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The Impact of Psychostimulants on the Executive Capacities of Children with Attention Deficit Hyperactivity Disorder

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THE IMPACT OF PSYCHOSTIMULANTS ON THE EXECUTIVE CAPACITIES OF CHILDREN WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER

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Dissertation Approval

This is to certify that the thesis presented to us by ________________________________ on the ______ day of ___________________, 20___, in partial fulfillment of the requirements for the degree of Doctor of Psychology, has been examined and is acceptable in both scholarship and literary quality.

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Abstract

The current study compared executive-skill and executive-function deficits resulting from teacher ratings of two clinical groups of students diagnosed with ADHD (ADHD-Med, ADHD-NoMed) with ratings of demographically- matched control groups. In addition, teacher ratings of the ADHD-Med group and the ADHD-NoMed group were compared. The data for both clinical groups and their respective matched control groups were part of the data collected during the standardization of the McCloskey Executive Function Scale – Teacher Report (MEFS-TR). Analyses examined teacher responses to all of the items of the seven Self-Regulation, the Self-Realization, and the Self-Determination Clusters of the MEFS. Congruent with the hypothesis of this study, both clinical groups demonstrated a higher degree of executive dysfunction than that of matched nonclinical groups, particularly within the Academic Arena. Additionally, the ADHD-NoMed group was rated with more deficits than the ADHD-Med group across most self-regulation clusters. Consistent with the hypothesis, a large proportion of deficit ratings for the clinical groups occurred with the Focus, Sustain, Inhibit, and Modulate executive capacities. Multiple other executive capacities were also rated as deficient for both clinical groups within the Engagement, Optimization, Inquiry and Solution Clusters. Overall, the study supported the notion that students diagnosed with ADHD who receive pharmaceutical intervention are most likely to be rated as having executive-function deficits reflecting a lack of knowing when to activate an executive capacity within the Academic Arena and sometimes within the Self/Social Arena, whereas students diagnosed with ADHD who do not receive pharmaceutical intervention are most likely to be rated as having executive-skill deficits and executive-function deficits reflecting a lack

of knowing how and when to activate an executive capacity within the Academic Arena, and also frequently within the Self/Social Arena.

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CHAPTER 1

INTRODUCTION

School-aged children with attention-deficit hyperactivity disorder (ADHD) often experience difficulty meeting academic and social demands. According to the *Diagnostic and Statistical Manual of Mental Disorders* (5^{th} ed.; *DSM-5;* American Psychiatric Association, 2013), individuals with ADHD experience a persistent pattern of hyperactivity/impulsivity and/or inattention that interferes with functioning. Specific symptoms for inattention and hyperactivity/impulsivity must be present for at least 6 months, with negative impact on social, academic, and occupational activities (American Psychiatric Association, 2013). Behavioral symptoms of ADHD typically present in early childhood and occur in approximately 5% of the school-aged population (American Psychiatric Association, 2013; Barkley, Fischer, Edelbrock, & Smallish, 1990).

Information provided by neuropsychological assessments and behavioral rating scales indicates that many children with ADHD also exhibit deficits in executive functions. Several decades of research on ADHD and executive functions have led to a more comprehensive understanding of ADHD, including difficulty with self-regulation and executive functioning (Barkley, 2007). Current neuropsychological literature depicts executive functions as separate but related processes within the frontal lobe that coordinate to control cognition and goal-directed behavior (McCloskey, Perkins, & Diviner, 2009; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Wiebe, Espy, & Charak, 2008). Specific cognitive processes and components commonly discussed in relation to executive functions include shifting, inhibition, working memory, planning, generative fluency, self-regulated learning, metacognition, and behavioral regulation (Cirino et al., 2018; Miyake et al., 2000; Roberts & Pennington, 1996).

Statement of the Problem

Although not all children with executive-function deficits also have ADHD, those who struggle with symptoms of ADHD that reflect poor use of executive functions need targeted interventions to support their social and academic growth. According to the *DSM*-V, school problems and peer neglect tend to be associated with symptoms of inattention, while peer rejection is more typically associated with symptoms of hyperactivity and impulsivity. Research indicates that executive-function deficits in children with high numbers of ADHD symptoms may lead to poorer academic functioning than social functioning (Biederman et al., 2004; Diamantopoulou, Rydell, Thorell, & Bohlin, 2007; McCloskey, 2016).

More recent research has focused on executive functions, specifically inhibition and working memory, as areas of impairment impacting the social functioning of children with ADHD (Huang-Pollock, Mikami, Pfiffner, & McBurnett, 2009; Kofler et al. 2011; Rinsky & Hinshaw 2011). Working memory and inhibition are related executive processes that contribute to symptoms of hyperactivity, impulsivity, and inattention in individuals with ADHD. The work of Bunford et al. (2015) concluded that executive-function deficits in inhibition and working memory are expressed through behavioral symptoms in individuals with ADHD that impact social functioning. Several longitudinal studies indicate behavioral symptoms observed in young children with ADHD typically improve with age; however, individuals with ADHD often continue to struggle with neuropsychological dysfunction years later (Biederman et al., 2000; Miller, Ho, & Hinshaw, 2012; Halperin, Trampush, Miller, Marks, & Newcorn, 2008).

Some children with ADHD receive pharmaceutical interventions to address their symptoms. Results of functional magnetic resonance imaging (fMRI) studies indicate that individuals with ADHD treated with psychostimulant medication exhibit different brain activity than that exhibited by nonmedicated individuals with ADHD. Findings are relatively inconsistent, however, regarding which specific areas of the frontal lobe differ in these populations (Rubia et al., 2014). Response inhibition appears to be the most agreed upon area of executive function improved in individuals with ADHD who receive psychostimulant medication when compared to nonmedicated individuals with ADHD (Rubia et al., 2014). Beyond response inhibition, the executive functions that pharmaceutical intervention impact for children with ADHD remain unclear. Although the use of psychostimulant medication is often a recommended part of a plan to reduce behavioral symptoms and improve the daily functioning of children with ADHD, additional interventions and accommodations should also be used as needed. In order to better understand the specific areas of executive functions most impacted in children diagnosed with ADHD and the effects of medication on these executive functions, a better understanding of the multidimensional nature of executive capacities and the application of this knowledge are important when evaluating the effects of medication.

Purpose of the Study

The McCloskey Executive Functions Scale (MEFS) is an indirect formal assessment tool that can be used in conjunction with other assessment tools to help determine a child's executive-capacity strengths and weaknesses based on teacher or clinician input (McCloskey, 2016). The development of the MEFS is based on a multidimensional theoretical model known as the holarchical model of executive functions (HMEF; McCloskey, 2016; McCloskey et al., 2009; McCloskey & Perkins, 2012;). This comprehensive model incorporates decades of research on executive functions and more recent neuropsychological literature to provide a view of executive control as a set of mental capacities used to direct and integrate perception, emotion, cognition, and action (Gioia, Isquith, Guy, & Kenworthy, 1996; McCloskey, 2016; McCloskey et al., 2009; McCloskey & Perkins, 2012). This study is designed to analyze teachers' perceptions of the executive capacities of samples of medicated and nonmedicated children between the ages of 5 and 18 years who were diagnosed with ADHD prior to data collection.

The MEFS and the information yielded in this study can help educators and clinicians investigate the specific patterns of executive-function strengths and weaknesses in executive capacities identified for individuals with ADHD and the impact of psychostimulants on these executive capacities. Furthermore, this study adds to the existing body of literature regarding the similarities and differences between the pattern of executive-capacity strengths and weaknesses observed in school-aged children diagnosed with ADHD and the pattern of executive-capacity strengths and weaknesses observed in school-aged children with no clinical diagnosis.

Most importantly, the outcomes of this study can help to inform the design of appropriate interventions to address the specific executive-capacity deficits identified with the MEFS for children diagnosed with ADHD. Specifically, in-depth analysis of the MEFS self-regulation clusters, including capacities related to attention, engagement, optimization, efficiency, memory, inquiry, and solution, can contribute to developing more individualized and targeted interventions to support academic and social functioning for children diagnosed with ADHD, with or without the use of psychostimulant medication (McCloskey, 2016).

CHAPTER 2

REVIEW OF THE LITERATURE

Executive functions have been conceptualized as separate but related mental processes within the frontal lobe of the brain that coordinate to control cognition and goal-directed behavior (McCloskey et al., 2009; Miyake et al., 2000; Wiebe, Espy, & Charak, 2008). Specific cognitive processes and components commonly discussed in relation to executive functions include shifting, inhibition, working memory, planning, generative fluency, self-regulated learning, metacognition, and behavioral regulation (Cirino et al., 2018; Miyake et al., 2000; Roberts & Pennington, 1996). More recently, McCloskey (2016) revised terminology related to the construct of executive control, specifying two distinct types: executive functions and executive skills. Executive functions are thought to be associated with knowing what and when to perceive, feel, think, or act in a given situation. Executive skills, on the other hand, are associated with knowing how to perceive, feel, think, or act in a given situation. When referring to both executive functions and executive skills, McCloskey replaces the currently used term *executive functions* with the term *executive capacities*. Because this research is examining data gathered to test hypotheses about the holarchical model of executive capacities (HMEC), the functions, skills, and capacities terminology proposed by McCloskey will be used throughout this literature review.

Individuals diagnosed with attention deficit hyperactivity disorder (ADHD) commonly present with executive-capacity deficits. The neuropsychological literature that addresses ADHD has focused on frontal-lobe functioning in the form of executive capacities, with an emphasis on the capacities of inhibition and working memory within the general domain of self-regulation as the primary deficits in ADHD (Barkley, 1997b; Denckla, 1996).

Individuals with many symptoms of ADHD who exhibit poor use of executive capacities typically experience some level of impairment in academic performance and also may exhibit impairments in social interactions throughout childhood and adolescence. Research indicates that although some observable behavioral symptoms subside with maturation, many individuals diagnosed with ADHD continue to experience dysfunction later in life (Biederman et al., 2000; Miller et al., 2012; Halperin et al., 2008). Owing to the large number of school-aged individuals diagnosed with ADHD and the developing understanding of the importance of executive capacities throughout life, a review of information regarding current assessment and intervention practices for working with individuals diagnosed with ADHD is essential. Current research and existing models of executive control are also discussed in this chapter, with an emphasis on the HMEC, as well as the relationship between executive capacities, ADHD, and psychostimulant medication.

ADHD

ADHD is currently the most commonly diagnosed psychological disorder in children (DuPaul & Stoner, 2014). It is recognized as a neurodevelopmental disorder by the American Psychiatric Association (2013), with a prevalence rate of approximately 5% in children and 2.5% in adults. Information provided by the National Survey of Children's Health, collected in 2016 through community samples, indicates that 9.4% (6.1 million) of children ranging in age from 2 to 17 years have been diagnosed with

ADHD in the United States. Boys are overrepresented, with twice as many boys diagnosed as girls during childhood (American Psychiatric Association, 2013).

Research on ADHD has accumulated over the past 40 years, as such researchers as Douglas (Douglas, 1972; Douglas, 1988; Douglas, 2005), Barkley (Barkley, 1997a and b; Barkley, 1998; Barkley, 2001; Barkley, 2007; Barkley, 2016; Barkley & Peters, 2012), Brown (Brown, 2006; Brown, 2009), and Denckla (Denckla, 1996) led the transition from conceptualizing ADHD as a collection of observable behavioral symptoms to developing a more unified, neuropsychologically oriented theory of ADHD as the result of executive dysfunction. The work of such researchers as Barkley and Brown contributed to the revision of the *DSM* from the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV;* American Psychiatric Disorders, 1994) description of ADHD as two behavioral deficits (i.e., inattention and hyperactivity/impulsivity) to the more comprehensive diagnostic criteria currently depicted in the *DSM-5* (2013). Although the criteria, models, and theories associated with ADHD may change, those researching the nature of ADHD and those living with ADHD commonly agree that the symptoms associated with the disorder impact daily functioning in various settings, including school and home (American Psychiatric Association, 2013).

ADHD Defined

Based on the *DSM-5* (2013), the three possible presentations of ADHD are inattentive presentation, hyperactive/impulsive presentation, and combined presentation. In order to meet criteria as outlined in the *DSM-5* (2013), the symptoms must occur in a minimum of two settings, such as school and home, and cause a negative impact on an individual's social, academic, and/or occupational functioning. Additionally, the symptoms must be present prior to the age of 12 years, with evidence that these symptoms significantly interfere with the individual's social, academic, or occupational functioning. The *DSM-5* (2013) also allows for clinicians to specify the level of severity of impairment in social or occupational functioning (American Psychiatric Association, 2013).

Inattentive presentation. According to the *DSM-5* (2013), individuals with ADHD Inattentive Presentation (ADHD-I) experience a high degree of difficulty with focusing and sustaining attention. The symptoms of inattention negatively impact social and academic/occupational functioning for these individuals. In order to meet diagnostic criteria for ADHD-I, a minimum of six of the following symptoms must be present for at least 6 months (American Psychiatric Association, 2013):

1. Often fails to provide close attention to details or often makes careless mistakes on schoolwork or at work
2. Often has difficulty sustaining attention for tasks or during play
3. Often seems not to listen when being directly spoken to
4. Often fails to follow through on instructions and/or fails to complete schoolwork, chores, or work place responsibilities
5. Often has difficulty with organizing tasks and activities
6. Often avoids, becomes reluctant, or dislikes tasks that require a high degree of sustained mental effort
7. Often loses items necessary for task or activities (e.g., school materials, personal items, such as a wallet or telephone)
8. Often is easily distracted by extraneous stimuli

9. Often is forgetful regarding daily activities, such as appointments, completing chores, etc.

Hyperactive/impulsive presentation. As outlined in the *DSM-5* (2013), individuals with ADHD Hyperactive/Impulsive Presentation (ADHD-H) experience a high level of hyperactive and/or impulsive behavior. These individuals are observed to frequently fidget, talk excessively, and appear to be "on the go." In order to meet diagnostic criteria for ADHD-H, a minimum of six of the following symptoms must be present for at least 6 months; however, only five symptoms are required for individuals 17 years of age and older (American Psychiatric Association, 2013):

1. Often fidgets with hands or feet, and/or may squirm when seated
2. Frequently leaves their seat in a situation when ones is expected to remain seated, such as in a classroom or at work place
3. May run or climb at inappropriate times; this may appear as restlessness in adolescents and adults
4. Difficulty in engaging in leisure activities quietly
5. Appears as "if driven by a motor," or "on the go"
6. Often talks excessively
7. May blurt out the answer to a question before the question was finished
8. Has frequent difficulty waiting their turn, such as in a line
9. Often interrupts or intrudes on the conversations or activities of others

Combined presentation. The third and final presentation of ADHD outlined in the *DSM-5* (2013) is the Combined Presentation (ADHD-C). Individuals with ADHD-C meet diagnostic criteria listed for both the Inattentive and Hyperactive/Impulsive presentations (American Psychiatric Association, 2013).

Neuropsychology of ADHD

ADHD is known to be highly heritable. Twin, family, and adoption studies conducted over the past 2 decades have supported this understanding about the etiology of the disorder. Studies by such researchers as Larsson, Chang, D'Onofrio, and Lichtenstein (2014) and Franke et al. (2012) analyzed large samples of twin data using clinically diagnosed cases. Results revealed high heritability of clinically diagnosed ADHD across the life span. Research from Franke et al. (2012) yielded inconsistent results that the more recent research from Larsson et al. (2014) attributes to measurement error resulting from rater effects, specifically a lack of consideration for multiple raters rather than sole use of self-ratings. Recent research supports that genetic and familial factors are involved in the neurodevelopmental disorder of ADHD.

Individuals with ADHD have anatomical and functional brain-based differences. Although some variation exists, those in the field agree overall regarding the major underpinnings of ADHD. Specifically, individuals with ADHD commonly have differences in brain networks involved in the control of attention. Research yielded from brain-imaging studies has demonstrated that specific cognitive deficits can be associated with abnormalities in the prefrontal cortex of the brain. Significant interest in the executive functions of individuals with ADHD has resulted from these findings, as the brains of individuals with prefrontal damage appear to be similar to those of individuals with ADHD (Douglas, 2005).

Prior research found that children with ADHD have decreased cortical thickness in the medial frontal wall and regions important for attentional control (Shaw et al., 2006). The research summarized previously, along with the large prospective studies conducted by Shaw et al. (2006; 2011), indicate that the cortical regions most involved in executive tasks and controlling cognitive processes, including motor and attentional planning, are delayed in children with ADHD. *DSM-5* (2013) criteria outline the three current presentations of ADHD. More recent research from Shaw et al. (2011) found that children with more symptoms of hyperactivity and impulsivity exhibited a slower rate of thinning of cortical gray matter in the prefrontal, frontal premotor, medial prefrontal, and cingulate regions. Children with higher rates of inattentive symptoms exhibited a slower rate of cortical thinning in the right ventrolateral cortex along with the lateral and medial prefrontal cortex regions. This research indicates that cortical thickness correlates with the severity of symptoms in most individuals with ADHD. Individuals with remitting ADHD experience a normalization of cortical thinning over time (Friedman & Rapoport, 2015). Overall, research suggests that cortical development in individual children with ADHD is delayed compared to the cortical development of their nonclinical peers.

A recent study conducted by Dirlikov et al. (2015) explored the similarities and differences in frontal-lobe cortical morphology for boys and girls with ADHD compared to nonclinical peers. The results of the study with greater than 225 participants provided evidence for sex-based differences with the use of MRI scans. While exploring functionally distinct subdivisions of the frontal lobe, the researchers found reduced frontal-lobe surface area in both sexes with ADHD when compared to nonclinical peers. Compared to their same-sex nonclinical peers, boys showed greater reduction in the posterior premotor cortex, whereas girls showed decreases in the anterior prefrontal cortex. The results may be best explained by differences in neurodevelopmental pathways, as research indicates that girls develop earlier than boys, and children with ADHD develop later than nonclinical peers. The boys in this study between the ages of 8 to12 years may not have achieved the same stage of cortical development as the girls. The research is consistent with prior research on the reduced premotor cortex surface area in boys with ADHD related to motor function impairments and reduced premotor cortex volume (Motsofsky, Newschaffer, & Denckla, 2003). Along with distinct differences, boys and girls with ADHD in the study showed similar reductions in the anterior cingulate cortex, orbitofrontal cortex, and medial prefrontal cortex. These regions of the brain are involved in the reward pathway and help integrate cognitive and motivational processes (Dirlikov et al., 2015).

Individuals with ADHD typically demonstrate deficient response inhibition. Therefore, a better understanding of the neurological mechanisms involved in response inhibition is important. Multiple studies indicate that individuals with ADHD exhibit differences in activation of the frontal-subcortical and frontal-parietal circuits of the brain, specifically during response inhibition tasks (Suskauer et al., 2008). A study conducted by Suskauer et al. (2008) used fMRI and a classic stop-go task to analyze the similarities and differences in activation patterns for habitual motor response (go task) and inhibition of motor response (no-go task) for children between the ages of 8 to 13 years with and without ADHD. The children with ADHD demonstrated decreased activation in medial frontal regions, which are necessary for control of voluntary actions. The findings support additional research that found that the presupplementary motor area (pre-SMA) is involved in deficits experienced by individuals with ADHD (Suskauer et al., 2008). The pre-SMA is associated with motor planning and readiness for action, and switches from automatic to voluntary control actions (Isoda & Hikosaka, 2007). The study conducted by Suskauer confirmed differences in individuals with ADHD and those without ADHD specific to reduced pre-SMA activation.

The results of multiple recent studies using advanced imaging technology provide strong support for theories developed by such researchers as Brown and Barkley that claim ADHD is a disorder of executive functions. Overall, findings support that individuals with ADHD have anatomical and functional brain-based differences specific to the attentional and control networks in the frontal lobe of the brain.

Early History of ADHD

Research on ADHD has made significant advances over the past several decades, although it has been described and discussed in medical and psychiatric literature for more than 200 years. Unlike other *DSM-5* (2013) disorders with relatively more recent origin, the first reference to attention disorders dates back to 1775, with Melchior Adam Weikard's description of attention deficit in medical literature. The discovery and translation of a German medical textbook by Weikard reveal an entire chapter devoted to the description of attention disorders (Barkley & Peters, 2012). Barkley and Peters (2012) were directly involved in accessing and translating to English the original document in order to determine the contributions of Weikard to the early literature on ADHD. Both researchers firmly concluded after translating and analyzing the document that Weikard should be credited as the first person to publish medical literature on the topic of attention deficit.

A translation of Weikard's Chapter 3, entitled "Attentio Volubilis" ("Lack of Attention"), describes children with attention problems as experiencing difficulty maintaining focus on a topic and being highly distractable when disturbed. He seemed to reference external and internal distractions, discussing imagination, along with objects in the environment, leading to distraction. When discussing features of attention problems, he described individuals not spending enough time on tasks, remembering only half of what they learn, and completing tasks in a messy manner. He used many analogies to vividly describe these individuals. Additional references to individuals with attention problems lacking thoroughness and exhibiting issues with execution of tasks are present throughout his work. With regard to causation, Weikard focused on environmental factors. Specifically, he discussed inattention issues developing when children are exposed to too much information without enough time to examine it properly. He believed overloading children with information resulted in weakening of nerve fibers, leading to distraction. Consistent with current accommodations and supports for individuals with ADHD, Weikard described the importance of reducing noise and distractions, the need for extended time with tasks, the importance of interest level, and the importance of exercise and activity (Barkley & Peters, 2012).

Soon after, in 1798, a physician from Scotland named Alexander Crichton published a chapter on disorders of attention in a medical textbook about mental disorders. Consistent with the modern understanding of ADHD, Crichton viewed attention disorders as consisting of different components, including inconstancy of attention and difficulty with energy levels. Crichton noted that individuals can be born with attention disorders, indicating the first reference in medical literature to the heritability of ADHD. He also discussed the important role of the environment and education for individuals with attention disorders. Specifically, he described the role of early education as either hindering or improving the attention of children, along with the importance of tailoring education to the interests of these individuals. Furthermore, Crichton referenced the comorbidity of attention disorders with other mental and physical disorders (Barkley & Peters, 2012).

The most widely recognized individual who has received scientific credit for writing about ADHD in medical literature, however, remains George Still, dating back to 1902. Still described children from his practice who exhibited difficulty with sustained attention. He described these children as resistant to discipline, with problems of aggression, defiance, and emotional control (Barkley & Peters, 2012). He frequently referenced impairment of the moral control of behavior resulting from environmental influences, lack of moral consciousness, and lack of inhibitory control. According to Barkley and Peters (2012), the most noteworthy aspects of Still's work that contributes to the current understanding of ADHD involves the emphasis on inhibitory control and emotionality issues in individuals with ADHD.

Throughout the first half of the 1900s, individuals with attention problems were conceptualized as brain-damaged individuals with behavioral problems. By the 1930s, individuals with ADHD in the United States began to be treated with amphetamines as medication therapy to reduce disruptive behavior (Barkley, 1998). Soon after this period, research focused on neurological underpinnings for individuals with increased hyperactivity. The outcome of this research during the 1950s led to the use of such terms as *minimal brain dysfunction* and *hyperkinetic syndrome* to describe individuals displaying inattention and or hyperactivity. Over the next 20 years, a greater focus on the neurological mechanisms involved in attention and hyperactivity were investigated. Fortunately, this supported the transition away from viewing these individuals as brain damaged and led to the inclusion of a description of hyperactivity as a type of mental disorder in the *Diagnostic and Statistical Manual of Mental Disorders* (2nd ed.; *DSM-II;* American Psychiatric Association, 1968; Barkley, 1998). Throughout the 1970s, the interest in researching individuals known as hyperactive or hyperkinetic increased significantly. The accumulation of research from this decade allowed for a broader understanding of the disorder and began to frame the more modern understanding of ADHD (Barkley, 1998).

Executive Functions

Executive functions begin to develop in utero and continue to strengthen and refine throughout early adulthood. The process is gradual, and development is sequenced according to developmental needs at different stages (Brown, 2009). Executive functions (EF) are conceptualized as separate but related processes within the frontal lobe of the brain that coordinate to control cognition and goal-directed behavior (McCloskey et al., 2009; Miyake et al., 2000; Wiebe et al., 2008). Executive functions cue and direct the use of mental capacities and coordinate efforts for multitasking (McCloskey & Perkins, 2012). Specific cognitive processes and components commonly discussed in relation to executive functions include shifting, inhibition, working memory, planning, generative fluency, self-regulated learning, metacognition, and behavioral regulation (Miyake et al., 2000; Roberts & Pennington, 1996; Cirino et al., 2018).

According to Dawson and Guare (2004), executive skills help with behavioral regulation and involve two sets of related skills. First, executive skills including planning, organization, time management, working memory, and metacognition are used to support goal selection and develop solutions to problems. Next, in order to maintain progress toward the goal and guide behavior, the second set of skills including response inhibition, self-regulation of affect, task initiation, flexibility, and goal-directed persistence must be employed. The various executive functions and skills discussed are imbedded in different frameworks and theories of executive functions found throughout the current neuropsychological literature. Additionally, neuropsychological assessments and rating scales assess many different aspects of executive control. As a result of recent research and assessment practices, an increasing number of interventions are also available that target executive weaknesses.

One must understand that not all children at the same age are at the same level of development in regard to executive functions. Development of each executive-control capacity progresses at a different rate, as intraindividual variation is great (McCloskey et al., 2009). From birth on, a child’s interaction with his or her environment shapes the development of executive capacities. Many children experience weaknesses in executive capacities but do not meet criteria for a specific disorder. Executive capacities are required to efficiently navigate academic and social demands throughout both childhood and adulthood. The developmental progression of executive capacities may not always keep pace with important transitions and demands based on cultural or educational expectations (McCloskey et al., 2009).

The initial understanding of executive capacities developed from the study of individuals with traumatic brain injuries who exhibited weakness in planning, organization, time management, memory, inhibition, and regulation of emotions. Over time, researchers and educators realized that many of these same executive capacities are commonly impaired in individuals with ADHD as well (Dawson & Guare, 2004). Several modern researchers made significant contributions to the current understanding of executive functions and ADHD. Specifically, Virginia I. Douglas, Russell A. Barkley, Thomas E. Brown, and Martha B. Denckla were vital in framing ADHD as a disorder resulting from deficits in executive functions.

Relationship Between Executive Functions and ADHD

Inhibition and self-regulation. In the 1970s, Virginia I. Douglas and colleagues studied the nature of cognitive deficits associated with childhood hyperactivity. Early on in her work, she understood multiple areas of impairment existed in these children, beyond the observable hyperactivity. In an article published in 1972, Douglas concluded the heightened activity level was not the most critical aspect of the disorder, as these individuals also struggled significantly with impulse control when concentration, organization, and planning were required.

