHD tends to be chronic and is characterized by developmentally inappropriate levels of inattention, hyperactive-impulsive behavior, or a combination of both that arise in childhood and may result in cognitive, behavioral, academic, peer, familial, and emotional impairments across various domains (Barkley et al, 2001). The symptoms must be present before the age of seven, must be exhibited in two or more settings, and must exist for a minimum duration of six months (American Psychiatric Association, 2000).

Approximately half of the children diagnosed with ADHD tend to exhibit symptoms by the age of five years, and most begin to exhibit behavioral difficulties during the first years of school (Barkley, 2002). This is expected because there are demands that come with a child's entry into school: they are expected to follow instructions, obey rules, remain seated at their desks, and stay focused on tasks for prolonged periods of time (Faraone & Biederman, 2005).

Most research to date has focused on the manifestation of ADHD in childhood and adolescence (Barkley, 2007; Biederman et al, 2006). In the 1990's, however, it became evident that individuals, diagnosed with ADHD as children, continued to exhibit difficulties in adulthood (Nylander et al, 2009). Studies estimate that 50 to 80 percent of children diagnosed with ADHD continue to manifest symptoms into adolescence (Wodushek & Neumann, 2003; Fischer et al, 2005), and that approximately 30 to 70 percent of children diagnosed with ADHD continue to exhibit symptoms into adulthood (Halmoy et al, 2009; Riccio et al, 2004; Wilens, Biederman, & Spencer, 2002). As children with ADHD grow towards adolescence and adulthood, the hyperactivity tends to diminish (Clarke, Heussler, and Kohn, 2005), but impulsivity and concentration difficulties tend to persist (Wodushek & Neumann, 2003).

### ***ADHD in Adulthood***

Until recently, the symptoms of ADHD were believed to remit in adolescence and early adulthood (Nylander et al, 2009; Wilens, Biederman, & Spencer, 2002). Current research supports the persistence of ADHD into adulthood (Biederman et al, 2008; Fischer et al, 2005; Clarke, Heussler, & Kohn, 2005; Wodushek & Neumann, 2003; Ossman & Mulligan, 2003), and demonstrates that children diagnosed with ADHD exhibit substantial impairment across the lifespan (Halmov et al, 2009; Nylander et al, 2009; Biederman, 2005; Torgersen et at, 2006; Fischer et al, 2005).

As children with ADHD grow towards adolescence and adulthood, the hyperactivity tends to diminish (Clarke, Heussler, and Kohn, 2005), but impulsivity and concentration difficulties tend to persist (Wodushek & Neumann, 2003). The decline in childhood ADHD symptoms “is enough to put some adults at or below the threshold that

the DSM defines for the disorder . . . implies that a child with ADHD may outgrow the DSM criteria but not necessarily outgrow the disorder” (Barkley, 2002b, p. 12). Studies also suggest that there is an atypical group of adults with ADHD, who were not diagnosed with the disorder in childhood, but demonstrate impairments in attention, impulsivity, and executive functioning (Faraone et al, 2009; Nylander et al, 2009).

### ***Prevalence***

Symptoms of ADHD are estimated to continue into adolescence in more than 75 percent of cases (Barkley, 2007), and symptoms persist into adulthood in approximately 65 percent of cases; affecting four percent of the adult population nationwide (Faraone et al, 2009; Tamam et al, 2008; Kessler et al, 2006; Philipsen et al, 2005; Torgersen, Gjervan & Rasmussen, 2006). ADHD occurs at all levels of intelligence, all socioeconomic levels (Barkley, 2002), across all racial groups (Riccio et al, 2004), and has been diagnosed in “all cultures and societies studied” worldwide (Clarke, Heussler, & Kohn, 2005).

***Bipolar Disorder.*** Current research suggests a bidirectional overlap between symptoms of Bipolar Disorder and ADHD (Biederman et al, 2008; Biederman et al, 2006). A study by Henin et al (2007) found that adults diagnosed with Bipolar Disorder had significantly higher rates of disruptive behavior disorders, ADHD, anxiety disorders and enuresis in childhood. A recent review by Wingo and Ghaemi (2007) found that the comorbid syndrome of ADHD and Bipolar Disorder is fairly common, and is diagnosed in up to 47% of adults with ADHD and 21% of adults with Bipolar Disorder. Tamam et al (2006) assessed 44 patients who had been diagnosed with Bipolar I disorder, and found that 15.9 percent manifested symptoms of ADHD. The National Comorbidity Survey

estimates a 10.4 percent prevalence of Bipolar I and Bipolar II Disorders among adults diagnosed with ADHD (Kessler et al, 2006).

The onset of bipolar symptomatology, in individuals with ADHD, is approximately 5 years earlier (age 13.5 years compared to 18 years) than is typically observed in the general population (Sobanski, 2006). Given chronic course of these disorders, it has been suggested that ADHD may be an early marker for the onset of Bipolar Disorder (Biederman et al, 2008; Henin et al, 2007) or that there may be a symptomological continuity between ADHD and Bipolar Disorder (Tamam et al, 2008) A study by Reimherr and associates (2005) surveyed adults diagnosed with ADHD, and determined that approximately 33 percent demonstrated met at least moderate impairment in emotional dysregulation including: difficulties with temper, affective liability and emotional overreactivity. It is difficult to discern, however, whether these symptoms can be attributed to a comorbid diagnosis (Kessler et al, 2006) or are indicative of the manifestation of ADHD in adulthood (Biederman et al, 2006; Barkley, 2002).

The difficulty in distinguishing ADHD and Bipolar Disorder, is due to the high prevalence of a comorbid diagnosis of ADHD among bipolar patients, and from the overlap of certain DSM-IV criteria for mania and ADHD (Kessler et al, 2006). Irritability is one of the most frequent symptoms of mania/hypomania, but it is of little help in the differential diagnosis because of its ubiquity across a number of diagnoses, including: anxiety, major depressive disorder and antisocial personality disorder (Barkley, 2007).

### ***Differential Diagnosis***

Research suggests that “ADHD-like symptoms occur with a high base rate in the general population” (Suhr et al, 2009). Thus, the field needs to examine symptom clusters that may be more specific to ADHD, and are more useful in differential diagnosis (Biederman et al, 2008).

### ***Rationale and Significance of the Problem***

Current research indicates that ADHD is associated with significant dysfunction across the lifespan (Nylander et al, 2009; Biederman et al, 2008; Biederman et al, 2006), and supports the persistence of the disorder into adulthood (Fischer et al, 2005; Clarke, Heussler, & Kohn, 2005; Wodushek & Neumann, 2003; Ossman & Mulligan, 2003). There is emerging evidence that the presentation of ADHD changes over time, with a reduction of hyperactive symptoms, and may place adults below the necessary threshold for diagnosis (Barkley, 2007; Faraone & Biederman, 2005).

***Executive Functioning.*** The prevailing views of the field are that executive functioning is the primary cognitive deficit in individuals with ADHD (Wodushek & Neuman, 2003). The functions of the prefrontal lobe are commonly referred to as the executive Functions, which is a concept that encompasses the higher-order abilities that are believed to be regulated by the prefrontal lobe (Nigg, 2005; Panzer & Viljoen, 2005; Fischer et al, 2005; Ossman & Mulligan, 2003). Executive functioning “is a relatively vague concept often referring to a myriad of abilities, including inhibition, planning and strategy development, future-directed behavior, persistence, and flexibility of action . . .” (Barkley et al, 2001, p. 542).

Current research has demonstrated that executive functioning is impaired or delayed, to some degree, in children and adolescents who have been diagnosed with ADHD, and that these difficulties appeared to influence the child's or adolescent's adaptive behavior and academic achievement (Boonstra et al, 2005; Nigg, 2005). A recent study by Fischer, Barkley, Smallfish and Fletcher (2005) demonstrated that subjects, who were hyperactive as children, manifested significant executive functioning deficits during a thirteen year follow up including: inattention, disinhibition, slowed reaction time, and greater ADHD behaviors.

Using the concept of executive functioning to conceptualize ADHD can be problematic. The results of executive functioning tests can be difficult to interpret, because performance relies upon underlying cognitive factors: selective attention, inhibitory control and working memory (Barkley, 2007; Biederman, 2005). Thus, a deficit in performance on an executive functioning test may reflect an impairment in any one (or more) of these underlying cognitive factors (Wilding, 2005).

### ***Attention***

In 1890, the renowned philosopher and psychologist William James proposed:

Every one knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state which in French is called *distracted*, and *Zerstreuung* in German (Green, 2009).

In cognitive psychology, attention is defined as the element of cognitive functioning in which the mental focus is maintained on a specific issue, object, or activity and consists of the ability to sustain attention and selectively attend to stimuli (Tucha et

al, 2009). In the literature about attention, one needs to distinguish between sustained attention and selective attention. Sustained attention refers to the individual's ability to maintain focus (attention) upon a task or activity for a sustained period of time (Douglas, 2005). Selective attention involves performance when there are "conflicts between signals" (Posner, 1988), requiring one to attend to a select or target stimulus while ignoring competing stimuli in the visual field (Gioia et al, 2000). The ability to sustain attention enables an individual to direct attention to one or more sources of information over a period of time (Tucha et al, 2009).

ADHD is characterized as an "attentional deficit" and marked by poor attention to detail, difficulties in sustaining attention and variability across task performance (Cornish et al, 2008). The current literature on ADHD, however, is unclear about the diagnostic criteria for inattention (Douglas, 2005; Cornish et al, 2005). The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition describes inattention as: failing to give close attention to details, making careless errors, difficulty sustaining attention, not listening when being spoken to, not following through on instructions, difficulty with organizing tasks, losing necessary materials for tasks, distractibility and a tendency to avoid sustained mental effort (American Psychiatric Association, 2000).

It has been generally accepted that individuals diagnosed with ADHD are more distractible than healthy controls (Nigg, 2005). The purported attentional dysfunction in ADHD is reflected in poorer performance by participants with ADHD, as compared to healthy controls, on continuous performance tests and processing speed tests (Lubow et al, 2005). Yet, the current literature indicates discrepancies in selective attention with studies concluding that individuals with ADHD are more likely to be distracted by

irrelevant stimuli (Douglas, 2005; Gaultieri & Johnson, 2006), whereas other studies have not found significant differences among individuals with ADHD and healthy controls (Barkley, 2007; Tucha et al, 2009).

Researches also argue that “Virtually all major psychiatric disorders are characterized by disturbance in attention or concentration” (Teicher, 2009). In fact, inattention, poor concentration, and distractibility are often symptoms associated with other psychiatric and medical diagnoses including: sleep problems, seizure disorders, medication side effects, visual and/or hearing problems, traumatic brain injury, substance use/abuse, prenatal exposure to substances, learning disabilities, Posttraumatic Stress Disorder, Anxiety Disorders, Bipolar Disorder and Mood Disorders (Teicher et al, 2008; Barkley, 2007; Sokol et al, 2003). The current diagnostic criteria of inattention in ADHD, therefore, may be of little help in differential diagnosis because of its ubiquity across a number of other medical and psychiatric diagnoses (Teicher, 2009; Barkley, 2007).

### ***Posner’s Theory of Selective Attention***

Michael Posner’s initial work on selective attention (Posner, 1980) illustrated that attention can be diverted independently of overt sensory and motor orientation (Posner, 1988), and can be shifted covertly without relying on physical eye movements (Douglas, 2005). Thus, attention can be drawn by a stimulus in the periphery of an individual’s visual field, prior to making an eye or head movement to focus (Posner, 1980; Posner, 1988).

According to Posner, there are three major processes of attention: Orienting, Detecting and Maintaining. Orienting involves activating the sensory receptors to focus on a specific spatial location of the stimulus and is independent of eye movements.

Detecting involves the sensory input reaching the attentional system, subjectively known as awareness. Maintaining is the third attention mechanism, which places the subjects in a vigilant state. For orienting to occur, however, there are three, fundamental cognitive processes that must occur: Disengagement, Movement, and Engagement. First, attention must be disengaged from its current focus, or the stimulus that one is attending to at the time. Second, attention must move to a new spatial location, or stimulus. Third, that attentional process must be engaged at the new spatial location, or stimulus (Posner, 1988; Mason et al, 2003; Landau & Bentin, 2008). Posner referred to this series of operations as covert attentional shifts, because attention is oriented automatically, and without reliance upon external body movements; including eye movements (Douglas, 2005).

### ***Statement of the Problem***

Current research indicates that ADHD is associated with significant dysfunction across the lifespan (Biederman et al, 2006), and supports the persistence of the disorder into adulthood (Fischer et al, 2005; Clarke, Heussler, & Kohn, 2005; Wodushek & Neumann, 2003; Ossman & Mulligan, 2003). There is emerging evidence that the presentation of ADHD changes over time, with a reduction of hyperactive symptoms, and may place adults below the necessary threshold for diagnosis (Faraone & Biederman, 2005). DSM-IV criteria for adult ADHD, therefore raise concerns about under-diagnosis, as there may be a large population of vulnerable adults who are not being treated for adult ADHD symptoms (Clarke, Heussler & Kohn, 2005; Spencer and Adler, 2004).

Current research defines executive dysfunction as the core deficit in ADHD (Nigg, 2005; Panzer & Viljoen, 2005; Fischer et al, 2005; Wodushek & Neumann, 2003;

Ossman & Mulligan, 2003), but the results of executive functioning studies can be misleading in conceptualizing ADHD (Biederman, 2005; Barkley, 2007). Performance on tests of executive functioning rely upon underlying cognitive factors (e.g. selective attention), and a poor performance on such tests may reflect an impairment in underlying cognitive factors, rather than executive functioning, per se (Wilding, 2005).

It is possible that the current diagnostic criteria of inattention, as specified in the DSM-IV-TR, might not accurately reflect the deficits inherent in a diagnosis of ADHD (Barkley, 2007). Reflecting upon the work of Michael Posner (1980), it becomes clear that the diagnostic criteria of ADHD's hallmark feature or inattention are, at best, unclear (Douglas, 2005; Cornish et al, 2005). This is of particular concern, because inattention is present in many, other medical and psychiatric diagnoses (Teicher et al, 2008; Sokol et al, 2003; Barkley, 2007). It is possible that by revisiting the concept of selective attention, and other cognitive processes that support selective attention, diagnostic indicators that are specific to ADHD might be illuminated.

