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An Exploratory Analysis of the Ecological Validity of a Performance-Based Assessment of Attention

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An Exploratory Analysis of the Ecological Validity of a Performance-Based Assessment
of Attention

by

Eun-Yeop Lee

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
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Eun-Yeop Lee

ABSTRACT

Executive functions impact everyday functioning. An individual's ability to adapt to and navigate their physical and social environments is largely determined by the ability to organize oneself, to plan and to coordinate activities. Despite the wide variety of cognitive tests that assess various aspects of executive function, there has been little work to validate the use of these measures in predicting real world functioning (Sbordone, Seyranian, & Ruff, 2000), particularly in children where characterization of executive function is less specified. Evaluating the ecological validity of neuropsychological tests has become an increasingly important topic over the past decade (Chaytor & Schmitter-Edgecombe, 2003). Ecologically valid assessments of executive function and attentional deficits provide insight into deficits related to the child's everyday adaptive functioning, which can assist in identifying targets for interventions. Although many performance based measures and caregiver behavior checklists exist for assessing a wide range of behaviors and adaptive functioning skills in children, comprehensive measures of executive functions are relatively new and largely unexplored.

The purpose of this study was to investigate and to define better the relationship between attention and corresponding behaviors that represent executive functions and

social/adaptive functioning. More specifically, this study sought to explore the correlation between ratings of varying subcomponents of attention (e.g., selective attention, sustained attention, and attentional control/switching), executive function behaviors, and ratings of social/adaptive functioning. Additionally, gender considerations were examined with aims to determine how this factor may affect the degree of relationship between the proposed variables.

Results of multiple regression and correlational analyses revealed the ability of child attentional performance to predict executive function and social/adaptive functioning behaviors. As parent/caregiver and teacher ratings of executive function behaviors increased thus noting adept skills in these areas of functioning child performance on measures of selective attention, sustained attention, and attentional control/shifting were also reported to improve. Future research should continue to explore the construct validity, positive predictive power, negative predictive power, diagnostic sensitivity and specificity of the Test of Everyday Attention for Children (TEA-Ch).

Chapter 1

Introduction

Statement of the Problem

Current literature supports that various attentional capacities provide the basis for many of the cognitive and neuropsychological functions that are required for everyday operations (Cooley & Morris, 1990; Heaton et al., 2001; Price, Joschko & Kerns, 2003, Stavro, Ettenhofer & Nigg, 2007). The ability to attend plays a critical role in the individual expression of cognitive and behavioral functioning, thus exerting considerable influence on academic and social development. Despite the importance of good attention skills, “poor concentration” is a relatively common problem in childhood (Warner-Rogers, Taylor, Taylor & Sandberg, 2000). Estimates indicate that 10-15% of the general population report to experience clinically significant levels of attention problems (Heaton et al., 2001; Mirksy, Anthony, Duncun, Ahearn & Kellam, 1991).

Impairment of attention is also characteristic of many other disorders including numerous psychiatric and neurological disorders. These conditions may include transient and reversible manifestations of neurologic conditions including traumatic brain injury, response to medication, and withdrawal states or progressive impairments including Parkinson’s disease and neurodegenerative dementias (e.g, diffuse Lewy body disease). Lastly, attention deficits are also present in more static conditions including major affective disorders, anxiety disorders, sleep disorders, and various developmental

disorders including Asperger's Syndrome, Tourette's Syndrome, and Turner's Syndrome (Coffey, McAllister & Silver, 2006; Cohen et al., 2001; Friedman et al., 2007; Heaton et al., 2001; Manly et al., 2001). However, no other childhood psychiatric disorder manifests the degree of impact on attention than that experienced by individuals diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) (Heaton et al., 2001). ADHD is one of the most prevalent neurodevelopmental disorders, occurring in approximately 7% of school age children, and 5% of adolescents and adults (Pasini, Paloscia, Alessandrelli, Porfirio & Curatolo, 2007; Sciotto & Eisenberg, 2007). Other studies have reported estimates ranging as high as 16% of the general population as meeting diagnostic criteria (Shafritz, Marchione, Gore, Shaywitz & Shaywitz, 2004). On average, estimates place at least one child diagnosed with ADHD in every classroom in America (Fabiano & Pelham, 2003). In addition, clinic referrals for ADHD reportedly consume 30-40% of resources in child psychopathology (Stavro et al., 2007). This disorder has become a significant public health issue affecting education, employment, social interactions, adaptive functioning, and overall quality of life (Heaton et al., 2001; Stavro et al., 2007). Long-term consequences have documented lower educational, behavioral, and occupational achievement as well as increased risk and vulnerability for the development of additional psychiatric disorders (Barkley, 1997; Shafritz, et al., 2004; Stavro et al., 2007). The impact of this disorder creates an intense need for support from children, families, schools, and mental health services (Lorys, Hynd & Lahey, 1990).