After more than a decade of research building on the originally proposed deficit of impulse control, Douglas (1988) determined that the central impairment in individuals with ADHD involves self-regulation. The secondary deficits resulting from impaired self-regulation include poor investment and maintenance of effort, deficient modulation of arousal to meet situational demands, strong inclination for immediate reinforcement, and difficulties with impulse control (Douglas, 1980, 1983). Throughout her research, Douglas and her team used assessment procedures, such as the continuous performance test, to work with individuals with ADHD. The work of Douglas helped lead to the standardization of such assessments and to widespread use of these methods to better understand the performance of individuals and to support proper diagnosis (Barkley, 1998). Douglas (2005) continued to contribute to the field for decades, building on her work and the work of others. In her most updated working conceptualization of ADHD, she describes self -regulation as comprised of three components: attentional, inhibitory, and strategic or organizational.

Barkley also has researched the role of executive-function deficits in individuals with ADHD for decades. Starting in the 1980s, Barkley worked to develop a unifying model of ADHD based on scientific theory and research. Much of the information regarding ADHD prior to Barkley's contributions relied on descriptions of ADHD based on observation and did not lead to testable hypotheses for research. Building on the work of prior researchers, such as Douglas, Barkley sought to define constructs, such as inhibition and self-regulation, and to more specifically relate them to the cognitive and behavioral deficits in individuals with ADHD (Barkley, 1997).

Barkley's (1977) hybrid model of ADHD focuses on behavioral inhibition as the core deficit, with secondary impairments in the executive functions known as working memory and self-regulation. Barkley further defines inhibition as the ability to inhibit the initial response to an event, interrupt ongoing activity/delay decision to respond, and protect the delay and self-directed responses from interruption/interference control (Barkley, 1997). Self-regulation is defined as an action directed toward oneself that will change one's future behavior to prevent a future negative consequence or obtain a future reward (Barkley, 1997).

According to Barkley (1977), four specific executive functions necessary for self-regulation rely on response inhibition in order to function properly. The executive functions involved in Barkley's model include working memory, internalization of speech, self-regulation of affect-motivation-arousal, and reconstitution. These executive functions direct motor control-fluency-syntax, which is deficient in individuals with ADHD. When inhibitory control is functioning properly, these executive functions coordinate to direct action and control behavior, allowing for increased persistence with tasks and goal-directed action (Barkley, 1997). Based on his framework, the development of inhibitory control is impaired in individuals with ADHD. This impairment disrupts several executive functions that contribute to self-regulation and therefore interferes with the individual's ability to sustain actions toward goals (Barkley, 1997). The majority of current neuropsychological research on ADHD supports the work of Barkley and emphasizes inhibitory control as a primary deficit in individuals with ADHD, impacting multiple domains, including motor, cognitive, and emotional control (Wodka et al., 2007).

Unlike Barkley, Thomas E. Brown did not view inhibitory control as the primary deficit in individuals with ADHD. He did, however, view ADHD as a cognitive disorder of self-regulation and executive functions, with inhibitory control as one of many executive functions impaired in individuals with ADHD. He broadly described executive functions as the brain's self-management system and individuals with ADHD as experiencing a developmental impairment of executive functions (Brown, 2009).

Brown’s model to conceptualize ADHD and executive-function skills is separated into six clusters that he considered necessary for self-regulation for tasks in everyday life: (a) Activation (i.e., organizing tasks and materials, estimating time, prioritizing tasks, getting started), (b) Focus (i.e., focusing, sustaining focus, shifting focus to tasks), (c) Effort (i.e., regulating alertness, sustaining effort, processing speed), (d.) Emotions (i.e., managing frustration and modulating emotions), (e) Memory (i.e., using working memory and accessing recall), and (f) Action (i.e., monitoring and self-regulating actions; Brown, 2006). Each cluster is required to function and coordinate in order for an individual to effectively self-regulate and conduct daily tasks. Brown explained that all individuals, including those with ADHD, differ in their profiles of executive-function impairment. The level of executive impairment for most individuals with ADHD, however, is chronic and typically manifests across all the clusters (Brown, 2009).

Working memory. According to Brown (2009), individuals with ADHD experience difficulty focusing attention to tasks and effectively using working memory. Some researchers hypothesize that individuals with ADHD struggle to efficiently use cognitive processes, such as working memory, to guide inhibition, further contributing to difficulty delaying or inhibiting responses (Motsofsky et al., 2003; Rubia et al., 2001). Assessing and interpreting results of research regarding working memory in individuals with ADHD is challenging. Based on Baddeley’s (2000) working-memory model, working memory involves three components for information storage and processing. The systems for storage and rehearsal include a visuospatial sketchpad for visual and spatial information and the phonological loop for speech-based information. The central executive coordinates information from these two subsidiary systems by managing attentional control (Baddeley, 2000). When assessing the working-memory functions of individuals with ADHD, one must assess these components separately as well as together.

Several researchers concluded the deficit in individuals with ADHD involves the central executive, which requires the simultaneous processing of visual and verbal information. Researchers, including Karatekin (2004), assessed components of Baddeley’s working-memory model in a group of children with ADHD. After conducting a verbal task, a visual task, and a dual task, researchers found individuals with ADHD performed the same as nonclinical peers on the visual and verbal working-memory tasks. The children with ADHD performed poorer than their nonclinical peers when they performed the two tasks at the same time, requiring use of the central executive. The researchers concluded individuals with ADHD have deficits in the central executive component of working memory, requiring divided attention between dual visual and verbal tasks (Karatekin, 2004). Another study, conducted in 2013, examined adults with ADHD using a regression approach to understand the role of central executive processes in working-memory deficits. Results suggested that as set sizes increase with more stimuli, the need for focused attention and interference control increases, placing greater demands on the central executive. Overall, the central executive processes of the adults with ADHD in this study were significantly more impaired than those of the nonclinical participants (Alderson, Kasper, Hudec, & Patros, 2013).

Recent research has focused specifically on the relationship between working memory and response inhibition. Previous research indicated that individuals with ADHD typically perform poorer on working-memory tasks, independent of difficulty with response inhibition (Denckla, 1996). In a study conducted in 2007, researchers, including Denckla, hypothesized children with ADHD would exhibit the greatest impairment on a cognitive go/no-go task that required inhibitory control with working-memory demands. Contrary to the hypothesis, the results indicated children with ADHD made significantly more errors on tests of inhibition, regardless of working-memory load. The researchers concluded that response inhibition is a primary deficit in these individuals, independent of executive-function demands, such as working memory (Wodka et al., 2007).

Holarchical Model of Executive Capacities

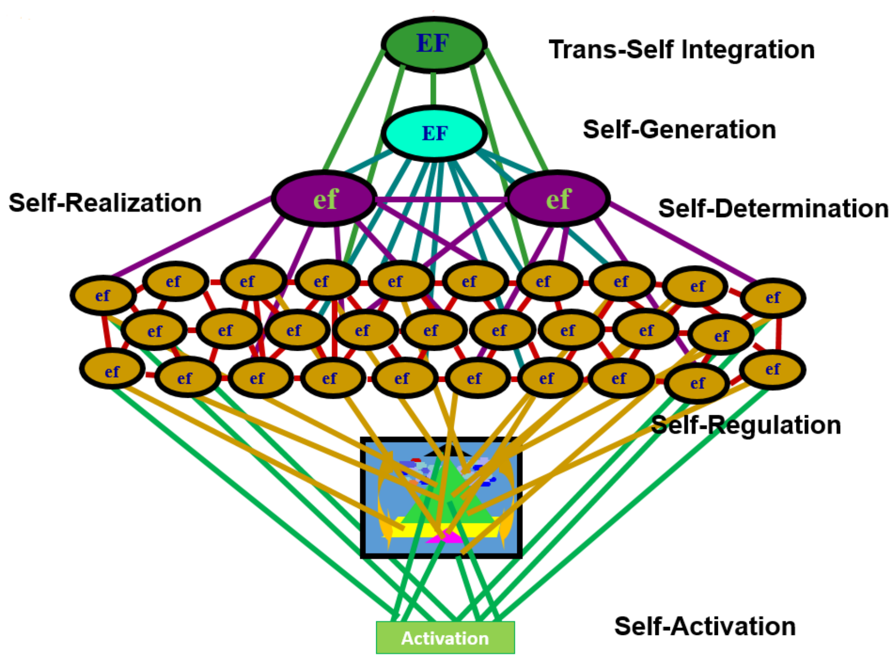
The work of Douglas (Douglas, 1972; Douglas, 1988; Douglas, 2005), Barkley (Barkley, 1997, a, b; Barkley, 1998, Barkley, 2001, Barkley, 2007, Barkley, 2016; Barkley & Peters, 2012), Brown (Brown, 2006; Brown, 2009), and Denckla (Denckla, 1996) contributed significantly to framing ADHD as a disorder associated with deficits in executive functions. Brown and Barkley also helped to provide a sequence of development for executive skills throughout life. The current work produced by these individuals, however, does not involve a comprehensive model of executive functions but rather focuses on specific executive deficits in the context of a specific disorder - ADHD. Building in part on this important body of work, the HMEC has been developed by George McCloskey. This model involves a comprehensive, multitiered theory of executive control. According to McCloskey's model, executive capacities can be viewed as an overarching neuropsychological construct that represents the mental capacities used to direct, cue, coordinate, and integrate most conscious aspects of perception, emotion, cognition, and action (McCloskey, 2016; McCloskey & Perkins, 2012; McCloskey, Perkins, & Divner, 2009).

According to McCloskey et al. (2009), executive control is comprised of four specific tiers with separate control functions, including (a) Self-Regulation, (b) Self-Realization and Self-Determination, (c) Self-Generation, and (d) Trans-Self Integration, all of which require adequate Self-Activation in order to be engaged. Self-Activation is an aroused state of consciousness that precedes engagement of executive control. Self-Activation occurs as an individual is waking up from sleep or transitioning from an unconscious to conscious state.

The four tiers include different levels of mental management (See Figure 1). The tiers represent a fluid and dynamic developmental holarchy, with movement among tiers. An individual may progress from a lower to a higher tier without mastery of the lower capacities. Unlike other models, McCloskey's differentiates between executive functions and executive skills and uses *executive capacities* as the overarching term that encompasses both executive functions and executive skills (McCloskey, 2016). According to McCloskey (2016), executive functions represent the awareness of a need to direct, and the executive skills actually do the directing. The direction provided by the executive skill enables a person to perceive, feel, think, and act consistent with the awareness initiated by the executive function. At each level within the model, portions of neural networks are involved in knowing when to direct perceptions, feelings, thoughts, and actions (i.e., executive functions) and portions of the same neural networks that are involved in knowing how to direct perceptions, feelings, thoughts, and actions (i.e., executive skills) consistent with the perceived need.

Executive functions, therefore, represent an awareness of when to engage specific aspects of executive control; executive skills represent an awareness of knowing how to activate the rest of the neural network to comply with executive-function cues. Knowing how to activate the rest of the neural network involves knowing the location and order of activation of various parts of the brain to engage the perceptions, feelings, thoughts, and actions required for complying with executive-function commands. In the HMEC, McCloskey (2016) referred to the executive capacities (i.e., functions and skills) as the supervisory system or the brain's managers, and to the parts of the brain that carry out the executive commands as the workers. Workers are located throughout the brain, including in the frontal and prefrontal cortex, but the supervisory system that manages them is located only within parts of the frontal and prefrontal cortex.

Figure 1
Tiers of Executive Control - Holarchical Model of Executive Capacities



Self-regulation. The first tier or first level of executive control within the HMEC is Self-Regulation. Self-regulation capacities form the foundation of executive-function operations for daily routines. The self-regulation tier is responsible for cueing the awareness of the need to direct (i.e., when) and then for directing (i.e., how) perceptions, feelings, thoughts, and actions, and for differentiating and coordinating between the when (i.e., executive function) and the how (i.e., executive skill) managers. At the Self-Regulation level, McCloskey outlines 33 executive capacities that are comprised of executive functions and executive skills.

The 33 self-regulation executive capacities are grouped into seven clusters, including (a) Attention, involving the capacities of perceive, focus, and sustain, (b) Engagement, involving the capacities of energize, initiate, inhibit, stop, interrupt, flexible, and shift, (c) Optimization, involving the capacities of modulate, balance, monitor, and correct, (d) Efficiency, involving the capacities of sense of time, pace, use of routines, and sequence, (e) Memory, involving the capacities of hold, manipulate, store, and retrieve, (f) Inquiry, involving the capacities of gauge, anticipate, estimate time, analyze, and compare/evaluate, and (g) Solution, involving the capacities of generate, associate, plan, organize, prioritize, and decide.

These self-regulation executive capacities are distinct from one another, and an individual’s effectiveness with each may vary significantly (McCloskey et al., 2009). An individual’s cueing capacity strength varies within each self-regulation executive function. For example, within the attention cluster, an individual may have a strong capacity for perceiving or becoming aware, involving cueing the taking in of information from an environment (external or internal) and cueing awareness of the need to focus on specific perceptions, thoughts, feelings, or actions. This same individual, however, may have a weaker capacity to sustain attention to the most salient aspects of perceptions, feelings, thoughts, or actions that are the subject of attention as long as necessary (McCloskey & Perkins, 2012).

Executive functions and executive skills act as managers for the rest of the brain (i.e., the workers) and must coordinate for each of the 33 self-regulation capacities within the clusters. In some cases, an individual may have an effective executive-function manager with an awareness of the need to cue self-regulation but an ineffective executive-skill manager that is unprepared to direct perceptions, feelings, thoughts, and actions as needed, or vice versa (McCloskey, 2016). When working with individuals with poor self-regulation, one must determine whether the difficulty is caused by an executive-function deficit (i.e., not knowing when), executive-skill deficit (i.e., not knowing how), or a combination of the two.

Arenas of involvement. The HMEC outlines four Arenas of Involvement to explain the variability of engagement of self-regulation capacities that are often observed in clinical cases. The four Arenas of Involvement include the Intrapersonal Arena, the Interpersonal Arena, the Environment Arena, and the Symbol System Arena (McCloskey et al., 2009; McCloskey & Perkins, 2012; McCloskey, 2016).

The Intrapersonal Arena relates to how an individual perceives, thinks about, feels about, and acts toward himself or herself. The effective use of executive capacities within this arena enables an individual to avoid self-destructive tendencies, including addictions, and to avoid or cope effectively with internalizing conditions, such as depression or anxiety. Individuals who effectively use self-regulation capacities within this arena are able to engage in purposeful and positive behavior on a daily basis through self-control and self-discipline. The interpersonal arena relates to how an individual interacts with others. The effective use of self-regulation capacities within the interpersonal arena enables an individual to understand the perspective of others and effectively regulate perceptions, feelings, thoughts, and actions in the presence of others.

The Environmental Arena relates to how an individual uses self-regulation capacities to deal effectively with or manage his or her environmental surroundings. The effective engagement of executive capacities in relation to the environment allows for an individual to understand how to use natural resources and to anticipate the impact of one's actions on the physical environment and how to avoid accidents or mistakes that threaten the environment of personal safety. The symbol system arena relates to how an individual uses self-regulation capacities to manage the processing, storage, retrieval, and use of information transmitted through symbol systems, such as when reading, writing, speaking, or quantifying.

Executive control may vary significantly based on whether an individual is trying to control him or herself, his or her interactions with others, interactions with the environment, or management of information processing and use of symbol systems. Dissociations among the various arenas of involvement can occur. An individual may be able to use most self-regulation capacities effectively while struggling with the use of others within the same or different arena (McCloskey et al., 2009; McCloskey & Perkins, 2012; McCloskey, 2016). Identifying executive-capacity strengths and weaknesses within arenas of involvement can be helpful when attempting to develop interventions for individuals struggling with the effective use of executive capacities.

Self-realization and self-determination. The second tier within the HMEC involves two subdomains: – Self-Realization and Self-Determination (McCloskey et al., 2009; McCloskey & Perkins, 2012; McCloskey, 2016). Self-Realization enables a more refined sense of self and others and the capacity for self-reflection and self-analysis. Self-Realization provides a greater sense of personal strengths and weaknesses and allows for the recognition of difficulties that may be hindering personal growth. The Self-Realization managers contribute to an increased awareness of self and awareness of others.

Self- Determination involves generating personal goals for the future and specific plans to accomplish these goals. In order to do so, an individual must evaluate the adequacy of self-regulation efforts in carrying out plans and achieving goals (McCloskey, 2016). Self-Determination has at least two managers: a long-term goals manager and a long-term planning manager. The long-term planning conducted at the level of Self-Determination is different from the short-term Plan executive function within the self-regulation capacities. The long-term planning capacity at the Self-Determination level allows an individual to develop foresight and plan well beyond a brief time span (McCloskey, 2016). Well-developed Self Determination capacities allow an individual to ignore urges for immediate gratification that may interfere with long-term goals. For example, an effective Self- Determination manager has the ability to influence the use of the Inhibit executive function within self-regulation to avoid engaging in behavior that could interfere with accomplishing long-term goals. The ability to consistently engage in use of self-determination tends to develop between the ages of 10 to 14 years in children and continues to develop in late adolescence and throughout adulthood (McCloskey, 2016).

Self-Realization and Self-Determination managers have the potential to become aware of all aspects of self-regulation, to evaluate the effectiveness of specific aspects of self-regulation, and to deliver commands to modify and improve self-regulation (McCloskey, 2016). The more effective the Self-Realization managers, the greater the likelihood that the self-regulation executive capacities will work efficiently and coordinate their efforts to achieve personal goals (McCloskey, 2016).

Self-generation. The next tier of executive control involves philosophical inquiries about the nature of existence, purpose of life, moral and ethical behavior, explorations of the spirit and soul, and the nature of the relationship of mind to body, and it considers the possibility of existence of a God. McCloskey (2016) noted that the conceptualization of this level of executive control was greatly influenced by the work of the psychiatrist Victor Frankl (1955, 1959, 1975, 1978, 2000), the psychologist Lawrence Kohlberg (1958, 1963, 1973, 1981, 1984) and the Dalai Lama (2011).. These capacities can emerge independent of other executive capacities and function with varying levels of effectiveness (McCloskey et al., 2009). For example, a person may become invested in understanding aspects of a higher power but may lack self-awareness of his or her strengths and weaknesses, have no particular long-term goals, and/or have difficulties with one or more self-regulation capacities. For example, adolescents may find themselves at great risk if they activate self-generative thoughts about the meaning of life but at the same time have no meaningful long-term goals (i.e., lack of adequately developed Self-Determination), are severely depressed because they are unable to effectively modulate their emotions (i.e., lack of adequate Self-Regulation), and are lacking the Self-Realization needed to seek help.

Trans-self-integration. Some individuals are capable of generating thoughts of a trans-self-integrative nature. Activation of executive control at this level involves a high level of frontal-lobe activation and is typically not attainable until adulthood. At this level, individuals make an effort to understand what lies beyond the sense of self to achieve a unified state of consciousness (McCloskey et al., 2009; Newberg & Waldman, 2009, 2017).

Summary of HMEC. The HMEC is a multifaceted model of executive capacities that incorporates existing models and theories to reflect the complex neural network within the frontal lobes of the brain. To avoid oversimplification of the executive-control processes, McCloskey compares executive functions to a multitiered management structure of a multinational mind corporation. Within this corporation, each manager is responsible for making contributions to the whole while working in collaboration with other managers to achieve desired outcomes for the corporation. With this in mind, the first tier of Self-Regulation is considered the first level of management, responsible for directly supervising parts of the neural network that carry out the commands of the executive managers. Each of the 33 self-regulation capacities previously discussed has an office within this network. The next level of management is comprised of the second tier, Self-Realization and Self-Determination. These executive functions are responsible for supervising or managing the Self-Regulation managers (McCloskey, 2016). The metaphor created by McCloskey extends well beyond the general comparison of chief executive officer or conductor of the brain’s orchestra commonly used by other researchers. Moving beyond these oversimplified representations of executive functions and moving toward an understanding that executive functions involve a multitiered set of directive capacities similar to managers at varying levels can lead to better assessment methods and interventions (McCloskey et al., 2009).

ADHD in the context of the HMEC. Unlike the theories proposed to explain ADHD, the HMEC is a theory developed to explain how executive control operates in all nonclinical and clinical populations. In terms of ADHD specifically, McCloskey, Hewitt, Henzel, & Eusebio, (2008) noted that the ADHD diagnosis is most likely to occur when an individual is deficient in the use of one or more of four specific self-regulation executive capacities: focus and sustain from the Attention Cluster, inhibit from the Engagement Cluster, and modulate from the Optimization Cluster. Focus and sustain deficits define the Inattentive type while inhibit and modulate deficits define the hyperactive type, and deficits in all four define the combined type. McCloskey et al. noted, however, that although these four are the core executive capacities that are deficient in individuals diagnosed with ADHD, the possibility that these are the only self-regulation executive capacities that are deficient for anyone diagnosed with ADHD is unlikely, and the nature of the other deficits can vary greatly from one person to another. As a result, McCloskey et al. posited that all individuals with ADHD exhibit the same core deficits consistent with their diagnosis but also exhibit an additional constellation of deficits that are not part of the ADHD diagnostic core. Exactly which self-regulation executive capacities make up the constellation of additional deficits wholly depends on the nature and situation of the individual under consideration. Therefore, an individual diagnosed with ADHD may exhibit as few as two self-regulation executive-capacity deficits or as many as 33. Direct assessment of the individual under consideration is necessary to identify the specific executive-capacity deficits and their effects on daily functioning and quality of life.

Additionally, McCloskey et al. (2008) suggested that ADHD symptomatology may vary greatly depending on Arenas of Involvement, noting that many individuals diagnosed with ADHD experience more difficulties within the Symbol System Arena than within the other three arenas. However, any individual diagnosed with ADHD could exhibit executive-capacity deficits in two or more arenas.

Assessment of Executive Functions and ADHD

Executive functions can be understood as a multidimensional construct with functions and skills that vary across each individual and develop throughout an individual's life. When assessing executive capacities, clinicians must consider the complexity of executive capacities and consider various domains of functioning and contextual factors (McCloskey & Perkins, 2012). Assessment of executive functions for all individuals, including those with ADHD, should help identify the pattern of strengths and weaknesses reflecting an individual's executive-function capacities. A thorough and comprehensive assessment process is needed to effectively identify executive-capacity difficulties that negatively impact an individual's academic performance and social experience. Most importantly, the assessment of executive capacities should lead to identification of interventions that address the specific executive-capacity problems.

As stated in the neuropsychological literature and reflected in the *DSM-5* (2013), a great deal of overlap is likely between assessment methods used to identify executive dysfunction and methods used to diagnose ADHD. One should note that while individuals with ADHD commonly experience weaknesses in executive capacities, not all individuals with executive deficits have ADHD. Currently, no state or federal regulations or professional guidelines such as those in the *DSM-5* (2013) help to formally identify and diagnose individuals who have executive-capacity deficits but are not diagnosed with ADHD, making access to services to improve life outcomes difficult. While many disorders in the current *DSM-5* (2013) are associated with executive deficits, no separate diagnostic criteria for identifying executive-capacity disorders currently exist. Only the World Health Organization's classification of health problems acknowledges the existence of stand-alone executive-capacity deficits, referring to them as Frontal Lobe and Executive Dysfunction (WHO, 2000). Even with changes to the *DSM*, however, encompassing the wide spectrum of difficulties associated with executive-capacity deficits will be challenging (McCloskey & Perkins, 2012).

Consistent with the complexity of executive capacities is the great variability within an individual's executive functions and skills. A major disadvantage of many assessment methods currently in use involves the lack of focus on executive-skill strengths (McCloskey & Perkins, 2012). In order identify the unique strengths and needs of an individual's executive profile, a more balanced and inclusive approach to assessment of executive skills and functions is necessary. According to McCloskey and Perkins (2012), the assessment of executive function must consider how the functions are cued and directed across the different contexts and settings that an individual may encounter. In order to do so, McCloskey and colleagues recommend the use of clinical interview techniques and observation in different settings, in addition to the norm-referenced measures and standardized rating scales discussed in the following sections (McCloskey et al., 2009; McCloskey & Perkins, 2012).

Direct Formal Methods

Throughout the 1970s, neuropsychologists developed assessment techniques to assess the executive-function deficits of patients with brain damage or strokes. These assessments aimed to identify the loss of function through tasks involving concept formation, planning, and self-regulation (Lezak, Howieson, Loring, Hannay & Fischer, 2004). As research on the importance of executive functions increased over the past several decades, the purpose of these assessment methods broadened to include assessment of children and adults without brain trauma. Three of the most commonly used norm-referenced neuropsychological assessments of executive functions include the NEPSY-II, the Delis-Kaplan Executive Functions System, and the Wisconsin Card Sorting Test. These assessment methods, however, focus entirely on the impact of executive functions within the symbol system arena (McCloskey & Perkins, 2012).

NEPSY-II. The NEPSY-II is a comprehensive neuropsychological battery used to assess neurocognitive abilities in children from preschool age through adolescence (Korkman, Kirk, & Kemp, 2007). The NEPSY-II contains 32 subtests divided into six domains of cognitive functioning. The first domain is Attention and Executive Functioning followed by Language, Memory and Learning, Sensorimotor, Social Perception, and Visuospatial Processing. The individual subtests within the Attention and Executive Function domain include Animal Sorting, Auditory Attention and Response Set, Clocks, Design Fluency, and Inhibition (Korkman et al., 2007). Individuals who perform poorly on the inhibition subtest are interpreted to have difficulty with inhibitory control and cognitive flexibility. Clinical studies using the NEPSY-II with individuals with ADHD suggest the NEPSY-II is an effective tool in identifying cognitive problems related to attention, executive functioning, and language in individuals with ADHD (Brooks, Sherman, & Strauss, 2010).

Delis-Kaplan Executive Function System. The Delis-Kaplan Executive Function System (DKEFS; Delis, Kaplan, & Kramer, 2001) is a comprehensive battery including nine individually administered tests. The DKEFS was designed to assess higher level cognitive functions for individuals aged 8 to 89 years. It is organized into four domains: Concept Formation, Flexibility, Fluency and Productivity, and Planning. The specific subtests within these domains are Trial-Making, Word Context, Sorting, Twenty Questions, Tower, Color-Word, Verbal Fluency, Design Fluency, and Proverb Test. The DKEFS provides both performance scores for each of the nine subtests and process-related scores for interpretation (Delis et al., 2001). The D-KEFS is often used with individuals suspected of having ADHD or a traumatic brain injury (Delis et al., 2001).

The Wisconsin Card Sorting Test. The Wisconsin Card Sorting Test (WCST) includes stimulus cards and specific parameters to assess the executive abilities of individuals aged 6 to 89 years. Test takers sort the cards based on different principles and adjust their approaches throughout the assessment. The WCST requires application of problem-solving strategies and is used to assess perseveration and abstract thinking abilities. The assessment provides information regarding the test taker’s planning; organization; and ability to use feedback to shift set, to direct behavior toward a goal, and to modulate impulsivity (Heaton, 1981).

Indirect Formal Methods

According to Brown (2014), neuropsychological tests of executive function overly simplify executive functions. He argues that neuropsychological assessments attempt to measure one specific process rather than the simultaneous management of different processes, the essence of executive functions (Brown, 2014). In order to best understand executive functions in individuals with ADHD, Brown (2014) supported an assessment of an individual's ability to perform self-managed tasks of everyday life over time. One method of understanding an individual's functioning throughout the day in different settings is through rating scales.