### ***Purpose of the Present Study***

The purpose of this study was to investigate the selective attention abilities of young adults (aged 18 to 22 years), diagnosed with ADHD. The study was guided by Michael Posner's (1990) Attention Network Theory that examines three, neural systems of visual attention. These systems are referred to as the Alerting, Orienting, and Executive Networks (Posner & Rothbart, 2007). The study also surveyed the domains of visual memory and visual processing speed to examine factors that might account for differences found among the participants. The sample included young adults who have been diagnosed with Attention-Deficit/Hyperactivity Disorder combined type (ADHD), a

comparison group of young adults who have been diagnosed with Bipolar Disorder, and a Control group of young adults who have never been diagnosed with ADHD or Bipolar Disorder. Individuals with Bipolar Disorder were chosen as a comparison group, due to the common diagnostic characteristics of ADHD and Bipolar Disorder that complicate differential diagnosis (McGough et al, 2005).

### ***Potential Benefits of the Present Study***

The information obtained from this study will further knowledge of the presentation of adult ADHD symptoms among undergraduate college students. Results will yield data that will contribute to the current body of literature examining selective attention abilities in young adult males diagnosed with ADHD.

### ***Major Research Questions***

#### ***Question 1***

Will young adult males, diagnosed with ADHD, exhibit a significant difference in the Alerting Attention Network, as compared to a Control and Bipolar Disorder group?

***Hypothesis 1.*** Individuals in the ADHD group would demonstrate significantly lower scores on speed of performance and accuracy on a selective attention test. This hypothesis was tested using the Total Speed, Automatic Detection Speed, and Control Search Speed of the Ruff Two & Seven Selective Attention Test. It was hypothesized that individuals in the ADHD group would demonstrate significantly lower scores on speed of performance and accuracy on the Ruff 2& 7 Selective Attention Test.

***Hypothesis 2.*** Individuals in the ADHD group would exhibit significantly higher error scores on a measure of selective attention. This hypothesis was tested using the Automatic Detection Accuracy, Controlled Search Accuracy and Total Accuracy of the

Ruff 2 & 7 Selective Attention Test. It was hypothesized that individuals in the ADHD group would exhibit significantly higher error scores on the Ruff 2 & 7 Selective Attention Test.

### ***Question 2***

Will young adult males, diagnosed with ADHD, exhibit a significant difference in the Orienting Attention Network, as compared to a Control and Bipolar Disorder group?

***Hypothesis 3.*** Individuals in the ADHD group would demonstrate significantly lower scores for accuracy of responses on measure of orienting attention. This hypothesis was tested using accuracy of responses on the Digit Symbol subtest. It was hypothesized that individuals in the ADHD group would demonstrate significantly lower scores for accuracy of responses on the Digit Symbol subtest.

***Hypothesis 4.*** Individuals in the ADHD group would demonstrate significantly lower scores for total time to complete a measure of executive attention. This hypothesis was tested using total time to complete the Trail Making Test. It was hypothesized that individuals in the ADHD group would exhibit significantly higher scores on the total time to complete the Trail Making Test.

### ***Question 3***

Will young adult males, diagnosed with ADHD, exhibit a significant difference in the Executive Attention Network, as compared to a Control and Bipolar Disorder group?

***Hypothesis 5.*** Individuals in the ADHD group would demonstrate significantly lower scores for accuracy of responses on measure of executive attention. This hypothesis was tested using accuracy of responses on the Symbol Search subtest. It was

hypothesized that individuals in the ADHD group would demonstrate significantly lower scores for accuracy of responses on the Symbol Search subtest.

***Question 4***

Will young adult males, diagnosed with ADHD, exhibit a significant difference in visual memory, as compared to a Control and Bipolar Disorder group?

***Hypothesis 6.*** Individuals in the ADHD group would demonstrate significantly lower scores on a measure of visual learning and memory. This hypothesis was tested using the copy, immediate and delayed conditions of Rey-Osterreith Complex Figure. It was hypothesized that individuals in the ADHD group would demonstrate significantly lower scores on the copy, immediate and delayed conditions of Rey-Osterreith Complex Figure.

***Question 5***

Will young adult males, diagnosed with ADHD, exhibit a significant difference in visual processing speed, as compared to a Control and Bipolar Disorder group?

***Hypothesis 7.*** Individuals in the ADHD group would demonstrate significantly lower scores on measures of processing speed. This hypothesis was tested using the Digit Symbol and Symbol Search subtests that comprise the Processing Speed Index of the Wechsler Adult Intelligence Scale–Third Edition (WAIS-III). It was hypothesized that individuals in the ADHD group would exhibit significantly decreased scores on the Processing Speed Index.

***Chapter Summary***

Current research indicates that symptoms of ADHD persist into adulthood, and are associated with significant dysfunction in relationships, education and occupational

history across the lifespan. Studies report that the symptoms of ADHD change into adulthood, with a reduction of hyperactive symptoms, and may place adults below the necessary threshold for diagnosis. Adult ADHD is also associated with psychiatric comorbidity; particularly adult Bipolar Disorder. There are significant discrepancies in the research considering the common diagnostic characteristics of ADHD and Bipolar Disorder (e.g. difficulties with temper, affective liability and emotional overreactivity), which complicate differential diagnosis. These factors raise concerns about accurately identifying and treating ADHD in adulthood.

Current research seems to be converging upon executive dysfunction as the core deficit in ADHD, but executive functioning is a vague concept that consists of various higher-order cognitive abilities (e.g. working memory, transitioning smoothly from one activity to another, etc.). Furthermore, the abilities termed executive functioning are dependent upon underlying cognitive factors (e.g. selective attention) that are often overlooked in recent studies. It is important to understand what factors may be contributing to adult ADHD, as a step toward prevention and treatment of this disorder.

It is possible that the current diagnostic criteria of inattention, as specified in the DSM-IV-TR, might not accurately reflect the deficits inherent in a diagnosis of ADHD. This is of particular concern, because inattention is present in many, other medical and psychiatric diagnoses. It is possible that by revisiting the concept of selective attention, and other cognitive processes that support selective attention, diagnostic indicators that are specific to ADHD might be illuminated.

This study investigated the selective attention abilities of young adults (aged 18 to 22 years), diagnosed with ADHD. The study was guided by Michael Posner's (1990)

Attention Network Theory that examines three, neural systems of visual attention: the Alerting, Orienting, and Executive Networks (Posner & Rothbart, 2007). The study also surveyed the domains of visual memory and visual processing speed to examine factors that might account for differences found among the participants.

## CHAPTER TWO

This chapter begins with a brief history of ADHD, discussion of adult presentation, comorbidity and etiology. Following the etiological discussion, the chapter introduces the concept of Barkley's theory of Behavioral Inhibition. Finally, the chapter concludes with a definition of selective attention and presentation of Posner's theory of Selective Attention.

### REVIEW OF THE LITERATURE

#### *A Brief History of ADHD*

In 1844, the physician Heinrich Hoffman described these difficulties in attention as *deficits in inhibitory control* in the poem of *Fidgety Philip*, "Let me see if Philip can be a little gentleman . . . He wriggles and giggles . . . See the naughty restless child. Growing still more rude and wild" (Barkley, 1997, p. 4).

In his 1890 book, *Principles of Psychology*, William James described children with an explosive will, and speculated that deficits in inhibitory control and attention were related to neurological deficits (Riccio et al, 2004). In 1902, the first discussion of difficulties in attention and inhibitory control appeared in a series of lectures presented by George Still to the Royal College of Physicians (Barkley, 2002a). Still presented cases of twenty children who exhibited *deficits in moral control* and *volitional inhibition* (Anastopoulous & Shelton, 2001). Still's clinical observations were reported in *Lancet* during that same year (Riccio et al, 2004).

Still's observations described associated features, of what is now referred to as ADHD, that were later corroborated by over one hundred years of research: 1) overrepresentation in males (Still's proposed 3:1 prevalence in males is considered valid

at the present time), 2) projected difficulties with alcoholism and delinquent/criminal behavior, 3) a history of depression in the biological family, 4) familial history of the disorder and 5) the disorder may arise as a result of diseases or injuries of the central nervous system (Riccio et al, 2004; Barkley et al, 2002a).

In the United States, interest in attention and inhibitory control deficits arose after the 1917-1918 influenza epidemic, which killed twenty million people nationwide (Barkley et al, 2002a). Following the influenza epidemic, there was a large-scale outbreak of encephalitis, a result of the chronic influenza (Anastopoulous & Shelton, 2001). The encephalitis left many survivors neurologically impaired: some went on to develop Parkinson's disease (Barkley et al, 2001), while others exhibited signs of disinhibition and dysfunction that had some similarities to the problems first described by Still (Riccio et al, 2004), and the cluster of behaviors, that were evident in these individuals, was referred to as Postencephalitic Behavioral Disorder (Barkley et al, 2002a).

Descriptions of children with behaviors similar to that of Postencephalitic Behavioral Disorder appeared in the medical and psychological research throughout the 1920's (Anastopoulous & Shelton, 2001). In 1937, Dr. Charles Bradley introduced the use of stimulants to treat children with symptoms characteristic of Postencephalitic Behavioral Disorder in the early 1930's (Nigg, 2005; Clarke, Heussler & Kohn, 2005). Stimulants did not become a popular treatment method, however, until Ritalin was introduced in 1956 (Riccio et al, 2004; Dige & Wik, 2005).

By the Late 1930's and early 1940's, it was generally assumed that some degree of brain damage had occurred to children who presented with difficulties in attention,

overactivity and inhibitory control (Riccio et al, 2004). Reflecting the prevailing views of the field, Kahn and Cohen (1934) attributed the symptoms “to brain stem damage,” and coined the term Organic Drivenness (Anastopoulous & Shelton, 2001, p. 6).

The presumption of a physiological etiology was further reinforced by the publication of *Psychopathology and Education of the Brain Injured Child* by Strauss in 1947 (Barkley et al, 2002a). Strauss’s research illustrated that difficulties in attention, overactivity and inhibitory control were more apparent among developmentally delayed children with brain damage. Generalizing from his research findings, Strauss reasoned that “any child exhibiting these behavioral difficulties probably had brain damage” (Anastopoulous & Shelton, 2001, p. 6). Strauss’s work was so influential, that the 1940’s came to be known as the era of the Minimally Brain Damaged Child (Riccio et al, 2004; Faraone & Biederman, 2005).

By the late 1950’s, the defining characteristics of the disorder came under study. The element of *overactivity* was studied by Laufer and Denhoff (1957), which they termed *hyperactivity* (Nigg, 2005). Laufer and Denhoff adhered strongly to the belief that ADHD-like behaviors were a result of damage to diencephalic structures in the brain, and in 1957 introduced Hyperkinetic Impulse Disorder and Hyperkinetic Behavior Syndrome as subtypes of Minimal Brain Damage (Anastopoulous & Shelton, 2001).

The causal role of brain damage was challenged by Chess (1960), Birch (1964), and Clements and Peters (1962), given that many behavior-disordered children did not exhibit evidence of brain damage or developmental delay (Barkley, 2002a). By the 1960’s, the diagnosis of Minimal Brain Damage was modified to Minimal Brain Dysfunction: reflecting increased disenchantment with the idea that brain damage was a

major cause of ADHD-like behaviors (Wilens, Biederman, and Spencer, 2002; Reimherr et al, 2005). At the same time, “this new label preserved the notion that the brain was somehow involved . . . albeit in a less well defined role” (Anastopoulous & Shelton, 2001, p. 7).

The work of Stella Chess is noteworthy, because she was one of the first researchers to propose that “such behavioral difficulties might represent the extreme end of the normal variability that occurs within child populations;” a viewpoint that was prevalent in ADHD research of the 1990’s (Anastopoulous & Shelton, 2001, p. 7).

Chess’s investigations of hyperactivity were so significant that the second edition of the *Diagnostic and Statistical Manual of Mental Disorders*, (DSM-II, 1968) introduced the diagnosis of Hyperkinetic Reaction of Childhood (Riccio et al, 2004). The DSM-II diagnostic criteria for Hyperkinetic Reaction of Childhood reflected both the diminished etiological importance of brain damage, and the growing interest in symptom-based descriptions; particularly in regards to hyperactivity (Wilens, Biederman, and Spencer, 2002).

By the 1970's, over two-thousand studies had been published on hyperactivity, but concerns were raised regarding the symptoms of hyperactivity and impulsivity (Barkley, 2002a). During this time, the prominent researcher Virginia Douglas (1972) proposed that there were shortcomings in the classifications of the DSM-II (Anastopoulous & Shelton, 2001). Her extensive research at McGill University introduced the element of an *attention deficit*, and proposed difficulties in attention as the defining symptom of these children who were diagnosed with either Hyperkinetic Reaction of Childhood or Minimal Brain Dysfunction (Douglas, 2005).

The focus on attention difficulties was further reflected in the work of Douglas's colleague, Gabrielle Weiss, who engaged in long-term follow-up studies of adolescents with ADHD (Barkley, 2002a). Results of Weiss's work illustrated an element that is prevalent in current research on ADHD: that as children with attention deficits reach adolescence, the hyperactivity may diminish, but the attention and impulse problems tend to persist (Douglas, 2005).

Following the work of Douglas and Weiss, the profession came to regard the symptom of *attention* as critically important to differentiating the disorder, and incorporated it into the name of the disorder itself (Riccio et al, 2004). The third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III, 1980) replaced the diagnoses of Hyperkinetic Reaction of Childhood and Minimal Brain Dysfunction with the diagnostic categories of Attention-Deficit Disorder with Hyperactivity (ADD/+H) and Attention-Deficit Disorder without Hyperactivity (ADD/-H) (Wilens, Biederman, and Spencer, 2002; Anastopoulous & Shelton, 2001).

Research of the 1980's challenged the notion of ADHD as a disturbance in attention, and investigated difficulties of motivation and insensitivity to consequences of behavior (Barkley, 2002a). Research demonstrated that children with ADHD did not respond, in the same way as children without the diagnosis of ADHD, to alterations in reinforcement contingencies. When reinforcement was altered to partial or intermittent contingencies, there was a significant decline in the performance of the ADHD children (Nigg, 2005). Under conditions of continuous reward schedules, however, the performance of children with ADHD was indistinguishable from non-ADHD children (Riccio et al, 2004). In 1987, the revised edition of the *Diagnostic and Statistical Manual*

of *Mental Disorders* (DSM-III-R) further changed the criteria, and included the Attention Deficit Disorders under the Category of the Disruptive Behavior Disorders: along with Conduct Disorder and Oppositional Defiant Disorder (Douglas, 2005).