Given the prevalence of ADHD, it is not surprising that considerable research efforts have been devoted to the etiology, diagnosis, and clinical manifestations of this disorder (Biederman & Faraone, 2005). Recently, the dynamic, multidimensional nature

of executive functions has been hypothesized to be characteristically impaired in individuals meeting criteria for ADHD (Barkley, 1997; Stavro et al., 2007). To date, the construct of executive functions has been challenging to define and assess in clinical settings (Barkley, 1997; Stuff & Alexander, 2000). In the past, the symptoms of ADHD have been described in behavioral terms incorporating inattention, hyperactivity, and impulsivity tendencies. Despite the vast research, consensus fails to be reached concerning a specific neurocognitive mechanism attributable to the behavioral problems of ADHD (Wu, Anderson & Castiello, 2002). Currently, prevailing theories conceptualize ADHD as a neurologically based disorder characterized by deficits in executive function as well as weaknesses in sustained and divided attention (Biederman & Faraone, 2005; Mullane & Corkum, 2007; Pasini et al., 2007). Although the emphasis on studying executive functions has been greatly highlighted due to an interest in further understanding and redefining ADHD, there is an increasing normative population of children who struggle behaviorally and academically (Barkley, 1997; Stavro et al., 2007). Therefore, difficulties with attention are not necessarily confined to clinical populations (Mirsky et al., 1991).

The purpose of this study was to investigate and better define the relationship between attention and corresponding behaviors that have been designed to represent executive functions and social/adaptive functioning. Research is provided to support the integration of the neurosciences with the field of education by defining the relevant role of executive functions and attention as it relates to learning and functioning across home, school, and community settings (Meltzer, 2007). Scientific understanding of the mind and brain is advancing quickly and society's need to improve the quality of education is a

reoccurring concern. Naturally, there is a great interest in applying findings from brain research to guide educational practice (Meltzer, 2007). The following sections provide an overview of executive functions and attention as well as the study and assessment of these constructs as it applies to child populations.

Definition of Executive Functions

Researchers have proposed multiple models of executive functions with varying degrees of overlap however; a specific definition of the construct remains elusive. The term “executive function” was initially described within the context of cognitive theory and in the past twenty years has become the focus of widespread research interest, particularly in children (Denckla, 1996; Espy, Kaumann, Glisky & McDiarmid, 2001; Hughes & Graham, 2002). Difficulties with documenting the role of executive function, beyond heterogeneity of individual profiles, are partially attributed to the breadth of functions and developmental dynamics of what constitutes executive function (Meltzer, 2007). Executive function is best understood as a broad umbrella term governing a collection of separate but inter-related processes that are necessary for completing purposeful, goal-directed behaviors (Anderson, 2002; Hughes & Graham, 2002; Weyandt, 2005).

The construct of executive function includes all supervisory or self-regulatory functions that organize and direct cognitive, emotional, and behavioral functions towards attaining future goals (Anderson, 1998; Anderson, 2002; Brocki & Bohlin, 2006; Gioia, Isquith, Guy & Kenworthy, 2001; Hughes, 2002; Pasini et al., 2007; Robbins, 1992). Among these functions, four discrete but inter-related executive domains can be defined: attentional control, information processing, cognitive flexibility, and goal setting

(Anderson, 2002). Furthermore, within these components are a variety of proposed underlying processes, subcomponents, or subdomains (Gioia et al., 2001) including a range of theoretical constructs such as, anticipation, goal selection, planning, set-shifting, reasoning, initiation, self-regulation, inhibition, attention, and utilization of feedback (Anderson, 2002; Barkley, 1997; Biederman et al., 2004; Gioia et al., 2000; Robbins, 1992). Specifically, these functions are proposed to direct and modulate attentional processes such as sustaining optimal levels of arousal and vigilance (Barkley, 1997).