Several rating scales are widely used to assess executive-function strengths and needs of individuals. A few of the most commonly used rating scales include the Behavior Rating Inventory of Executive Function-Second Edition (BRIEF-2; Gioia, Isquith, Guy, & Kenworthy., 2015), Delis-Rating of Executive Functions (D-REFS; Delis, 2012), the Comprehensive Executive Function Inventory (CEFI; Naglieri & Goldstein, 2012), and the MEFS (McCloskey, 2016). These rating scales are used by clinicians as an important part of the process to determine an individual's functional executive skills and to determine if an individual has ADHD.

Behavior Rating Inventory of Executive Function-Second Edition (BRIEF-2). The BRIEF-2 is a behavioral rating scale designed to assess a child's executive-function skills in his or her natural environment, specifically home and school. The BRIEF-2 evaluates self-regulatory aspects of executive functions, such as inhibition and emotional control, and metacognitive abilities, such as working memory, organization of materials, and self-monitoring. The clinical scales are Inhibit, Self-Monitor, Shift, Emotional Control, Initiate, Task Completion, Working Memory, Plan/Organize, Task-Monitor, and

Organization of Materials. These clinical scales form two broader index scores known as Behavioral Regulation and Metacognition, along with an overall score known as the Global Executive Composite score (Gioia et al., 2015) . These self-regulatory and metacognitive abilities are assessed through rating scales completed by parents and teachers and often from self-ratings from the individual to provide input about the child’s functioning in everyday life (Donders, 2002).

A study conducted by Semrud-Clikeman, Walkowiak, Wilkinson, and Butcher (2010) found that children with ADHD-C were rated as having significantly more difficulty on behavioral regulation, emotional control, and monitoring of behavior when compared to nonclinical peers and individuals with ADHD-I. Specifically, the group of children identified as ADHD-C were rated as having more difficulty shifting and inhibiting. Brown (2014) and most researchers currently view executive-function impairments as the core issue in individuals with ADHD, regardless of the presentation type. Neuropsychological assessment and rating scales, such as the BRIEF-2, may identify the executive dysfunction of only a minority of individuals with ADHD.

Delis-Rating of Executive Functions (D-REF). Created by Dean C. Delis in 2012, the D-REF consists of rating scales to measure executive-function difficulties in children aged 5 to18 years. The D-REF is considered a supplemental assessment to support the understanding of behavioral or cognitive difficulties in children, including children with ADHD. The D-REF assesses four broad areas of executive functioning: Attention/Working Memory, Activity Level/Impulse Control, Compliance/Anger Management, and Abstract Thinking/Problem Solving (Delis, 2012). Similar to the

BRIEF-2, ratings from home and school are typically completed, along with a self-report for children aged 11 to18 years.

The Comprehensive Executive Function Inventory (CEFI). The CEFI consists of parent, teacher, and self-report rating scales created by Jack Naglieri and Sam Goldstein in 2012. It is designed to assess strengths and weaknesses in executive functions for children aged 5 to18 years. An executive-function full-scale score is derived from the subscales Attention, Inhibitory Control, Planning, Emotional Regulation, Initiation, Self-Monitoring, Flexibility, Organization, and Working Memory (Naglieri & Goldstein, 2012).

The McCloskey Executive Functions Scale (MEFS). The MEFS is an Internet-based, norm referenced assessment tool that can be used in conjunction with other assessment tools to help determine a child's strengths and weaknesses in executive skills and executive functions based on teacher or parent input (McCloskey, 2016). The development of the MEFS is based on a multidimensional theoretical model known as the holarchical model of executive capacities described earlier in this review. It is designed to assess the executive-function capacities for children between the ages of 5 and 18 years. Parent, teacher, and self-rating forms of the MEFS exist; however, only the teacher form has been standardized for use as an indirect, formal method of assessment at this time.

The MEFS teacher form assesses judgments about students' degrees of effectiveness with the use of 33 self-regulation executive capacities within the context of two arenas of involvement (i.e., academic arena and self/social arena), self-realization, and self-determination. The MEFS includes 104 questions to examine 33 executive capacities from the Self-Regulation tier of the HMEF, along with the Self-Realization and Self-Determination tiers. The Symbol System and Environment arena are combined to form the Academic arena. The Intrapersonal and Interpersonal arenas are combined into the Self/Social arena. The MEFS includes a strengths and weaknesses item analysis for the 33 Self-Regulation Executive Functions and several aspects of Self-Realization and Self-Determination.

Unlike other rating systems based on frequency of behaviors, the MEFS focuses on the degree to which an individual uses the executive functions and/or skills. Another important difference between the MEFS and other executive-function rating scales is the differentiation between executive-function strengths and deficits and executive-skill strengths and deficits (McCloskey et al., 2009; McCloskey & Perkins, 2012). This balanced approach incorporating strengths helps in fully understanding an individual's executive capacities, rather than identifying only the areas of weakness. Furthermore, differentiating between skills and functions can support in developing specific interventions to address challenges in an individual's awareness of the need to direct (i.e., Executive Function) or weakness in actually directing the rest of the neural network (i.e., Executive Skill; McCloskey, 2016).

Interventions for Executive Functions and ADHD

A comprehensive assessment of executive capacities should support the identification of the strengths and needs within an individual's executive profile. Determining the appropriate interventions to build on an individual's strengths and improve the area(s) of deficit is essential. If an individual struggles with an executive-function deficit evident through a lack of awareness for the need to self-regulate, then the intervention must involve increasing awareness of the need to cue self-regulation skills. If an individual experiences an executive-skill deficit, explicitly teaching and then practicing directing perceptions, thoughts, and actions are necessary to achieve self-regulation. Sometimes, an individual has difficulty with both aspects and will need intervention to increase the awareness of the need for self-regulation and then learn to direct the self-regulation process (McCloskey, 2016).

Multiple interventions are available to support in developing internal control and external control for individuals with and without ADHD who exhibit deficits in executive functions. When developing and selecting interventions, one must understand that an individual's self-regulatory capacities are distinct from one another and an individual's effectiveness in using each may vary greatly (McCloskey, 2016). Therefore, a combination of interventions is likely required and may need to be addressed in different contexts and settings in order to be generalized.

Psychosocial Interventions

Cognitive-behavioral therapy. Cognitive-behavioral therapy (CBT) can be used to improve aspects of self-regulation difficulties. CBT supports the increase of executive control over perceptions, thought patterns, emotional reactions, and behaviors (McCloskey et al., 2009). Specifically, strategies and skills gained through CBT can increase an individual's awareness of the need to cue and regulate executive functions.

A multimodal treatment package works best when working with children with ADHD. Both parent and child must participate at each stage or tier of the therapy process. According to Friedberg and McClure (2002), the first tier of treatment involves engaging the child and parent in treatment by providing psychoeducation to help motivate the desire to change. An important part of this initial process involves developing an understanding of the need to change and increasing self-monitoring skills. Within the second tier, the focus is on teaching the child and parent basic behavioral management skills and positive coping skills. Parents learn to give effective commands and reinforce compliance. Family-based problem-solving approaches are also used at this level, with a focus on learning to understand a problem from a different perspective. Next, at the third tier, the child begins to learn self-instructional coping skills, such as how to rethink situations using internal dialogue and self-talk. If needed, empathy training may be incorporated at this point. Finally, at the final tier, therapy focuses more on rational analysis and cognitive techniques. At each tier, the child is directly taught and acquires a skill, followed by a performance task to apply the skill. The performance-based tasks help the child to generalize the skill through practice with set exercises, assignments, and activities inside and outside of therapy (Friedberg & McClure, 2002).

Multiple studies have explored the effectiveness of CBT for individuals with ADHD. A recent meta-analysis on this topic summarized findings that CBT is an effective treatment for individuals with externalizing disorders, such as ADHD. Results from relevant studies indicate that treatment with CBT reduces parental stress while increasing parenting skills. For the child, CBT reduces externalizing symptoms while improving attention and social competence (Battagliese et al., 2015). The researchers found a moderate effect of CBT in reducing symptoms of ADHD, with parents reporting a greater reduction than teacher reports. Overall, the review of recent research indicated that CBT is an effective intervention for individuals with ADHD. Specifically, the multimodal approach of CBT is effective, as it supports both parent and child, thereby allowing for a greater sustained impact and generalization (Battagliese et al., 2015).

Behavioral Therapy. Psychosocial behavioral interventions emphasize psychological and social factors over biological factors. These interventions aim to cue the use of skills and then to motivate their continued use in natural settings through the use of artificial consequences (Antshel, 2015). The main goal of behavioral interventions is to replace less desirable behavior with a more appropriate behavior. In order to do so, an understanding of the antecedents and consequences of the behavior is critical (DuPaul, Gormley, & Laracy, 2014). With younger children, methods typically used in school and home are based heavily on behavioral modification. At the middle- and high-school age, one should rely more on teaching skills and using operant-conditioning principles to improve functioning (Antshel, 2015).

School-based behavioral interventions aim to increase positive behaviors though an analysis of contextual factors (i.e., antecedents and consequences) of the negative behaviors. Behavioral interventions in a school setting can be categorized as proactive/preventative or reactive. Proactive interventions emphasize reviewing rules and expectations prior to starting an activity, using verbal and nonverbal cueing systems (discussed further in the next section), maintaining eye contact, providing a clear schedule of activities, actively monitoring student during class, and monitoring and maintaining appropriate pacing of activities (DuPaul et al., 2014). These methods target the antecedents to a child’s behavior and attempt to reduce the likelihood the child will engage in certain behaviors. More reactive-based interventions focus on consequences, including teacher attention, reinforcement of positive behavior (i.e., token economy), and selectively ignoring or punishing negative behaviors (i.e., time-out; Antshel, 2015).

As mentioned with the CBT model, parental involvement is vital to the intervention process when working with children and adolescents with ADHD. Multiple parental behavioral training programs are available to address disruptive behaviors and intention/impulsive symptoms of children and adolescents with ADHD. These programs, such as Community Parent Education Program (COPE), Parent-Child Interaction, and Triple P (Positive Parenting Program), are based on the social learning model of behavior and focus on operant conditioning as a primary technique. These programs extend beyond just reducing observable ADHD symptoms and aim to improve the functional impairments in children with ADHD. These interventions attempt to reduce the child's dependence on parents to manage daily tasks, such as morning and homework routines. At the same time, the program works to address counterproductive parenting practices and to improve a child's compliance with parental requests. Some parental behavioral training programs have been developed to address specific social problems and improve organization skills or school performance. Some of the additional strategies discussed in the following sections, such as a daily report card, are incorporated into these programs (Antshel, 2015). Although multiple studies show that behavioral interventions in a school setting can result in large effect sizes, few studies show how this progress in generalized or maintained after the interventions end (DuPaul, Eckert, & Vilardo, 2012).

Mind-Body Interventions

Mindfulness. Mindfulness is a form of meditation and attention training based in Buddhist tradition. According to Kabat-Zinn (2003), mindfulness involves an awareness of the present moment with an increase in nonjudgmental observation and a decrease in automatic responding. Mindfulness can be used in isolation or as part of mindfulness-based CBT. Mindfulness involves learning strategies to help improve self-control of perceptions, emotions, thoughts, and actions. Mindfulness may be particularly beneficial for older children and adolescents with increased Self-Realization and Self-Determination capacities. Several studies have connected meditation and mindfulness training to improvements in executive control, such as attention, working memory, and cognitive control (Taren et al., 2017). Researchers recently found increased functional connectivity in regions associated with executive functions during active meditation (Taren et al., 2017).

A recent study explored the effectiveness of mindfulness training on behavioral and attention problems in adolescents with ADHD (Weijer-Bergsma, Formsma, Bruin, & Bogels, 2012). For 8 weeks, adolescents with ADHD and their parents participated in mindfulness training. Rating scales administered before and after the group intervention indicated reduced attention and behavioral problems, with reported improvements in executive functioning. The adolescents with ADHD also participated in sustained-attention tasks that indicated improvements after the mindfulness training. The effects of the training were stronger during the 8-week follow-up but then decreased by the 16-week follow-up. Overall, results support that mindfulness is an effective intervention for adolescents with ADHD, but continuing to apply strategies is important to maintain positive effects long term (Weijer-Bergsma et al., 2012).

Neurofeedback. Neurofeedback is another mind-body therapy option that involves modulation of specific brain activity patterns through regular feedback to improve self-regulation. Neurofeedback training involves a minimum of 30 sessions (Leins et al., 2007). During these sessions, neurofeedback is intended to normalize frequency bands and electrode sites by providing feedback on the EEG. The goal is to train individuals with ADHD to self-regulate their brain activity through the positive feedback (Vollebregt, Dongen-Boomsma, Buitelaar, & Slaats-Willemse, 2014). Although a few studies yielded positive effects in reducing symptoms of ADHD through this intervention, being able to prove that the reduction is the result of the electrophysiological variables associated with the neurofeedback has been difficult (Leins et al., 2007). Many studies involving neurofeedback for ADHD involve methodological limitations, specifically small sample sizes (Vollebregt et al., 2014). At this time, neurofeedback is not accepted as a standard therapy for children and adolescents with ADHD.

Other mind-body therapies that may help in reducing symptoms and improve functioning for individuals with ADHD include yoga, Tai Chi, deep breathing, guided imagery, and progressive relaxation. Mind-body therapies using mindfulness and meditation methods likely improve symptoms of ADHD because the individuals participating in the intervention learn to control attention and sustain focus on a specific purpose, such as breathing (Herbert & Esparham, 2017).

Additional Strategies

A challenge of more widely known methods of improving internal- and external-control strategies through psychosocial interventions, such as CBT and behavioral therapy, is their application and generalization across settings. As McCloskey (2016) has identified throughout his work, individuals with executive deficits struggle in different settings, and the challenges experienced in school must be addressed in that setting. Close communication between outside supports and home-school can help, but direct intervention provided at school is vital.

Several resources are available to support in development of internal- and external-control strategies in a school setting, including *Assessment and Intervention for Executive Function Difficulties* by McCloskey et al. (2009). This resource connects well with the MEFS and also provides a thorough review of best assessment practices. Another option available to support the design of interventions is *Managing ADHD in Schools: The Best Evidence Based Methods for Teachers* by Barkley (2016). A few helpful and commonly used resources for teaching executive skills and functions in a school setting have been created by Peg Dawson and Richard Guare, including *Executive Skills in Children and Adolescents: A Practical Guide to Assessment and Intervention,* 2nd edition (2004); *Smart but Scattered (2008);* and *Coaching Students with Executive Skills Deficits (2012).* The I Can Problem-Solve program created by Mryna Shure (1992) can support improvement of self-awareness through teaching concrete problem-solving skills. This program can support working with younger children to apply a CBT approach in a school setting to improve self-regulation skills. A description of various techniques and strategies discussed in these resources will be outlined in the following sections.

Develop skill routines. A less programmatic approach involves the cognitive strategy training approach of breaking an executive task down and providing explicit self-direction cues for a child to practice and apply. With enough scaffolding and application over time, tasks become more routine and can improve an individual's functioning in intrapersonal, interpersonal, and environmental arenas (McCloskey et al., 2009).

Verbal mediation – internal feedback. Verbal mediation is a highly effective tool to improve self-regulation capacities. In line with CBT strategies, the use of self-talk can support the improvement of self-control. The use of social stories can teach younger children to use internalized language to navigate various situations, leading to behavioral change (McCloskey et al., 2009). Self-talk can support children and adolescents as they learn to generate and cue perceptions, feelings, and thoughts, as well as provide feedback on the perceptions, feelings, and thoughts experienced (McCloskey et al., 2009).

Cueing systems. According to McCloskey (2016), verbal and nonverbal cueing systems can be developed to increase a child's awareness and to actually direct children lacking specific executive functions and skills from the Attention (i.e., perceive, focus) and Engagement (i.e., initiate, inhibit, stop, pause, shift) clusters within the Self-Regulation tier of the HMEF. Barkley (2016) provided an example for cueing a young child using the word *turtle*. After being directly taught the word and sequence of how to respond, when a child hears the word, he or she will (a) Stop (or Pause) what he or she is doing and pull hands and legs closer to his or her body, (b) Slowly look around the class to see what is happening in the environment, (c) Ask aloud, "What was I told to do?," and (d) Recall rule and expectation (may use clues from environment) to either follow instruction or return to assigned task (Barkley, 2016).

Barkley's example of a cueing system can also be adapted for use with other executive functions. The cue helps increase awareness, but the specific skill the child is to follow through with must be explicitly taught and practiced with regular feedback. Some nonverbal cues may include drawing a checkmark (on desk or paper), a stamp, a sticker, a Post-it note, a tap on the shoulder or desk, or a hand gesture. The Motivaider is a vibrating box with built-in timer that a child can wear on a belt or place in a pocket. It vibrates at intervals determined by the teacher and serves as a tactile cueing device (Barkley, 2016).

In some cases, Barkley (2016) recommended video recording a child during a particularly challenging class to reflect the executive dysfunction(s) that need to be improved. The video can be reviewed with the student and student's family, with a focus on what the child can do differently. Most likely, a token system or reporting system should follow this experience to ensure a system is in place to allow the student to practice and track the changes (Barkley, 2016).

Structuring time. Individuals with difficulties related to executive function and ADHD may struggle with time management. To improve these deficits found within the Efficiency cluster (i.e., sense time, pace, routines, sequence), the use of external time-keeping devices may be necessary. External time-keeping devices can increase awareness and improve the actual skills needed for these individuals to determine the length of time they need to work and the amount of time that is left. Additionally, timers can support individuals who struggle with the shifting during transitions to understand the amount of time they have to move between activities. Many options for timers are available, including a stop watch, the Time Timer, My Time Activity Timer, or a variety of timer apps for electronic devices (Barkley, 2016).

Increasing wait time. An important finding over the several decades of research regarding ADHD involves the role of inhibitory control. Adults working with children with ADHD must keep in mind that these children have more difficulty than their peers in situations requiring response inhibition, even when demands on working memory seem low and the task seems simple. The work of Wodka et al. (2007) indicated that some behavioral techniques can support an increase in wait time and delaying responses in children with ADHD. The use of such techniques as counting to a set number before responding may provide more time for activation of key aspects of the prefrontal cortex and motor areas (Wodka et al, 2007).

Graph productivity and progress. Many children with ADHD and executive-function deficits are less aware of their behavior than others and lack self-monitoring skills. Research on improving self-awareness or self-monitoring is limited; however, Barkley (2016) has provided some suggestions.. Children lacking specific executive functions and skills from the Attention cluster (i.e., sustain), Engagement cluster (i.e., initiate, energize), and/or Efficiency cluster (i.e., sense time, pace) may find that recording work productivity on a daily chart or graph is helpful. The graph could include the number of problems completed in math or the number of words written for a language arts class. These graphs can improve a student's awareness of performance and progress over time.

Daily behavioral report card and behavioral contracts. Another method suggested by Barkley (2016) involves the use of a daily report card in which the student self-evaluates behavior. Teachers can also evaluate the child using this report card, and the two can conference about the similarities and differences in the ratings to improve awareness and provide corrective feedback. When creating these tools, one must be sure to state goals in a positive and specific manner. Important components include both quantitative (i.e., ratings) and qualitative feedback from the teacher after and/or during each class, along with daily communication with parents. Home and school must collaborate in order to agree on a reward-and-consequence system (Barkley, 2016).

Psychostimulant Medication

Individuals with ADHD in the United States began to be treated with amphetamines as medication therapy to reduce disruptive behavior as early as the 1930s (Barkley, 1998). Nearly a century later, psychostimulant medication is still considered the most effective treatment for managing symptoms of ADHD (Rubia et al., 2014). The most commonly used psychostimulant medication is methylphenidate. Other stimulants available for the treatment of ADHD include dexamphetamine and mixed amphetamine salts (Rubia et al., 2014). Psychostimulants, such as methylphenidate and dexamphetamine, can reduce symptoms of ADHD in approximately 70% of patients (Hanwella, Senanayake, & de Silva, 2011; Wilens, 2008). Several nonstimulant options for the treatment of ADHD include atomoxetine, tricyclic antidepressant, and bupropion, all found to be effective (Conners et al., 1996; Hammerness, McCarthy, Mancuso, Gendron, & Geller, 2009).

A recent fMRI study and a meta-analysis conducted by Rubia et al. (2014) found that methylphenidate significantly improved activation in the bilateral inferior frontal cortex/insula during inhibition tasks in a group of adolescents with ADHD. No significant effect was found on brain functioning during working-memory tasks. Several other whole-brain fMRI studies support these findings, showing that methylphenidate stimulants increase right inferior frontal cortex/insula activation during response inhibition and sustained-attention tasks (Rubia, Halari, Cubillo, Mohammad, & Taylor, 2009; Rubia, Halari, Taylor, & Brammer, 2011).

Additional fMRI studies using go/no-go tasks found that individuals with ADHD who were chronically medicated with methylphenidate exhibited greater activation in inferior medial frontal, anterior cingulate cortex, and striatum areas of the brain (Epstein et al., 2007; Vaidya et al., 1998). The right inferior frontal cortex is involved in cognitive control and in mediating time estimation, as well as in selective and sustained attention (Shulman et al., 2009; Wiener, Turkeltaub, & Coslett, 2010). These functions mediated by the right inferior frontal cortex have been found to be consistently impaired in individuals with ADHD (Rubia et al., 2014). A cross-sectional study of elementary-aged children with ADHD-C receiving psychostimulant medication found that children who took medication long term exhibited better executive-function performance than those who had recently begun taking medication (Vance, Maruff, & Barnett, 2003). A longitudinal study is needed to help in determining if improved executive function is in fact a marker of psychostimulant medication in the longer term (Vance et al., 2003).

Overall findings indicate that stimulants, such as methylphenidate, increase activation of an important cognitive control region, the right inferior frontal cortex, which is typically underactive in individuals with ADHD. Specific functions that may be improved with use of stimulant medication include inhibition, attention, and timing (Rubia et al., 2014). Most fMRI studies involving methylphenidate indicate the stimulant has a positive effect on brain activation for individuals with ADHD.

Summary of Literature

ADHD is the most commonly diagnosed neurodevelopmental disorder in children (APA, 2013). Individuals diagnosed with ADHD typically present with executive-capacity deficits. The neuropsychological literature that addresses ADHD has focused on frontal-lobe functioning in the form of executive capacities, with an emphasis on the capacities of inhibition and working memory within the general domain of self-regulation, as the primary deficits in ADHD (Barkley, 1997; Denckla, 1996). Research indicates that although some behavioral symptoms subside over time, many individuals diagnosed with ADHD continue to experience dysfunction later in life (Biederman et al., 2000; Halperin et al., 2008; Miller et al., 2012).

The results of studies using advanced-imaging technology provide strong support for theories developed by researchers, such as Brown and Barkley, that ADHD is a disorder of executive functions. Individuals with ADHD have anatomical and functional brain-based differences specific to the attentional and control networks in the frontal lobe of the brain. Barkley's (1997b) work focuses on the development of inhibitory control as the primary impairment in individuals with ADHD. This impairment disrupts several executive functions that contribute to self-regulation and, therefore, interferes with the individual's ability to sustain actions toward goals (Barkley, 1997b). Brown also viewed ADHD as a cognitive disorder of self-regulation and executive functions, but with inhibitory control as just one of many executive functions impaired in individuals with ADHD (Brown, 2009).

As research accumulates and theories evolve over time, a move toward a more comprehensive model of executive functions that focuses on specific executive deficits in the context of a specific disorder (i.e., ADHD) is important. The HMEC has been developed by George McCloskey. According to the HMEC, executive capacities can be viewed as an overarching neuropsychological construct that represents the mental capacities used to direct, cue, coordinate, and integrate most conscious aspects of perception, emotion, cognition, and action (McCloskey et al., 2009; McCloskey, 2016; McCloskey & Perkins, 2012). Based on the HMEC, the four specific tiers of executive control with separate control functions (i.e., Self-Regulation, Self-Realization and Self-Determination, Self-Generation, and Trans-Self-Integration) include different levels of mental management.

As outlined by various researchers for decades, individuals with ADHD exhibit poor self-regulation. McCloskey's model enables those working with individuals with ADHD to determine whether the difficulty is the result of an executive-function deficit (i.e., not knowing when), executive-skill deficit (i.e., not knowing how), or a combination of the two (McCloskey, 2016). In terms of ADHD specifically, McCloskey et al. (2008) noted that the ADHD diagnosis is most likely to occur when an individual is deficient in the use of one or more of four specific self-regulation executive capacities: focus and sustain from the Attention Cluster, inhibit from the Engagement Cluster, and modulate from the Optimization Cluster. Focus and sustain deficits define the Inattentive type, inhibit and modulate deficits define the Hyperactive type, and deficits in all four define the Combined type.

When evaluating and treating individuals with ADHD, clinicians must consider the complexity of executive capacities and the various domains of functioning and contextual factors (McCloskey & Perkins, 2012). McCloskey and colleagues recommend the use of clinical interview techniques and observation in different settings, in addition to the norm-referenced measures and standardized rating scales discussed later (McCloskey et al., 2009; McCloskey & Perkins, 2012). The assessment of executive capacities should lead to identification of interventions that address the specific executive-capacity problems. Multiple interventions are available to support the development of internal control and external control for individuals with and without ADHD who exhibit deficits in executive capacities. Psychosocial therapies, such as CBT or behavioral therapy, and mind-body interventions, such as mindfulness or neurofeedback, are used to support individuals with ADHD. Additional internal- and external-control strategies, such as cueing and monitoring systems, may support the application and generalization of skills across settings. A common intervention for treating individuals with ADHD is external control through use of psychostimulant medication. Studies involving methylphenidate indicate the stimulant has a positive effect on brain activation for individuals with ADHD. Overall, a multimodal treatment plan including therapy, mind-body methods, psychostimulants, and specific strategies to improve executive capacity across settings can support individuals with ADHD.

Although focus, sustain, inhibit, and modulate are the core executive capacities deficient in individuals diagnosed with ADHD, they are most likely not the only self-regulation executive capacities that are deficient in anyone diagnosed with ADHD. Furthermore, the nature of the other deficits can vary greatly from one person to another. This study helps to identify the specific executive-capacity deficits most commonly identified for individuals with ADHD, in addition to the likely deficits in focus, sustain, inhibit, and modulate. Information yielded from the MEFS regarding executive capacities for individuals with ADHD with and without medication can support in the selection and development of specific interventions and strategies to better support these individuals.

Research Questions

1. What are the similarities and differences between the pattern of executive-function EF deficits resulting from teacher ratings of a group of students diagnosed with ADHD and receiving medication and the pattern of executive-function deficits resulting from teacher ratings of a demographically matched control group of students with no clinical diagnosis?
2. What are the similarities and differences between the pattern of executive-function deficits resulting from teacher ratings of a group of students diagnosed with ADHD and receiving no medication and the pattern of executive-function deficits resulting from teacher ratings of a demographically matched control group of students with no clinical diagnosis?
3. What are the similarities and differences between the pattern of executive-function deficits resulting from teacher ratings of a group of students diagnosed with ADHD and receiving medication and the pattern of executive-function deficits resulting from teacher ratings of a group of students diagnosed with ADHD and not receiving medication?