Research of the 1990's investigated the application of information-processing paradigms with children who were diagnosed with ADHD (Nigg, 2005). There were difficulties, however, in demonstrating that the ADHD child's problem in attending to tasks was attentional in nature: research consistently indicated a problem in inhibitory and motor systems control (Barkley, 2002a). It was further hypothesized that the symptoms of hyperactivity and impulsivity formed a single dimension of behavior (Riccio et al, 2004; Wilens, Biederman, and Spencer, 2002). In 1994, the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV) specified two different thresholds for ADHD: inattentive and hyperactive/impulsive; making the distinction of ADHD with or without hyperactivity and/or impulsivity (Douglas, 2005).

### ***Current DSM-IV-TR Criteria***

The following are the diagnostic criteria, according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition—Text revision (American Psychiatric Association, 2000, pp. 92-93), for Attention-Deficit/Hyperactivity Disorder (ADHD):

**Table 1. DSM-IV-TR Criteria for Attention-Deficit/Hyperactivity Disorder**

<p>Either criterion A or B:          (A) Six (or more) of the following symptoms of inattention that have persisted for at least six months to a degree that is maladaptive and inconsistent with developmental level:  <i>Inattention</i></p> <ol style="list-style-type: none"> <li>1) often fails to give close attention to details or make careless mistakes in schoolwork, work or other activities.</li> <li>2) often has difficulty sustaining attention in tasks or play activities.</li> <li>3) often does not seem to listen when spoken to directly.</li> <li>4) often does not follow through on instructions and fails to finish schoolwork, chores or duties in the workplace (not due to oppositional behavior or failure to understand instructions).</li> </ol>
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- 5) often has difficulty organizing tasks and activities.
- 6) often avoids, dislikes or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework).
- 7) often loses things necessary for tasks or activities (i.e. school assignments, pencils, books, etc.).
- 8) is often easily distracted by extraneous stimuli.
- 9) is often forgetful in daily activities

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

*Hyperactivity*

- 1) often fidgets with hands or feet or squirms in seat.
- 2) often leaves seat in classrooms or other situations in which remaining seated is expected.
- 3) often runs about or climbs excessively in situations in which it is appropriate (in adolescents or adults, may be limited to subjective feelings of restlessness).
- 4) often has difficulty playing or engaging in leisure activities quietly.
- 5) is often “on the go” or often acts as if “driven by a motor”
- 6) often talks excessively.

*Impulsivity*

- 1) often blurts out answers before questions have been completed.
- 2) often has difficulty waiting turn.
- 3) often interrupts or intrudes on others (i.e. Butts into conversations or games).
- 4) Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before age 7 years.
- 5) Some impairment from the symptoms is present in two or more settings (i.e. at school, work, and home).
- 6) There must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.
- 7) The symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another mental disorder (i.e. Mood Disorder, Anxiety Disorder, Dissociative Disorder, or a Personality Disorder).

According to current diagnostic criteria, ADHD is currently diagnosed according to three possible types:

- 1) 314.00 Attention-Deficit Disorder/Hyperactivity Disorder, Predominately Inattentive Type (if Criteria 1 is met but Criteria 2 is not met for the past 6 months)
  - 2) 314.01 Attention-Deficit/Hyperactivity Disorder, Predominately Hyperactive-Impulsive Type (if Criteria 2 is met but Criteria 1 is not met for the past 6 months).
- 314.01 Attention-Deficit/Hyperactivity Disorder, Combined Type (if both Criteria 1 and 2 are met for the past 6 months).

Until the 1990s, researchers believed that children and adolescents “outgrew” the symptoms of ADHD by adulthood (Nylander et al, 2009; Wilens, Biederman, & Spencer, 2002). As children with ADHD grow into adulthood, the symptoms of hyperactivity tend to diminish (Clarke, Heussler, and Kohn, 2005), but symptoms of impulsivity and concentration difficulties tend to persist (Wodushek & Neumann, 2003) and causes significant impairment across the life span (Halmov et al, 2009; Nylander et al, 2009; Biederman, 2005; Torgersen et at, 2006; Fischer et al, 2005). Adult cases of ADHD are

likely to present in one of three possible scenarios: a) an adult with a history of ADHD symptoms in childhood, b) an adult who was diagnosed with ADHD in childhood and treatment was terminated once he or she reached adolescence or adulthood, and c) adults who have never been diagnosed with ADHD (Waite, 2007; Barkley, 2007).

Recent studies of ADHD in adulthood have assumed a syndrome uniformity that reflects consistency with how the symptoms manifest in childhood and adolescence (Clarke, Heussler, and Kohn, 2005). The current DSM-IV-TR criteria were developed from trials with children (Biederman, 2005), and it has been argued that the child-based criteria may be too limiting for adults (Riccio et al, 2004). Recent studies suggest that ADHD changes in its clinical presentation over the course of individual development (Barkley, 2002b).

The current DSM-IV-TR criteria “offer only minimal guidance regarding diagnosis among adults” (Kessler et al, 2006). It is estimated that the current diagnostic criteria anchoring the diagnosis, could artificially reduce the likelihood that an individual would be diagnosed with ADHD in adulthood (Barkley, 2002a), because the symptoms used to define the disorder in childhood may not include features that are more characteristic for adults (Biederman, 2006). As adult ADHD is only beginning to be recognized and studied, this leads researchers to question whether ADHD is under-diagnoses in adults (Riccio et al, 2004).

Despite emerging evidence that the diagnostic criteria might have poor applicability to adults (Panzer & Viljoen, 2005; Ossman & Mulligan, 2003), clinicians and researchers continue to utilize DSM-IV-TR criteria to diagnose ADHD in adults (Epstein & Collins, 2006; Nigg, 2005; Wodushek & Neumann, 2003). ADHD was

previously thought to remit in the late childhood to adolescent years (Barkley, 2007; Wilens, Biederman, & Spencer, 2002), and adult ADHD was not included in neither the United States Psychiatric Epidemiological survey, for the last two decades, nor the Epidemiologic Catchment Area Study nor the National Comorbidity Survey (Kessler et al, 2006).

### ***Comorbid Psychiatric Disorders***

Another issue complicating the diagnosis of ADHD in youth and adults is that ADHD is associated with high prevalence rates of comorbid psychiatric disorders in childhood and adolescence including: Conduct Disorder (20-45%), Oppositional Defiant Disorder (40-65%), Anxiety Disorders (40-60% lifetime prevalence), Mood Disorders (23-45%), Bipolar Disorder (6-10%) and Substance Use Disorders (10-24%) (Kessler et al, 2006; Sobanski, 2006; Barkley, 2007; Barkley, 2002b). Although the presence of comorbid psychiatric conditions has been documented in children and adolescents with ADHD, comorbid diagnoses have not been extensively studied in adults diagnosed with ADHD (Murphy, Barkley, & Bush, 2002).

***Anxiety Disorders.*** Anxiety disorders have been associated with ADHD, but the research has been inconsistent in this area (Torgersen, Gjervan, & Rasmussen, 2006). It is estimated that anxiety disorders co-occur at high rates among adults diagnosed with ADHD (McGough et al, 2005; Biederman et al, 2006) including: Obsessive Compulsive Disorder (1.4 to 13%), Generalized Anxiety Disorder (10 to 45%), and Separation Anxiety Disorder (18%) (Kessler et al, 2006; McGough et al, 2005), Agoraphobia (4.0%), Social Phobia (20-34%), Specific Phobia (29.5%), Panic Disorder (5.5%) and Posttraumatic Stress Disorder (16.1%) (Kessler et al, 2006; Sobanski, 2006).

It has been hypothesized that the co-occurrence of ADHD and anxiety disorders may be related to poor emotional regulation, rather than overt feelings of fear or panic (Reimherr et al, 2005). Ranzon (2001) illustrated that the physiological symptomatology associated with anxiety disorders may make a differential diagnosis difficult, and individuals may be misdiagnosed with ADHD. Thus, it has been proposed that the high comorbidity rate with anxiety disorders reflects “an overdiagnosis of general anxiety. . . due to reduced stress tolerance in a subgroup of adults with ADHD resulting in feelings of fear and emotional dysregulation” (Sobanski, 2006, p. 127-128). Furthermore, research has demonstrated that the use of stimulant medications may exacerbate the physiological symptoms associated with anxiety (Bezchlibnyk-Butler & Jeffries, 2006), further complicating the diagnostic presentation of the individual (Torgersen, Gjervan, & Rasmussen, 2006; Reimherr et al, 2005).

***Major Depressive Disorder and Dysthymia.*** The comorbidity of depression has been controversial, but current research indicates a 35 to 50 percent lifetime prevalence of depression in individuals diagnosed with ADHD (Sobanski, 2006). A diagnosis of ADHD is associated with a lifetime comorbidity of 15 to 49 percent for Major Depressive Disorder (Kessler et al, 2006; Barkley, 2002) and 25 percent for Dysthymia (McGough et al, 2005). Researchers have speculated, however, that depression in ADHD should be considered representative of an adjustment disorder due to cumulative life failures in social, academic, vocational and familial challenges (Sobanski, 2006).

***Bipolar Disorder.*** The common diagnostic characteristics of ADHD and Bipolar Disorder complicate differential diagnosis (McGough et al, 2005). A recent study by Reimherr and associates (2005) surveyed adults diagnosed with ADHD, and determined

that approximately 33 percent demonstrated met at least moderate impairment in emotional dysregulation including: difficulties with temper, affective liability and emotional overreactivity. It is difficult to discern, however, whether these symptoms can be attributed to a comorbid diagnosis (Kessler et al, 2006) or are indicative of the manifestation of ADHD in adulthood (Biederman et al, 2006; Barkley, 2002).

***Antisocial Personality Disorder.*** A recent study by McGough et al (2005) found a 13 percent comorbidity of Antisocial Personality Disorder (APD) in adults with ADHD, whereas other studies estimate that APD co-occurs in up to 18-23 percent in individuals diagnosed with ADHD: comprising 10 percent of ADHD females and 35 percent of ADHD males (Sobanski, 2006; Biederman, 2005). The diagnosis of Antisocial Personality Disorder is associated with history of Oppositional Defiant Disorder and Conduct Disorder in childhood and adolescence (Torgersen, Gjervan & Rasmussen, 2006; Sobanski, 2006; Wilens, Biederman, & Spencer, 2002).

***Borderline Personality Disorder.*** The emotional dysregulation associated with an adult diagnosis of ADHD, is similar to diagnostic criteria for Borderline Personality Disorder: impulsivity, emotional lability and cognitive impairments/deficits (Philipsen, 2006; Reimherr et al, 2005). Current studies suggest that the co-occurrence of ADHD and Borderline Personality Disorder is 29.7 percent (Biederman, 2006), but further research is needed to determine prevalence, course and differential diagnosis (Sobanski, 2006).

***Substance Use Disorders.*** Individuals diagnosed with ADHD are at an increased risk for alcohol and tobacco use (Upadhyaya et al, 2005; Barkley, 2007; Murphy, Barkley, & Bush, 2002), and reportedly maintain their addictions longer than their non-

ADHD peers (Wilens et al, 2005). Adults with ADHD exhibit a 34 percent lifetime alcohol abuse, alcohol dependence, and/or other drug use and dependence (McGough et al, 2005). Substance use disorders have been consistently diagnosed in up to 50 percent of adults diagnosed with ADHD (Sobanski, 2006). Furthermore, severe and longer durations of substance abuse and lower remission rates (Wilens et al, 2005; Torgersen, Gjervan, & Rasmussen, 2006) are associated with adult ADHD.

Marijuana, Cocaine (McGough et al, 2005), and tobacco (Upadhyaya et al, 2005) are reportedly the most frequently abused substances among adults with ADHD. Current research suggests, however, that treatment of ADHD symptoms with psychotropic medications does not increase the risk for future substance use (Biederman, 2005; Upadhyaya et al, 2005), but rather the substance abuse risk is increased by those who are not given a medication regimen to treat ADHD symptoms (Wilens et al, 2006).

### ***Etiology of ADHD***

***Environmental Theories.*** Research of the 1970's and 1980's focused upon various environmental factors and toxins as contributing to the development of ADHD: lead exposure, food allergies, or allergies to food additives and dyes (Barkley, 1997). In 1973, Benjamin Feingold, M.D. proposed that salicylates, artificial colors and artificial flavors caused hyperactivity in children (Barkley, 2007). To treat or prevent this condition, the "Feingold Diet" required that a diet free of these chemicals, but has fallen out of favor due to lack of empirical evidence (Biederman, 2005).

Lead contamination can cause symptoms that are characteristic of ADHD (Rice, 2000), but fail to account for the vast majority of children, adolescents and adults who are diagnosed with ADHD (Biederman, 2005). Furthermore, many individuals who are

exposed to lead or suffer lead poisoning do not develop ADHD. Other proposed environmental etiologies include: excessive sugar intake, excessive television/videogame viewing, and the influences of our current cultural tempo (Barkley, 2007). These theories, however, have gained little scientific support.

***Familial Influences.*** Familial stress and poor child rearing have come under investigation as etiological factors of ADHD (Barkley, 2007). It has been theorized that children who came from a chaotic home environment or homes where there has been family loss, family breakdown, and/or disruption in early bonding had higher incidences of ADHD (Barkley, 1997). Parental conflict, decreased family cohesion, and exposure to familial psychopathology are more common among individuals diagnosed with ADHD (Biederman, 2005; Schoechlin & Engel, 2005). These differences, however, could reflect the effects of heredity. That individuals with ADHD may be more likely to relate in a manner that creates increase conflict within the home.

***Genetics.*** There is substantial evidence for the heritability of ADHD (Biederman, 2005), and it is estimated that ADHD has the highest genetic heritability among the neurobehavioral disorders (Schultz et al, 2005; Krause et al, 2006). Children of parents with ADHD, exhibit a two to eight-fold increase risk for ADHD (Clarke, Heussler, & Kohn, 2005; Biederman, 2005). Current research indicates that 70 to 80 percent of the phenotypic variation in ADHD is accounted for by genetic factors (Schultz et al, 2005; Banaschewski et al, 2005). There is a concordance rate of 11 to 32 percent among biological siblings, a concordance rate of 29 to 38 percent among dizygotic twins, and a 57 to 82 percent incidence among monozygotic twins for a diagnosis of ADHD (Anastopoulous & Shelton, 2001; Barkley, 2007).

***Prenatal and Perinatal Events.*** Pregnancy and delivery complications (toxemia, eclampsia, poor maternal health, fetal distress and low birth weight) are more commonly found among individuals diagnosed with ADHD (Biederman, 2005). Recent studies have focused on maternal smoking during pregnancy. Nicotine seems to influence levels of norepinephrine and dopamine, in the developing fetal brain, by stimulating the dopamine transporters (Krause et al, 2006; Pliszka, 2004).