Gioia and Isquith (2004) also include the role of cognition in their interpretation of executive function. They suggest that emotional control and regulation of one's affective state is reciprocally related to efficient problem solving (Gioia & Isquith, 2004). Similarly, executive functions have also been associated with involvement in guiding socially useful, personally enhancing, constructive, and creative activities (Anderson, Anderson, Northam, Jacobs & Mikiewicz, 2002). Thus, "executive dysfunction" may be reflected in test performance as evidenced by poor planning/organization, perseveration, inability to correct errors or utilize feedback, and rigid or concrete thought processes (Anderson, 1998).

Apart from the vastly inclusive subdomains and related tasks of executive functions, various models tend to incorporate sets of common attributes. Upon reviewing the terminology and definitions related to executive function that exist in current research a general set of beliefs appear to be universally accepted. These core features state that: (1) executive functions are primarily localized and supported by the prefrontal cortex, (2) executive functions follow a developmental trajectory that is mediated by the environment, and (3) there is no unitary condition of executive dysfunction, but rather

distinct executive function profiles that may present in different clinical conditions (Gioia, 2000). These features will be revisited and explored in detail upon review of the neuroanatomical structures involved in specific executive functions.

Neuroanatomical Substrate of Executive Functions

One common view of the neuroanatomic organization of executive functions is that they are located solely within the frontal lobes and specifically in the prefrontal region (Anderson et al., 2002; Barkley, 1997; Gioia et al., 2000; Stavro et al., 2007). Neuropsychological evidence obtained from patients with frontal lobe lesions in conjunction with functional neuroimaging support the hypothesis that the prefrontal cortex plays a major and specific role in response selection processes (Robbins, 1996). However, as functional anatomy research expands it is becoming apparent that constricting executive functions to the frontal lobe may be an oversimplification of the organizational execution of the brain. Thus, it is understood that although the frontal regions play a vital role in the mediation of performance intact executive function rests upon the integrity of the entire brain (Anderson, 1998).

The prefrontal region is an association region. An association area is a multimodal area that receives information from sensory areas and is involved in “higher order” functions such as perception, abstract thoughts, decision-making, etc. The frontal association area lies in the frontal lobe and is involved in creating general plans for actions that are activated through connections to the primary motor cortex and basal ganglia (Gazzaniga, Ivry & Mangun, 2002). The prefrontal region has extensive connections that span all areas of the neocortex via cortico-cortical projections as well as with limbic and subcortical structures including the cingulate gyrus, hippocampus,

reticular activating system, basal ganglia, thalamus, and motor system of the frontal lobes (Anderson et al., 2002; Dawson & Guare, 2004; Gioia et al., 2000; Weyandt, 2005). The prefrontal cortex is not a functionally homogenous region, which has implications for the nature and organization of executive functions (Robbins, 1996; Weyandt, 2005).

Importantly, damage or disorder involving any component of the frontal system may interfere with the bidirectional connections of the prefrontal cortex, and in turn, influence performance of executive function tasks (Anderson et al., 2002; Gioia et al., 2000).

Developmental Trajectory of Executive Functions

The assessment of executive functions in children stem from controversial roots. Historically, many researchers considered executive functions to be “functionally silent” in children under the age of 12 years (Anderson, 1998; Espy et al., 2001). Such beliefs were aligned with the popular perception that children lack inhibitory control, are easily distractible, and have difficulty shifting from one cognitive task to another (Anderson, 1998). However, as current research strongly supports, executive functions although not present in their fully developed form can be measured across the early life span. Similar to the assessment of other cognitive skills such as language, developmentally appropriate tasks must be used that take into account the more limited behavioral repertoire of young children (Espy et al., 2001). Particularly for children, if executive abilities and attention can be reliably assessed prior to school entry or during early school years, early intervention can be accessed to reduce the adverse impact on future outcomes (Espy et al., 2001).