CHAPTER 3

METHODS

The McCloskey Executive Functions Scale (MEFS) is an indirect formal assessment tool. The MEFS helps to determine a child's strengths and weaknesses in executive skills based on teacher or clinician input (McCloskey, 2016). This study examined archival data collected during the standardization of the McCloskey Executive Functions Scale Teacher Report Form (MEFS-TR; see Appendix A). The source of the archival data used in this study is the MEFS-TR standardization data file. This file was created during the development of the MEFS-TR to create the normative database for test interpretation. The data were collected during the scale standardization project throughout the 2013-2014 and 2014-2015 school years.

Source of Data

The data used for this study included the MEFS-TR teacher ratings of samples of students diagnosed with ADHD who were medicated at the time of teacher rating (*n* = 56), samples of students diagnosed with ADHD who were not medicated at the time of teacher rating (*n* = 47), and samples of nonclinical, demographically matched student controls (ADHD-Medicated matched controls [*n* = 56]; ADHD Nonmedicated matched controls [*n* = 47]). The norming data for the MEFS were collected from March 2014 through April 2015. The sample included 1,127 subjects from 167 communities in 29 states in the United States. The ratings for the 1,127 subjects were completed by 255 teachers. From the 1,127 students who were rated by teachers, 103 were diagnosed with ADHD (47 medicated and 56 nonmedicated). Matched control samples were obtained by selecting the ratings of a nonclinical sample of standardization cases that matched the clinical sample cases by using the demographic data variables of age, gender, ethnicity, geographic region, and academic-skills rankings provided by teachers (McCloskey, 2016).

Teacher ratings reflected teacher perceptions of the frequency and effectiveness of students' performances of behaviors that reflected the degree of use or disuse of executive functions and executive skills. Teachers rated each student with a pool of 104 items that represented 31 self-regulation executive functions organized into seven self-regulation clusters, and three facets of self-realization and two facets of self-determination (see Appendix A for the items on the MEFS-TR form). The teachers who provided the MEFS-TR ratings were regular and special-education teachers from across the United States. A total of 255 teachers completed ratings on 1,127 children and adolescents who were their students. Of the 255 teachers, 11.4% were men and 88.6% were women (McCloskey, 2016).

Variables Used in the Analyses

The variables used in the data analyses included (a) Raw score sums based on teacher ratings for seven Self-Regulation executive-function clusters (Attention, Engagement, Optimization, Efficiency, Memory, Inquiry, and Solution), one Self-Realization composite, and one Self-Determination composite; (b) raw score sums based on teacher ratings for each of the 31 Self-Regulation executive functions and three facets of Self-Realization and two facets of Self-Determination; (c) raw scores based on teacher ratings for each of the 104 items of the MEFS; and (d) demographic data for student age and clinical status.

Psychometric Properties of MEFS

Item Ratings

Each MEFS item was rated by teachers using six potential responses:

5-AA = ALMOST ALWAYS does it on own without prompting

4-F = FREQUENTLY does it on own without prompting

3-S = SELDOM does it on own without prompting

2-AP = Does it, but only AFTER PROMPTING

1-DA = Only does it with DIRECT ASSISTANCE

0-UA = UNABLE to do it even with ASSISTANCE

The rating options for the items comprising the Self-Realization and Self-Determination facets were as follows:

3-VO = Does this VERY OFTEN

2-O = Does this OFTEN

1-S = Does this SOMETIMES, but not much

0-N = NEVER does this

Evidence of Reliability

Teacher ratings were examined using a measure of inconsistent responding. The MEFS Consistency Index is composed of six self-regulation items that were altered slightly in wording. The original items and the slightly altered items were included on the rating form but placed in different locations. Ratings on the original item and the slightly altered item were compared to obtain a rating difference score. The absolute values of these rating difference scores were summed across all six pairs of consistency items to produce the score for the Inconsistency Index. An acceptable level of variation that was not likely to be cause for concern about the consistency of teacher ratings was established (raw score of 6). All teacher ratings of the consistency items for students in the ADHD clinical samples and students in the matched control samples produced Consistency Index scores within the acceptable level (McCloskey, 2016).

The MEFS manual also reports internal consistency and split-half reliability coefficients for the seven Self-Regulation clusters and 14 subclusters (each self-regulation cluster was divided into items assessing the Self/Social Arena and items assessing the Academic Arena) and the Self-Realization and Self-Determination composites by six age groups. The large majority of these coefficients were above .90, and no coefficient was less than .85. Test-retest reliability coefficients also were provided for the cluster, subcluster, and composite scores, with all but two of these coefficients at or greater than .80 (McCloskey, 2016).

Statistical Analyses

Frequency counts were generated for the item scores of the Self-Regulation Clusters and the facets of Self-Realization and Self-Determination that were obtained by the clinical groups and the matched controls. Differences between clinical and matched controls and the differences between ADHD Medicated and ADHD Nonmedicated samples were tested for statistical significance. Statistical analyses determined the differences in proportion of overall executive deficits (i.e., executive-function and executive-skill deficits combined) and the differences in proportion of executive-skill deficits only.

Statistical analyses of the proportions of each sample exhibiting overall executive deficits were completed by calculating the percentage of students in each sample who were rated as exhibiting executive-function or executive-skill deficits (ratings of 0-3).

The proportions were tested for statistical significance for each MEFS item using the following comparisons: (a) ADHD-Medicated versus matched controls, (b) ADHD-Nonmedicated versus matched controls, and (c) ADHD-Medicated versus ADHD-Nonmedicated. Statistical significance of the difference in proportions of executive-deficit ratings were tested for each item using the Fisher Exact Test.

CHAPTER 4

RESULTS

The results of the analyses of teacher ratings of the executive capacities of groups of clinical and nonclinical students using the McCloskey Executive Functions Scale Teacher Report form (MEFS-TR) are reviewed in this section. The data used for this study included the MEFS-TR teacher ratings of samples of students diagnosed with ADHD who were medicated at the time of teacher rating (n = 56), students diagnosed with ADHD who were not medicated at the time of teacher rating (n = 47), and the teacher ratings of student samples of nonclinical, demographically matched controls (ADHD-Medicated matched controls [n = 56]; ADHD-Nonmedicated matched controls [n = 47]).

Table 1 shows the demographic characteristics of the sample of students diagnosed with ADHD and the matched control sample based on the variables used to match the samples. Table 2 shows the grade in school of the ADHD-diagnosed students and the matched control samples. Table 3 shows the summary of the significant differences in teacher ratings of executive-function deficits and executive-skill deficits when comparing ADHD-diagnosed/Medicated and ADHD-diagnosed/Nonmedicated groups with matched controls and when comparing the ADHD-diagnosed/Medicated group with the ADHD-diagnosed/Nonmedicated group on the MEFS Attention Cluster items.

Table 1
Demographic Characteristics of the Samples of Students Diagnosed with ADHD and the Control Sample Based on the Variables Used to Match the Sample

	ADHD-medicated sample	Matched control sample	ADHD nonmedicated sample	Matched control sample
Gender				
Female	15	15	17	17
Male	32	32	39	39
Total	47	47	56	56
Ethnicity				
African-American	8	8	12	13
Hispanic	9	9	8	8
White	29	29	34	33
Asian	1	1	2	2
Other	0	0	0	0
Total	47	47	56	56
Region				
Midwest	2	7	6	9
Northeast	13	7	13	14
South	20	20	25	20
West	12	13	12	13
Total	47	47	56	56
Academic skills level				
Above average	10	10	4	4
Average	25	31	34	44
Below average	12	6	18	8
Total	47	47	56	56
Gender of teacher rater				
Female	44	43	48	47
Male	3	4	8	9
Total	47	47	56	56
Student age (years)				
5	0	0	1	1
6	2	2	6	6
7	5	5	7	7
8	5	5	2	2

9	9	9	7	7
10	8	8	5	5
11	1	1	2	2
12	3	3	2	1
13	0	0	0	2
14	2	2	8	6
15	3	3	7	6
16	2	3	3	6
17	6	5	5	3
18	1	1	1	2
Total	47	47	56	56

Table 2

Grade in School of the ADHD-diagnosed Students and the Matched Control Samples

Student grade	ADHD medicated sample	Matched control sample	ADHD nonmedicated sample	Matched control sample
K	2	1	5	4
1	3	5	5	4
2	5	3	6	7
3	9	11	3	6
4	8	4	7	2
5	3	6	2	4
6	1	1	2	4
7	2	2	1	1
8	0	2	3	8
9	5	3	10	4
10	3	3	6	4
11	2	2	2	5
12	4	4	4	3
Total	47	47	56	56

Table 3

Self-Regulation Executive Capacities Assessed Within Each Self-Regulation Cluster

Self-Regulation Cluster	Self-Regulation Executive Capacity	Academic Arena	Self/Social Arena
Attention	Aware	1	1
	Focus	1	1
	Sustain	1	1
Engagement	Effort	1	1
	Initiate	1	1

	Inhibit	1	6
	Stop	1	2
	Pause	1	1
	Flexible	2	2
	Shift	1	1
Optimization	Monitor	2	2
	Modulate	2	3
	Correct	1	1
	Balance	1	2
Efficiency	Sense Time	1	1
	Pace	1	1
	Routines	7	1
	Sequence	1	1
Memory	Hold/Manipulate	1	1
	Store/Retrieve	2	3
Inquiry	Gauge	1	1
	Anticipate	1	2
	Estimate Time	1	1
	Analyze	1	1
	Compare/Evaluate	1	1
Solution	Generate	1	1
	Associate	1	1
	Organize	1	1
	Plan	1	2
	Prioritize	1	1
	Decide	1	1

Research Questions

The research questions for this study were addressed by (a) comparing the teacher ratings of a clinical sample of students diagnosed with ADHD who were medicated at the time of teacher rating compared with the teacher ratings of a nonclinical matched control sample, (b) comparing the teacher ratings of a clinical sample of students diagnosed with ADHD who were nonmedicated at the time of teacher rating with teacher ratings of a nonclinical matched control sample, and (c) comparing the teacher ratings of a clinical sample of students diagnosed with ADHD who were medicated at the time of teacher rating with the teacher ratings of a clinical sample of students diagnosed with ADHD who were nonmedicated at the time of teacher rating. The analyses were conducted using the MEFS-TR individual item ratings organized by the Self-Regulation Clusters and Self-Realization and Self-Determination facets. Frequency counts were generated for the item scores obtained by the clinical groups and the matched controls. For each of the three comparative analyses, the proportions of teacher ratings reflecting executive-function and/or executive-skill deficits for each MEFS-TR item were tested for statistical significance using Fisher's Exact z Test. Appendix B contains the results of the statistical analyses for each item within each Executive Capacities Cluster. Appendix C provides the percentage of each type of deficit for each item within each Executive Capacities Cluster.

Research Question 1

What are the similarities and differences between the pattern of executive-function deficits resulting from teacher ratings of a group of students diagnosed with ADHD and receiving medication and the pattern of executive-function deficits resulting from teacher ratings of a demographically matched control group of students with no clinical diagnosis?

Research Question 2

What are the similarities and differences between the pattern of executive-function deficits resulting from teacher ratings of a group of students diagnosed with ADHD and receiving no medication and the pattern of executive-function deficits resulting from teacher ratings of a demographically matched control group of students with no clinical diagnosis?

Research Question 3

What are the similarities and differences between the pattern of executive-function deficits resulting from teacher ratings of a group of students diagnosed with ADHD and receiving medication and the pattern of executive-function deficits resulting from teacher ratings of a group of students diagnosed with ADHD and not receiving medication?

Given the literature available on ADHD, executive function, and the impact of psychostimulant medication, it was hypothesized that the teacher ratings using the MEFS would indicate more executive-function deficits (rated as seldom doing it unless told to do so) and executive-skill deficits (rated as unable to do it even when shown how) for the nonmedicated group with ADHD (ADHD-NoMed) than the medicated group with ADHD (ADHD-Med). It also was hypothesized based on the holarchical model of executive capacities (HMEC) theory that the NoMed group would exhibit more deficits in the Academic Arena (symbol system) than in the Self/Social Arena, with the greatest number of deficit ratings evident for the Focus, Sustain, Inhibit, and Modulate executive capacities. Additionally, although other executive capacities would likely be rated as deficient, these additional deficiencies would not be as frequent as those reported for the core four capacities of Focus, Sustain, Inhibit, and Modulate.

Clusters

Attention Cluster

Within the Attention Cluster, three items are included in the Academic Arena and three items are included in the Self/Social Arena. Table 4 shows a summary of the significant differences that were identified when comparing proportions of students who were rated by teachers as exhibiting executive-function deficits or executive-skills deficits on the items of the Attention Cluster. Proportion comparisons were made between the clinical groups and their respective matched control samples and between the two clinical samples. The results of the statistical analyses completed for each Attention Cluster item are provided in Appendix B.

Table 4
Summary of the Significant Differences in Teacher Ratings of EFDs and ESDs for the Clinical and Matched Control Groups on the MEFS Attention Cluster Items

Type of deficit	Group comparisons					
	MED > Controls		NOMED > Controls		NOMED > MED	
	Number of Attention Cluster items by arena					
	ACA 3 items	S/S 3 items	ACA 3 items	S/S 3 items	ACA 3 items	S/S 3 items
	Number of Attention items showing significant differences					
EFD	2	0	2	1	0	0
ESD	0	0	1	0	0	0

Table 5 shows the percentages of students in each group who were rated as having an executive-function deficit or an executive-skill deficit for each item of the Attention Cluster.

Table 5
Percentages of EFD and ESD Teacher Ratings for the Clinical and Control Groups on the MEFS Attention Cluster Items

Executive Function Deficit (EFD)

	Control Groups		Clinical Groups	
ATTENTION	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an EFD			
Aware with school tasks	19%	25%	34%	57%*
Focused with school tasks	28%	34%	60%*	55%
Sustains with school tasks	34%	32%	62%*	61%*
Self/Social Arena				
Aware during social interactions	13%	16%	32%	30%
Focused in social interactions	21%	16%	38%	27%
Sustains with social interactions	23%	14%	45%	36%*

Color Code for EFDs

0-10%	11-35%	36-50%	>50%

	Executive Skill Deficit (ESD)			
	Control Groups		Clinical Groups	
ATTENTION	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an ESD			
Aware with school tasks	0%	0%	4%	14%
Focused with school tasks	2%	0%	9%	16%
Sustains with school tasks	4%	0%	17%	23%*
Self/Social Arena				
Aware during social interactions	0%	2%	4%	13%
Focused in social interactions	0%	0%	6%	7%
Sustains with social interactions	0%	0%	4%	13%

Color Code for ESDs

0-5%	6-10%	11-25%	>25%

*Clinical group % significantly greater than control group %

ADHD-Med group versus control group. As predicted, the ADHD-Med group had significantly larger proportions of students than the matched control group who were rated as having an executive-function deficit within the Academic Arena for the items assessing the self-regulation capacities of Focus (“focuses attention on school tasks”) and Sustain (“sustains attention for school tasks”). In contrast, no significant differences were found between the proportion of students in the ADHD-Med group and the matched control group rated as having an executive-skill deficit within either the Academic Arena or the Self/Social Arena.

ADHD-NoMed group versus control group. As predicted, the ADHD-NoMed group had significantly larger proportions of students than the matched control group who were rated as having an executive-function deficit for the Academic Arena items assessing the self-regulation capacities of Perceive (“aware of what to do for school tasks”) and Sustain (“sustains attention for school tasks”), but contrary to predictions, no significant difference was found for the item assessing the self-regulation capacity of Focus. In addition, the ADHD-NoMed group had a significantly larger proportion of students than the matched control group rated as having an executive-function deficit for the self-regulation capacity of Sustain (“sustains attention in social interactions”) within the Self/Social Arena.

The ADHD-NoMed group also had a significantly larger proportion of students than the matched controls group who were rated as having an executive-skill deficit with the Academic Arena items assessing the self-regulation of Sustain (“sustains attention for school tasks”). No significant differences were found between the proportion of students in the ADHD-NoMed group and the matched control group rated as having an executive-skill deficit within the Self/Social Arena.

ADHD-NoMed group versus ADHD-Med group. When comparing the clinical groups, no significant differences were found in the proportion of students rated as having an executive-function deficit or as having an executive-skill deficit for any of the items of the Attention Cluster within the Academic Arena or within the Self/Social Arena. Consistent with the initial hypothesis, both clinical groups demonstrated significant impairments with Sustains with school tasks in the Academic Arena. When analyzing executive-function deficits within the Academic Arena, the ADHD-Med and ADHD-NoMed clinical groups demonstrated similarly larger proportions of items rated as having deficits than those of their matched control groups. For the Self/Social Arena, however, teacher ratings reflected larger proportions of both executive-function and executive-skill deficits for the ADHD-NoMed group than for the ADHD-Med group for all three Attention Cluster self-regulation executive capacities, but the proportion differences were not statistically significant.

Engagement Cluster

Within the Engagement Cluster, eight items are included in the Academic Arena and 14 items are included in the Self/Social Arena. Table 6 shows a summary of the significant differences that were identified when comparing proportions of students who were rated by teachers as exhibiting executive-function deficits or executive-skill deficits on the items of the Engagement Cluster. Proportion comparisons were made between the clinical groups and their respective matched control samples and between the two clinical samples. The results of the statistical analyses completed for each Engagement Cluster item are provided in Appendix B.

Table 6
Summary of the Significant Differences in Teacher Ratings of EFDs and ESDs for the Clinical and Matched Control Groups on the MEFS Engagement Cluster Items

Type of deficit	Group comparisons					
	MED > Controls		NOMED > Controls		NOMED > MED	
	Number of Engagement Cluster items by arena					
	ACA 8 items	S/S 14 items	ACA 8 items	S/S 14 items	ACA 8 items	S/S 14 items
	Number of Engagement items showing significant differences					
EFD	5	3	4	6	0	0
ESD	0	0	3	2	0	0

Table 7 shows the items of the Engagement Cluster and the percentages of students in each group who were rated as having an executive-function deficit or an executive-skill deficit.

Table 7
Percentages of EFD and ESD Teacher Ratings for the Clinical and Control Groups on the MEFS Engagement Cluster Items

	Executive Function Deficit (EFD)			
	Control Groups		Clinical Groups	
ENGAGEMENT	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an EFD			
Starts school tasks	19%	29%	49%*	57%*
Effortful with school tasks	17%	38%	49%*	55%
Inhibits with challenging school tasks	17%	14%	51%*	39%*
Stops playing a game	28%	25%	47%	41%
Returns to school tasks	19%	21%	51%*	52%*
Tries different ways for school tasks	19%	27%	47%*	50%*
Accepts changes in school	15%	13%	26%	30%
Shifts for school tasks	21%	25%	45%	46%
Self/Social Arena				
Starts social interactions	13%	20%	28%	32%
Effortful in social interactions	15%	20%	26%	30%
Waits turn	15%	16%	40%*	39%*
Thinks before acting	36%	25%	45%	41%
Refrains from aggression	11%	9%	15%	14%
Inhibits thoughtless comments	23%	20%	43%	34%
Inhibits in frustrating situations	21%	16%	43%	39%*
Inhibits in social situations	21%	20%	45%	39%
Stops talking about one thing	32%	18%	43%	46%*
Stops annoying others	23%	18%	38%	46%*
Returns in social interactions	17%	13%	36%	39%*
Accept good ideas from others	11%	18%	38%*	32%
Accepts changes in social patterns	15%	7%	15%	21%
Shifts in social interactions	9%	16%	34%*	41%*

Color Code for EFDs

0-10%	11-35%	36-50%	>50%

	Executive Skill Deficit (ESD)			
	Control Groups		Clinical Groups	
ENGAGEMENT	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an ESD			
Starts school tasks	2%	4%	15%	18%
Effortful with school tasks	9%	0%	17%	21%*
Inhibits with challenging school tasks	2%	4%	9%	13%
Stops playing a game	4%	0%	13%	23%*
Returns to school tasks	2%	4%	15%	18%
Tries different ways for school tasks	2%	2%	17%	18%

Accepts changes in school	0%	0%	6%	5%
Shifts for school tasks	2%	0%	13%	18%*
Self/Social Arena				
Starts social interactions	0%	0%	9%	9%
Effortful in social interactions	2%	0%	9%	7%
Waits turn	2%	0%	6%	14%
Thinks before acting	2%	0%	17%	25%*
Refrains from aggression	2%	0%	9%	11%
Inhibits thoughtless comments	0%	0%	11%	11%
Inhibits in frustrating situations	4%	2%	13%	13%
Inhibits in social situations	6%	0%	11%	11%
Stops talking about one thing	0%	0%	15%	16%
Stops annoying others	6%	0%	21%	20%*
Returns in social interactions	0%	0%	9%	13%
Accept good ideas from others	0%	0%	13%	9%
Accepts changes in social patterns	0%	0%	6%	5%
Shifts in social interactions	0%	0%	6%	11%
	Color Code for ESDs			
	0-5%	6-10%	12-25%	>25%

*Clinical group % significantly greater than control group %

ADHD-Med group versus control group. The ADHD-Med group had a significantly larger proportion of students than the matched control group who were rated as having an executive-function deficit within the Academic Arena for the items assessing the self-regulation capacities of Initiate ("starts with school tasks"), Effort ("effortful with school tasks"), Inhibit ("inhibits with challenging school tasks"), Pause ("returns to school tasks"), and Flexible ("tries different ways to solve problems"). Within the Self/Social Arena, the ADHD-Med group had a significantly larger proportion of students than the matched control group rated as having an executive-function deficit for the items assessing the self-regulation capacities of Inhibit ("waits turn"), Flexible ("accepts changes in good ideas from others"), and Shift ("shifts in social situations"). In contrast, no significant differences were found between the proportions of students in the

ADHD-Med group and the matched control group rated as having an executive-skill deficit within either the Academic Arena or the Self/Social Arena.

ADHD-NoMed group versus control group. As predicted, the ADHD-NoMed group had a significantly larger proportion of students than the matched control group who were rated as having an executive-function deficit for the Academic Arena items assessing Initiate ("starts with school tasks"), Inhibit ("inhibits with challenging school tasks"), Pause ("returns to school tasks"), and Flexible ("tries different ways to solve a problem" and "accepts changes in school"). In addition, the ADHD-NoMed group had a significantly larger proportion of students than the matched control group who were rated as having an executive-function deficit for the Self/Social Arena items assessing the self-regulation capacities of Inhibit ("waits turn'" and "inhibits in frustrating situations"), Stop ("stops talking about one thing" and "stops annoying others"), Pause ("returns in social situations"), and Shift ("shifts in social situations").

The ADHD-NoMed group also had a significantly larger proportion of students than the matched control group who were rated as having an executive-skill deficit for the Academic Arena items assessing the self-regulations of Effort ("effortful with school tasks"), Stop ("stops playing a game or doing something that is fun when asked") and Shift ("shifts for school tasks") and within the Self/Social Arena for items assessing the self-regulations of Inhibit ("thinks before acting") and Stop ("stops annoying others").

ADHD-NoMed group versus ADHD-Med group. When comparing the clinical groups, no significant differences were found in the proportion of students rated as having an executive-function deficit or as having an executive-skill deficit for any of the items of the Engagement Cluster within the Academic Arena or within the Self/Social

Arena. Consistent with the initial hypothesis, the clinical groups demonstrated significant impairments with Inhibition in both the Academic and Self/Social Arenas. When analyzing executive-function deficits within the Academic and Self/Social Arenas, the ADHD-Med and ADHD-NoMed clinical groups consistently demonstrated similarly larger proportions of items rated as having deficits compared to their respective matched control groups for all of the items of the Engagement Cluster. Only some of these differences, however, were statistically significant when comparing the clinical groups with their matched controls.

Optimization Cluster

Within the Optimization Cluster, six items are included in the Academic Arena and eight items are included in the Self/Social Arena. Table 8 shows a summary of the significant differences that were identified when comparing proportions of students who were rated by teachers as exhibiting executive-function deficits or executive-skill deficits on the items of the Optimization Cluster. Proportion comparisons were made between the clinical groups and their respective matched control samples and between the two clinical samples. The results of the statistical analyses completed for each Optimization Cluster item are provided in Appendix B.

Table 8
Summary of the Significant Differences in Teacher Ratings of EFDs and ESDs for the Clinical and Matched Control Groups on the MEFS Optimization Cluster Item

<table>
<tr><td rowspan="5">Type of deficit</td><td colspan="6">Group comparisons</td></tr>
<tr><td colspan="2">MED > Controls</td><td colspan="2">NOMED > Controls</td><td colspan="2">NOMED > MED</td></tr>
<tr><td colspan="6">Number of Optimization Cluster items by arena</td></tr>
<tr><td>ACA
6 items</td><td>S/S
8 items</td><td>ACA
6 items</td><td>S/S
8 items</td><td>ACA
6 items</td><td>S/S
8 items</td></tr>
<tr><td colspan="6">Number of Optimization items showing significant differences</td></tr>
<tr><td>EFD</td><td>3</td><td>2</td><td>4</td><td>5</td><td>0</td><td>0</td></tr>
</table>

ESD	2	3	3	3	0	0

Table 9 shows the items of the Optimization Cluster and the percentages of students in each group who were rated as having an executive-function deficit or an executive-skill deficit.