***Neurochemistry.*** Research has reported abnormalities in the monoaminergic systems, involving the neurotransmitters dopamine and norepinephrine (Krause et al, 2006). Dopamine was the initial candidate for investigation, because of the assumed dopamine-agonistic action of the stimulant drugs, but current studies have emphasized the interaction of dopaminergic and noradrenergic neurotransmitter pathways in the etiology of ADHD (Clarke, Heussler & Kohn, 2005; Biederman, 2005).

The dopamine and norepinephrine pathways in the frontal cortex play critical roles in attention, organization, planning and motivation (Berridge et al, 2006). Thus, it is theorized that deficits of dopamine and norepinephrine, in the frontal cortex-basal ganglia circuit, result in inattention, difficulty focusing, and decreased motivation, planning and organization (Lydon & El-Mallakah, 2006). The nigrostriatal dopamine pathway is implicated in motor activity (Scahill, Carroll, & Burke, 2004), and decreased dopamine activity in this pathway is associated with hyperactivity and impulsivity (Barkley, 2007).

***Neuroanatomy.*** Research of the last two decades has focused on the neurobiological origins of ADHD (Banaschewski et al, 2005; Krause et al, 2006). It is theorized that ADHD has a neurological-developmental basis as exhibited by: symptoms

that persist over time, association with other developmental disorders (i.e. learning disabilities, language disorders, motor abnormalities and lower IQ) and relative improvement by stimulant medication (Biederman, 2005).

Several studies have illustrated decreased blood flow “to the prefrontal regions and the pathways connecting these regions to the limbic system” in individuals with ADHD (Barkley, 1997, p. 32). The blood flow deficits, further, were decreased with the administration of stimulant medication (Anastopoulous & Shelton, 2001). Studies involving Magnetic Resonance Imaging (MRI) have shown reduced brain activity involving the prefrontal lobe (Barkley, 2007). Positron Emission Tomography (PET) has illustrated reduced prefrontal cortex metabolism in adults with ADHD (Wilens, Biederman, & Spencer, 2002).

Current studies using functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) have revealed reduced brain volumes in cerebellum, caudate, prefrontal lobe, and rostral corpus callosum in adults diagnosed with ADHD (Clarke, Heussler, & Kohn, 2005; Biederman, 2005; Schoechlin & Engel, 2005). Single photon emission computed tomography (SPECT) and fMRI studies have also found abnormal brain activation patterns during tasks of sustained attention and response inhibition, particularly in the frontal lobes of the brain (Banaschewski et al, 2005; Krause et al, 2006).

*Neurocognitive Deficits.* At the present time, neuropsychological assessment of ADHD in adulthood is in its infancy (Dowson et al, 2004). The evaluation of ADHD is considered valid when direct history and observation data are obtained, but direct observation of an adult at a work or educational setting is often not possible (Barkley,

2007). Neurocognitive studies of ADHD have focused upon vigilance, sustained attention, signal detection, working memory, processing speed and set shifting (Dowson et al, 2004). Studies have demonstrated difficulties with sustained attention, selective attention and set-shifting (Nigg et al, 2002).

***Executive Functioning.*** Boonstra et al (2005) conducted a meta-analytic review of thirteen studies, utilizing the performance on measures of executive function, in adults with ADHD and adult controls. The review surveyed studies that utilized DSM-IV or DSM-III-R criteria to diagnose adult ADHD, and effect sizes had to be immediately discernable from the paper or direct author contact. The executive functioning measures surveyed included: the Controlled Oral Word Association (COWAT), Continuous Performance Test (CPT), WAIS Digit Span (DS), Stroop Color Word Test (Stroop) and Trailmaking Test (TMT).

Results of the meta-analytic review indicated that the core deficit in ADHD might not be confined to executive functioning. Additionally, the authors concluded that executive functioning deficits are not unique to ADHD, and have been implicated in a variety of other psychiatric and developmental disorders. Results evidenced cognitive set-shifting difficulties in ADHD and deficits in working memory. Boonstra et al (2005) proposed a “general slowing on more cognitive responses” as contributing to adult ADHD, and argued that slower cognitive processing might account for the inconsistent performances of individuals with ADHD groups across studies (Riccio et al, 2004; Nigg, 2005).

Another, recent meta-analysis found significant deficits in various executive functioning domains among adults diagnosed with ADHD: verbal memory, focused

attention, sustained attention, abstract verbal problem solving and working memory (Schoechlin & Engel, 2005). Executive functioning deficits persist, even when controlling for comorbid diagnoses in adult ADHD (Clarke, Heussler, & Kohn, 2005). A recent study by Gualtieri and Johnson (2006) surveyed 175 individuals with ADHD between the ages of ten and twenty-nine, and results yielded deficits in executive control including: reaction time, psychomotor speed, reaction time, cognitive flexibility and attention.

Studies suggest diffuse cognitive dysfunction among adults diagnosed with ADHD (Gualtieri & Johnson, 2006). Thus, there is variability among the noted executive functioning deficits, or rather, a ‘consistent inconsistency’ (Boonstra et al, 2005, p. 1104). Maturation may account for the variability noted among executive functioning abilities: as children and adolescents with ADHD mature, they learn how to compensate for executive functioning deficits (Gualtieri & Johnson, 2006). Such cognitive strategies permit the individual to engage in more complex thought and behavioral processes, but are inefficient and inconsistent for problem-solving (Boonstra et al, 2005). More research is needed to establish the specificity, duration and intensity of executive functioning deficits in adult ADHD (Banaschewski et al, 2005).

In consideration of the early onset and consistency of symptoms associated with ADHD, “present research has focused on central nervous system (CNS) substrates” of ADHD; particularly in the frontal lobes of the brain (Reeve & Schandler, 2001). The presumption of a neurophysiological etiology for ADHD, however, was first proposed in 1947 by Strauss and Lehitnen in their publication of *Psychopathology and Education of the Brain Injured Child* (Nigg, 2005).

Executive functioning “is a relatively vague concept often referring to a myriad of abilities, including inhibition, planning and strategy development, future-directed behavior, persistence, and flexibility of action . . .” (Barkley et al, 2001, p. 542).

Historically, the construct of EF has been derived from analysis of damage to the prefrontal lobe of the human brain (Wise, Murray, & Gerfen, 1996). The construct of EF is intended to capture the psychological abilities the impairment of which is presumed to underlie these manifest deficits (Nigg, 2005).

### ***Barkley’s Theory of Behavioral Inhibition***

One of the prominent theorists in the field, Russell Barkley (1997), theorizes that Behavioral Inhibition permits a delay in one’s behavior, and that this delay is necessary for an individual to engage in executive functioning (Wodushek & Neumann, 2003). Behavioral Inhibition, according to Barkley, permits the individual to think before taking action (Gualtieri & Johnson, 2006). Barkley points out that Behavioral Inhibition does not necessarily directly cause self-directed actions (Barkley, 1997), but rather, provides the necessary delay during which the four executive functions can operate and guide the individual’s motor behavior (Barkley, 1997; Gualtieri & Johnson, 2006). Barkley’s theory, therefore, conceptualizes ADHD as a disorder of performance, rather than skill or knowledge (Barkley, 2007; Wilens et al, 2005); individuals with ADHD may know what behavior is or is not appropriate in particular circumstances, but cannot inhibit their behavior long enough for the executive functions to operate and guide behavior (Wodushek & Neumann, 2003).

A recent meta-analysis found significant deficits in various executive functioning domains among adults diagnosed with ADHD: verbal memory, focused attention,

sustained attention, abstract verbal problem solving and working memory (Schoechlin & Engel, 2005). Executive functioning deficits persist, even when controlling for comorbid diagnoses in adult ADHD (Clarke, Heussler, & Kohn, 2005). A recent study by Gualtieri and Johnson (2006) surveyed 175 individuals with ADHD between the ages of 10 and 29, and results yielded deficits in executive control including: reaction time, psychomotor speed, reaction time, cognitive flexibility and attention.

Recent findings suggest diffuse cognitive dysfunction among adults diagnosed with ADHD (Gualtieri & Johnson, 2006). Thus, there is variability among the noted executive functioning deficits, or rather, a ‘consistent inconsistency’ (Boonstra et al, 2005, p. 1104).

In the absence of compensatory strategies, these core deficits can directly or indirectly result in a chain of continued cognitive and behavioral impairments. . . result in symptoms maintenance and exacerbation, and functional impairment” (Safren et al, 2005, p. 838).

Maturation may account for the variability noted among executive functioning abilities: as children and adolescents with ADHD mature, they learn how to compensate for executive functioning deficits (Gualtieri & Johnson, 2006). Such cognitive strategies permit the individual to engage in more complex thought and behavioral processes, but are inefficient and inconsistent for problem-solving (Boonstra et al, 2005). More research is needed to establish the specificity, duration and intensity of executive functioning deficits in adult ADHD (Banaschewski et al, 2005).

Evidence in support of Barkley’s theory is widespread, and deficits are clearly evident on several tasks that require response inhibition, but findings are inconsistent

(Douglas, 2005). A recent study by Van Mourik, Oosterlaan Sergeant (2005) reviewed studies using the Stroop task and concluded that it did not reliably differentiate groups differing in attentional ability. The majority of the evidence suggests slower rather than faster responding in ADHD, contrary to what such a theory would predict (Cornish et al, 2008).

Studies suggest diffuse cognitive dysfunction among adults diagnosed with ADHD, and results are inconsistent (Gualtieri & Johnson, 2006; Boonstra et al, 2005, p. 1104). Furthermore, the higher-order abilities that are conceptualized as “executive functioning” rely upon basic cognitive factors including: selective attention, sustaining attention, working memory and processing speed (Barkley, 2007; Biederman, 2005). Thus, a deficit in performance on an executive functioning test may reflect an impairment in any one (or more) of these underlying cognitive factors (Wilding, 2005).

### ***Visual Memory***

Visual memory refers to one’s capacity to recall visual images from previously viewed objects (Fan et al, 2005). There is little recent research looking specifically at visual memory of individuals with ADHD but rather, studies have included memory under the conceptualization of “working memory” in studies of executive functioning (Barkley, 2007). This is problematic, because it does not explore different facets of memory that are necessary for executive functioning. Current studies, however, suggest that there may be significant weaknesses in working memory for adults diagnosed with ADHD (Messing et al, 2006; Rodriguez-Jimenez et al, 2006). A recent study by Gropper and Tannock (2009) found significant weaknesses in the visual spatial abilities of college students diagnosed with ADHD.

### ***Visual Processing Speed***

Visual processing speed refers to one's capacity to receive and process visual information, in order to formulate a reaction in real-time (Fox, 2009). This ability permits an organism to navigate through its environment with in a timely fashion (Posner, 1990). Current studies have consistently found significantly lower processing speed among children and adolescents with ADHD (Oram-Cardy et al, 2009; Mayes et al 2009; Fox, 2009; Marchetta et al, 2008; Muller et al, 2007). This domain has been controversial in the study of ADHD, because it has been proposed that processing speed difficulties are easy to fake (Harrison et al, 2007). This may be evident among populations who are seeking academic accommodations, and wish to fake neuropsychological symptoms that are consistent with a diagnosis of ADHD (Harrison et al, 2007).

### ***Attention***

Current literature indicates discrepancies in selective attention with studies concluding that individuals with ADHD are more likely to be distracted by irrelevant stimuli (Douglas, 2005; Gaultieri & Johnson, 2006), whereas other studies have not found significant differences among individuals with ADHD and healthy controls (Barkley, 2007). The current literature on ADHD, however, is unclear about the diagnostic criteria for inattention (Douglas, 2005; Cornish et al, 2005), and there are few findings that distinguish among initiating, sustaining, selecting and shifting attentional set (Barkley, 2007).

It also needs to be considered that attentional difficulties are a symptom in many psychiatric and medical disorders (Teicher, 2009). The current diagnostic criteria of

inattention in ADHD, therefore, may be of little help in differential diagnosis because of its ubiquity across a number of other medical and psychiatric diagnoses (Teicher, 2009; Barkley, 2007).

### ***Selective Visual Attention***

Selective visual attention refers to one's capacity to maintain a behavioral or cognitive set in the face of distracting or competing stimuli (Mullane & Klein, 2008). Thus, the individual is required to filter-out irrelevant stimuli, in order to focus on the task at hand (Barkley, 2007). In a recent literature review, Mullane and Klein (2008) reviewed seven studies of visual attention in children. Results indicated that children diagnosed with ADHD were less efficient on tasks of serial search that require selective visual attention (Mullane & Klein, 2008). In comparison to controls, children with ADHD have exhibited deficits in selective attention (Tsal et al, 2005; Tucha et al, 2008; Kilic et al, 2007), or "require more resources to execute the task and were more vulnerable to distraction" (Mason et al, 2005). It is important to note that most research in this domain focuses upon children and adolescents (Mullane & Klein, 2008), and exploration of selective visual attention in adults is needed.

### ***Posner's Theory of Selective Attention***

Michael Posner's theory evolved to examine selective attention as a neurological system (Posner & Raichle, 1994), and he developed the Attention Network Theory (Posner & Petersen, 1990) in conjunction with neuroimaging studies (Posner & Rothbart, 2007). Within the Attention Network Theory, three neural systems of visual attention are delineated. These systems are referred to as the Orienting, Executive and Alerting Networks (Posner & Rothbart, 2007). The Orienting Network directs attention to sensory

events and selects locations for additional processing (Posner & Rothbart, 2007). Current neuroanatomical studies have implicated that superior parietal cortex, temporal parietal junction, and superior colliculus as critical to orienting (Fan et al, 2005). The Executive Network is defined as the effortful control of attention and behavior, and the primary function is theorized to be filtering out interference that is created by two competing stimuli (Posner & Rothbart, 2007). It is hypothesized that the anterior cingulate gyrus and prefrontal cortex underlie the Executive Network (Fan et al, 2005). The Alerting Network is responsible for regulating and maintaining an individual's level of alertness (Berger & Posner, 2000; Posner & Rothbart, 2007). Current studies suggest that the right frontal lobe, right parietal lobe and locus coeruleus may be involved in alerting (Fan et al, 2005; Mason et al, 2003).