As previously discussed, frontal lobe functioning appears to play a central and pervasive role in human cognition as it serves to organize and modulate higher brain

functioning (e.g., reasoning, abstraction, emotions, behavior) (Anderson, 1998; Espy et al., 2001; Gazzaniga, Ivry & Mangun, 2002). One of its main functions is to assist individuals with goal-directed and self-regulatory behaviors (Romine & Reynolds, 2005). The acquisition of abilities thought to be mediated by the frontal lobes emerge in childhood and continue to develop through late adolescence and into early adulthood, contrary to prior belief and in contrast to the earlier maturation of other cortical regions (Romine & Reynolds, 2005). Neuroanatomical, neurophysiological, and neurochemical changes occur in the continued development of frontal lobes throughout the lifespan (Romine & Reynolds, 2005).

It is proposed that development of the frontal lobes follow a hierarchical pattern, consistent with processes such as dendritic arborization, myelination, and synaptogenesis which progress through stages from primary, sensory, association areas and lastly to frontal regions (Anderson, 1998; Chugani, 1999; Romine & Reynolds, 2005). Secondary and tertiary systems that involve language, learning, memory, emotion, cognition, and attention continue to develop beyond birth (Romine & Reynolds, 2005). These changes have been reported to parallel the development of cognitive and social abilities observed during childhood and adolescence. The functional developments that are mediated by the frontal lobes have also been perceived to exist as a multistage process with different functions maturing at different rates (Chugani, 1999; Romine & Reynolds, 2005). Researchers have attempted to define the differential components of executive functions and align them with their unique developmental trajectories. A growing body of research describes the sequential improvement of performance of executive tasks through childhood that coincides with growth spurts observed in frontal lobe development

(Anderson, 1998; Romine & Reynolds, 2005; Welsh & Pennington, 1988). For example, children develop attentional control initially from birth to five years, followed by the development of inhibitory control from three to four years. Working memory is proposed to develop by four or five years, cognitive flexibility emerges by seven to nine years, and more complex problem solving develops from 11 to 13 years with later proficiency and refinement of skills continuing to emerge through adolescence and adulthood (Anderson, 2002; Espy et al., 2001).

In a study of 100 pediatric participants, ages 3-12 years, Welsh et al. (1991) proposed that executive functions develop in three prominent stages of skill integration and maturation. Organized strategic planning behaviors were detected by six years of age while adult-like performance on increasingly complex measures of organized search ability, and utilization of hypothesis testing was evident by 10 years of age. Tasks of verbal fluency, motor sequence, and use of complex planning skills were proposed to be in continual development at the age of 12 years. Despite findings, a serious limitation of this study involved the use of measures that were originally designed for the assessment of executive functions in adults. Thus, they are unlikely to have maintained adequate validity when task complexity was simplified for use with children and adolescents (Welsh et al., 1991).

Likewise, in their meta-analysis of frontal lobe functioning, Romine and Reynolds (2005) found that the greatest period of overall development occurred between the ages of six and eight years. The capacity to shift between response sets first emerged around four years of age and became more fluent by the age of six years (Espy et al., 2001). Moderate increases in skill level were proposed to be evident between the ages of 9-12

years and performance approximating adult levels was projected to occur between adolescence and the early 20s. Similar to previous findings, researchers reported that between the ages of five and eight years, basic cognitive abilities were present and evident through performance on recognition memory, concept formation, set-shifting, and rudimentary planning skills (Romine & Reynolds, 2005).