Table 9

Percentages of EFD and ESD Teacher Ratings for the Clinical and Control Groups on the MEFS Optimization Cluster Items

	Executive Function Deficit (EFD)			
	Control Groups		Clinical Groups	
OPTIMIZATION	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an EFD			
Monitors school task performance	36%	18%	51%	45%*
Monitors school situations	26%	20%	51%	50%*
Activity level fits school tasks	11%	41%	40%*	59%
Emotional response fits school tasks	11%	29%	34%*	50%
Fixes errors in school tasks	30%	41%	53%	70%*
Balances school task elements	38%	30%	51%	68%*
Self/Social Arena				
Monitors social interactions	32%	18%	51%	46%*
Monitors personal appearance	15%	20%	28%	41%*
Activity level fits social situation	17%	23%	40%*	43%
Emotional response fits social interactions	19%	20%	40%	38%
Modulates sensory stimulation	17%	20%	43%*	46%*
Makes social interaction corrections	23%	20%	38%	39%
Balances social interactions	28%	18%	49%	45%*
Balances personal activity, care, habits	30%	20%	47%	55%*
	Color Code for EFDs			
	0-10%	11-35%	36-50%	>50%

	Executive Skill Deficit (ESD)			
	Control Groups		Clinical Groups	
OPTIMIZATION	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an ESD			
Monitors school task performance	2%	0%	30%*	20%*
Monitors school situations	6%	0%	23%	9%

Activity level fits school tasks	0%	9%	21%*	36%*
Emotional response fits school tasks	0%	2%	15%	32%*
Fixes errors in school tasks	6%	7%	23%	20%
Balances school task elements	4%	7%	21%	21%
Self/Social Arena				
Monitors social interactions	0%	2%	19%*	7%
Monitors personal appearance	4%	0%	11%	20%*
Activity level fits social situation	0%	2%	23%*	25%*
Emotional response fits social interactions	2%	2%	17%	9%
Modulates sensory stimulation	0%	0%	9%	18%*
Makes social interaction corrections	4%	0%	17%	14%
Balances social interactions	0%	2%	13%	16%
Balances personal activity, care, habits	0%	4%	19%*	14%
	Color Code for ESDs			
	0-5%	6-10%	11-25%	>25%

*Clinical group % significantly greater than control group %

ADHD-Med group versus control group. The ADHD-Med group had significantly larger proportions of students than the matched control group who were rated as having an executive-function deficit within the Academic Arena for two items assessing the self-regulation capacity of Modulate ("activity level fits school tasks" and "emotional response fits school tasks"). In addition, the ADHD-Med group had significantly larger proportions of students than matched controls rated as having an executive-function deficit within the Self/Social Arena for the two items assessing the self-regulation capacity of Modulate ("activity level fits social situation" and "modulates sensory stimulation"). Consistent with the hypothesis, the ADHD-Med group exhibited a greater proportion of executive-function deficits within the Academic Arena (50% of items) than within the Self/Social Arena (25% of items). The ADHD-Med group had significantly larger proportions of students than the matched control group rated as having an executive-skill deficit within the Academic Arena for items assessing the self-regulation capacities of Monitor (“monitors school tasks performance”) and Modulate (“activity level fits school tasks”). The ADHD-Med group also had significantly larger proportions of students than the matched control group rated as having an executive-skill deficit within the Self/Social Arena for items assessing the self-regulation capacities of Monitor (“monitors social interactions”), Modulate (“activity level fits social situation”), and Balance (“balances personal activity, care, habits”). Unexpectedly, when analyzing the executive-skill deficits for the ADHD-Med group, the percentage of deficits within the Self/Social Arena (38% of items) was slightly greater than the percentage of deficits within the Academic Arena (33% of items).

ADHD-NoMed group versus control group. As predicted, the ADHD-NoMed group had significantly larger proportions of students than the matched control group who were rated as having an executive-function deficit within the Academic Arena for items assessing Monitor (“monitors school task performance” and “monitors school situations”), Correct (“fixes errors in school tasks”), and Balance (“balances school task elements”). In addition, the ADHD-NoMed group had significantly larger proportions of students than the matched control group who were rated as having an executive-function deficit for the Self/Social Arena items assessing the self-regulation capacities of Monitor (“monitors social interactions” and “monitors personal appearance”), Modulate (“emotional response fits social interactions” and “modulates sensory stimulation”), and Balance (“balances social interactions” and “balances personal activity, care, and habits”). Overall, the ADHD-NoMed group of students were rated as having significantly more executive-function deficits than their matched controls for a slightly larger percentage of Optimization Cluster items within the Academic Arena (67%) than items within the Self/Social Arena (63%).

The ADHD-NoMed group also had significantly larger proportions of students than the matched control group rated as having an executive-skill deficit within the Academic Arena for items assessing the self-regulation capacities of Monitor ("monitors school task performance") and Modulate ("activity level fits school tasks" and "emotional response fits school tasks"). The ADHD-NoMed group also had significantly larger proportions of students than matched controls rated as having an executive-skill deficit within the Self/Social Arena for items assessing the self-regulation capacities of Monitor ("monitors personal appearance") and Modulate ("activity level fits social situation" and "modulates sensory stimulation"). Overall, the students in the ADHD-NoMed group were rated as having significantly more executive-skill deficits than their matched controls for a larger percentage of Optimization Cluster items within the Academic Arena (50%) than items in the Self/Social Arena (38%).

ADHD-NoMed group versus ADHD-Med group. When comparing the clinical groups, no significant differences were found in the proportions of students rated as having an executive-function deficit or as having an executive-skill deficit for any of the items for the Optimization Cluster within the Academic or within the Self/Social Arena. Several patterns of overlapping areas of executive-function and executive-skill deficits emerged for the clinical ADHD groups. Consistent with the initial hypothesis regarding core deficits for ADHD, both clinical groups exhibited significantly more executive-function deficits than controls for a Self/Social Arena item assessing the same self-regulation capacity of Modulate ("modulates sensory stimulation"). When comparing executive-skill deficits, both clinical groups experienced significant dysfunction within the Academic Arena for an item assessing the self-regulation capacities of Monitor ("monitors school task performance") and Modulate ("activity level fits school task"). In addition, both clinical groups experienced significant dysfunction within the Self/Social Arena for an item assessing the self-regulation capacity of Modulate ("activity level fits social situation").

Efficiency Cluster

Within the Efficiency Cluster, 10 items are included in the Academic Arena and four items are included in the Self/Social Arena. Table 10 shows a summary of the significant differences that were identified when comparing proportions of students who were rated by teachers as exhibiting executive-function deficits or executive-skill deficits on the items of the Optimization Cluster. Proportion comparisons were made between the clinical groups and their respective matched control samples and between the two clinical samples. The results of the statistical analyses completed for each Optimization Cluster item are provided in Appendix B.

Table 10
Summary of the Significant Differences in Teacher Ratings of EFDs and for the Clinical and Matched Control Groups on the MEFS Efficiency Cluster Items

Type of deficit	Group comparisons					
	MED > Controls		NOMED > Controls		NOMED > MED	
	Number of Efficiency Cluster items by arena					
	ACA 10 items	S/S 4 items	ACA 10 items	S/S 4 items	ACA 10 items	S/S 4 items
	Number of Efficiency items showing significant differences					
EFD	2	1	4	1	1	0
ESD	2	1	4	1	0	0

Table 11 shows the items of the Efficiency Cluster and the percentages of students in each group who were rated as having an executive-function deficit or an executive-skill deficit.

Table 11

Percentages of EFD and ESD Ratings for the Clinical and Control Groups on the MEFS Efficiency Cluster Items

	Executive Function Deficit (EFD)			
	Control Groups		Clinical Groups	
EFFICIENCY	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an EFD			
Keeps track of time with school tasks	43%	36%	45%	48%
Changes pace with school tasks	43%	38%	45%	50%
Uses routines for school tasks	26%	23%	34%	43%
Gets ideas onto paper effectively	38%	41%	49%	57%
Uses routines and strategies on tests	30%	32%	43%	55%*
Uses routines and strategies with school tasks	30%	32%	45%	55%*
Participates in class discussions	13%	25%	21%	25%
Brings materials home from school	15%	30%	49%*	55%*
Hands in school work	11%	27%	36%*	48%
Gets the steps in the correct order for school tasks	17%	25%	28%	54%**
Self/Social Arena				
Keeps track of time in social interactions	55%	27%	51%	52%*
Changes pace in social interactions	30%	29%	51%	48%
Uses routines for social interactions	19%	18%	28%	29%
Gets the right order when telling stories	11%	18%	36%*	38%
Color Code for EFDs	0-10%	11-35%	36-50%	>50%

	Executive Skill Deficit (ESD)			
	Control Groups		Clinical Groups	
EFFICIENCY	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an ESD			
Keeps track of time with school tasks	2%	2%	23%*	30%*
Changes pace with school tasks	6%	4%	21%	20%
Uses routines for school tasks	0%	0%	9%	13%
Gets ideas onto paper effectively	4%	4%	28%*	14%

Uses routines and strategies on tests	2%	5%	19%	20%
Uses routines and strategies with school tasks	4%	5%	21%	23%*
Participates in class discussions	2%	0%	6%	2%
Brings materials home from school	11%	0%	17%	21%*
Hands in school work	11%	2%	21%	23%*
Gets the steps in the correct order for school tasks	2%	0%	19%	13%
Self/Social Arena				
Keeps track of time in social interactions	0%	2%	19%	23%*
Changes pace in social interactions	2%	2%	13%	14%
Uses routines for social interactions	0%	0%	9%*	7%
Gets the right order when telling stories	0%	0%	4%	11%
	Color Code for ESDs			
	0-5%	6-10%	11-25%	>25%

*Clinical group % significantly greater than control group %
**Clinical group % significantly greater than clinical group % and control group %

ADHD-Med group versus control group. The ADHD-Med group had significantly larger proportions of students than the matched control group who were rated by teachers as having an executive-function deficit within the Academic Arena for two items assessing the self-regulation capacities of Routines (“brings materials home from school” and “hands in school work”). Within the Self/Social Arena, the ADHD-Med group had a significantly larger proportion of students than the matched control group rated as having an executive-function deficit for the item assessing the self-regulation capacity of Sequence (“gets the right order when telling stories”).

The ADHD-Med group also had significantly larger proportions of students than the matched control group rated as having an executive-skill deficit for items within the Academic Arena assessing the self-regulation capacities of Sense Time (“keeps track of time with school tasks”) and Routines (“gets ideas onto paper effectively”). Within the

Self/Social Arena, the ADHD-Med group had significantly larger proportions of students than the matched control group rated as having an executive-skill deficit for the item assessing the self-regulation capacity of Routines ("uses routines for social interactions").

ADHD-NoMed group versus control group. As predicted, the ADHD-NoMed group had significantly larger proportions of students than the matched control group who were rated as having an executive-function deficit for the Academic Arena items assessing the self-regulation capacities of Routines ("uses routines and strategies on tests," "uses routines and strategies for school tasks," and "brings materials home from school") and Sequence ("gets the steps in the correct order for school tasks"). In addition, the ADHD-NoMed group had significantly larger proportions of students than the matched control group who were rated as having an executive-function deficit for the Self/Social Arena item assessing the self-regulation capacity of Sense Time ("keeps track of time in social interactions").

The ADHD-NoMed group also had a significantly larger proportion of students than the matched control group who were rated as having an executive-skill deficit for the Academic Arena items assessing the self-regulation capacities of Sense Time ("keeps track of time with school tasks") and Routines ("uses routines and strategies with school tasks," "brings materials home from school," and "hands in school work"). In addition, the ADHD-NoMed group had significantly larger proportions of students than the matched control group who were rated as having an executive-skill deficit for the Self/Social Arena item assessing the self-regulation capacity of Sense Time ("keeps track of time in social interactions").

ADHD-NoMed group versus ADHD-Med group. When comparing the two clinical groups, a clinically significant difference was found in the proportion of students rated as having an executive-function deficit within the Academic Arena for the item assessing the self-regulation capacity of Sequence ("gets the steps in the correct order for school tasks"). Individuals from the ADHD-NoMed group (54%) were rated as significantly more impaired compared to the matched control group (25%) and compared to the ADHD-Med group (28%). Additionally, the ADHD-Med and ADHD-NoMed clinical groups both demonstrated a significant executive-skill deficit within the Academic Arena for the self-regulation capacity of Sense Time ("keeps track of time with school tasks").

Overall, the ADHD groups consistently were rated as having more executive-function deficits and more executive-skill deficits within the Efficiency Cluster than matched controls. However, the differences between the clinical groups and the matched controls in proportions of executive-function deficits were much smaller than was the case for most other clusters. The smaller percentage differences for executive-function deficits was countered by much higher percentages of executive-skill deficits for the clinical groups, leading to much larger differences in the proportions of executive-skill deficits when comparing the clinical groups and their matched controls.

Memory Cluster

Within the Memory Cluster, three items are included in the Academic Arena and four items are included in the Self/Social Arena. Table 12 shows a summary of the significant differences that were identified when comparing proportions of students who were rated by teachers as exhibiting executive-function deficits or executive-skill deficits on the items of the Memory Cluster. Proportion comparisons were made between the clinical groups and their respective matched control samples and between the two clinical samples. The results of the statistical analyses completed for each Memory Cluster item are provided in Appendix B.

Table 12

Summary of the Significant Differences in Teacher Ratings of EFDs and ESDs for the Clinical and Matched Control Groups on the MEFS Memory Cluster Items

Type of deficit	Group comparisons					
	MED > Controls		NOMED > Controls		NOMED > MED	
	Number of Memory Cluster items by arena					
	ACA 3 items	S/S 4 items	ACA 3 items	S/S 4 items	ACA 3 items	S/S 4 items
	Number of Memory items showing significant differences					
EFD	1	0	2	2	0	0
ESD	0	0	0	0	0	0

Table 13 shows the items of the Memory Cluster and the percentages of students in each group who were rated as having an executive-function deficit or an executive-skill deficit.

Table 13

Percentages of EFD and ESD Teacher Ratings for the Clinical and Control Groups on the MEFS Memory Cluster Items

	Executive Function Deficit (EFD)			
	Control Groups		Clinical Groups	
MEMORY	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an EFD			
Keeps information in mind for school tasks	21%	16%	45%	41%*
Stores and recalls school information	19%	32%	45%*	46%
Recalls information for tests	23%	34%	45%	61%*
Self/Social Arena				

Keeps information in mind in social interactions	13%	14%	30%	25%
Stores and retrieves social information	15%	16%	32%	39%*
Recalls information in social interactions	15%	20%	36%	46%*
Recalls information about self	6%	14%	26%	29%
	Color Code for EFDs			
	0-10%	11-35%	36-50%	>50%

	Executive Skill Deficit (ESD)			
	Control Groups		Clinical Groups	
MEMORY	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an ESD			
Keeps information in mind for school tasks	0%	4%	13%	16%
Stores and recalls school information	0%	4%	15%	16%
Recalls information for tests	2%	4%	17%	11%
Self/Social Arena				
Keeps information in mind in social interactions	0%	2%	4%	14%
Stores and retrieves social information	2%	0%	6%	7%
Recalls information in social interactions	0%	0%	6%	9%
Recalls information about self	2%	0%	4%	5%
	Color Code for ESDs			
	0-5%	6-11%	12-25%	>25%

*Clinical group % significantly greater than control group %

ADHD-Med group versus control group. The ADHD-Med group had significantly larger proportions of students than the matched control groups who were rated as having an executive-function deficit within the Academic Arena for the items assessing the self-regulation capacity of Store/Retrieve (“stores and recalls school information”). In contrast, no significant differences were found between the proportion of students in the ADHD-Med group and the matched control group rated as having an executive-skill deficit within either the Academic Arena or the Self/Social Arena.

ADHD-NoMed group versus control group. As predicted, the ADHD-NoMed group had significantly larger proportions of students than the matched control group who were rated as having an executive-function deficit within the Academic Arena for the two items assessing the self-regulation capacity of Hold/Manipulate (“keeps information in mind for school tasks”) and Store/Retrieve (“recalls information for tests”). In addition, the ADHD-NoMed group had significantly larger proportions of students than the matched control group who were rated as having an executive-function deficit within the Self/Social Arena for the two items assessing the self-regulation capacity of Store/Retrieve (“stores and retrieves social information” and “recalls information in social interactions”). In contrast, no significant differences were found between the proportion of students in the ADHD-NoMed group and the matched control group rated as having an executive-skill deficit within either the Academic Arena or the Self/Social Arena.

ADHD-NoMed group versus ADHD-Med group. When comparing the ADHD-Med and ADHD- NoMed groups, no significant differences were found in the proportions of students rated as having an executive-function deficit and/or as having an executive-skill deficit for any of the items within the Memory Cluster within the Academic Arena or within the Self/Social Arena. A notable difference, however, was observed in the teacher ratings of executive-function deficits for the Academic Arena item Store/Retrieve (“recalls information for tests”), where 61% of the students in the ADHD-NoMed group were rated as having an executive-function deficit, but only 45% of the students in the ADHD-Med group were rated as having an executive-function deficit.

Inquiry Cluster

Within the Inquiry Cluster, five items are included in the Academic Arena and six items are included in the Self/Social Arena. Table 14 shows a summary of the significant differences that were identified when comparing proportions of students who were rated by teachers as exhibiting executive-function deficits or executive-skill deficits on the items of the Inquiry Cluster. Proportion comparisons were made between the clinical groups and their respective matched control samples and between the two clinical samples. The results of the statistical analyses completed for each Inquiry Cluster item are provided in Appendix B.

Table 14

Summary of the Significant Differences in Teacher Ratings of EFDs and for the Clinical and Matched Control Groups on the MEFS Inquiry Cluster Items

	Group comparisons					
	MED > Controls		NOMED > Controls		NOMED > MED	
	Number of Inquiry Cluster items by arena					
Type of	ACA 5 items	S/S 6 items	ACA 5 items	S/S 6 items	ACA 5 items	S/S 6 items
deficit	Number of Inquiry items showing significant differences					
EFD	1	3	4	6	0	0
ESD	2	1	5	2	0	0

Table 15 shows the items of the Inquiry Cluster and the percentages of students in each group who were rated as having an executive-function deficit or an executive-skill deficit.

Table 15

Percentages of EFD and ESD Teacher Ratings for the Clinical and Control Groups on the MEFS Inquiry Cluster Items

	Executive Function Deficit (EFD)	
	Control Groups	Clinical Groups

INQUIRY	Med	No Med	Med	No Med
Academic Arena	% of Group Rated		as Having an EFD	
Accurately estimates difficulty/demands of school tasks	36%	27%	49%	54%*
Anticipates events at school	13%	23%	49%*	50%*
Estimates time for school tasks	34%	34%	51%	59%*
Examines and analyzes school tasks	40%	36%	45%	63%*
Evaluates the quality of school work	43%	41%	53%	63%
Self/Social Arena				
Figures out how to interact in social situations.	17%	14%	45%*	50%*
Anticipates effects of own actions	32%	20%	38%	48%*
Anticipates the consequences of own actions	17%	18%	45%*	54%*
Estimates time in social situations	32%	23%	60%*	55%*
Examines and analyzes social interactions	34%	29%	49%	55%*
Evaluates the quality of social interactions	28%	25%	45%	57%*

Color Code for EFDs

0-10%	11-35%	36-50%	>50%

Executive Skill Deficit (ESD)

	Control Groups		Clinical Groups	
INQUIRY	Med	No Med	Med	No Med
Academic Arena	% of Group Rated		as Having an ESD	
Accurately estimates difficulty/demands of school tasks	2%	5%	21%	29%*
Anticipates events at school	6%	2%	23%	23%*
Estimates time for school tasks	6%	2%	26%	27%*
Examines and analyzes school tasks	4%	5%	26%*	29%*
Evaluates the quality of school work	4%	7%	30%*	29%*
Self/Social Arena				
Figures out how to interact in social situations.	0%	0%	11%	14%
Anticipates effects of own actions	2%	0%	23%*	16%
Anticipates the consequences of own actions	6%	0%	15%	23%*
Estimates time in social situations	6%	0%	11%	21%*
Examines and analyzes social interactions	2%	0%	15%	16%

Evaluates the quality of social interactions	9%	4%	21%	18%
	Color Code for ESDs			
	0-5%	6-10%	11-25%	>25%

*Clinical group % significantly greater than control group %

ADHD-Med group versus control group. The ADHD-Med group had significantly larger proportions of students than the control group who were rated as having an executive-function deficit within the Academic Arena for only one of the five items (i.e., 20%) assessing the self-regulation executive capacity of Anticipate (“anticipates events at school”). Contrary to the initial hypotheses, the ADHD-Med group had significantly larger proportions of students than the control group who were rated as having executive-function deficits for three of six items (i.e., 50%) within the Self/Social Arena, specifically for the items that assessed the self-regulation executive capacities of Gauge (“figures out how to interact in social situations”), Anticipate (“anticipates the consequences of own actions”), and Estimate Time (“estimates time in social situations”). The ADHD-Med group also had significantly larger proportions of students than the matched control group rated as having executive-skill deficits within the Academic Arena for two of five items (i.e.,40%), specifically the items assessing the self-regulation executive capacities of Analyze (“examines and analyzes school tasks”) and Evaluate/Compare (“evaluates the quality of school work”) and for only one of six items (i.e., 17%) within the Self/Social Arena for the self-regulation executive capacity of Anticipate (“anticipates effects of own actions”).

ADHD-NoMed group versus control group. The ADHD-NoMed group had significantly larger proportions of students rated as having executive-function deficits than the matched control group for four of five items (i.e., 80%) within the Academic Arena, specifically for the items assessing the self-regulation executive capacities of Gauge (“accurately estimates difficulty of school tasks”), Anticipate (“anticipates events at school”), Estimate Time (“estimates time for school tasks”), and Analyze (“examines and analyzes school tasks”). The ADHD-NoMed group also had significantly larger proportions of students than the matched control group rated with executive-skill deficits within the Academic Arena for all five of the self-regulation executive capacity items, that is, the Gauge, Anticipate, Estimate Time, and Analyze items previously mentioned, as well as the item assessing Evaluate/Compare (“evaluates quality of school work”). In contrast to the initial hypothesis, the ADHD-NoMed group had significantly larger proportions of executive-function deficit ratings than the control group for all six items (i.e., 100%) within the Self/Social Arena, specifically for the items assessing the self-regulation executive capacities of Gauge (“figures out how to interact in social situations”), Anticipate (anticipates effects of own actions,” “anticipates the consequences of own actions”), Estimate Time (“estimates time in social situations”), Analyze (“examines and analyzes social interactions”), and Evaluate (“evaluates the quality of social interactions”). These results indicate slightly greater functional deficits of not knowing when in the Self/Social Arena than in the Academic Arena for the ADHD-NoMed group within the Inquiry Cluster. The ADHD-NoMed group also had significantly more students than the control group who were rated with executive-skill deficits within the Self/Social Arena for the items assessing the self-regulation executie capacities of Anticipate (“anticipates the consequences of own actions”) and Estimate (“estimates time in social situations”).

ADHD-NoMed group versus ADHD-Med group. When comparing the clinical groups, no significant differences were found in the proportions of students rated as having an executive-function deficit or as having an executive-skill deficit for any of the items of the Inquiry Cluster within either the Academic Arena or the Self/Social Arena. Consistent patterns of executive-function and executive-skill deficits emerged for the clinical ADHD groups. With regard to executive-function deficits, both clinical groups demonstrated significant impairments with the Inquiry executive capacities of Anticipate (“anticipates events at school”) within the Academic Arena and Gauge (“figures out how to interact in social situations”), Anticipates (“anticipates consequences of own actions”) and Estimates Time (“estimates time in social situations”) within the Self/Social Arena. When analyzing executive-skill deficits, both clinical groups demonstrated significant impairments with Analyze (“examines and analyzes school tasks”) and Evaluate (“evaluates the quality of school work”) within the Academic Arena.

Solution Cluster

Within the Solution Cluster, six items are included in the Academic Arena and seven items are included in the Self/Social Arena. Table 16 shows a summary of the significant differences that were identified when comparing proportions of students who were rated by teachers as exhibiting executive-function deficits or executive-skill deficits on the items of the Solution Cluster. Proportion comparisons were made between the clinical groups and their respective matched control samples and between the two clinical samples. The results of the statistical analyses completed for each Solution Cluster item are provided in Appendix B.

Table 16

Summary of the Significant Differences in Teacher Ratings of EFDs and ESDs for the Clinical and Matched Control Groups on the MEFS Solution Cluster Items

Type of deficit	Group comparisons					
	MED > Controls		NOMED > Controls		NOMED > MED	
	Number of Solution Cluster items by arena					
	ACA 6 items	S/S 7 items	ACA 6 items	S/S 7 items	ACA 6 items	S/S 7 items
	Number of Solution items showing significant differences					
EFD	0	0	3	3	0	0
ESD	4	1	5	1	0	0

Table 17 shows the items of the Solution Cluster and the percentages of students in each group who were rated as having an executive-function deficit or an executive-skill deficit.

Table 17

Percentages of EFD and ESD Teacher Ratings for the Clinical and Control Groups on the MEFS Solution Cluster Items

	Executive Function Deficit (EFD)			
	Control Groups		Clinical Groups	
SOLUTION	Med	No Med	Med	No Med
Academic Arena	% of Group Rated as Having an EFD			
Comes up with new ways to solve school tasks	34%	41%	49%	66%*
Sees similarities in ideas	23%	38%	47%	57%
Organizes school tasks	32%	32%	51%	59%*
Makes plans for school tasks	43%	38%	47%	63%*
Orders school tasks	40%	39%	45%	59%
Makes own decisions about school	28%	29%	34%	48%
Self/Social Arena				

Comes up with new ways to solve social issues	28%	30%	47%	57%*
Sees similarities in social interactions	30%	34%	49%	46%
Organizes social activities	26%	18%	36%	36%
Makes plans for social activities	28%	25%	43%	38%
Makes plans for the use of own time	38%	30%	40%	46%
Prioritizes social activities	34%	20%	45%	48%*
Makes own decisions about social situations	28%	18%	30%	39%*
	Color Code for EFDs			
	0-10%	11-35%	36-50%	>50%

Executive Skill Deficit (ESD)

	Control Groups		Clinical Groups	
SOLUTION	Med	No Med	Med	No Med
Academic Arena	% of Group Rated		as Having an ESD	
Comes up with new ways to solve school tasks	6%	4%	21%	23%*
Sees similarities in ideas	2%	2%	17%	16%
Organizes school tasks	6%	7%	30%*	29%*
Makes plans for school tasks	6%	0%	28%*	30%*
Orders school tasks	4%	5%	30%*	32%*
Makes own decisions about school	2%	2%	26%*	20%*
Self/Social Arena				
Comes up with new ways to solve social issues	0%	2%	17%	13%
Sees similarities in social interactions	0%	4%	15%	16%
Organizes social activities	0%	4%	26%*	20%
Makes plans for social activities	2%	0%	17%	13%
Makes plans for the use of own time	0%	2%	15%	20%*
Prioritizes social activities	0%	4%	13%	18%
Makes own decisions about social situations	0%	2%	11%	13%
	Color Code for ESDs			
	0-5%	6-10%	11-25%	>25%

*Clinical group % significantly greater than control group %

ADHD-Med group versus control group. The ADHD-Med group did not yield a significantly larger proportion of students than the matched control group rated as having an executive-function deficit within either the Academic or the Self/Social Arena. However, the ADHD-Med group did have significantly larger proportions of students than the matched control group rated as having an executive-skill deficit within the Academic Arena for four of six items (i.e., 67%) assessing the self-regulation executive capacities of Organize (“organizes school tasks”), Plan (“makes plans for school tasks”), Prioritize (“orders school tasks”), and Decide (“makes own decisions about school”). The ADHD-Med group also had a significantly larger proportion of students than the matched control group rated as having an executive-skill deficit for one of the seven items (i.e., 14%) within the Self/Social Arena assessing the self-regulation executive capacity of Organize (“organizes social activities”).

ADHD-NoMed group versus control group. The ADHD-NoMed group had significantly larger proportions of students than the matched control group rated as having an executive-function deficit on three of the six items (i.e., 50%) within the Academic Arena that assess the self-regulation executive capacities of Generate (“comes up with new ways to solve school tasks”), Organize (“organizes school tasks”), and Plan (“makes plans for school tasks”). The ADHD-NoMed group also had significantly larger proportions of students than the matched control group rated as having an executive-function deficit for three of the seven items (i.e., 43%) within the Self/Social Arena that assess the self-regulation executive capacities of Generate (“comes up with new ways to solve social issues”), Prioritize (“prioritizes social activities”), and Decide (“makes own decisions about social situations”).