Traditionally, visual search tasks have been utilized to assess the mechanisms mediating selective attention in vision (Mason et al, 2003). Such tasks require the subject to detect a pre-specified target item among distractor items (Landau & Bentin, 2008). Search efficiency is measured in terms of the effects of the number of distractors present, speed of performance and accuracy (Mason et al, 2003). ADHD has been associated with intact orienting attention, but significant weaknesses in alerting and executive attention (Berger & Posner, 2000). Continuous Performance Tasks have been used to study the alerting system in ADHD (Nigg, 2006). During such tasks, a participant is told to respond to certain stimuli while withholding a response to other stimuli. Alerting is evaluated according to the individual's ability to discriminate between targets and non-targets; with smaller values indicating poorer performance. The general finding of continuous performance tasks is that performance decreases over time, and weaker

sustained attention is inferred with a decrement in performance is more pronounced (Mullane & Klein, 2008). The current research suggests that an alerting attention deficit, or weaker sustained attention, is present in ADHD (Nigg, 2006).

Orienting of attention is often examined using visual orienting tasks, which requires a participant to detect targets based upon cues (Douglas, 2005). When an invalid cue is present, the participant must disengage their attention from the incorrect location and shift attentional set to locate the appropriate target (Mullane & Klein, 2008).

Current research indicates that there is limited evidence of a clinically-significant orienting attentional deficit in ADHD (Huang-Pollock & Nigg, 2003). The executive attention network is defined as resolving interference that occurs when two competing stimuli are activated simultaneously (Berger & Posner, 2000; Posner & Rothbart, 2007). The executive attention network has been measured with tasks that require the individual to differentiate between irrelevant and relevant stimuli (Fan et al, 2003). More time is often “required to respond to the target, because the individual must resolve the interference that was created by the two response tendencies. The difference in response time, for irrelevant and relevant stimuli, is referred to as the congruency effect (Ridderinkhoff & van der Stelt, 2000). Larger congruency effects are indicative of deficits in executive attention, and studies suggest poor executive attention in ADHD (Hornack & Riccio, 2004).

### ***Chapter Summary: Implications of the Literature***

This review of the literature has many implications for the current research study. The current studies in the field are converging on executive dysfunction as the core deficit in ADHD, in children and adolescent populations, and Barkley’s theory of

Behavioral Inhibition has become a popular model to conceptualize this disorder. Yet, many studies of executive functioning tend to disregard, or perhaps overlook, how cognitive abilities (e.g. attention, working memory, etc.) form the foundation for the higher-order abilities believed to be representative of executive functioning. Critics of Barkley's theory argue, however, that, the aspects of executive functioning are vaguely defined to provide an adequate characterization of the complex strategic and metacognitive processes involved.

It should also be considered that, although ADHD is defined as an "attentional deficit," attentional difficulties are also associated with other psychiatric and medical diagnoses including: sleep problems, seizure disorders, medication side effects, visual and/or hearing problems, traumatic brain injury, substance use/abuse, prenatal exposure to substances, learning disabilities, Posttraumatic Stress Disorder, Anxiety Disorders, Bipolar Disorder and Mood Disorders (Teicher et al, 2008; Barkley, 2007; Sokol et al, 2003). The current diagnostic considerations of inattention and executive functioning in ADHD, therefore, may be of little help in differential diagnosis because of the ubiquity of the symptoms across a number of other medical and psychiatric diagnoses (Teicher, 2009; Barkley, 2007).

Reflecting upon the work of Michael Posner (1980), it is possible that by revisiting the concept of selective attention, and other cognitive processes that support selective attention, diagnostic indicators that are specific to ADHD could be reconceptualized.

## CHAPTER THREE

This chapter presents the methodology of the proposed study. It begins with a description of the sample, procedure, review of instruments and the statistical analysis.

### METHOD

#### *Participants*

Thirty-six participants were recruited from a sample of male undergraduate students, ages 18 to 22, at Northeastern University. Two participants were dropped from the study: one due to alcohol abuse that was affecting the subject's functioning. The other participant was dropped due to a co-morbid neurodevelopmental diagnosis (Asperger's Disorder) that would have confounded the subject's performance. This study recruited eleven undergraduate males who were diagnosed with ADHD (ADHD group), twelve undergraduate males who were diagnosed with Bipolar Disorder (Bipolar group), and eleven undergraduate males who had never been diagnosed with ADHD or Bipolar Disorder (Control group). The age of participants ranged from 18 to 22 years ( $\mu=20.53$ ,  $SD=1.331$ ), and grade-point average ranged from 2 to 3.9 ( $\mu= 3.007$ ,  $SD = .42.6$ ). Results of the SCID-I revealed that 8 participants (23.5% of the sample) did not meet criteria for any psychiatric diagnosis, and 14 participants (41.2% of the sample) were not taking any medications at the time of this study. Demographic characteristics of the entire sample are presented in Tables 2, 3, 4, 5 and 6.

Table 2

**Race and Ethnicity for the Entire Sample**


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	<u>Race and Ethnicity (N=34)</u>				
	<u>ADHD</u>	<u>Bipolar Disorder</u>	<u>Control</u>	<u>Total Sample</u>	
	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>%</u>
<u>Caucasian</u>	7	8	10	25	73.5
<u>Biracial</u>	1	1	1	3	8.8
<u>Asian</u>	2	1	0	3	8.8
<u>Middle Eastern</u>	1	0	0	1	2.9
<u>African American</u>	0	1	0	1	2.9
<u>Hispanic/Latino</u>	0	1	0	1	2.9

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**Table 3****Academic Year for the Entire Sample**


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	<u>Academic Year (N=34)</u>				
	<u>ADHD</u>	<u>Bipolar Disorder</u>	<u>Control</u>	<u>Total Sample</u>	
	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>%</u>
<u>Freshman</u>	1	2	2	5	14.7
<u>Sophomore</u>	3	2	2	7	20.6
<u>Middler</u>	4	3	2	9	26.5
<u>Junior</u>	0	4	1	5	14.7
<u>Senior</u>	3	1	3	7	20.6
<u>Graduate</u>	0	0	1	1	2.9

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**Table 4****Academic Major for the Entire Sample**


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	<u>Academic Major (N=34)</u>				
	<u>ADHD</u>	<u>Bipolar Disorder</u>	<u>Control</u>	<u>Total Sample</u>	
	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>%</u>
<u>Psychology</u>	2	2	1	5	14.7
<u>Communications</u>	3	1	1	5	14.7
<u>Civil Engineering</u>	0	1	2	3	8.8
<u>Business Mgt.</u>	1	0	1	2	5.9
<u>Computer Eng.</u>	1	0	1	2	5.9
<u>Mechanical Eng.</u>	0	1	1	2	5.9
<u>English</u>	0	2	0	2	5.9
<u>Athletic Training</u>	0	2	0	2	5.9
<u>Finance</u>	1	0	0	1	2.9
<u>Environ. Sci.</u>	1	0	0	1	2.9
<u>Undeclared</u>	1	0	0	1	2.9
<u>Behavioral Neurosci.</u>	1	0	0	1	2.9
<u>Music Tec. &amp; Comp.</u>	0	0	1	1	2.9
<u>Industrial Eng.</u>	0	0	1	1	2.9
<u>Journalism</u>	0	0	1	1	2.9
<u>Political Science</u>	0	0	1	1	2.9

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**Table 4 (Continued)****Academic Major for the Entire Sample**


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	<u>Academic Major (N=34)</u>			
	<u>ADHD</u>	<u>Bipolar Disorder</u>	<u>Control</u>	<u>Total Sample</u>
<u>Mathematics</u>	0	1	0	1 2.9
<u>Physics</u>	0	1	0	1 2.9
<u>History</u>	0	1	0	1
2.9				

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**Table 5****Psychiatric Diagnosis for the Entire Sample**


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	<u>Psychiatric Diagnoses (N=34)</u>				<u>Total Sample</u>	
	<u>ADHD</u>	<u>Bipolar Disorder</u>	<u>Control</u>	<u>N</u>	<u>%</u>	
<u>No Diagnosis</u>	0	0	8	8	23.5	
<u>ADHD</u>	5	0	0	5	14.7	
<u>ADHD, MDD<sup>1</sup></u>	2	0	0	2	5.9	
<u>ADHD, CA<sup>2</sup></u>	1	0	0	1	2.9	
<u>ADHD, CA, OCD<sup>3</sup></u>	1	0	0	1	2.9	
<u>ADHD, AD-R<sup>4</sup>, CA</u>	1	0	0	1	2.9	
<u>ADHD, PD<sup>5</sup>, GAD<sup>6</sup></u>	1	0	0	1	2.9	
<u>AD-P<sup>7</sup>, CA</u>	0	0	1	1	2.9	
<u>BPI-A<sup>8</sup></u>	0	3	0	3	8.8	
<u>BPI-A, AD-P, CA</u>	0	1	0	1	2.9	
<u>BPI-A, CA</u>	0	1	0	1	2.9	
<u>BPI-B<sup>9</sup></u>	0	1	0	1	2.9	

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**Table 5 (Continued)**<sup>1</sup> Major Depressive Disorder, recurrent, moderate<sup>2</sup> Cannabis Abuse<sup>3</sup> Obsessive Compulsive Disorder<sup>4</sup> Alcohol Dependence, in full remission<sup>5</sup> Panic Disorder without Agoraphobia<sup>6</sup> Generalized Anxiety Disorder<sup>7</sup> Alcohol Dependence in partial remission<sup>8</sup> Bipolar Disorder I, most recent episode depressed, moderate<sup>9</sup> Bipolar Disorder I, most recent episode manic, moderate

**Psychiatric Diagnosis for the Entire Sample**


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<u>Psychiatric Diagnoses (N=34)</u>					
	<u>ADHD</u>	<u>Bipolar Disorder</u>	<u>Control</u>	<u>Total Sample</u>	
	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	
<u>BPI-B, AA</u> <sup>10</sup>	0	1	0	1	2.9
<u>BPI-B, AA, CA</u>	0	1	0	1	2.9
<u>BPI-B, CA</u>	0	1	0	1	2.9
<u>BPI-B, AD-R</u>	0	1	0	1	2.9
<u>BPI-C</u> <sup>11</sup> , <u>CDep</u> <sup>12</sup> , <u>PTSD</u>	0	1	0	1	2.9
<u>BPI-A, CA, AA</u>	0	1	0	1	2.9
<u>MDD, PD, ANX-NOS</u> <sup>13</sup>	0	0	1	1	2.9
<u>OCD</u>	0	0	1	1	2.9

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<sup>10</sup> Alcohol Abuse

<sup>11</sup> Bipolar Disorder I, most recent episode manic, severe without psychotic features

<sup>12</sup> Cannabis Dependence

<sup>13</sup> Anxiety Disorder, NOS

**Table 6****Medications for the Entire Sample**

	<u>Medications (N=34)</u>				
	<u>ADHD</u>	<u>Bipolar Disorder</u>	<u>Control</u>	<u>Total Sample</u>	
	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>%</u>
<u>None</u>	3	1	10	14	41.2
<u>Albuterol</u> <sup>14</sup>	0	0	1	1	2.9
<u>Ritalin</u>	2	0	0	2	5.9
<u>Adderall</u>	1	0	0	1	2.9
<u>Vyvanse</u>	1	0	0	1	2.9
<u>Concerta</u>	1	0	0	1	2.9
<u>Zyprexa</u>	0	1	0	1	2.9
<u>Rit, Cel</u> <sup>15</sup>	1	0	0	1	2.9
<u>Add, Cel</u> <sup>16</sup>	1	0	0	1	2.9
<u>Rit, P, At, Lor</u> <sup>17</sup>	1	0	0	1	2.9
<u>Lith, L</u> <sup>18</sup>	0	1	0	1	2.9
<u>Lith, Risp</u> <sup>19</sup>	0	1	0	1	2.9
<u>Lith, Abilify</u> <sup>20</sup>	0	1	0	1	2.9

<sup>14</sup> Albuterol Inhaler<sup>15</sup> Ritalin, Celexa<sup>16</sup> Adderall, Celexa<sup>17</sup> Ritalin, Provigil, Ativan, Lorazepam<sup>18</sup> Lithium, Lamictal<sup>19</sup> Lithium, Risperdal<sup>20</sup> Lithium, Abilify

**Table 6 (Continued)****Medications for the Entire Sample**


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	<u>Medications (N=34)</u>				
	<u>ADHD</u>	<u>Bipolar Disorder</u>	<u>Control</u>	<u>Total Sample</u>	
	<u>N</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>%</u>
<u>Lam, Dep</u> <sup>21</sup>	0	1	0	1	2.9
<u>Lith, Buspar</u> <sup>22</sup>	0	1	0	1	2.9
<u>Top, Lor</u> <sup>23</sup>	0	1	0	1	2.9
<u>Lith, Ab, Cel</u> <sup>24</sup>	0	1	0	1	2.9
<u>Dep, Teg, Pax</u> <sup>25</sup>	0	1	0	1	2.9
<u>Dep, A, Lam, Lu</u> <sup>26</sup>	0	1	0	1	2.9
<u>Dep, Ris, Lex, A</u> <sup>27</sup>	0	1	0	1	2.9

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<sup>21</sup> Lamictal, Depakote

<sup>22</sup> Lithium, Buspar

<sup>23</sup> Topamax, Lorazepam

<sup>24</sup> Lithium, Abilify, Celexa

<sup>25</sup> Depakote, Tegretol, Paxil

<sup>26</sup> Depakote, Ativan, Lamictal, Luvox

<sup>27</sup> Depakote, Risperdal, Lexapro, Ativan

***Ascertainment of Young Adults for the ADHD Group.*** Participants diagnosed with ADHD, were recruited through the Disability Resource Center (DRC) at Northeastern University. Additionally, posters were displayed on the Northeastern University Campus (Please refer to Appendix A).

***Screening of Participants for the ADHD Group.*** Prior to their entrance into the study, each participant was asked to participate in the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I). Then, each participant was asked to complete two self-report measures of ADHD symptoms: the Childhood Symptoms Scale—Self Report and the Current Behavior Scale—Self Report. Each participant was included in the study if he demonstrated: 1.) No evidence of a Bipolar I or Bipolar II diagnosis using the SCID-I, 2.) A clinically significant score on The Childhood Symptoms Scale—Self Report and 3.) A clinically significant score on The Current Behavior Scale—Self Report.

***Medication Issues Concerning Participants in the ADHD Group.*** Participants diagnosed with ADHD were asked to discontinue their medications on the day of testing only.

***Ascertainment of Young Adults for the Bipolar Disorder Group.*** Participants diagnosed with bipolar disorder were recruited through the Disability Resource Center (DRC) at Northeastern University. Additionally, posters were displayed on the Northeastern University Campus (Please refer to Appendix B).