Welsh et al. (1999) also documented rapid advances in systematic problem solving during this period. Thus, evidence supports the “5-7 year shift” that was first coined by White (1965), to refer to a transition period characterized by children’s increased ability to think autonomously and the emergence of strategic and controlled self-regulation, skills of inhibition, and the ability to maintain attention on complex problems, planfulness, and reflection (Welsh & Pennington, 1988). By the age of 10 years, the ability to inhibit attention to distractible stimuli and perseveratory responses were thought to be proficient with mastery achieved by 12 years of age (Romine & Reynolds, 2005; Stuss, 1992). Additional skills such as planning, visual working memory, coordination of working memory and inhibition, verbal fluency, and motor sequencing are skills mediated by the frontal lobes and require development beyond adolescence (Anderson, 1998; Romine & Reynolds, 2005; Stuss, 1992). Processing speed was also proposed to increase during this period, allowing for faster response rates and solution times, greater output, and commission of fewer errors (Stuss, 1992).

In sum, the developmental emergence and growth of executive functions have several important implications. First, executive functions have demonstrated close associations with the prefrontal cortex, an area of the brain that was long thought to be functionally inactive until very late in development (Hughes, 2002). Second, impairments

in executive functions are now perceived to play a key role in a range of developmental disorders. In addition, interest in the normative development of executive functions has also heightened which has provided an opportunity to identify distinct executive functions. The research collaboratively lends support to the fact that there is no singular core disorder of executive function (Gioia et al., 2001) and rather clinical as well as normative groups may reflect unique profiles of executive function deficits. Finally, the emergence of executive functions is understood to vary across age specific groups of individuals and parallels the subsequent stages of development. Research has begun to examine and further delineate a time-related course for the development of specific executive subdomains (e.g., inhibitory control, attention, shifting, cognitive flexibility, planning, and organizational skills). (Anderson, 1998; Stuss, 1992; Romine & Reynolds, 2005).

Likewise, cognitive models also support a hierarchical view of development. Specifically, Piaget's theory of cognitive development (Piaget, 1963) is highly compatible with current understanding of cerebral development, although it fails to provide reference to relevant neural substrates (Anderson, 1998). Piaget's model consists of four sequential cognitive stages described as sensorimotor (birth- 2 years), preoperational (two to seven years), concrete operational (seven to nine years), and formal operational (adolescence). It is worthy to note the close associations of timing between transitions of proposed cognitive stages and growth spurts identified within the framework of executive function development. In particular, this research lends support to the importance of recognizing and examining executive functions within a

developmentally appropriate context allowing for assessment of specific skills in varying aged populations of children (Anderson, 1998; Weyandt, 2005).

Validity of Executive Functions in Children

Executive functions play a vital role in the development of intellectual, academic achievement, adaptive/social functioning, and communication aspects of a child's life. Therefore, given the importance of developing skills in childhood, measures that are suitable for use with children are essential (Anderson et al., 2002). As previously indicated, executive dysfunction is not represented by a homogenous pattern of behavior, but instead may be reflected in a diverse array of deficits that are associated with the severity and location of impairment as related to brain structure and functional anatomy. Typically, during formal assessment executive impairments are examined through tasks understood to elicit impulsivity, disinhibition, difficulties monitoring and regulating performance, poor planning/problem solving, perseveration, and cognitive inflexibility. Aside from cognitive deficits, specific behavioral and personality traits may also be indicative of executive dysfunction including diminished affective response, apathy, reduced social judgment, inadequate self-control, and poor interpersonal skills (Gioia & Isquith, 2004; Stuss, 1992).

Although executive functions are measurable in children, accurate identification of the cognitive aspects of executive dysfunction remains elusive. Oftentimes, researchers and clinicians depend on performance obtained on standardized neuropsychological measures, (e.g. problem solving tasks), which may lack sufficient construct validity (Anderson et al., 2002; Brocki & Bohlin, 2006). The complexity of many executive function tasks that are presented in standardized neuropsychological measures are likely

to result in measures that are indicative of pooled outcomes of several distinct underlying processes (Hughes & Graham, 2002). Moreover, traditional measures of executive functions are dependent on lower-level cognitive skills such as language and memory making it difficult to determine the influence of the targeted executive components. Given the relatively limited processing capacity of children, it is not necessary to elicit several processes simultaneously in order to tap into targeted executive functions (Hughes & Graham, 2002). As critics of neuropsychological measures of executive functions note, there has been little attempt to isolate and identify the specific impairments that researchers seek to study in clinical and normative populations (Anderson, 1998).