Analyses of the executive-skill deficit ratings also indicated that the ADHD-NoMed group had significantly larger proportions of students than the matched control group who were rated as having an executive-skill deficit for five of the six items (i.e., 83%) within the Academic Arena that assess the self-regulation executive capacities of Generate (“comes up with new ways to solve school tasks”), Organize (“organizes school tasks”), Plan (“makes plans for school tasks”), Prioritize (“orders school tasks”), and Decide (“makes own decisions about school”). The ADHD-NoMed group also had a significantly larger proportion of students than the matched control group rated as having an executive-skill deficit for one of the seven items (i.e., 14%) within the Self/Social Arena that assess the self-regulation executive capacity of Plan (“makes plans for the use of own time”).

ADHD-NoMed group versus ADHD-Med group. When comparing the clinical groups, no significant differences were found in the proportions of students rated as having an executive-function deficit or rated as having an executive-skill deficit for any of the items of the Solution Cluster within either the Academic or Self/Social Arenas. Consistent patterns of executive-skill deficits emerged for the clinical ADHD groups. When analyzing executive-skill deficits, both clinical groups demonstrated significant impairments within the Academic Arena for the self-regulation executive capacities of Organize (“organizes school tasks”), Plan (“makes plans for school tasks”), Prioritize (“orders school tasks”), and Decide (“makes own decisions about school”).

Summary of Self-Regulation Executive-Capacity Cluster Results

Table 18 shows a summary of the total number of significant differences found when comparing teacher ratings of students in the clinical groups with matched control samples and when comparing the clinical samples with each other. Table 18 shows the number of statistically significant differences in the proportions of executive-function deficits and executive-skill deficits found within each Self-Regulation Cluster, as well as the total number of the statistically significant differences among the groups for ratings reflecting executive-function deficits and executive-skill deficits on all of the items included on the seven MEFS Self-Regulation Clusters.

Table 18

Summary of the Significant Differences in Teacher Ratings of EFDs and ESDs for the Clinical and Matched Control Groups on the Seven MEFS Self-Regulation Clusters

	Group comparisons of number of items rated as EFD					
EFDs	MED > Controls		NOMED > Controls		NOMED > MED	
	Number of significant differences in EFDs by arena					
Cluster	ACA	S/S	ACA	S/S	ACA	S/S
Attention	2 (67%)	0	2 (67%)	1 (33%)	0	0
Engagement	5 (63%)	3 (21%)	4 (50%)	6 (43%)	0	0
Optimization	3 (50%)	2 (25%)	4 (67%)	5 (63%)	0	0
Efficiency	2 (20%)	1 (25%)	4 (40%)	1 (25%)	1 (10%)	0
Memory	1 (33%)	0	2 (67%)	2 (50%)	0	0
Inquiry	1 (20%)	3 (50%)	4 (80%)	6 (100%)	0	0
Solution	0	0	3 (50%)	3 (43%)	0	0
Total	14 (34%)	9 (20%)	23 (56%)	24 (52%)	1 (2%)	0
	Group comparisons of number of items rated as ESD					
ESDs	MED > Controls		NOMED > Controls		NOMED > MED	
	Number of significant differences in ESDs by arena					
Cluster	ACA	S/S	ACA	S/S	ACA	S/S
Attention	0	0	1 (33%)	0	0	0
Engagement	0	0	3 (38%)	2 (14%)	0	0
Optimization	2 (33%)	3 (38%)	3 (50%)	3 (38%)	0	0
Efficiency	2 (20%)	1 (25%)	4 (40%)	1 (25%)	0	0
Memory	0	0	0	0	0	0
Inquiry	2 (40%)	1 (17%)	5 (100%)	2 (33%)	0	0
Solution	4 (67%)	1 (14%)	5 (83%)	1 (14%)	0	0
Total	10 ((24%)	6 (13%)	21 (51%)	9 (20%)	0	0

As shown in Table 18, significantly larger proportions of students in the ADHD-Med clinical group than the matched control group were rated as having an executive-function deficit across the seven clusters for 14 of the 41 items (i.e., 31%) within the Academic Arena and nine items (i.e., 20%) within the Self/Social Arena.

In contrast, the ADHD-NoMed clinical group analyses indicated significantly larger proportions of students than the matched control group rated as having an executive-function deficit for 23 of the 41 items (i.e., 56%) within the Academic Arena and 24 of the 46 items (i.e., 52%) within the Self/Social Arena. Additionally, when comparing the clinical groups, significantly larger proportions of students in the ADHD-NoMed group than the ADHD-Med group were rated as having an executive-function deficit for only one of the 41 items (i.e., 2%) within the Academic Arena and for none of the 46 items (i.e., 0%) within the Self/Social Arena.

In the case of executive-skill deficits, a review of the total numbers indicated significantly larger proportions of students in the ADHD-Med group than in the matched control group were rated as having an executive-skill deficit for 10 of the 41 items (i.e., 24%) within the Academic Arena and five of the 46 items (i.e., 13%) within the Self/Social Arena. Comparatively, a significantly larger proportion of students in the ADHD-NoMed group than students in the matched control group were rated as having an executive-skill deficit for 21 of the 41 items (i.e., 51%) within the Academic Arena and nine of the 46 (i.e., 20%) items within the Self/Social Arena. When comparing the two clinical groups, no significant differences were found in the proportions of executive-skill deficit ratings for any of the items within the Academic or the Self/Social Arenas.

Self-Realization Cluster. Table 19 shows a summary of the significant differences found when comparing students in the clinical groups with matched control samples and when comparing the ADHD-Med and ADHD-NoMed clinical groups who were rated by teachers as exhibiting delayed development in the executive capacities assessed by the Self-Realization Cluster.

Table 19
Summary of the significant Differences in Teacher Ratings of Students Exhibiting Delayed Development for the Clinical and Matched Control Groups on the MEFS Self-Realization Cluster Items

Dev. delays	Group comparisons		
	MED > Controls	NOMED > Controls	MED > NOMED
	Number of Self-Realization Cluster items		
	11 items	11 items	11 items
	Number of items showing significant differences		
Delays	0	0	0

As shown in Table 19, analyses of teacher ratings of students in the ADHD-Med and ADHD-NoMed groups and their nonclinical peers did not indicate statistically significant findings for any of the items within the Self-Realization Cluster. Additionally, no statistically significant differences were found between teacher ratings of the ADHD-Med group and the ADHD-NoMed group on any items within the Self-Realization Cluster.

Self-Determination Cluster. Table 20 shows a summary of the significant differences found when comparing students in the clinical groups with matched control samples and when comparing the ADHD-Med and ADHD-NoMed clinical groups who were rated by teachers as exhibiting delayed development in the executive capacities assessed by the Self-Determination Cluster.

Table 20

Summary of the Significant Differences in Teacher Ratings of Students Exhibiting Delayed Clinical and Matched Control Groups on the MEFS Self-Determination Cluster Items

Dev. delays	Group comparisons		
	MED > Controls	NOMED > Controls	MED > NOMED
	Number of Self-Determination Cluster items		
	6 items	6 items	6 items
	Number of items showing significant differences		
Delays	0	0	0

As shown in Table 20, analyses of teacher ratings of students in the ADHD-Med and ADHD-NoMed groups and their nonclinical peers did not indicate statistically significant findings for any of the items within the Self-Determination Cluster. Additionally, no statistically significant differences were found between teacher ratings of the ADHD-Med group and the ADHD-NoMed group on any items within the Self-Determination Cluster.

CHAPTER 5

DISCUSSION

This study compared the pattern of executive-function deficits and executive-skill deficits resulting from teacher ratings of groups of students diagnosed with ADHD and receiving medication (ADHD-Med), diagnosed with ADHD and not receiving medication (ADHD-NoMed), and teacher ratings of demographically matched control groups of students with no clinical diagnosis. Analyses examined teacher responses to all of the items of the seven Self-Regulation Clusters and all of the items of the Self-Realization and Self-Determination Clusters of the McCloskey Executive Functions Scale (MEFS). Furthermore, the study examined teacher ratings to determine if more deficits were noted for items within the Academic Arena than for items within the Self/Social Arena in each of the Self-Regulation Clusters when comparing the clinical groups to their matched controls and when comparing the ADHD-Med group with the ADHD-NoMed groups.

Summary of Findings

Overall, results support the initial hypothesis that the ADHD clinical groups demonstrated greater levels of executive dysfunction than matched groups of nonclinical peers. The teacher ratings using the MEFS also indicated that a larger proportion of the ADHD-NoMed group was rated as having executive-function deficits and executive-skill deficits than the ADHD-Med group for a majority of the items of each of the seven Self-Regulation Clusters. Additionally, results support that larger proportions of both the ADHD-Med and the ADHD-NoMed groups were rated as having more executive-capacity deficits within the Academic Arena than within the Self/Social Arena.

These patterns remained consistent across most clusters, with a few exceptions. Analysis of ratings from the Inquiry Cluster revealed that the ADHD-NoMed group exhibited a greater proportion of executive-function deficit ratings within the Self/Social Arena than within the Academic Arena. Additionally, the ADHD-NoMed group demonstrated a different pattern than expected within both the Inquiry and Solution Clusters, as a greater proportion of executive-skill deficits than executive-function deficits were identified for the Academic Arena.

Finally, it was hypothesized that the greatest proportions of deficit ratings for the clinical groups with ADHD (i.e., Med, NoMed) would occur with items that assessed the Focus, Sustain, Inhibit, and Modulate executive capacities. Results indicate that although the groups diagnosed with ADHD were rated as exhibiting proportionately more executive-capacity deficits than matched controls on some items assessing focusing, sustaining, inhibiting, and modulating, many other executive capacities also were rated as proportionately reflecting even more executive-capacity deficits than matched controls. Further details are summarized as follows according to Executive-Capacity Cluster across all three research questions.

Attention Cluster

Overview of Attention Cluster findings. The items of the Attention Cluster represent the self-regulation capacities of Perceive, Focus, and Sustain. For all six items of the Attention Cluster, larger proportions of students in both clinical groups were rated as having deficits compared to their respective control groups. Clinically significant differences were noted for executive-function deficit ratings for most Attention Cluster items within the Academic Arena. Overall, both ADHD clinical groups had larger proportions of students rated as having executive-function deficits (i.e., not knowing when) than having executive-skill deficits (i.e., not knowing how). As hypothesized, the findings of this study suggest that students diagnosed with ADHD more frequently demonstrate greater difficulty knowing “when” to apply Attention Cluster executive capacities than knowing “how” to apply them. In support of the initial hypothesis, analyses of executive-function deficit and executive-skill deficit ratings indicated that both clinical groups had greater proportions of executive-function deficit and executive-skill deficit ratings within the Academic Arena than within the Self/Social Arena.

Summary of Attention Cluster findings. Results within the Attention Cluster indicate that many individuals with ADHD who receive pharmaceutical intervention were rated by teachers as exhibiting significant impairment when required to focus and sustain attention in an academic setting. However, many students taking medication demonstrated improved perception/awareness of the need to attend compared to nonmedicated peers.

Engagement Cluster

Overview of Engagement Cluster findings. The items of the Engagement Cluster represent the self-regulation capacities of Initiate, Energize, Inhibit, Stop, Pause, Flexible, and Shift. For all 22 of the Engagement Cluster items, larger proportions of the students in both clinical groups were rated as having deficits compared to their respective control groups. Clinically significant differences were noted for executive-function deficit ratings for most Engagement Cluster items within the Academic Arena. Overall, both ADHD clinical groups had larger proportions of students rated as having executive-function deficits (i.e., not knowing when) than executive-skill deficits (i.e., not knowing how). As hypothesized, the findings of this study suggest that overall students diagnosed with ADHD more frequently demonstrate greater difficulty with knowing "when" to apply Engagement Cluster executive capacities than difficulty with knowing "how" to apply them. Although teacher ratings indicated several executive-skill deficits for the ADHD-NoMed group, these executive-skill deficits were much smaller in proportion compared to the executive-function deficits identified for either the ADHD-NoMed group or the ADHD-Med group. In support of the initial hypothesis, analyses of the executive-function deficit and executive-skill deficit ratings indicated that both clinical groups had greater proportions of executive-function deficit and executive-skill deficit ratings within the Academic Arena than within the Self/Social Arena, even considering the fact that six of the seven items that assess Inhibit are included in the Self/Social Arena.

Summary of Engagement Cluster findings. Results within the Engagement Cluster indicate that individuals with ADHD who do not receive pharmaceutical intervention are more likely than individuals who do receive medication to have difficulty with knowing how and/or knowing when to inhibit impulses, stop ongoing activity, return to a task after a pause, or shift between tasks in both academic and social situations. The data indicate that students diagnosed with ADHD who are not receiving pharmaceutical intervention are likely to benefit most from interventions designed to first strengthen, through teaching and practice, the executive skills of how to engage Effortfully, to Inhibit, to Shift, and to Stop, whereas students diagnosed with ADHD who receive pharmaceutical intervention are more likely to benefit from the teaching of strategies to address the executive functions that enable knowing when to employ Engagement Cluster skills in vivo, as teacher ratings of the ADHD-Med group reflected almost no skill level deficits. Additionally, the results of the study indicate that individuals with ADHD who do not receive pharmaceutical intervention are more likely to require intervention for Engagement Cluster deficits in the Self/Social Arena more often than those who receive pharmaceutical intervention.

Optimization Cluster

Overview of Optimization Cluster findings. The items of the Optimization Cluster represent the self-regulation capacities of Monitor, Modulate, Correct, and Balance. For all 14 items of the Optimization Cluster, larger proportions of the students in both clinical groups were rated as having deficits when compared to their respective control groups. In support of the initial hypothesis, larger proportions of the ADHD-NoMed group were rated as having executive-function deficits and executive-skill deficits than students in the ADHD-Med group for most of the items of the Optimization Cluster. In support of the initial hypothesis, analyses of the executive-function deficit ratings indicated that both clinical groups had larger proportions of deficit ratings within the Academic Arena than within the Self/Social Arena. Although the pattern of larger proportions of executive-skill deficit ratings for the ADHD-NoMed group than for their matched controls was anticipated, the same pattern of larger proportions of executive-skill deficit ratings for the ADHD-Med group than for their matched controls was not anticipated. The relatively larger proportions of executive-skill deficits identified for both clinical groups within the Optimization cluster indicated that, regardless of psychostimulant medication use, students diagnosed with ADHD are more likely than undiagnosed students to demonstrate some level of difficulty with knowing “how” to apply some of the Optimization Cluster executive capacities.

Summary of Optimization Cluster findings. Results within the Optimization Cluster indicated that individuals diagnosed with ADHD (medicated or nonmedicated) are likely to require help with developing some aspects of the self-regulation capacities of Monitor and Modulate. Most individuals with ADHD are likely to benefit from interventions designed to first strengthen, through teaching and practice, the executive skills of how to monitor their performance on school tasks and modulate their activity level in both academic and social situations. In addition, individuals diagnosed with ADHD (medicated or non-medicated) are likely to benefit from the teaching of strategies that enable them to know when to modulate sensory stimulation. Overall, students diagnosed with ADHD exhibited larger proportions of both executive-function deficits and executive-skill deficits than matched controls, although executive-function deficits were more prominent than executive-skill deficits. Students diagnosed with ADHD were more likely than controls to be rated as having Optimization executive-capacity deficits within both the Academic Arena and the Self/Social Arena.

Efficiency Cluster

Overview of Efficiency Cluster findings. The items of the Efficiency Cluster represent the self-regulation capacities of Sense Time, Pace, Use Routines, and Sequence. For a majority of the 14 items of the Efficiency Cluster, larger proportions of the students in both clinical groups were rated as having deficits when compared to their respective control groups. Clinically significant differences were noted for executive-function deficit and executive-skill deficit ratings for several Efficiency Cluster items within the Academic Arena. In support of the initial hypothesis, larger proportions of the ADHD-NoMed group were rated as having executive-function deficits and executive-skill deficits within the Academic Arena than students in the ADHD-Med group for items in the Efficiency Cluster. Unexpectedly, an equal proportion of executive-skill deficits and executive-function deficits were found for both clinical groups within the Efficiency Cluster, indicating that students diagnosed with ADHD demonstrate the same level of difficulty with knowing “how” to and knowing “when” to apply several Efficiency Cluster executive capacities, regardless of the use of psychostimulant medication.

Summary of Efficiency Cluster findings. Results within the Efficiency Cluster indicate that a sizable number of both clinical and nonclinical students would benefit from instruction related to knowing when to sense time; adjust pace; use routines; and sequence perceptions, thoughts, and actions. Individuals with ADHD, however, are much more likely than their nonclinical peers to require assistance in learning how to perform the Efficiency Cluster executive capacities, specifically those related to Routines and Timing within both the Academic and Self/Social Arenas. Results of this study indicate that individuals with ADHD who do not receive pharmaceutical intervention exhibit a clinically significant deficit in efficient sequencing within the Academic Arena. This population requires extensive instruction and practice regarding when to sequence school tasks correctly to support academic functioning.

Memory Cluster

Overview of Memory Cluster findings. The items of the Memory Cluster represent the self-regulation capacities of Hold/Manipulate and Store/Retrieve. Although larger proportions of the students in both clinical groups were rated as having executive-capacity deficits compared to their respective control groups for all seven items of the Memory Cluster, the differences in proportions of clinical and nonclinical students rated as having deficits were less than those found with the other clusters. Statistical differences in executive-function deficit ratings between the ADHD NoMed group and matched controls were identified for four of the seven Memory Cluster items, with two items each from the Academic and Self/Social Arenas. In contrast, only one significant difference in executive-function deficit ratings was identified between the ADHD-Med group and matched controls. This cluster is the only cluster in which no statistically significant differences were found for executive-skill deficit ratings comparing ADHD groups and matched controls within either the Academic or the Self/Social Arenas.

Summary of Memory Cluster findings. Results within the Memory Cluster indicate that students diagnosed with ADHD and not receiving pharmaceutical intervention will be more likely to require assistance in learning when to cue themselves to hold and manipulate information, learning when to retrieve information, and learning when to use Memory Cluster executive capacities for academic tasks. Individuals with ADHD who do not receive pharmaceutical intervention are more likely than their nonclinical peers to require support to recall information for tests in academic situations and more likely to experience deficits in storing, retrieving, and recalling social information.

Inquiry Cluster

Overview of Inquiry Cluster findings. The items of the Inquiry Cluster represent the self-regulation capacities of Gauge, Anticipate, Estimate Time, Analyze, and Evaluate/Compare. Analysis of the Inquiry Cluster items indicates that a larger proportion of students in both clinical groups were rated as having deficits compared to their respective control groups. As hypothesized, a larger proportion of students in the

ADHD-NoMed group were rated as having executive-function deficits and executive-skill deficits than students in the ADHD-Med group for Inquiry Cluster items. As anticipated, analyses of the executive-skill deficit ratings indicated that both clinical groups had larger proportions of deficit ratings within the Academic Arena than within the Self/Social Arena. Not anticipated, however, were the findings that larger proportions of executive-function deficit ratings were evident within the Self/Social Arena than the Academic Arena for both ADHD groups. Statistically larger proportions of students diagnosed with ADHD demonstrate difficulties with knowing “how” and “when” to apply some Inquiry Cluster executive capacities.

Summary of Inquiry Cluster findings. Results within the Inquiry Cluster indicate that all students with ADHD are likely to need assistance with knowing when to estimate time, anticipate consequences, and gauge for social situations and when to anticipate school events. Individuals with ADHD are also likely to require instruction to learn strategies for how to use these Inquiry Cluster executive capacities for examining, analyzing, and evaluating school tasks. The data indicate that students diagnosed with ADHD who do not receive pharmaceutical intervention are likely to need additional support in knowing how and/or when to employ Inquiry Cluster executive capacities in academic situations, as well as when to apply them for social situations.

Solution Cluster

Overview of Solution Cluster findings. The items of the Solution Cluster represent the self-regulation capacities of Generate, Associate, Organize, Plan, Prioritize, and Decide. Analysis of the Solution Cluster items indicates that a larger proportion of students in both clinical groups were rated as having deficits compared to their respective control groups. As hypothesized, a larger proportion of students in the ADHD-NoMed group were rated as having executive-function deficits and executive-skill deficits than students in the ADHD-Med group for Solution Cluster items. Analyses of the executive-skill deficit ratings indicated that both clinical groups had larger proportions of deficit ratings within the Academic Arena than within the Self/Social Arena. Contrary to the initial hypotheses is the finding that although a larger proportion of students in the ADHD-Med group were rated as having an executive-skill deficit compared to the matched control group, no significant differences were found for executive-function deficits in the Academic Arena or the Self/Social Arena. Statistically larger proportions of students diagnosed with ADHD demonstrate difficulties with knowing "how" to apply most of the Solution Cluster executive capacities within the Academic Arena.

Summary of Solution Cluster findings. Results within the Solution Cluster indicate students with ADHD are likely to initially benefit from interventions designed to teach how to apply skills related to organizing, planning, prioritizing, and making decisions with academic tasks. In social situations, individuals with ADHD who do not receive pharmaceutical intervention may also require assistance with knowing when to use Solution Cluster executive capacities, such as generating solutions, prioritizing, and making decisions about social situations.

Self-Realization Cluster

With regard to skills assessed within the Self-Realization Cluster, none of the 11 items indicated statistically significant differences between teacher ratings of the clinical ADHD groups and their matched controls. Similarly, comparison of the teacher ratings for the ADHD-NoMed and the ADHD-Med yielded no statistically significant differences between groups for all 11 items within the Self-Realization Cluster. These findings suggest that although teacher ratings indicated many significant differences in the self-regulation executive capacities of students diagnosed with ADHD and nonclinical peers, students diagnosed with ADHD were not rated as having more developmental delays than their nonclinical peers in their levels of awareness of self and others or in their capacity for self-analysis.

Self-Determination Cluster

With regard to skills assessed within the Self-Determination Cluster, none of the six items indicated statistically significant differences between teacher ratings of the clinical ADHD groups and their matched controls. Similarly, comparison of the teacher ratings for the ADHD-NoMed and the ADHD-Med yielded no statistically significant differences between groups for all six items within the Self-Determination Cluster. These findings suggest that although teacher ratings indicated many significant differences in the self-regulation executive capacities of students diagnosed with ADHD and nonclinical peers, students diagnosed with ADHD were not rated as having more developmental delays than their nonclinical peers in their levels of goal setting and long-term planning.

Implications of the Findings

School-aged children with ADHD experience a combination of behavioral, academic, and social challenges. As previously discussed, psychostimulant medication is typically recommended to reduce behavioral symptoms associated with ADHD, such as impulsivity. A more comprehensive treatment plan must be created, however, to address the specific executive impairments impacting these individuals in various settings, such as home and school. Most researchers and clinicians support multimodal treatment, including psychostimulant medication and therapy to treat individuals with ADHD. Medication and behavioral therapy yield similar results in reducing ADHD symptoms and improving academic performance for adolescents (Sibley, Kuriyan, Evans, Waxmonsky, & Smith, 2014). Although the general consensus is that a combination of treatment is best, systematic evaluations of the efficacy of this approach are few. A review of the research regarding treatment options for school-aged children highlighted the need for more information regarding the efficacy of psychostimulant medication in improving daily-life function along with a more comprehensive understanding of the impact of medication on academic and social impairments in individuals with ADHD.

The results of this study are consistent with previous research linking ADHD to deficits with executive capacities. The data presented in this study examined teacher ratings using the MEFS to determine differences when (a) comparing the teacher ratings of a clinical sample of students diagnosed with ADHD who were medicated at the time of teacher rating with the teacher ratings of a nonclinical matched control sample, (b) comparing the teacher ratings of a clinical sample of students diagnosed with ADHD who were nonmedicated at the time of teacher rating with the teacher ratings of a nonclinical matched control sample, and (c) comparing the teacher ratings of a clinical sample of students diagnosed with ADHD who were medicated at the time of teacher rating with the teacher ratings of a clinical sample of students diagnosed with ADHD who were nonmedicated at the time of teacher rating. The analyses were conducted using the McCloskey Executive Functions Scale-Teacher Report (MEFS-TR) individual item ratings organized by the Self-Regulation Clusters and Self-Realization and Self-

Determination facets. Frequency counts were generated for the item scores obtained by the clinical groups and the matched controls. For each of the three comparative analyses, the proportions of teacher ratings reflecting executive-function and/or executive-skill deficits for each MEFS-TR item were tested for statistical significance using Fisher's Exact z Test.

The results support the study hypothesis and the current research indicating that both clinical groups with ADHD (i.e., Med and NoMed) demonstrated a higher degree of executive dysfunction than matched groups of nonclinical peers. Additionally, when considering the combination of executive-function and executive-skill deficits across Academic and Self/Social Arenas, the ADHD-NoMed group was rated with more deficits than the ADHD-Med group across most self-regulation clusters. The data supported the hypothesis that the clinical groups with ADHD would be rated as having a greater proportion of executive-control deficits than matched peers within the Academic Arena for the Attention, Engagement, Optimization, Efficiency, Memory, and Solution Clusters. An analysis of ratings for the nonmedicated clinical group with ADHD revealed more Self/Social Arena deficits than Academic Arena deficits within the Inquiry Cluster. Additionally, for both clinical groups with ADHD, a greater proportion of executive-skill deficits were identified than executive-function deficits for the Inquiry and Solution Clusters within the Academic Arena.

Consistent with the hypothesis, a large proportion of deficit ratings for the clinical groups with ADHD occurred within the Sustain, Inhibit, and Modulate executive capacities found primarily within the Self-Regulation Clusters for Attention, Engagement, and Optimization. A large proportion of deficit ratings for the clinical groups with ADHD also occurred within the Focus executive capacity; however, the results for the ADHD-NoMed group were not clinically significant compared to those of the matched control group. Multiple other executive capacities were also rated as deficient for both clinical groups at a greater frequency than predicted, specifically within the Engagement (i.e., Initiate, Pause, Flexible, Shift), Optimization (i.e., Monitor), Efficiency (i.e., Routines, Time), Inquiry (i.e., Gauge, Analyze, Estimate Time, Evaluate, Anticipate), and Solution (i.e., Organize, Plan, Prioritize, Decide) Clusters. When comparing the two clinical groups within the Efficiency Cluster, the ADHD-NoMed group was found to be significantly more impaired for the Self-Regulation capacity of Sequence ("gets steps in the correct order for school tasks") than the ADHD-Med group.

Overall results indicated that the ADHD-NoMed group was rated as having a greater degree of executive dysfunction; however, trends existed upon examination of the differences between executive-skill deficits and executive-function deficits and when considering the Arena of Involvement. In most cases, much larger proportions of the ADHD-Med group were rated as having an executive-function deficit rather than an executive-skill deficit, and these executive-function deficits were more prominent within the Academic Arena. Findings for the ADHD-NoMed group showed that much larger proportions were rated as having executive-function deficits and executive-skill deficits in both the Academic and Self/Social Arenas. Consistent with the original hypotheses, the study supports the notion that students diagnosed with ADHD who receive pharmaceutical intervention are most likely to require assistance in knowing when to apply self-regulation executive capacities within the Academic Arena and sometimes within the Self/Social Arena, whereas students diagnosed with ADHD who do not receive pharmaceutical intervention are most likely to require assistance in learning how and when to use self-regulation executive capacities within the Academic Arena and also frequently within the Self/Social Arena.