***Screening of Participants for the Bipolar Disorder Group.*** Prior to their entrance into the study, each participant was asked to participate in the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I). Then, each participant was asked to complete two self-report measures of ADHD symptoms: the Childhood

Symptoms Scale—Self Report and the Current Behavior Scale—Self Report. Each participant was included in the study if he demonstrated: 1.) Evidence of a Bipolar I or Bipolar II diagnosis using the SCID-I, 2.) A non-clinical score on The Childhood Symptoms Scale—Self Report and 3.) A non-clinical score on The Current Behavior Scale—Self Report.

*Medication Issues Concerning Participants in the Bipolar Disorder Group.* The participants, diagnosed with Bipolar Disorder, were not excluded because they were using psychotropic medications, and were not asked to discontinue the use of medications at the time of testing.

*Ascertainment of Young Adults for the Control Group.* Participants who had never been diagnosed with ADHD or Bipolar Disorder were recruited through class announcements and posters displayed on the Northeastern University campus (Please refer to Appendix C).

*Screening of Participants for Control Group.* Prior to their entrance into the study, each participant was asked to participate in the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I). Then, each participant was asked to complete two self-report measures of ADHD symptoms: the Childhood Symptoms Scale—Self Report and the Current Behavior Scale—Self Report. Each participant was included in the study if he demonstrated: 1.) No evidence of a Bipolar I or Bipolar II diagnosis using the SCID-I, 5.) A non-clinical score on The Childhood Symptoms Scale—Self Report and 6.) A non-clinical score on The Current Behavior Scale—Self Report.

***Exclusionary Criteria***

Participants were excluded from the study if they demonstrated: 1.) Any psychiatric hospitalizations within the last six months, 2.) Symptoms of psychosis within the last six months, and 3.) Current substance abuse problems that were affecting day to day functioning. Participants with major sensorimotor handicaps (e.g. deafness and blindness), medical illnesses (including hepatic, renal, gastroenterologic, respiratory, cardiovascular, endocrinologic, neurologic, or immunologic, or hematologic diseases) were also excluded from the study. Participants, who could not speak English fluently, were also excluded from the study. There were no exclusionary criteria concerning race, ethnicity, religion or socioeconomic status.

***Procedure***

Thirty-six participants were recruited from a sample of male undergraduate students, ages 18 to 22, at Northeastern University. Two participants were dropped from the study: one due to alcohol abuse that was affecting the subject's day to day functioning. The other participant was dropped due to a co-morbid neurodevelopmental diagnosis (Asperger's Disorder) that would have confounded the subject's performance. This study recruited eleven undergraduate males who were diagnosed with ADHD (ADHD group), twelve undergraduate males who were diagnosed with Bipolar Disorder (Bipolar group), and eleven undergraduate males who had never been diagnosed with ADHD or Bipolar Disorder (Control group).

Once the study was explained, and informed consent was obtained, each participant was asked to participate in the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I). Then, each participant was asked to complete two self-report

measures of ADHD symptoms: the Childhood Symptoms Scale—Self Report and the Current Behavior Scale—Self Report. Once these assessments were complete, it was determined whether the participant was eligible for the study.

All eligible participants were assessed using an identical diagnostic and neuropsychological assessment battery. The study was conducted in room 367 of the Snell Library on the Northeastern University Campus. It took approximately 1.5 hours to administer all measures. The order of the measures was counterbalanced across the three groups, to reduce the threat of order effects to the internal validity of the study.

### ***Reliability of SCID-I Ratings***

All thirty-six SCID-I results were reviewed with a diagnostic expert. The review determined that two participants needed to be dropped from the study: one due to alcohol abuse that was affecting the subject's day to day functioning. The other participant was dropped due to a co-morbid neurodevelopmental diagnosis (Asperger's Disorder) that would have confounded the subject's performance.

### ***Protection of Human Subjects***

All study procedures were reviewed and approved by the Institutional Review Board and Human Subjects Committee of Northeastern University.

### ***Ethical Concerns***

A Counseling and Substance Abuse Referral sheet was provided to all participants who reported experiencing emotional or behavioral difficulties or a problematic use of substances.

***Confidentiality***

Participants were informed that individual results would be kept completely confidential. The participants were assured anonymity and confidentiality, as all data is identified by number only. To protect confidentiality, all records are kept in a locked file cabinet at the Department of Counseling and Applied Educational Psychology. Consent forms are separate from testing results. One researcher administered all measures.

***Informed Consent***

Participation was voluntary, and an individual's information was included in the study only if he gave written, informed consent. This investigator obtained informed consent by reading and reviewing an IRB approved consent form with the participant in person, and obtaining a signature. Participants were told that they could stop their involvement at any time during the study without penalty.

***Inducement to Participate***

Participants were entered into a raffle for \$150.

***Measures***

***Childhood Symptoms Scale—Self Report Form.*** According to current DSM-IV criteria, a diagnosis of ADHD, combined type requires symptoms of ADHD present before seven years of age (American Psychiatric Association, 2000). Retrospective childhood symptomatology of ADHD was assessed using the Childhood Symptoms Scale—Self-Report Form. The Childhood Symptoms Scale is a brief, self-report screening questionnaire that was constructed by Barkley and Murphy in 1998 (Barkley & Murphy, 2006). Norms were based on a sampling of 720 adults in central Massachusetts renewing their driver's license (Barkley & Murphy, 1996). In this study, three age

groups were created: 17-29, 30-49, and 50+ years. Requiring that DSM-IV diagnostic thresholds be met for both current and childhood symptoms, the prevalence of adult ADHD was found to be 1.3 percent for the Inattentive Type, 2.5 percent for the Hyperactive-Impulsive Type and 0.9 percent for the Combined Type (Barkley & Murphy, 1996). The internal reliability of this scale in a general population sample of 137 adults was .81 (Barkley & Murphy, 2006).

The Childhood Symptoms Scale consists of eighteen screening items, based on DSM-IV criteria for ADHD, that assess symptoms of ADHD that were present in childhood. Items are rated using a 4-point Likert scale (0 = never or rarely, 1 = sometimes, 2 = often, 3 = very often). Odd-numbered items assess frequency of inattentive symptoms and even-numbered items assess hyperactive/impulsive symptoms. Sixteen items ask adults to report the age of onset for ADHD symptoms and to denote how often their symptoms interfere with activities in social arenas like school, relationships, work, and the home. Fifteen additional questions address Oppositional Defiant Disorder (ODD) and Conduct Disorder comorbidity. The eighteen symptoms for ADHD are arranged so that the items pertaining to inattention are the odd-numbered items (e.g. 1, 3, etc.) and the items regarding hyperactive-impulsive symptoms are even-numbered items (e.g. 2, 4, etc.). If six or more clinical symptoms are endorsed, for either the impulsive or hyperactive-impulsive symptom categories, this score is considered to be clinically significant.

***Current Symptoms Scale–Self Report Form.*** The Current Symptoms Scale is a brief, self-report screening questionnaire that was constructed by Barkley and Murphy in 1998 (Barkley & Murphy, 2006). Norms were based on a sampling of 720 adults in

central Massachusetts renewing their driver's license (Barkley & Murphy, 1996). In this study, three age groups were created: 17-29, 30-49, and 50+ years. Requiring that DSM-IV diagnostic thresholds be met for current and childhood symptoms, the prevalence of adult ADHD was found to be 1.3 percent for the Inattentive Type, 2.5 percent for the Hyperactive-Impulsive Type and 0.9 percent for the Combined Type (Barkley & Murphy, 1996). The internal reliability of this scale in a general population sample of 137 adults was .81 (Barkley & Murphy, 2006).

The Current Symptoms Scale consists of 18 screening items, based on DSM-IV criteria for ADHD, to assess the current symptoms of ADHD that the student has experienced in adulthood. Items are rated using a 4-point Likert scale (0 = never or rarely, 1 = sometimes, 2 = often, 3 = very often). Odd-numbered items assess frequency of inattentive symptoms and even-numbered items assess hyperactive/impulsive symptoms. 10 items ask the individual to report the age of onset for ADHD symptoms and to denote how often their symptoms interfere with activities in social arenas like school, relationships, work, and the home. This is followed by eight questions that address Antisocial Personality Disorder comorbidity. The eighteen symptoms for ADHD are arranged so that the items pertaining to inattention are the odd-numbered items (e.g. 1, 3, etc.) and the items regarding hyperactive-impulsive symptoms are even-numbered items (e.g. 2, 4, etc.). If six or more clinical symptoms are endorsed, for either the impulsive or hyperactive-impulsive symptom categories, this score is considered to be clinically significant.

***The Digit Symbol—Coding Subtest.*** The Digit Symbol—Coding is a subtest of the Wechsler Adult Intelligence Scale—Third Edition (WAIS-III), and is one of the two

tests that comprise the processing speed index. In this test, the respondent learns a code in which each digit is represented by a symbol, and then tries to indicate the correct symbols for a series of digits as quickly and accurately as possible (Pearson Education, 1997). The test-retest reliability is in the .82 to .88 range (Lezak, 2004). The symbol search subtest contributes to the overall Processing Speed Index (PSI), which also includes that symbol digit subtest. The reliability coefficient for the PSI is .88. The split-half reliability of the PSI is .88, and the test-retest reliability of the PSI is .89.

***Rey-Osterrieth Complex Figure (ROCF).*** For the ROCF, participants are presented with a standard stimulus that they are asked to copy (copy condition) and then draw from memory immediately upon removal of the figure (immediate recall) and after a 5-minute delay (delayed recall). The scoring system includes an ordinal organization score that ranges from 1 to 13 and is based on 24 critical features for the copy condition and 16 criterion for the recall condition. Across several studies, interrater reliability for this scoring system has ranged from .87 to .96 (Bernstein & Waber, 1996).

***The Ruff 2 & 7 Test.*** The Ruff 2 & 7 Test was developed to measure two aspects of visual attention: sustained attention (ability to maintain consistent performance level over time) and selective attention (ability to select relevant stimuli while ignoring distractors). The test consists of a series of 20 trials of a visual search and cancellation task. The respondent detects and marks through all occurrences of the two target digits: "2" and "7." In the 10 Automatic Detection trials, the target digits are embedded among alphabetical letters that serve as distractors. In the 10 Controlled Search trials, the target digits are embedded among other numbers that serve as distractors. Correct hits and errors are counted for each trial and serve as the basis for scoring the test. Speed scores

reflect the total number of correctly identified targets (hits). Accuracy scores evaluate the number of targets identified in relation to the number of possible targets (Allen & Ruff, 2005). Test-retest reliability coefficients range from .94 to .98 for speed scores, and .73 to .89 for accuracy scores (Messinis et al, 2007).

***The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I).*** The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I), is a semi-structured interview for making the major DSM-IV Axis I diagnoses. Test-retest reliability coefficients range from .70 to 1.00 (First et al, 1997).

***Symbol Search Subtest.*** The Symbol Search is a subtest of the Wechsler Adult Intelligence Scale–Third Edition (WAIS-III), and is one of the two tests that comprise the processing speed index. In this test, the examinee scans a search group and indicates whether one of the two target symbols matches any of the five symbols in the search group in a specified time limit (Pearson Education, 1997). The test-retest reliability coefficient is .79 (Lezak, 2004). ). The symbol search subtest contributes to the overall Processing Speed Index (PSI), which also includes that symbol digit subtest. The reliability coefficient for the PSI is .88. The split-half reliability of the PSI is .88, and the test-retest reliability of the PSI is .89.

***Trail Making Test.*** The Trail Making Test is a widely-used test that requires a client to draw lines connecting consecutively numbered circles (Part A), followed by a similar task in which they draw lines connecting alternating numbered and lettered circles (Part B). Scores are based on the total time it takes to complete part A and part B. Most reports of reliability have been above .60, with some studies reporting .90 (Lezak, 2003).

***Data Analysis***

The study is a mixed effects design. A 3 x 5 Analysis of Variance (ANOVA) with repeated measures was conducted, to measure within and between interactions. A general power analysis was conducted using G\*Power 2 calculations (Erdfelder, Faul & Buchner, 1996). A sample size of 12 generates power = .9, effect size = .5, and alpha level = .05.

## CHAPTER FOUR

The purpose of the proposed study was to investigate the selective attention abilities of young adult males (aged 18 to 22 years), diagnosed with ADHD. More specifically, the study emphasized visual-spatial selective attention, visual memory and visual processing speed. The sample included young adult males who have been diagnosed with Attention–Deficit/Hyperactivity Disorder combined type (ADHD), a comparison group of young adult males who have been diagnosed with Bipolar Disorder, and a control group of young adults who have never been diagnosed with ADHD or Bipolar Disorder. The study utilized Posner’s Model of Visual-Spatial Attention to conceptualize the findings. There were three predictions. As compared to the Control and Bipolar Disorder Group: 1.) selective visual attention would be significantly lower in the ADHD group, 2.) visual memory would be significantly lower in the ADHD group, and 3.) visual processing speed would be significantly lower in the ADHD group.

## RESULTS

### *Alerting Attention Network*

A One-Way Analysis of Variance (ANOVA) was conducted to examine whether there were any statistically significant differences found among the groups on measures of alerting attention. It was hypothesized that individuals in the ADHD group would demonstrate significantly lower scores on speed of performance and accuracy on a selective attention test. This hypothesis was tested using the Total Speed, Automatic Detection Speed, and Control Search Speed of the Ruff Two & Seven Selective Attention Test. Means and Standard Deviations are presented in Tables 7 and 8.

**Table 7.**

**Means and Standard Deviations for the Alerting Attention Network using the Total Speed, Automatic Detection Speed and Control Search Speed of the Ruff Two & Seven Selective Attention Test.**

	ADHD ( <i>N</i> = 11)		Bipolar ( <i>N</i> = 12)		Control ( <i>N</i> = 11)	
	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<u><i>SD</i></u>
Total Speed	64.55	14.638	64.58	16.121	71.91	12.771
Auto. Det Speed	65.73	15.595	65.50	16.418	69.91	13.308
Cont. Search Speed	60.09	15.070	61.33	17.799	70.64	13.648

***Hypothesis 1: Alerting Attention Network.*** The hypothesis that individuals in the ADHD group would demonstrate significantly lower scores on Total Speed, Automatic Detection Speed, and Control Search Speed of the Ruff Two & Seven Selective Attention Test was not supported. A One-Way Analysis of Variance (ANOVA) revealed that there were no statistically significant differences found among the groups. Total Speed:  $F(2,31) = .938, p = .008$ . Automatic Detection Speed:  $F(2,31) = .298, p = .744$ . Controlled Search Speed:  $F(2,31) = 1.501, p = .239$ .