Construct Validity of the Assessment of Executive Functions

In addition, inconsistencies between performance on traditional executive function measures and real life behavior often surface (Anderson, 2002). Neuropsychological tests are commonly administered in well-structured, quiet, clinic settings with minimal distractions where the examiner plans and initiates the majority of the evaluation, thereby contributing to a lack of ecological validity (Anderson, 1998; Anderson et al., 2002). Performances on such tests are unlikely to be representative of behaviors exhibited in the home, classroom, or social environments. Thus, this information is likely to be limited in use when considering the development of interventions in the school and home settings.

Lastly, the vast majority of tasks have been designed and validated for use with adult populations (Anderson, 2002). Simply utilizing downward extensions of adult tasks are expected to be of little interest or relevance to children. In addition, these tasks

frequently lack sufficient normative data for use with a younger population and lack the data necessary to differentiate between normative and clinical populations within a developmental context (Anderson, 1998; Anderson et al., 2002). For example, fluent literacy emerges relatively late in development, however many adult executive function tasks depend upon routine written language and reading skills which are developmentally inappropriate for use with children (e.g., Stroop tests, Trail-making) (Hughes & Graham, 2002). Furthermore, assumptions that such tests similarly detect localized dysfunction in groups of adults and children alike remain questionable (Anderson, 1998; Meltzer, 2007).

The Need for Measures

There is clearly a need for valid, sensitive, and efficient assessment tools that evaluate specific executive function impairments that are appropriate for use with children. Frequently, clinicians rely on observation and informed judgment in collaboration with reports from family and social contexts (Anderson, 1998). In order to establish valid measures of executive function, it is essential to use measures that detect the primary skills of interest through novelty, complexity, and the need to integrate information to elicit executive skills (Anderson, 1998). An accurate understanding of normal cognitive development is critical for school and health professionals working with children and adolescents. This knowledge will enable earlier identification of developmental deviations, improve diagnostic capabilities, and emphasize use of age appropriate tools in the assessment stage (Anderson, 2002).

Presently, the Behavior Rating Inventory of Executive Function (BRIEF) is the only behavior rating scale that has been designed to explore childhood executive functions relative to the home and school settings (Mares, McLuckie, Schwartz & Saini,

2007). The BRIEF utilizes parent and teacher ratings to sample children's everyday executive skills. It has been designed for use with a broad range of childhood disorders to enhance traditional clinic-based assessments and to provide an increased level of ecological validity for clinical assessments (Mahone et al., 2002). In response to concerns regarding the sensitivity and validity of individually administered cognitive measures of executive function, this rating scale seeks to serve as an important indicator of everyday, rather than test-driven, executive function (Gioia et al., 2000). This tool is envisioned to serve as a supplement to other methods of gathering data on executive functions.

Conceptualization of Attention

At present, there is no unified operational definition of attention. Researchers however, do generally agree that attention is a multidimensional construct that requires a multi method approach to assessment at varying points of development (Manly et al., 2001). Similar to the difficulties faced with operationalizing and measuring executive functions, the fundamental problem in measuring attention is the difficulty with accurately capturing this construct while taking into consideration the developmental aspects and stages of progression (Manly et al, 2001; Palfrey et al., 1985). Manly et al. (2001) indicates that attention cannot be measured unless an individual is asked to do *something*. Subsequently, when the individual performs a task, additional perceptual, cognitive, and output systems inevitably influence performance on the task even more so than attention itself (DeGangi & Proges, 1990; Manly et al., 2001; Warner-Rogers et al., 2001).

Attention is a multi dimensional construct consisting of a number of components (Mirsky et al., 1991). Broadly, attention has been defined as a cognitive brain mechanism

that enables one to process relevant inputs, thoughts, or actions while ignoring irrelevant or distracting stimuli (Gazzaniga, Ivry & Mangun, 2002). Behaviorally, attention is studied by identifying specific, overt actions or responses and examining the variables and functional relationships that operate to control such behaviors (Warner-Rogers et al., 2001). “Attentive behavior” is typically assessed by directly observing an individual’s interaction with the environment, or indirectly assessed by asking others familiar with the individual to rate the occurrence of behaviors (Warner-Rogers et al., 2001).