Decades of research indicate that a comprehensive treatment plan for children and adolescents with ADHD must address the behavioral symptoms, such as inattention, motor activity, and impulsivity, along with the functional impairments that impact school performance and social relations. The findings of this study can support educators and clinicians with developing appropriate interventions to support students by increasing their awareness of the specific executive-function deficits and executive-skill deficits identified for school-aged children with ADHD with and without the use of psychostimulant medication. With consideration to a clinical application, the executive-capacity profiles of the clinical groups of children with ADHD used in this study can support the development of these interventions.

Limitations

Several limitations apply to the current study. One limitation is that one standardized measure was used to examine the research questions. The MEFS (McCloskey, 2016) was the only measure used to identify executive-function and executive-skill deficits within and between the clinical groups. By using additional executive-function rating scale(s) or other methods of assessing executive functions, comparisons between scales could examine in greater depth the construct validity of the MEFS.

Additional limitations to this study include sample size and demographics of the sample. Confounding variables and statistical limitations unaccounted for in this study serve as additional limitations. These limitations may affect the validity of the results and limit the generalizability of the findings.

Sample Size

This study consisted of a sample size of 56 students diagnosed with ADHD who were medicated at the time of teacher rating, 47 students diagnosed with ADHD who were not medicated at the time of teacher rating, and 56 demographically matched controls (ADHD-Med matched controls [*n* = 56]; ADHD-NoMed matched controls [*n* = 47]). Owing to the limited number of individuals involved in this study, the sample is not a true representation of the population and restricts the generalizability of findings. Although the sample sizes are large enough to ensure adequate power for testing statistical significance, their relatively small size limits the generalizability of the study findings.

Confounding Teacher Variables

The validity of the teachers' ratings is limited because of the variability in such factors as teacher's age, years of teaching experience, and years of training and development, factors that were not explored in this present study. The result might be influenced by the halo effect resulting from teacher bias, including varying teacher interpretations of the scale's items and varied perceptions of the students rated.

Confounding Student Variables

Student factors, including ethnicity and gender, that may be associated with a specific socioeconomic status may be rater lower regarding executive capacity based on teacher bias. While data regarding demographic characteristics of the students in the sample, such as ethnic group membership and gender, were obtained and reported, the potential impact of these demographic variables was not accounted for as a part of this study.

Additionally, this current study examined the executive-function deficits and executive-skills deficits of those with ADHD; however, details regarding their levels of impairment were not analyzed. Those with ADHD could present with varying levels of difficulty regarding inattention, hyperactivity, impulsivity, or a combination of all three. Based on the *DSM-5* (2013), the three possible presentations of ADHD include inattentive presentation, hyperactive/impulsive presentation, and combined presentation. The students may present with cognitive deficits not accounted for in this current study. Further examination in this area could highlight different results between subtypes of ADHD and levels of impairment, further enhancing this area of research.

Furthermore, for students in the ADHD-Med group, the type of medication, duration of use, and specific dosage of medication were not included or analyzed in this study. As research indicates, the type of medication and duration of use impact functioning across the lifespan. Further examination in this area could highlight different results related to medication use and levels of impairment that would further enhance this area of research.

Statistical Limitations

Statistical limitations exist in the current study; therefore, causal implications cannot be made. Unknown mediating or moderating factors may provide alternative explanations for the results yielded in the current study.

Future Directions

The current study explored the executive-function and executive-skill deficits for two clinical groups of school-aged children with ADHD (i.e., Med, NoMed) across the seven Self-Regulation, Self-Realization, and Self-Determination Clusters from the MEFS. Since the MEFS was the sole measure used in the current study to evaluate and compare executive capacities between the groups, a future study should use multiple rating scales and/or direct assessments to examine the current or related research questions. Additionally, considering the ratings for the current study were provided only by teachers, future research using the MEFS should include parental ratings.

One should note that a clinically significant difference was found between the ADHD-Med and ADHD No-Med groups within the Efficiency Cluster for the self-regulation capacity of Sequence ("gets the steps in the correct order for school tasks"). The results indicate that individuals with ADHD who do not receive psychostimulant medication require extensive instruction and practice regarding when to sequence school tasks correctly to support academic functioning. Additional assessments should be administered to support these findings. Furthermore, specific interventions directed at these sequencing issues should be developed and used with individuals with ADHD who do not receive medication. This rating scale information, along with additional assessment tools, can be used to determine the efficacy of the intervention.

Future research should extend to examine the executive capacities of individuals with ADHD, while considering the different presentations of Inattentive, Hyperactive/Impulsive, or Combined groups. Additionally, a more comprehensive evaluation of the effects of different kinds of medication, including stimulant and nonstimulant options, could have on the aforementioned groups would be beneficial.

Studies should also explore the impact of dosing of psychostimulants and the sequencing of combination treatments, such as cognitive-behavioral therapy or behavioral therapy.

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Appendices

Appendix A. McCloskey Executive Functions Scale (MEFS) – School Age Teacher Form

5	AA	Always or almost always does this on his or her own. Does not need to be prompted or reminded (cued) to do it.
4	F	Frequently does this on own without prompting
3	S	Seldom does this on own without being prompted, reminded, or cued to do so.
2	AP	Does this only after being prompted, reminded, or cued to do it.
1	DA	Only does it with direct assistance. Requires much more than a simple prompt or cue to be able to get it done in situations that require it.
0	UA	Unable to do this, even when direct assistance is provided.

BECOMING AWARE						
Knows what he or she should be doing for school tasks and knows when to do it.	AA	F	S	AP	DA	UA
Makes eye contact with, listens to, and touches others in an appropriate way in social situations.	AA	F	S	AP	DA	UA
FOCUSING ATTENTION						
Focuses attention on school tasks.	AA	F	S	AP	DA	UA
Focuses attention on others in social situations.	AA	F	S	AP	DA	UA
SUSTAINING ATTENTION						
Sustains attention for school tasks until a task is completed.	AA	F	S	AP	DA	UA
Sustains attention to others in social situations.	AA	F	S	AP	DA	UA
INITIATING						
Starts school work.	AA	F	S	AP	DA	UA
Initiates socially appropriate interactions with other students.	AA	F	S	AP	DA	UA
GETTING ENERGIZED FOR / PUTTING EFFORT INTO						
Puts adequate energy into, school tasks.	AA	F	S	AP	DA	UA
Puts adequate energy into, interacting with others.	AA	F	S	AP	DA	UA
INHIBITING						
Waits for turn.	AA	F	S	AP	DA	UA
Considers the consequences before saying or doing things he or she may regret.	AA	F	S	AP	DA	UA
Refrains from acts of physical aggression.	AA	F	S	AP	DA	UA

Does not make inappropriate or thoughtless comments (for example, name-calling, insulting, inappropriately tattling on others).	AA	F	S	AP	DA	UA
Maintains emotional control in frustrating situations.	AA	F	S	AP	DA	UA
Maintains emotional control when doing challenging school work.	AA	F	S	AP	DA	UA
Maintains emotional control when disagreeing with others.	AA	F	S	AP	DA	UA
STOPPING						
Knows when to stop talking about a single topic.	AA	F	S	AP	DA	UA
Stops playing a game or stops doing something that is fun when asked to do so.	AA	F	S	AP	DA	UA
Stops doing things that annoy others when asked to do so.	AA	F	S	AP	DA	UA
PAUSE & CONTINUE						
Returns to a school task after a brief pause.	AA	F	S	AP	DA	UA
Pauses to listen to what another person has to say during conversations.	AA	F	S	AP	DA	UA
FLEXIBLY ENGAGING						
Willing to try a different way to do school tasks when he or she gets stuck.	AA	F	S	AP	DA	UA
Accepts a good idea when it is what most others in a group want to do.	AA	F	S	AP	DA	UA
Accepts changes in school work or school routines without getting upset about it.	AA	F	S	AP	DA	UA
Accepts changes in a person he or she knows or to accept unfamiliar persons without getting upset.	AA	F	S	AP	DA	UA
SHIFTING						
Moves from one school task to another without difficulty.	AA	F	S	AP	DA	UA
Changes from one activity to another in social situations without difficulty.	AA	F	S	AP	DA	UA
MONITORING						
Checks school work to avoid careless errors on tests and other school work.	AA	F	S	AP	DA	UA
Recognizes situations in which his or her behavior bothers or upsets others.	AA	F	S	AP	DA	UA

Checks to make sure that he or she has everything they need before leaving class or school.	AA	F	S	AP	DA	UA
Checks on his or her appearance, cleanliness and personal hygiene.	AA	F	S	AP	DA	UA
MODULATING OR ADJUSTING						
Physical activity level fits the situation when doing school tasks (Not hyperactive or inactive).	AA	F	S	AP	DA	UA
Physical activity level fits the situation when working in a group (Not hyperactive or inactive).	AA	F	S	AP	DA	UA
Emotional response fits the situation when working on school tasks (Doesn't overreact or underact).	AA	F	S	AP	DA	UA
Emotional response fits the situation when interacting with others (Doesn't overreact or underreact).	AA	F	S	AP	DA	UA
Avoids being overstimulated or understimulated by sights, sounds, or touches.	AA	F	S	AP	DA	UA
CORRECTING						
Corrects errors that are made in school work.	AA	F	S	AP	DA	UA
Apologizes when aware of offending others.	AA	F	S	AP	DA	UA
BALANCING						
Balances the elements of a school assignment (speed vs accuracy, quality vs quantity; general vs specific statements; depth vs breadth, etc.).	AA	F	S	AP	DA	UA
Maintains a balance in social situations (talking vs listening, sharing too much vs sharing too little; being humorous vs being serious).	AA	F	S	AP	DA	UA
Maintains a balance in his or her own activities (play vs work; time alone vs time with others; sleep vs awake).	AA	F	S	AP	DA	UA
SENSING TIME						
Keeps track of time (e.g., realizes how much time has passed) when doing school tasks.	AA	F	S	AP	DA	UA
Keeps track of time (e.g., realizes how much time has passed) when talking to or doing things with others.	AA	F	S	AP	DA	UA
PACING						
Changes pace (works slower or works faster) when taking tests or doing school assignments.	AA	F	S	AP	DA	UA

Changes pace in social situations (for example, talks slower or talks faster to maintain the pace of the conversation).	AA	F	S	AP	DA	UA
USING ROUTINES/COMPLETING ASSIGNMENTS (EXECUTING)						
Uses well-rehearsed or practiced routines for school tasks (for example, recognizing words by sight, printing or writing letters and words, reciting basic math facts).	AA	F	S	AP	DA	UA
Uses well-rehearsed or practiced social greetings or conversation starters.	AA	F	S	AP	DA	UA
Generate good ideas and gets them down on paper quickly and efficiently.	AA	F	S	AP	DA	UA
Uses routines and strategies to do well on tests.	AA	F	S	AP	DA	UA
Uses routines and strategies to get assignments and projects done.	AA	F	S	AP	DA	UA
Participates in discussions about topics that he or she knows a lot about.	AA	F	S	AP	DA	UA
Brings home all the materials need to complete homework and other school tasks.	AA	F	S	AP	DA	UA
Hands in homework, assignments or important papers when they are completed.	AA	F	S	AP	DA	UA
SEQUENCING						
Gets the steps in the right order when working on school tasks.	AA	F	S	AP	DA	UA
Gets the order of events right when telling stories or explaining things to others.	AA	F	S	AP	DA	UA
HOLDING and WORKING WITH INFORMATION IN MIND						
Can keep information in mind for short periods of time when doing school tasks. (For example, can add 3 or more numbers without pencil and paper; can remember directions that were just given by the teacher.)	AA	F	S	AP	DA	UA
Can keep information in mind for short periods of time when talking with others. (For example, can follow and participate in a longer conversation.)	AA	F	S	AP	DA	UA
STORING and RETRIEVING						
Stores and recalls specific information about school subjects no matter how questions are worded.	AA	F	S	AP	DA	UA

Stores and recalls specific information about others or about social situations.	AA	F	S	AP	DA	UA
Does well on tests that require recall of stored facts no matter what test format is used.	AA	F	S	AP	DA	UA
Does well in social situations that require recall of facts about others.	AA	F	S	AP	DA	UA
Does well in situations that require recall of facts about himself or herself.	AA	F	S	AP	DA	UA
GAUGING or "SIZING UP"						
Accurately estimates the difficulty of school tasks and/or tests and what it takes to complete them and/or do well with them.	AA	F	S	AP	DA	UA
Figures out how to interact appropriately in various social situations.	AA	F	S	AP	DA	UA
ANTICIPATING						
Anticipates events at school. (for example, recognizes the need to prepare for tests or assignments; connects homework with grades, etc.).	AA	F	S	AP	DA	UA
Anticipates how what he or she says or does will affect how others feel, think or act.	AA	F	S	AP	DA	UA
Anticipates the consequences of his or her own thoughts, feeling and actions. (for example, recognizes that if he or she doesn't do a chore he or she won't be able to play with a friend and will feel disappointed about it).	AA	F	S	AP	DA	UA
ESTIMATING TIME						
Accurately estimates how long it will take to do something when involved with one or more school tasks.	AA	F	S	AP	DA	UA
Accurately estimates how long it will take to do something when talking to others or doing things with others.	AA	F	S	AP	DA	UA
ANALYZING SITUATIONS						
Examines and analyzes things in more detail when doing school tasks.	AA	F	S	AP	DA	UA
Examines and analyzes in more detail what others are saying or doing in social situations.	AA	F	S	AP	DA	UA
EVALUATING / COMPARING						

Evaluates the quality and/or adequacy of his or her work on school tasks.	AA	F	S	AP	DA	UA
Evaluates the quality and/or adequacy of his or her social interactions.	AA	F	S	AP	DA	UA
GENERATING SOLUTIONS						
Comes up with new ways to solve problems with school tasks.	AA	F	S	AP	DA	UA
Come up with new ideas about things to say to, or do with, others.	AA	F	S	AP	DA	UA
MAKING ASSOCIATIONS						
Sees or understands how two or more things or ideas are similar and can use that knowledge to solve a problem with school work.	AA	F	S	AP	DA	UA
Sees or understands how one social situation can be similar to another and can use that knowledge to solve a social relationship problem.	AA	F	S	AP	DA	UA
ORGANIZING						
Organizes school tasks.	AA	F	S	AP	DA	UA
Organizes age appropriate social activities.	AA	F	S	AP	DA	UA
PLANNING						
Makes plans for school tasks.	AA	F	S	AP	DA	UA
Makes plans for age appropriate social activities.	AA	F	S	AP	DA	UA
Makes plans for the use of his or her own time.	AA	F	S	AP	DA	UA
PRIORITIZING						
Orders school tasks according to their relevance, importance, or urgency.	AA	F	S	AP	DA	UA
Handles social activities according to their relevance, importance or urgency.	AA	F	S	AP	DA	UA
DECISION-MAKING						
Makes own decisions about what to do for school and/or when to do it.	AA	F	S	AP	DA	UA
Makes own decisions about what to do with others and/or when to do it.	AA	F	S	AP	DA	UA
INSTRUCTIONS For each statement below, think about this student and circle the option that best describes him or her: N/R Never or rarely does this.						

S Does this sometimes, but not much O Does this often VO Does this very often				
SELF-REALIZATION: AWARENESS OF SELF				
Makes realistic comments about his or her own mental and emotional strengths and weaknesses.	N/R	S	O	VO
Makes realistic comments about his or her own physical abilities.	N/R	S	O	VO
Makes realistic comments about what he or she feels or thinks about himself or herself.	N/R	S	O	VO
SELF-REALIZATION: AWARENESS OF OTHERS				
Makes realistic comments about the mental and emotional strengths and weaknesses of others.	N/R	S	O	VO
Makes realistic comments about the physical abilities of others.	N/R	S	O	VO
Makes realistic comments about what he or she thinks other people feel or think about others.	N/R	S	O	VO
Makes realistic comments about what he or she thinks others feel or think about him or her.	N/R	S	O	VO
Makes realistic comments about what he or she thinks other people feel or think about themselves.	N/R	S	O	VO
SELF-REALIZATION: ANALYSIS OF SELF AND OTHERS				
Realistically analyzes and comments about his or her school performance.	N/R	S	O	VO
Realistically analyzes and comments about his or her ability to know what others appear to think or feel about him or her.	N/R	S	O	VO
Realistically analyzes and comments about his or her ability to manage himself or herself.	N/R	S	O	VO
SELF-DETERMINATION: GOAL-SETTING				
States realistic goals for schooling based on personal interests.	N/R	S	O	VO
States realistic goals for work beyond school based on personal interests.	N/R	S	O	VO
Expresses strong desires to make his or her own decisions about what to do rather than be told what to do by parents or others.	N/R	S	O	VO
SELF-DETERMINATION: LONG-TERM PLANNING				

States realistic plans for accomplishing long-term schooling goals.	N/R	S	O	VO
States realistic plans for accomplishing long-term work goals.	N/R	S	O	VO
States realistic plans for accomplishing social and/or personal goals.	N/R	S	O	VO

Appendix B: Fisher's Z Analyses

ADHD-Med Group vs Control Group Function Deficit Proportions

EFD	MED N = 47		MEDCON N = 47		Fisher's z	Sig. Level
ATN1PA	16	34%	9	19%	1.63	0.102
ATN3FA	28	60%	13	28%	3.12	0.002
ATN5SA	29	62%	16	34%	2.68	0.007
ATN2PS	15	32%	6	13%	2.23	0.030
ATN4FS	18	38%	10	21%	1.80	0.070
ATN6SS	21	45%	11	23%	2.18	0.030
ENG7IA	23	49%	9	19%	3.05	0.002
ENG9EA	23	49%	8	17%	3.29	0.001
ENG16HA	24	51%	8	17%	3.48	0.001
ENG19SA	22	47%	13	28%	1.92	0.050
ENG22PA	24	51%	9	19%	3.24	0.001
ENG24FA	22	47%	9	19%	2.85	0.004
ENG26FA	12	26%	7	15%	1.28	0.199
ENG28TA*	21	45%	10	21%	2.41	0.016
ENG8IS	13	28%	6	13%	1.80	0.070
ENG10ES	12	26%	7	15%	1.28	0.190
ENG11HS	19	40%	7	15%	2.77	0.006
ENG12HS	21	45%	17	36%	0.84	0.400
ENG13HS	7	15%	5	11%	0.62	0.540
ENG14HS	20	43%	11	23%	1.97	0.050
ENG15HS	20	43%	10	21%	2.21	0.030
ENG17HS	21	45%	10	21%	2.41	0.020
ENG18SS	20	43%	15	32%	1.07	0.290
ENG20SS	18	38%	11	23%	1.56	0.120
ENG23PS	17	36%	8	17%	2.10	0.036
ENG25FS	18	38%	5	11%	3.12	0.002

ENG27FS	7	15%	7	15%	0.00	1.000
ENG29TS	16	34%	4	9%	2.92	0.004

OPT35NA	24	51%	17	36%	1.45	0.145
OPT37NA	24	51%	12	26%	2.55	0.011
OPT30DA	19	40%	5	11%	3.31	0.001
OPT32DA	16	34%	5	11%	2.72	0.006
OPT39CA	25	53%	14	30%	2.30	0.021
OPT43BA	24	51%	18	38%	1.25	0.213

OPT36NS	24	51%	15	32%	1.88	0.056
OPT38NS	13	28%	7	15%	1.51	0.131
OPT31DS	19	40%	8	17%	2.51	0.012
OPT33DS	19	40%	9	19%	2.26	0.024
OPT34DS	20	43%	8	17%	2.21	0.007
OPT40CS	18	38%	11	23%	1.56	0.118
OPT44BS	23	49%	13	28%	2.12	0.034
OPT45BS	22	47%	14	30%	1.70	0.089

EFF72TA	21	45%	20	43%	0.21	0.835
EFF74PA	21	45%	20	43%	0.21	0.835
EFF76RA	16	34%	12	26%	0.90	0.367
EFF79RA	23	49%	18	38%	1.04	0.298
EFF80RA	20	43%	14	30%	1.29	0.197
EFF81RA	21	45%	14	30%	1.49	0.135
EFF82RA	10	21%	6	13%	1.09	0.272
EFF83RA	23	49%	7	15%	3.54	0.001
EFF84RA	17	36%	5	11%	2.92	0.004
EFF85SA	13	28%	8	17%	1.24	0.216

EFF73TS	24	51%	26	55%	-0.41	0.680
EFF75PS	24	51%	14	30%	2.10	0.036
EFF77RS	13	28%	9	19%	0.92	0.330

EFF86SS	17	36%	5	11%	2.92	0.004
MEM87MA	21	45%	10	21%	2.41	0.016
MEM89RA	21	45%	9	19%	2.66	0.008
MEM91RA	21	45%	11	23%	2.12	0.029
MEM88MS	14	30%	6	13%	2.02	0.044
MEM90RS	15	32%	7	15%	1.95	0.051
MEM92RS	17	36%	7	15%	2.37	0.018
MEM93RS	12	26%	3	6%	2.31	0.021
INQ46GA	23	49%	17	36%	1.25	0.211
INQ48TA	23	49%	6	13%	3.79	0.002
INQ51EA	24	51%	16	34%	1.67	0.095
INQ53ZA	21	45%	19	40%	0.42	0.677
INQ66CA	25	53%	20	43%	1.03	0.302
INQ47GS	21	45%	8	17%	2.90	0.004
INQ49TS	18	38%	15	32%	0.65	0.517
INQ50TS	21	45%	8	17%	2.90	0.004
INQ52ES	28	60%	15	32%	2.69	0.007
INQ54ZS	23	49%	16	34%	1.47	0.143
INQ67CS	21	45%	13	28%	1.72	0.086
SOL55GA	23	49%	16	34%	1.47	0.143
SOL57AA	22	47%	11	23%	2.38	0.018
SOL59OA	24	51%	15	32%	1.88	0.059
SOL61PA	22	47%	20	43%	0.42	0.678
SOL68RA	21	45%	19	40%	0.42	0.677
SOL70DA	16	34%	13	28%	0.67	0.503
SOL56GS	22	47%	13	28%	1.92	0.055
SOL58AS	23	49%	14	30%	1.90	0.057
SOL60OS	17	36%	12	26%	1.12	0.264

SOL62PS	20	43%	13	28%	1.51	0.130
SOL63PS*	19	40%	18	38%	0.21	0.833
SOL69RS	21	45%	16	34%	1.06	0.291
SOL71DS	14	30%	13	28%	0.23	0.820

ADHD-Med Group vs Control Group Skill Deficit Proportions

ESD	MED N = 47		MEDCON N = 47		Fisher's z	Sig. Level
ATN1PA*	2	4%	0	0%	0.62	0.540
ATN3FA*	4	9%	1	2%	0.90	0.370
ATN5SA*	8	17%	2	4%	1.65	0.090
ATN2PS*	2	4%	0	0%	0.62	0.540
ATN4FS*	3	6%	0	0%	0.90	0.370
ATN6SS*	2	4%	0	0%	0.62	0.540
ENG7IA*	7	15%	1	2%	1.65	0.090
ENG9EA*	8	17%	4	9%	1.16	0.250
ENG16HA*	4	9%	1	2%	0.90	0.370
ENG19SA*	6	13%	2	4%	1.16	0.250
ENG22PA*	7	15%	1	2%	1.65	0.099
ENG24FA*	8	17%	1	2%	1.88	0.061
ENG26FA*	3	6%	0	0%	0.89	0.370
ENG28TA*	6	13%	1	2%	1.41	0.159
ENG8IS*	4	9%	0	0%	1.16	0.250
ENG10ES*	4	9%	1	2%	0.90	0.370
ENG11HS*	3	6%	1	2%	0.62	0.540
ENG12HS*	8	17%	1	2%	1.88	0.060
ENG13HS*	4	9%	1	2%	0.90	0.370
ENG14HS*	5	11%	0	0%	1.41	0.160
ENG15HS*	6	13%	2	4%	1.16	0.250
ENG17HS*	5	11%	3	6%	0.62	0.540
ENG18SS*	7	15%	0	0%	1.88	0.060

ENG20SS*	10	21%	3	6%	1.88	0.060
ENG23PS*	4	9%	0	0%	1.16	0.242
ENG25FS*	6	13%	0	0%	1.65	0.099
ENG27FS*	3	6%	0	0%	0.89	0.370
ENG29TS*	3	6%	0	0%	0.89	0.012

OPT30DA	10	21%	0	0%	2.72	0.006
OPT32DA	7	15%	0	0%	1.88	0.061
OPT35NA	14	30%	1	2%	3.12	0.002
OPT37NA	11	23%	3	6%	2.09	0.036
OPT39CA	11	23%	3	6%	2.09	0.036
OPT43BA	10	21%	2	4%	2.09	0.036

OPT31DS	11	23%	0	0%	2.74	0.006
OPT33DS	8	17%	1	2%	1.88	0.061
OPT34DS	4	9%	0	0%	3.12	0.002
OPT36NS	9	19%	0	0%	2.31	0.021
OPT38NS	5	11%	2	4%	0.90	0.370
OPT40CS	8	17%	2	4%	1.65	0.099
OPT44BS	6	13%	0	0%	1.65	0.099
OPT45BS	9	19%	0	0%	2.52	0.012

EFF72TA*	11	23%	1	2%	2.52	0.012
EFF74PA*	10	21%	3	6%	1.87	0.061
EFF76RA*	4	9%	0	0%	1.16	0.247
EFF79RA*	13	28%	2	4%	2.72	0.006
EFF80RA*	9	19%	1	2%	2.09	0.036
EFF81RA*	10	21%	2	4%	2.09	0.036
EFF82RA*	3	6%	1	2%	1.41	0.159
EFF83RA*	8	17%	5	11%	2.09	0.036
EFF84RA*	10	21%	5	11%	0.62	0.537
EFF85SA*	9	19%	1	2%	2.09	0.036

EFF73TS*	9	19%	0	0%	2.31	0.021
EFF75PS*	6	13%	1	2%	1.41	0.159
EFF77RS*	4	9%	0	0%	2.72	0.006
EFF86SS*	2	4%	0	0%	0.62	0.537

MEM87MA*	6	13%	0	0%	1.89	0.061
MEM89RA	7	15%	0	0%	1.88	0.061
MEM91RA	8	17%	1	2%	1.88	0.061

MEM88MS*	2	4%	0	0%	0.62	0.537
MEM90RS*	3	6%	1	2%	0.62	0.537
MEM92RS*	3	6%	0	0%	0.89	0.370
MEM93RS*	2	4%	1	2%	0.32	0.748

INQ46GA*	10	21%	1	2%	2.31	0.021
INQ48TA*	11	23%	3	6%	2.09	0.036
INQ51EA*	12	26%	3	6%	2.31	0.021
INQ53ZA	12	26%	2	4%	2.52	0.012
INQ66CA*	14	30%	2	4%	2.92	0.004

INQ47GS*	5	11%	0	0%	1.41	0.159
INQ49TS*	11	23%	1	2%	2.52	0.012
INQ50TS*	7	15%	3	6%	1.16	0.247
INQ52ES*	5	11%	3	6%	0.62	0.537
INQ54ZS	7	15%	1	2%	1.65	0.099
INQ67CS*	10	21%	4	9%	1.65	0.099