**Table 8.**

**Means and Standard Deviations for the Alerting Attention Network using the Automatic Detection Accuracy, Controlled Search Accuracy and Total Accuracy of the Ruff Two & Seven Selective Attention Test.**

	ADHD ( <i>N</i> = 11)		Bipolar ( <i>N</i> = 12)		Control ( <i>N</i> = 11)	
	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<u><i>SD</i></u>
Auto. Det. Acc.	65.91	21.769	59.92	18.637	61.27	16.032
Contr. Sear. Acc.	82.27	15.544	83.67	4.924	81.91	14.209
Total Accuracy	73.18	18.579	73.25	11.514	70.73	14.283

***Hypothesis 2: Alerting Attention Network.*** The hypothesis that individuals in the ADHD group would exhibit significantly higher error scores on the Automatic Detection Accuracy, Controlled Search Accuracy and Total Accuracy of the Ruff 2 & 7, was not supported. A One-Way Analysis of Variance (ANOVA) revealed that there were no statistically significant differences found among the groups. Automatic Detection Accuracy:  $F(2,31) = .311, p = .735$ . Controlled Search Accuracy:  $F(2,31) = .066, p = .936$ . Total Accuracy:  $F(2,31) = .103, p = .902$ .

***Orienting Attention Network***

A One-Way Analysis of Variance (ANOVA) was conducted to examine whether there were any statistically significant differences found among the groups on measures of orienting attention. It was hypothesized that individuals in the ADHD group would demonstrate significantly lower scores for time to complete and accuracy of responses on measure of orienting attention. This hypothesis was tested using accuracy of responses on the Digit Symbol subtest, and using total time to complete the Trail Making Test and Means and Standard Deviations are presented in Tables 9 and 10.

**Table 9.**

**Means and Standard Deviations for the Orienting Attention Network using the Digit Symbol subtest.**

	ADHD ( <i>N</i> = 11)		Bipolar ( <i>N</i> = 12)		Control ( <i>N</i> = 11)	
	<u>X</u>	<u>SD</u>	<u>X</u>	SD	<u>X</u>	<u>SD</u>
Digit Symbol	9.36	3.557	10.42	4.274	11.36	3.325

***Hypothesis 3: Orienting Attention Network.*** The hypothesis that individuals in the ADHD group would exhibit tested lower accuracy of responses on the Digit Symbol, was not supported. Digit Symbol:  $F(2,31) = .779, p = .468$ .

**Table 10.**

**Means and Standard Deviations for the Executive Attention Network using Trails A and Trails B tests.**

	ADHD ( <i>N</i> = 11)		Bipolar ( <i>N</i> = 12)		Control ( <i>N</i> = 11)	
	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<i>SD</i>	<u><i>X</i></u>	<u><i>SD</i></u>
Trails A	61.82	30.682	58.75	29.628	64.09	26.251
Trails B	54.55	35.599	40.42	29.190	59.09	33.153

***Hypothesis 4: Orienting Attention Network.*** The hypothesis that individuals in the ADHD group would exhibit significantly higher scores on the total time to complete the Trail Making Test, was not supported. Trails A:  $F(2,31) = .099, p = .906$ . Trails B:  $F(2,31) = 1.033, p = .368$ .

***Executive Attention Network***

A One-Way Analysis of Variance (ANOVA) was conducted to examine whether there were any statistically significant differences found among the groups on measures of executive attention. It was hypothesized that individuals in the ADHD group would demonstrate significantly higher scores on the accuracy of responses on measures of executive attention. This hypothesis was tested using the accuracy of responses on the Symbol Search subtest. Means and Standard Deviations are presented in Table 11.

**Table 11.**

**Means and Standard Deviations for the Executive Attention Network using the Symbol Search subtest.**

	ADHD ( <i>N</i> = 11)		Bipolar ( <i>N</i> = 12)		Control ( <i>N</i> = 11)	
	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<i>SD</i>	<u><i>X</i></u>	<u><i>SD</i></u>
Symbol Search	14	2.966	12.75	4.993	13.00	3.000

***Hypothesis 5: Executive Attention Network.*** The hypothesis that individuals in the ADHD group would demonstrate significantly lower scores for accuracy of responses on the Symbol Search subtest, was not supported. Symbol Search:  $F(2,31) = .338, p = .716$ .

***Visual Learning and Memory***

A One-Way Analysis of Variance (ANOVA) was conducted to examine whether there were any statistically significant differences found among the groups on measures of visual learning and memory. It was hypothesized that individuals in the ADHD group would demonstrate significantly lower scores on the copy, immediate and delayed conditions of a visual learning and memory test. This hypothesis was tested using the copy, immediate and delayed conditions of Rey-Osterreith Complex Figure Task. Means and Standard Deviations are presented in Table 12.

**Table 12.**

**Means and Standard Deviations for Visual Memory and Learning using the using the copy, immediate, and delay conditions of the Rey-Osterreith Complex Figure (ROCF) Test.**

	ADHD ( <i>N</i> = 11)		Bipolar ( <i>N</i> = 12)		Control ( <i>N</i> = 11)	
	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<u><i>SD</i></u>
Copy	3.09	4.571	6.67	7.050	8.18	7.574
Immediate	15.18	28.262	27.42	35.574	18.82	31.045
Delay	17.64	30.595	21.83	30.641	12.55	24.337

***Hypothesis 6: Visual Learning and Memory.*** The hypothesis that individuals in the ADHD group would demonstrate significantly lower scores on the copy, immediate and delayed conditions of Rey-Osterreith Complex Figure, was not supported. Copy:  $F(2,31) = 7.568, p = .002$ . Immediate:  $F(2,31) = 1.070, p = .355$ . Delay:  $F(2,31) = .683, p = .513$ .

***Visual Processing Speed***

A One-Way Analysis of Variance (ANOVA) was conducted to examine whether there were any statistically significant differences found among the groups on measures of visual processing speed. It was hypothesized that individuals in the ADHD group would exhibit significantly decreased scores on the tests of processing speed. This hypothesis

was tested using the Processing Speed Index of the Wechsler Adult Intelligence Scale–Third Edition (WAIS-III), which is comprised of the Digit Symbol and Symbol Search subtests. Means and Standard Deviations are presented in Table 13.

**Table 13.**

**Means and Standard Deviations for processing speed using the Processing Speed Index (PSI), Symbol Search, and Digit Symbol subtests.**

	ADHD ( <i>N</i> = 11)		Bipolar ( <i>N</i> = 12)		Control ( <i>N</i> = 11)	
	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<u><i>SD</i></u>	<u><i>X</i></u>	<u><i>SD</i></u>
PSI	63.91	26.704	60.66	37.888	68.65	28.451
Symbol Search	14	2.966	12.75	4.993	13.00	3.000
Digit Symbol	9.36	3.557	10.42	4.274	11.36	3.325

***Hypothesis 7: Visual Processing Speed.*** The hypothesis that individuals in the ADHD group would demonstrate significantly lower scores the Digit Symbol and Symbol Search subtests that comprise the Processing Speed Index of the Wechsler Adult Intelligence Scale–Third Edition (WAIS-III), was not supported. PSO:  $F(2,31) = 1.922$ ,  $p = .163$ . Symbol Search:  $F(2,31) = 2.936$ ,  $p = .068$ . Digit Symbol:  $F(2,31) = .332$ ,  $p = .720$ .

***Summary***

### ***Alerting Attention Network***

The present study examined the Alerting Network using The Ruff 2 & 7, a pencil and paper continuous performance task that require the participant to detect a pre-specified target item among distractor items (Landau & Bentin, 2008). Search efficiency is measured in terms of the effects of the number of speed of performance, errors and accuracy (Mason et al, 2003). The first hypothesis of this study was that scores on speed of performance and accuracy would be significantly lower in ADHD group, as compared to the Control and Bipolar Disorder groups. The second hypothesis was that error scores would be significantly higher in the ADHD group, as compared to the Control and Bipolar Disorder groups.

The first and second hypotheses were not supported by the findings of this study, and there were no significant differences found among the three groups. This suggests that the ADHD group performed as well as the Bipolar and Control groups on speed of performance and accuracy on the Ruff 2 & 7 selective attention test. Additionally, the ADHD group did not exhibit significantly higher error scores, as compared to the Control and Bipolar Disorder groups.

### ***Orienting Attention Network***

The present study examined the Orienting Network using the Digit Symbol subtest, and the Trail Making Test. The third hypothesis of this study was that the ADHD group would exhibit significantly lower scores on the accuracy of responses on the Digit Symbol subtest. The fourth hypothesis was that the ADHD group would exhibit significantly higher scores on the total time to complete the Trail Making Test, as compared to the Bipolar Disorder and Control groups. The third and fourth hypotheses

were not supported by the findings of this study, and there were no significant differences found among the three groups. This suggests that the ADHD group performed as well as the Bipolar and Control groups on the accuracy of responses on the Digit Symbol subtest and total time to complete the Trail Making Test.

### ***Executive Attention Network***

The Executive Network is defined as resolving interference that occurs when two competing stimuli are activated simultaneously (Berger & Posner, 2000; Posner & Rothbart, 2007). The present study examined the Executive Network using the Symbol Search subtest. The Symbol Search subtest requires an individual to scan a search group and indicate whether one of the two target symbols matches any of the five symbols in the search group in a specified time limit (Pearson Education, 1997). Scores are based on the total time it takes to complete the task. The fifth hypothesis of this study was that the ADHD group would exhibit significantly lower scores on the accuracy of responses on the Symbol Search subtest. The fifth hypothesis was not supported by the findings of this study, and there were no significant differences found among the three groups. This suggests that the ADHD group performed as well as the Bipolar and Control groups on the accuracy of responses on the Symbol Search.

### ***Visual Memory***

The sixth hypothesis proposed that individuals in the ADHD group would demonstrate significantly lower scores on a measure of visual memory. This hypothesis was tested using the copy, immediate and delayed conditions of Rey-Osterreith Complex Figure. It was hypothesized that individuals in the ADHD group would demonstrate significantly lower scores on the copy, immediate and delayed conditions of Rey-

Osterreith Complex Figure. There were no significant differences between the groups on a task of visual immediate memory and visual delayed memory. A significant difference was found, however, on a task of visual copy. Thus, the ADHD group performed worse than the Bipolar Disorder and Control group when copying a visual stimulus from a model.

### ***Visual Processing Speed***

In examining visual processing speed, studies have consistently found significantly lower processing speed among children and adolescents with ADHD (Oram-Cardy et al, 2009; Mayes et al 2009; Fox, 2009; Marchetta et al, 2008). How was this measured. The seventh and final hypothesis proposed that visual processing speed would be significantly lower in the ADHD group, as compared to the Control and Bipolar Disorder groups. The seventh hypothesis was not supported by the findings of this study, and there were no significant differences found among the three groups. This suggests that the ADHD group performed as well as the Bipolar Disorder and Control groups on tasks of visual processing speed.

## CHAPTER FIVE

### DISCUSSION

The present study revisited the concept of selective attention, and other cognitive processes that support selective attention. This study investigated the selective visual attention abilities of young adults (aged 18 to 22 years), diagnosed with ADHD. The study emphasized visual-spatial selective attention, visual memory and visual processing speed. Available research suggests that children diagnosed with ADHD were less efficient on tasks requiring selective visual attention (Mullane & Klein, 2008; Tsal et al, 2005; Tucha et al, 2008; Kilic et al, 2007), and require more effort to filter out irrelevant stimuli (Mason et al, 2005). Based upon these findings, the first hypothesis proposed that selective visual attention would be significantly lower in the ADHD group, as compared to the Control and Bipolar Disorder groups. The first hypothesis was not supported by the findings of this study, and there were no significant differences found among the three groups. This suggests that the ADHD group performed as well as the Bipolar and Control group on a task of selective visual attention. This finding conflicts with current research findings (Teicher et al, 2009; Barkley, 2007; Douglas, 2005; Cornish et al, 2005).

In terms of visual memory, there are few studies that have explored specifically the visual memory of individuals with ADHD, but findings suggest that there may be significant weaknesses in working memory for adults diagnosed with ADHD (Messing et al, 2006; Rodriguez-Jimenez et al, 2006) and weaknesses in overall visual spatial abilities (Gropper & Tannock, 2009). The second hypothesis proposed that visual memory would be significantly lower in the ADHD group, as compared to the Control and Bipolar

Disorder group. There were no significant differences between the groups on a task of visual learning and visual short-term memory. For the Rey-Osterreith Complex figure, the immediate memory condition reflects an individual's learning ability, whereas, the delayed condition reflects short-term memory abilities. A significant difference was found, however, on a task of visual copy. It could be hypothesized that the ADHD group performed worse than the Bipolar Disorder and Control group, when copying a visual stimulus from a model, which reflects reduced attention to detail, organization, visual-spatial skills and attention. Yet, this study included several univariate tests, and the result is likely a statistical artifact.

In examining Visual processing speed, studies have consistently found significantly lower processing speed among children and adolescents with ADHD (Oram-Cardy et al, 2009; Mayes et al 2009; Fox, 2009; Marchetta et al, 2008). The third and final hypothesis proposed that visual processing speed would be significantly lower in the ADHD group, as compared to the Control and Bipolar Disorder groups. The third hypothesis was not supported by the findings of this study, and there were no significant differences found among the three groups. This suggests that the ADHD group performed as well as the Bipolar Disorder and Control groups on tasks of visual processing speed.

### ***Limitations of the Present Study***

The present study must be viewed in the context of some limitations. The first limitation of this study is the use of self-reports. One of the measures, in particular, the Childhood Symptoms Scale, requires retrospective reports on their childhood experiences of ADHD symptomatology. This was utilized because parental reports and medical

records were not available, but reflects poor ecological validity. A diagnosis of ADHD in adulthood requires a childhood diagnosis of ADHD (Boonstra et al, 2005; Kessler et al, 2006), and diagnosis often involves multiple informants (e.g., parents and teachers), but such informants are not typically available when assessing ADHD in adults (Riccio et al, 2004). Currently, assessment of ADHD in adulthood relies on the client's retrospective account of childhood symptoms (Schultz et al, 2008). Further, research suggests that adults tend to under report ADHD symptoms (Knoke et al, 2005; Magnusson et al, 2006). A study of young adults by Barkley and his associates (2001) demonstrated that when self-report measures were used, 12 percent of the subjects met diagnostic criteria for ADHD. Whereas, when parental reports were used, 66 percent of the participants met diagnostic criteria for ADHD at the 98<sup>th</sup> percentile. Retrospective self-report of childhood ADHD symptoms is an area that requires exploration in the literature, because medical and psychiatric records are often not available for an adult client (Boonstra et al, 2005), and diagnosis critically depends on the accuracy of the client's memories (Schultz et al, 2005).