On the other hand, “attention problems” are broadly used to describe a collection of behavioral difficulties that may include inattentiveness, distractibility, poor concentration, impulsivity, and hyperactivity, or a lack of appropriate response to the ongoing environment (Friedman et al., 2007; Warner-Rogers et al., 2001). Importantly, individual differences in attention problems can be perceived as a continuum where at a specific level, deficits may be considered a significant impairment, not only in clinical populations, but also in normative groups of children (Friedman et al., 2007).

Neuropsychological models of attention attempt to explain the frequency of attentional difficulties that are present in a range of acquired and developmental neurologic disorders. These models generally propose that the brain’s attentional system depends on the efficient functioning of a broad network of distinct neuronal structures rather than the control of a unitary neural system (Anderson, Fenwick, Manly & Robertson, 1998; Castellanos, 1997). Damage or dysfunction in any of the involved areas may result in deficiencies affecting attention generally, or differentially on specific aspects of attentional processing (Anderson et al., 1998). Although the nature of the neuropsychological impairment varies as a function of the specific frontal region

affected, attentional and executive functioning impairments appear to be common in most forms of frontal lobe disorders including ADHD (Barkley, 1997).

Anatomical Structures Involved in the Control of Attention

Major anatomical structures that have been implicated in the control of attention include the cortex, basal ganglia, and thalamus (Castellanos, 1997). The cortical-striatal-pallidal-thalamic-cortical circuit is a neuroanatomical loop that provides feedback to other cortical regions and serves as a pathway for many executive functions, including attention. Briefly, neuronal signals travel from the prefrontal cortex to the subsequent structures of the pathway where the final result is feedback that is sent back to the original cortical output regions and to additional cortical areas. Dysfunction within these pathways has been implicated in attentional deficits (Castellanos, 1997). Given the involvement of numerous structures, attention may be viewed as a complex system that is subserved by multiple attentional networks and manifested through different types of attention rather than a unitary construct (Wang & Fan, 2007), thus, leading into a discussion of the different subcomponents of attention.

Subcomponents of Attention

A number of contemporary theoretical models of attention have been developed, which typically divide the construct of attention into several different component processes (DeGangi & Proges, 1990; Heaton et al., 2001). Traditional neuropsychological assessment of attention, particularly in the assessment of children and ADHD has typically assessed multiple frontal lobe abilities, including response inhibition, ability to shift set (flexibility), and planning/organization. Similar tasks have been conducted with adult patients with acquired brain lesions and more recently, through functional imaging

studies (Heaton et al., 2001; Manly et al., 2001). Converging research has allowed enhanced understanding of the neural basis of attention and separations between different attentional systems (Manly et al., 2001).

In their review, Posner and Petersen (1990) argued for three characteristics of attention functions within the brain. Initially, the researchers presented the notion that specific attention systems exist. Furthermore, these attention systems were noted to be separable from more “basic” perceptual, cognitive, and output systems. Lastly, authors stated that within the attention system, specific brain regions and neural networks performed different types of operations. On the basis of their theoretical understanding, distinct systems were proposed and characterized as: (a) a capacity to move attention within space (spatial attention); (b) a capacity to enhance the processing of targets regardless of spatial location (selective attention); and (c) a capacity to maintain a particular processing set over time (sustained attention) (Manly et al., 2001). These conclusions have important clinical implications. The functional/anatomical separation of attention systems from other cognitive and basic perception indicates that whether it evolves through acquired brain damage or developmental anomaly, it is altogether possible to present with deficits that are exclusively or predominantly attentional in nature (Manly et al., 2001). In addition, the separation of attentional systems, depending on the locus of the damage, could allow individuals to present with distinct profiles of attentional deficits, each with different implications for problems in everyday life (Manly et al., 2001).