SOL55GA*	10	21%	3	6%	1.88	0.061
SOL57AA*	8	17%	1	2%	1.88	0.061
SOL59OA*	14	30%	3	6%	2.72	0.006
SOL61PA*	13	28%	3	6%	2.52	0.012
SOL68RA*	14	30%	2	4%	2.92	0.004
SOL70DA*	12	26%	1	2%	2.72	0.006

SOL56GS*	8	17%	0	0%	2.09	0.036
SOL58AS*	7	15%	0	0%	1.88	0.061
SOL60OS*	12	26%	0	0%	2.92	0.004
SOL62PS*	8	17%	1	2%	1.88	0.061
SOL63PS*	7	15%	0	0%	1.88	0.061
SOL69RS*	6	13%	0	0%	1.65	0.099
SOL71DS*	5	11%	0	0%	1.88	0.061

Self-Realization Developmental Delays

	MED N = 47		MEDCON N = 47		Fisher's z	Sig. Level
SR96SAW	6	13%	3	6%	0.90	0.370
SR97SAW	6	13%	6	13%	0.00	1.000
SR98SAW	4	9%	7	15%	0.81	0.370
SR99OAW	9	15%	10	21%	0.26	0.797
SR100OAW	12	26%	9	19%	0.74	0.457
SR101OAW	10	21%	8	17%	0.52	0.600
SR102OAW	10	21%	11	23%	-0.25	0.804
SR103OAW	11	23%	12	26%	-0.24	0.810
SR104SAN	8	17%	3	6%	1.41	0.159
SR105SAN	11	23%	5	11%	1.65	0.099
SR106SAN	8	17%	9	19%	-0.27	0.789

Self-Determination Developmental Delays

	MED N = 47		MEDCON N = 47		Fisher's z	Sig. Level
SD107GO	13	28%	6	13%	1.80	0.072
SD108GO	16	34%	11	23%	1.14	0.254
SD109GO	9	19%	8	17%	0.27	0.789
SD110PL	18	38%	8	17%	2.31	0.021
SD111PL	17	36%	8	17%	2.10	0.036
SD112PL	15	31%	8	17%	1.68	0.093

ADHD-NoMed Group vs Control Group Function Deficit Proportions

EFD	NOMED N = 56		NOMEDCON N = 56		Fisher's z	Sig. Level
ATN1PA	32	57%	14	25%	3.46	0.001
ATN3FA	31	55%	19	34%	2.28	0.023
ATN5SA	34	61%	18	32%	3.03	0.002
ATN2PS	17	30%	9	16%	1.79	0.074
ATN4FS	15	27%	9	16%	1.38	0.167
ATN6SS	20	36%	8	14%	2.62	0.009
ENG7IA	32	57%	16	29%	3.06	0.002
ENG9EA	31	55%	21	38%	1.90	0.058
ENG16HA	22	39%	8	14%	2.99	0.003
ENG19SA	23	41%	14	25%	1.81	0.071
ENG22PA	29	52%	12	21%	3.34	0.001
ENG24FA	28	50%	15	27%	2.53	0.012
ENG26FA	17	30%	7	13%	2.30	0.021
ENG28TA	26	46%	14	25%	2.37	0.018
ENG8IS	18	32%	11	20%	1.51	0.131
ENG10ES	17	30%	11	20%	1.31	0.191
ENG11HS	22	39%	9	16%	2.75	0.006
ENG12HS	23	41%	14	25%	1.81	0.071
ENG13HS	8	14%	5	9%	0.89	0.376
ENG14HS	19	34%	11	20%	1.71	0.088
ENG15HS	22	39%	9	16%	2.75	0.006
ENG17HS	22	39%	11	20%	2.28	0.023
ENG18SS	26	46%	10	18%	3.24	0.001
ENG20SS	26	46%	10	18%	3.24	0.001
ENG23PS	22	39%	7	13%	3.24	0.001
ENG25FS	18	32%	10	18%	1.75	0.081
ENG27FS*	12	21%	4	7%	2.06	0.039
ENG29TS	23	41%	9	16%	2.93	0.003

OPT35NA	25	45%	10	18%	3.06	0.002
OPT37NA	28	50%	11	20%	3.37	0.001
OPT30DA	33	59%	23	41%	1.89	0.059
OPT32DA	28	50%	16	29%	2.32	0.020
OPT39CA	39	70%	23	41%	3.04	0.002
OPT43BA	38	68%	17	30%	3.97	0.001

OPT36NS	26	46%	10	18%	3.24	0.001
OPT38NS	23	41%	11	20%	2.47	0.014
OPT31DS	24	43%	13	23%	2.21	0.027
OPT33DS	21	38%	11	20%	2.09	0.036
OPT34DS	26	46%	11	20%	3.01	0.003
OPT40CS	22	39%	11	20%	2.28	0.023
OPT44BS	25	45%	10	18%	3.06	0.002
OPT45BS	31	55%	11	20%	3.90	0.001

EFF72TA	27	48%	20	36%	1.34	0.180
EFF74PA	28	50%	21	38%	1.33	0.183
EFF76RA	24	43%	13	23%	2.21	0.027
EFF79RA	32	57%	23	41%	1.70	0.088
EFF80RA	31	55%	18	32%	2.48	0.013
EFF81RA	31	55%	18	32%	2.48	0.013
EFF82RA	14	25%	14	25%	0.00	1.000
EFF83RA	31	55%	17	30%	2.67	0.008
EFF84RA	27	48%	15	27%	2.34	0.019
EFF85SA	30	54%	14	25%	3.10	0.002

EFF73TS	29	52%	15	27%	2.71	0.007
EFF75PS	27	48%	16	29%	2.14	0.033
EFF77RS	16	29%	10	18%	1.34	0.179
EFF86SS	21	38%	10	18%	2.32	0.020

MEM87MA	23	41%	9	16%	2.93	0.003

MEM89RA	26	46%	18	32%	1.55	0.122
MEM91RA	34	61%	19	34%	2.84	0.005
MEM88MS	14	25%	8	14%	1.43	0.154
MEM90RS	22	39%	9	16%	2.75	0.006
MEM92RS	26	46%	11	20%	3.01	0.003
MEM93RS	16	29%	8	14%	1.84	0.066
INQ46GA	30	54%	15	27%	2.89	0.004
INQ48TA	28	50%	13	23%	2.94	0.003
INQ51EA*	33	59%	19	34%	2.65	0.008
INQ53ZA	35	63%	20	36%	2.84	0.005
INQ66CA	35	63%	23	41%	2.27	0.023
INQ47GS	28	50%	8	14%	4.05	0.001
INQ49TS	27	48%	11	20%	3.19	0.001
INQ50TS	30	54%	10	18%	3.94	0.001
INQ52ES	31	55%	13	23%	3.48	0.001
INQ54ZS	31	55%	16	29%	2.87	0.004
INQ67CS	32	57%	14	25%	3.46	0.001
SOL55GA	37	66%	23	41%	2.65	0.008
SOL57AA	32	57%	21	38%	2.08	0.037
SOL59OA	33	59%	18	32%	2.85	0.004
SOL61PA	35	63%	21	38%	2.65	0.008
SOL68RA	33	59%	22	39%	2.08	0.038
SOL70DA	27	48%	16	29%	2.14	0.033
SOL56GS	32	57%	17	30%	2.86	0.004
SOL58AS	26	46%	19	34%	1.35	0.177
SOL60OS	20	36%	10	18%	2.13	0.033
SOL62PS	21	38%	14	25%	1.43	0.154
SOL63PS	26	46%	17	30%	1.75	0.080
SOL69RS	27	48%	11	20%	3.19	0.001

SOL71DS	22	39%	10	18%	2.51	0.012

ADHD-NoMed Group vs Control Group Skill Deficit Proportions

ESD	NOMED N = 56		NOMEDCON N = 56		Fisher's z	Sig. Level
ATN1PA	8	14%	0	0%	2.06	0.040
ATN3FA*	9	16%	0	0%	2.27	0.024
ATN5SA*	13	23%	0	0%	3.04	0.002
ATN2PS*	7	13%	1	2%	1.62	0.105
ATN4FS*	4	7%	0	0%	1.14	0.253
ATN6SS*	7	13%	0	0%	1.84	0.065
ENG7IA*	10	18%	2	4%	2.06	0.040
ENG9EA*	12	21%	0	0%	2.85	0.004
ENG16HA*	7	13%	2	4%	1.39	0.165
ENG19SA*	13	23%	0	0%	3.04	0.002
ENG22PA*	10	18%	2	4%	2.06	0.040
ENG24FA*	10	18%	1	2%	2.27	0.024
ENG26FA*	3	5%	0	0%	0.89	0.376
ENG28TA*	10	18%	0	0%	2.47	0.013
ENG8IS*	5	9%	0	0%	1.39	0.165
ENG10ES*	4	7%	0	0%	1.14	0.253
ENG11HS*	8	14%	0	0%	2.06	0.040
ENG12HS*	14	25%	0	0%	3.22	0.001
ENG13HS*	6	11%	0	0%	1.62	0.105
ENG14HS*	6	11%	0	0%	1.62	0.105
ENG15HS*	7	13%	1	2%	1.62	0.105
ENG17HS*	6	11%	0	0%	1.62	0.105
ENG18SS*	9	16%	0	0%	2.27	0.024
ENG20SS*	11	20%	0	0%	2.66	0.008
ENG23PS*	7	13%	0	0%	1.84	0.065
ENG25FS*	5	9%	0	0%	1.39	0.165

ENG27FS*	3	5%	0	0%	0.89	0.376
ENG29TS*	6	11%	0	0%	1.62	0.105

OPT30DA	20	36%	5	9%	3.40	0.001
OPT32DA	18	32%	1	2%	3.76	0.001
OPT35NA	11	20%	0	0%	2.66	0.008
OPT37NA	5	9%	0	0%	1.39	0.165
OPT39CA	11	20%	4	7%	1.84	0.065
OPT43BA	12	21%	4	7%	2.06	0.040

OPT31DS	14	25%	1	2%	3.04	0.002
OPT33DS	5	9%	1	2%	1.14	0.253
OPT34DS	10	18%	0	0%	2.47	0.014
OPT36NS	4	7%	1	2%	0.89	0.376
OPT38NS	11	20%	0	0%	2.66	0.008
OPT40CS	8	14%	0	0%	2.06	0.040
OPT44BS	9	16%	1	2%	2.06	0.040
OPT45BS	8	14%	2	4%	1.62	0.105

EFF72TA*	17	30%	1	2%	3.58	0.001
EFF74PA*	11	20%	2	4%	2.27	0.024
EFF76RA*	7	13%	0	0%	1.84	0.065
EFF79RA*	8	14%	2	4%	1.62	0.105
EFF80RA*	11	20%	3	5%	2.06	0.040
EFF81RA*	13	23%	3	5%	2.47	0.014
EFF82RA*	1	2%	0	0%	0.32	0.751
EFF83RA*	12	21%	0	0%	2.85	0.004
EFF84RA*	13	23%	1	2%	2.85	0.004
EFF85SA*	7	13%	0	0%	2.06	0.040

EFF73TS*	13	23%	1	2%	2.85	0.004
EFF75PS*	8	14%	1	2%	1.84	0.065
EFF77RS*	4	7%	0	0%	1.14	0.253

EFF86SS*	6	11%	0	0%	1.62	0.105
MEM87MA*	9	16%	2	4%	1.84	0.065
MEM89RA*	9	16%	2	4%	1.84	0.065
MEM91RA*	6	11%	2	4%	1.14	0.253
MEM88MS*	8	14%	1	2%	1.84	0.065
MEM90RS*	4	7%	0	0%	1.14	0.253
MEM92RS*	5	9%	0	0%	1.39	0.165
MEM93RS*	3	5%	0	0%	0.89	0.376
INQ46GA*	16	29%	3	5%	3.04	0.002
INQ48TA*	13	23%	1	2%	2.85	0.004
INQ51EA*	15	27%	1	2%	3.22	0.001
INQ53ZA*	16	29%	3	5%	3.04	0.002
INQ66CA*	16	29%	4	7%	2.85	0.004
INQ47GS*	8	14%	0	0%	2.06	0.040
INQ49TS*	9	16%	0	0%	2.27	0.024
INQ50TS*	13	23%	0	0%	3.04	0.002
INQ52ES*	12	21%	0	0%	2.66	0.008
INQ54ZS*	9	16%	0	0%	2.27	0.024
INQ67CS*	10	18%	2	4%	2.06	0.040
SOL55GA*	13	23%	2	4%	2.66	0.008
SOL57AA*	9	16%	1	2%	2.09	0.036
SOL59OA*	16	29%	4	7%	2.85	0.004
SOL61PA*	17	30%	0	0%	3.76	0.001
SOL68RA*	18	32%	3	5%	3.40	0.001
SOL70DA*	11	20%	1	2%	2.47	0.014
SOL56GS*	7	13%	1	2%	1.62	0.105
SOL58AS*	9	16%	2	4%	1.84	0.065
SOL60OS*	11	20%	2	4%	2.27	0.024

SOL62PS*	7	13%	0	0%	1.84	0.065
SOL63PS*	11	20%	1	2%	2.47	0.014
SOL69RS*	10	18%	2	4%	2.06	0.040
SOL71DS*	7	13%	1	2%	1.62	0.105

Self-Realization Developmental Delays

	NOMED N = 56		NOMEDCON N = 56		Fisher's z	Sig. Level
SR96SAW	13	23%	6	11%	1.76	0.078
SR97SAW	9	16%	8	14%	0.26	0.793
SR98SAW	7	13%	8	14%	-0.28	0.782
SR99OAW	12	21%	11	20%	0.23	0.815
SR100OAW	11	20%	11	20%	0.00	1
SR101OAW	8	14%	9	16%	-0.26	0.793
SR102OAW	11	20%	10	18%	0.24	0.809
SR103OAW	12	21%	14	25%	-0.45	0.654
SR104SAN	9	16%	4	7%	1.39	0.165
SR105SAN	10	18%	5	9%	1.39	0.165
SR106SAN	13	23%	13	23%	0.00	1

Self-Determination Developmental Delays

	NOMED N = 56		NOMEDCON N = 56		Fisher's z	Sig. Level
SD107GO	12	21%	8	14%	0.99	0.324
SD108GO	8	14%	10	18%	-0.52	0.607
SD109GO	8	14%	12	21%	-0.99	0.324
SD110PL	20	36%	11	20%	1.90	0.057
SD111PL	21	38%	14	25%	1.43	0.154
SD112PL	18	32%	14	25%	0.84	0.403

ADHD-Med Group vs ADHD-NoMed Group Function Deficit Proportions

EFD	MED = 47		NOMED = 56		Fisher's z	Sig. Level
ATN1PA	16	34%	32	57%	-0.08	0.468

ATN3FA	28	60%	31	55%	0.43	0.666
ATN5SA	29	62%	34	61%	0.10	0.918

ATN2PS	15	32%	17	30%	0.17	0.865
ATN4FS	18	38%	15	27%	1.25	0.212
ATN6SS	21	45%	20	36%	0.93	0.354

ENG7IA	23	49%	32	57%	-0.83	0.405
ENG9EA	23	49%	31	55%	-0.65	0.516
ENG16HA	24	51%	22	39%	1.20	0.231
ENG19SA	22	47%	23	41%	0.59	0.559
ENG22PA	24	51%	29	52%	-0.07	0.942
ENG24FA	22	47%	28	50%	-0.32	0.747
ENG26FA	12	26%	17	30%	-0.54	0.588
ENG28TA	21	45%	26	46%	-0.18	0.860

ENG8IS	13	28%	18	32%	-0.49	0.621
ENG10ES	12	26%	17	30%	-0.54	0.588
ENG11HS	19	40%	22	39%	0.12	0.906
ENG12HS	21	45%	23	41%	0.37	0.712
ENG13HS	7	15%	8	14%	0.09	0.931
ENG14HS	20	43%	19	34%	0.90	0.369
ENG15HS	20	43%	22	39%	0.34	0.737
ENG17HS	21	45%	22	39%	0.55	0.580
ENG18SS	20	43%	26	46%	-0.39	0.694
ENG20SS	18	38%	26	46%	-0.83	0.406
ENG23PS	17	36%	22	39%	-0.33	0.745
ENG25FS	18	38%	18	32%	0.65	0.514
ENG27FS	7	15%	12	21%	-0.85	0.394
ENG29TS	16	34%	23	41%	-0.73	0.464

OPT35NA	24	51%	25	45%	-0.43	0.667
OPT37NA	24	51%	28	50%	-0.97	0.331

OPT30DA	19	40%	33	59%	-0.80	0.424
OPT32DA	16	34%	28	50%	0.11	0.914
OPT39CA	25	53%	39	70%	-1.72	0.086
OPT43BA	24	51%	38	68%	-1.73	0.083

OPT36NS	24	51%	26	46%	-1.27	0.203
OPT38NS	13	28%	23	41%	0.15	0.879
OPT31DS	19	40%	24	43%	0.83	0.405
OPT33DS	19	40%	21	38%	-1.06	0.290
OPT34DS	20	43%	26	46%	-0.61	0.541
OPT40CS	18	38%	22	39%	-0.10	0.918
OPT44BS	23	49%	25	45%	0.44	0.664
OPT45BS	22	47%	31	55%	-0.87	0.387

EFF72TA	21	45%	27	48%	-0.36	0.720
EFF74PA	21	45%	28	50%	-0.54	0.591
EFF76RA	16	34%	24	43%	-0.91	0.361
EFF79RA	23	49%	32	57%	-0.83	0.405
EFF80RA	20	43%	31	55%	-1.30	0.195
EFF81RA	21	45%	31	55%	-1.08	0.281
EFF82RA	10	21%	14	25%	-0.45	0.656
EFF83RA	23	49%	31	55%	-0.65	0.516
EFF84RA	17	36%	27	48%	-1.23	0.218
EFF85SA	13	28%	30	54%	-2.66	0.008

EFF73TS	24	51%	29	52%	-0.07	0.942
EFF75PS	24	51%	27	48%	0.29	0.773
EFF77RS	13	28%	16	29%	-0.10	0.919
EFF86SS	17	36%	21	38%	-0.14	0.890

MEM87MA	21	45%	23	41%	0.37	0.712
MEM89RA	21	45%	26	46%	-0.18	0.860
MEM91RA	21	45%	34	61%	-1.63	0.104

MEM88MS	14	30%	14	25%	0.54	0.586
MEM90RS	15	32%	22	39%	-0.78	0.437
MEM92RS	17	36%	26	46%	-1.05	0.293
MEM93RS	12	26%	16	29%	-0.35	0.730

INQ46GA	23	49%	30	54%	-0.47	0.639
INQ48TA	23	49%	28	50%	-0.11	0.914
INQ51EA	24	51%	33	59%	-0.80	0.424
INQ53ZA	21	45%	35	63%	-1.81	0.071
INQ66CA	25	53%	35	63%	-0.95	0.340

INQ47GS	21	45%	28	50%	-0.54	0.591
INQ49TS	18	38%	27	48%	-1.01	0.312
INQ50TS	21	45%	30	54%	0.90	0.369
INQ52ES	28	60%	31	55%	0.43	0.666
INQ54ZS*	23	49%	31	55%	-0.65	0.516
INQ67CS	21	45%	32	57%	-1.26	0.208

SOL55GA	23	49%	37	66%	-1.76	0.079
SOL57AA	22	47%	32	57%	-1.05	0.296
SOL59OA	24	51%	33	59%	-0.80	0.424
SOL61PA	22	47%	35	63%	-1.60	0.111
SOL68RA	21	45%	33	59%	-1.44	0.149
SOL70DA	16	34%	27	48%	-1.45	0.146

SOL56GS	22	47%	32	57%	-1.05	0.296
SOL58AS	23	49%	26	46%	0.25	0.800
SOL60OS	17	36%	20	36%	0.05	0.962
SOL62PS	20	43%	21	38%	0.52	0.602
SOL63PS	19	40%	26	46%	-0.61	0.541
SOL69RS	21	45%	27	48%	-0.36	0.720
SOL71DS	14	30%	22	39%	-1.01	0.314

ADHD-Med Group vs ADHD-NoMed Group Skill Deficit Proportions

ESD	MED = 47		NOMED = 56		Fisher's z	Sig. Level
ATN1PA*	2	4%	8	14%	-1.26	0.209
ATN3FA*	4	9%	9	16%	-1.04	0.301
ATN5SA	8	17%	13	23%	-0.78	0.437
ATN2PS*	2	4%	7	13%	-1.04	0.301
ATN4FS*	3	6%	4	7%	-0.01	0.990
ATN6SS*	2	4%	7	13%	-1.04	0.301
ENG7IA	7	15%	10	18%	-0.40	0.686
ENG9EA	8	17%	12	21%	-0.56	0.573
ENG16HA*	4	9%	7	13%	-0.56	0.579
ENG19SA	6	13%	13	23%	-1.36	0.173
ENG22PA	7	15%	10	18%	-0.40	0.686
ENG24FA	8	17%	10	18%	-0.11	0.912
ENG26FA*	3	6%	3	5%	0.29	0.770
ENG28TA	6	13%	10	18%	-0.71	0.478
ENG8IS*	4	9%	5	9%	-0.01	0.990
ENG10ES*	4	9%	4	7%	0.29	0.770
ENG11HS*	3	6%	8	14%	-1.04	0.301
ENG12HS	8	17%	14	25%	-0.98	0.325
ENG13HS*	4	9%	6	11%	-0.29	0.769
ENG14HS	5	11%	6	11%	-0.01	0.990
ENG15HS	6	13%	7	13%	0.04	0.968
ENG17HS	5	11%	6	11%	-0.01	0.990
ENG18SS	7	15%	9	16%	-0.16	0.870
ENG20SS	10	21%	11	20%	0.21	0.838
ENG23PS*	4	9%	7	13%	-0.56	0.579
ENG25FS	6	13%	5	9%	0.63	0.530
ENG27FS*	3	6%	3	5%	0.29	0.770
ENG29TS	3	6%	6	11%	-0.56	0.579

OPT30DA	10	21%	20	36%	-0.64	0.524
OPT32DA	7	15%	18	32%	-0.98	0.326
OPT35NA	14	30%	11	20%	0.46	0.643
OPT37NA	11	23%	5	9%	1.23	0.218
OPT39CA	11	23%	11	20%	0.46	0.643
OPT43BA	10	21%	12	21%	-0.02	0.985

OPT31DS	11	23%	14	25%	-0.71	0.478
OPT33DS	8	17%	5	9%	0.29	0.770
OPT34DS	4	9%	10	18%	0.44	0.662
OPT36NS	9	19%	4	7%	1.23	0.218
OPT38NS	5	11%	11	20%	-1.47	0.142
OPT40CS	8	17%	8	14%	0.38	0.703
OPT44BS	6	13%	9	16%	-0.47	0.636
OPT45BS	9	19%	8	14%	0.66	0.508

EFF72TA	11	23%	17	30%	-0.79	0.430
EFF74PA	10	21%	11	20%	0.21	0.838
EFF76RA*	4	9%	7	13%	-0.56	0.579
EFF79RA	13	28%	8	14%	1.68	0.093
EFF80RA	9	19%	11	20%	-0.06	0.949
EFF81RA	10	21%	13	23%	-0.24	0.814
EFF82RA*	3	6%	1	2%	0.94	0.347
EFF83RA	8	17%	12	21%	-0.56	0.573
EFF84RA	10	21%	13	23%	-0.24	0.814
EFF85SA	9	19%	7	13%	0.93	0.353

EFF73TS	9	19%	13	23%	-0.50	0.616
EFF75PS	6	13%	8	14%	-0.22	0.823
EFF77RS*	4	9%	4	7%	0.29	0.770
EFF86SS*	2	4%	6	11%	-0.80	0.423

MEM87MA	6	13%	9	16%	-0.47	0.636

MEM89RA	7	15%	9	16%	0.16	0.870
MEM91RA	8	17%	6	11%	0.93	0.352

MEM88MS*	2	4%	8	14%	-1.26	0.209
MEM90RS*	3	6%	4	7%	-0.01	0.990
MEM92RS*	3	6%	5	9%	-0.29	0.770
MEM93RS*	2	4%	3	5%	-0.01	0.990

INQ46GA	10	21%	16	29%	-0.85	0.396
INQ48TA	11	23%	13	23%	0.02	0.982
INQ51EA	12	26%	15	27%	-0.14	0.886
INQ53ZA	12	26%	16	29%	-0.35	0.730
INQ66CA	14	30%	16	29%	0.14	0.893

INQ47GS	5	11%	8	14%	-0.56	0.579
INQ49TS	11	23%	9	16%	0.94	0.349
INQ50TS	7	15%	13	23%	-1.06	0.288
INQ52ES	5	11%	12	21%	-1.47	0.142
INQ54ZS	7	15%	9	16%	-0.16	0.870
INQ67CS	10	21%	10	18%	0.44	0.662

SOL55GA	10	21%	13	23%	-0.24	0.814
SOL57AA	8	17%	9	16%	0.13	0.897
SOL59OA	14	30%	16	29%	0.14	0.893
SOL61PA	13	28%	17	30%	-0.30	0.764
SOL68RA	14	30%	18	32%	-0.26	0.797
SOL70DA	12	26%	11	20%	0.48	0.475

SOL56GS	8	17%	7	13%	0.65	0.517
SOL58AS	7	15%	9	16%	0.16	0.870
SOL60OS	12	26%	11	20%	0.72	0.475
SOL62PS	8	17%	7	13%	0.65	0.517
SOL63PS	7	15%	11	20%	-0.63	0.527
SOL69RS	6	13%	10	18%	-0.71	0.477

SOL71DS	5	11%	7	13%	-0.29	0.770

Self-Realization Developmental Delays

	MED = 47		NOMED = 56		Fisher's z	Sig. Level
SR96SAW	6	13%	13	23%	-1.36	0.173
SR97SAW	6	13%	9	16%	-0.47	0.636
SR98SAW	4	9%	7	13%	-0.56	0.579
SR99OAW	9	15%	12	21%	-0.29	0.775
SR100OAW	12	26%	11	20%	0.72	0.475
SR101OAW	10	21%	8	14%	0.93	0.352
SR102OAW	10	21%	11	20%	0.21	0.838
SR103OAW	11	23%	12	21%	0.24	0.81
SR104SAN	8	17%	9	16%	0.13	0.897
SR105SAN	11	23%	10	18%	0.70	0.486
SR106SAN	8	17%	13	23%	-0.78	0.437

Self-Determination Developmental Delays

	MED = 47		NOMED = 56		Fisher's z	Sig. Level
SD107GO	13	28%	12	21%	0.74	0.462
SD108GO	16	34%	8	14%	2.36	0.018
SD109GO	9	19%	8	14%	0.66	0.508
SD110PL	18	38%	20	36%	0.27	0.786
SD111PL	17	36%	21	38%	-0.14	0.889
SD112PL	15	31%	18	32%	-0.03	0.980