A second limitation of the present study is that an overall, omnibus measure of cognitive ability was not administered. In the initial proposal of the study, it was determined that a cognitive screener would increase the time demands of the study, and decrease the overall number of participants. In the interest of time, the investigator chose to prioritize particular cognitive functions that were reflected in the measures used. Furthermore, an omnibus cognitive measure would not address elements of the Posner Model. Had there been an overall difference between the groups, a measure of cognitive abilities could have a variable of more focused analyses. Since there was no statistically

significant differences among the groups, one can conclude that cognitive abilities were unlikely to have played a role. Yet, it would have been useful to have an omnibus cognitive measure to verify the range of cognitive abilities among the participants.

A third limitation of the present study is that the sample probably only constitutes a subgroup of the population of college-age males diagnosed with ADHD, and a subgroup of the population of college-age males diagnosed with Bipolar Disorder. Furthermore, the samples were skewed toward a higher number of Caucasian participants, which impacts the generalizability of the findings. All subjects were recruited with advertisements on a college campus, and it is likely that only subjects who were motivated and willing to discuss their symptoms sought participation in the study. Another issue to consider, is that the ADHD and Bipolar Disorder groups were comprised of individuals diagnosed by a number of different professionals, who may have used a wide variety of instruments and criteria for diagnosing ADHD and Bipolar Disorder. Various clinicians may disagree as to what constitutes a symptom that is “maladaptive and inconsistent with developmental level” as specified in the DSM-IV-TR (American Psychiatric Association, 2000). For this reason, the ADHD group may not represent a homogenous group in terms of level of ADHD symptomatology, and may not be representative of the larger ADHD population. Additionally, the Bipolar Disorder group likely does not represent a homogenous group that is representative of the larger population of individuals with Bipolar Disorder.

It also needs to be considered that the ADHD and Bipolar Disorder groups were recruited from a population of males at a local university. It might be argued that, by being admitted to a university and completing academic work on an advanced level, these

individuals are not representative of the general population that has been diagnosed with ADHD or Bipolar Disorder. It is possible that college students with ADHD have adopted compensatory strategies for their attentional deficits (Gualtieri & Johnson, 2006), and such strategies may permit these students to engage in more complex thought and behavioral processes (Boonstra et al, 2005). Similarly, college students diagnosed with Bipolar Disorder may have learned strategies to manage their mood dysregulation, or have been on an effective regimen of mood stabilizing medications. These factors may differentiate between individuals with Bipolar Disorder who are currently in college, and individuals with Bipolar Disorder who are not in college.

As a fourth limitation, this study was a single pilot study. The samples were large enough to meet the requirements of the power analysis for a power of .9, effect size of .5, and alpha level of .05. The small sample size, however, likely made differences among the groups difficult to detect.

As a fifth limitation, the *Hawthorne Effect* likely impacted the results of this study. Due to their previous experiences as individuals diagnosed with ADHD or Bipolar Disorder, the subjects may have put forth a strong effort to portray himself positive/light/seem unaffected by his ADHD or Bipolar Disorder symptomatology, or respond in a manner that he thinks the examiner wants or expect to hear.

A sixth limitation of the present study is that only sustained attention, in relation to visual stimuli, was assessed. The presentation of auditory stimuli might have resulted in different findings. Furthermore, using a different stimulus duration, interval, or level of complexity, as well as modality (verbal versus graphomotor) may have produced different results.

### ***Directions for Future Research***

The relationship between selective visual attention and ADHD is difficult to isolate in a single study. A longitudinal study of selective visual attention and ADHD may provide the field with a greater understanding of the cognitive deficits that are unique to ADHD, and how these deficits manifest throughout development. In formulating effective psychological and educational intervention strategies, it is crucial to identify the key concepts that may be related the etiology, prevalence, and prognosis of ADHD, especially from a lifespan perspective.

In the present study, only selective attention in relation to a particular pattern and type of visual stimulation, was assessed. The presentation of auditory stimuli might have resulted in different findings. Furthermore, using a different stimulus duration, interval, or level of complexity, as well as modality (verbal versus graphomotor) may have produced different results. The presence of a more precise description of attention would permit more specificity in the interpretation of these results. Additionally, the present study relied upon graphomotor-based visual-spatial tasks. Future studies may want to assess overall graphomotor speed to determine whether this may contribute to differences in adults diagnosed with ADHD.

Future studies should incorporate questions pertaining to symptoms and diagnosis of ADHD for collateral reporters: parents, teachers, medical staff and mental health professionals. Additionally, documentation of ADHD diagnosis, from a medical or psychiatric profession, should be obtained to verify a diagnosis of ADHD. It is also necessary to observe the individual's behavior in a variety of settings (e.g. classroom,

research lab, etc.) to verify the presence of ADHD symptomatology across settings as is specified in the DSM-IV-TR.

Over the past century, the central diagnostic features of Attention-Deficit/Hyperactivity Disorder (ADHD) have been a source of controversy and debate in the field. It is possible that the current diagnostic criteria of inattention, as specified in the DSM-IV-TR, might not accurately reflect the deficits inherent in a diagnosis of ADHD (Barkley, 2007). The current diagnostic criteria of ADHD's hallmark feature or inattention are, at best, unclear (Douglas, 2005; Cornish et al, 2005). The measures used in the present study may not have been sufficiently sensitive to attention, and the array of attentional abilities. Further examination of Posner's theory, with more sensitive measures, is warranted. According to Barkley (2002b):

Clearly, research on ADHD has not been exhausted. Because ADHD is not a benign disorder that disappears after childhood, people are affected by the disorder in major areas throughout their lives (p. 15).







## APPENDIX D

### Consent to Participate in a Research Study

Northeastern University, Department of Counseling and Applied Educational Psychology  
Principal Investigator: Katherine Donahue, M.A., Ph.D. Candidate in Counseling  
 Psychology

Study: Visual-Spatial Abilities in Young Adult Males with Attention-Deficit/Hyperactivity Disorder (ADHD).

#### **Informed Consent to Participate in a Research Study**

I am inviting you to take part in a research study. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any questions that you have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you to sign this statement and will give you a copy to keep.

#### **Why am I being asked to take part in this research study?**

You are being asked to be in this study because you are a young adult male, between the ages of 18 to 22, and you have been identified as falling into one of the three categories: 1.) diagnosed with ADHD, 2.) diagnosed with Bipolar Disorder or 3.) have never been diagnosed with any psychiatric disorder.

#### **Why are you doing this research study?**

The purpose of this research study is to evaluate the visual-spatial abilities in young adult males (ages 18 to 22) in young adult males who have been diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD).

#### **What will I be asked to do?**

If you decide to take part in this study, the following will happen over the next hour:

1. You will be asked questions about yourself on a demographic form
2. You will complete three, self-report measures about your behavior.
3. You will be asked to complete a brief battery of tests that will evaluate your visual-spatial skills.

#### **Where will this take place and how much of my time will it take?**

The study will take place in this room, and will take approximately 2-3 hours to complete.

#### **Will there be any risk or discomfort to me?**

There are no risks and discomforts to you.

#### **Will I benefit by being in this research?**

There are no immediate benefits to you for participating in this study. The results of this study may benefit individuals with a diagnosis of ADHD in the future.

**Who will see the information about me?**

Your individual results will be kept completely confidential. You will be assured anonymity, as your information will be identified by number only. To protect confidentiality, all records will be kept in a locked file cabinet kept in the Department of Counseling and Applied Educational Psychology. This consent form will be kept separate from the demographic form and test results. One researcher will administer all measures and analyze the data.

*In the event that you report information regarding child abuse, elder abuse, and harm to yourself or others, the researcher will immediately stop the study. This information may have to be reported to the local authorities.*

**If I do not want to take part in the study, what choices do I have?**

Participation in this study is completely voluntary, and you do not have to participate if you do not want to. Your information will be included in the study only if you give written, informed consent. If you do not participate, you will not lose any rights, benefits, or services that you would otherwise have as a student.

**What will happen if I suffer any harm from this research?**

There is no known chance of risk in this study.

**Can I stop my participation in this study?**

You can stop your participation, at any time during the study, without penalty.

**Who can I contact if I have questions or problems?**

You may contact the primary investigator, Katherine Donahue, at 617-309-8525 or donahue.k@neu.edu.

**Who can I contact about my rights as a participant?**

If you have any questions about your rights as a participant, you may contact the Human Subject Research Protection, Division of Research Integrity, 413 Lake Hall, Northeastern University Boston, MA 02115. Telephone: 617-373-7570. You may call anonymously if you wish.

**Will I be paid for my participation?**

Your name will be entered in a raffle for a \$150 gift certificate.

**Will it cost me anything to participate?**

There are no costs to participate.

**Is there anything else I need to know?**

- You have the right to choose not to sign this form. If you decide not to sign, you cannot participate in this research study.
- You must be at least 18 years old to participate in this study.

I agree to take part in this research study.

\_\_\_\_\_  
Signature of volunteer

\_\_\_\_\_  
Date

\_\_\_\_\_  
Printed name of person above

\_\_\_\_\_  
Signature of Primary Investigator

\_\_\_\_\_  
Date

**APPENDIX E**

**Subject Demographic Form**

ID #: \_\_\_\_\_

Date: \_\_\_\_\_

\*\*\*\*\*

Please complete the following questions:

- 1. **Age:** \_\_\_\_\_
  
- 2. **Please identify your Race** (Please check as many as apply):
  - \_\_\_\_\_ American Indian or Alaska Native
  - \_\_\_\_\_ Asian
  - \_\_\_\_\_ Black or African American
  - \_\_\_\_\_ Native Hawaiian or Other Pacific Islander
  - \_\_\_\_\_ White
  - \_\_\_\_\_ Hispanic or Latino
  - \_\_\_\_\_ Caribbean/West Indian
  - \_\_\_\_\_ Biracial
  - \_\_\_\_\_ Other: (please identify) \_\_\_\_\_
  
- 3. **Current year in college** (please check only ONE):
  - \_\_\_\_\_ Freshman
  - \_\_\_\_\_ Sophomore
  - \_\_\_\_\_ "Middler"
  - \_\_\_\_\_ Junior
  - \_\_\_\_\_ Senior
  - \_\_\_\_\_ Graduate
  - \_\_\_\_\_ Non-matriculating student
  
- 4. **Current GPA:** \_\_\_\_\_
  
- 5. **Major:** \_\_\_\_\_

6. **Have you ever been diagnosed with ADHD?** (Please circle)

YES NO

7. **Do you currently have a diagnosis of ADHD?** (Please circle)

YES NO

8. **Have you ever been diagnosed with Bipolar Disorder?** (Please circle)?

YES NO

9. **Do you currently have a diagnosis of Bipolar Disorder?** (Please circle)?

YES NO

10. **Are you currently taking any medications?** (Please circle)?

YES NO

11. **Please list what medication (s) you are taking:** \_\_\_\_\_

\_\_\_\_\_

12. **Have you ever had medical problems? If so, what?** \_\_\_\_\_

\_\_\_\_\_

13. **Has anyone in your family ever been diagnosed with ADHD?** \_\_\_\_\_

**If so, who?**

Father \_\_\_\_\_

Mother \_\_\_\_\_

Sister \_\_\_\_\_

Brother \_\_\_\_\_

14. **Has anyone in your family ever been diagnosed with Bipolar Disorder?** \_\_\_\_\_

**If so, who?**

Father \_\_\_\_\_

Mother \_\_\_\_\_

Sister \_\_\_\_\_

Brother \_\_\_\_\_

## APPENDIX F

### Counseling and Substance Use Resources

#### Counseling Services at Northeastern University

College can be an exciting, transformative time, but it can also bring its own challenges and concerns. Stress, anxiety and a range of emotions can be normal reactions to college life, but emotional, relational, or psychological difficulties can make it hard to be a successful student. When these types of issues occur, it is important to reach out and ask for help. Various types of support and treatment are available and may address your needs

**If you would like to schedule an initial Behavioral Health appointment, please call the Main UHCS # at (617) 373-2772 and choose “1” and a Patient Associate will be available to help you.**

When the Health Center is closed, you may call the **New England Baptist Hospital** at 617-754-5544. There is always a health provider available to assist you.

### Alcohol and Other Drugs

UHCS at Northeastern University provides individual and group counseling services to help students who may have questions or concerns regarding alcohol and other drugs. Speaking with one of our counselors may be helpful, whether you have been having difficulties associated with your alcohol and drug use, or have been affected by someone’s use of substances such as a family member, friend, roommate or significant other.

A counselor can help answer questions you may have about substance use, determine if your alcohol or drug use is a problem or explore your options for reducing or stopping your substance use. Counseling can also help you manage the influence that another’s alcohol or drug use has had in your relationships, self-esteem and outlook on life.

**If you are interested in making an appointment, please call our front desk at 617-373-2772, choose “1” and ask to make a Mental Health Assessment. If you have questions or concerns you may ask directly for the UHCS Alcohol and Other Drug Counselor, Felix F. Pizzi, LMHC, CCMHC.**

UHCS works in coordination with the Office for Prevention and Education at Northeastern (O.P.E.N) and supports its mission to provide education and prevention programming on campus regarding alcohol and drug use.

Here are some resources that may be helpful to you or someone you know:

**National Alcohol and Drug Resources:**

National Institute on Alcohol Abuse and Alcoholism (NIAAA)

<http://www.niaaa.nih.gov/>

National Institute on Drug Abuse (NIDA)

<http://www.nida.nih.gov/>

Substance Abuse and Mental Health Services Administration

<http://www.samhsa.gov/>

**Self-Help Groups:**

Alcoholics Anonymous (AA)

<http://www.aaboston.org/>

Al-Anon/Al-Ateen

<http://www.ma-al-anon-alateen.org/>

Narcotics Anonymous (NA)

<http://www.newenglandna.org/>

Nar-Anon

<http://nar-anon.org/>

SMART Recovery  
(SOS)

<http://www.smartrecovery.org/>

Secular Organizations for Sobriety/Save Our Selves

<http://www.sossobriety.org/>

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