Differential Assessment of Attention

Although the interpretation of ADHD has become increasingly cognitive in its emphasis from a primarily behavioral understanding, the diagnosis continues to rest exclusively on reports of behavior and inferences about underlying processes. Although parents or teachers are often asked to indicate degree of difficulties with sustaining adequate attention, there are few reliable measures of such capacities (Manly et al., 2001). The assessment of attentional disorders and difficulties have traditionally relied on information obtained from clinical interviews and behavioral observations with supplemental data acquired from parent and teacher reports on behavior rating scales (American Academy of Pediatrics, 2000; Barkley, 1998). Although multi-informant rating scales can provide clinicians with useful information regarding children's attentional impairments in everyday settings, objective measures of attention can provide additional information from a more controlled, standardized, first-hand assessment that may be less susceptible to reporting bias (Heaton et al., 2001). Recently, there has been a call for alternative strategies in the assessment of ADHD, including an emphasis on objective laboratory and clinic-based instruments that can provide both research and clinical utility (Frick, 2000). Likewise, the National Institute of Health (NIH) has emphasized the need for studies to address the nature of cognitive processing in the diagnosis of attentional disorders by considering multidimensional aspects (NIH Consensus Development Panel, 2000).

The Test of Everyday Attention for Children (TEA-Ch; Manly, Robertson, Anderson & Nimmo-Smith, 1999) is a measure, that is gaining greater attention in the United States and has been noted to have considerable potential for use in assessing

different subcomponents of attention (sustained, selective, attentional control/switching). The TEA-Ch presents several potential advantages when compared to other existing objective measures that purport to assess attention. A distinct advantage of the TEA-Ch is its inclusion of multiple components of attention whereas the majority of other commonly used neuropsychological tests typically examine only one component (e.g., continuous performance test, Wisconsin Card Sorting Test, Trail Making Test, Stroop Color and Word Task). The TEA-Ch also utilizes various sensory modalities throughout its administration, including visual, auditory, and motor modalities (Heaton et al., 2001; Manly et al., 2001). This is important to consider since most neuropsychological tests of sustained and selective attention have focused solely on visual presentation of stimuli (Cooley & Morris, 1990). Finally, the TEA-Ch was designed for the purposes of addressing the lack of ecological validity between real world functioning and neuropsychological tests as it seeks to more closely simulate real world attentional demands (Heaton et al., 2001). The use of the BRIEF in conjunction with the TEA-Ch may provide valuable data in description of cognitive and behavioral impairments across a variety of settings (Gioia et al., 2000).

In summary, the existing research literature highlights the significant impact of executive function deficits on everyday functioning (Warner-Rogers et al., 2000). An individual's success in adapting to and navigating through daily routines and the environment is determined by their ability to utilize organizational and coordination skills. These skills include expectations for self-monitoring and self-regulatory skills of behavior and the ability to inhibit and adapt responses according to the changing conditions of the environment. Despite the wide variety of cognitive tests that are

purported to assess various aspects of executive functions, there is a paucity of research validating the use of such measures in predicting real world functioning. This is particularly true in children where characterization of executive functions has proven to be much more difficult (Manly et al., 2001).

A caveat in neuropsychological assessment is the limited ecological validity that is found with the use of many neuropsychological measures. Current research suggests that although neuropsychological tests can be helpful in identifying differences among clinical and control groups, they often lack utility in predicting behavior outside of the clinic or laboratory settings (Sbordone, 1996). Thus, more research and test development to improve the ecological validity of neuropsychological assessment measures is needed (Gioia & Isquith, 2004). In addition, although many performance-based measures and caregiver behavior checklists exist for assessing a wide range of behaviors, specific measures dedicated to examining multiple components of a single executive function construct, namely attention, warrants further research and exploration as to the utility and developmental appropriateness with child populations.

Research Questions

This research study developed specific aims. The first was to investigate the predictive validity of a specific measure of attention (i.e., TEA-Ch) and the three different subtypes of attention as proposed by Manly and colleagues (1991). This relationship was determined by relating a performance-based measure of attention and behavior rating scale, in differentiating between children presenting with varying degrees of executive function skills. The second aim was to explore the ecological validity of a performance-based measure of attention by examining the relationship with a behavior

rating scale of executive functions, and a social/adaptive measure, as reported by parents/caregivers and teachers. Lastly, gender effects were explored. The purpose of this study was to examine the relationship between attention, executive function behaviors, and social/adaptive functioning through exploratory analysis. The following research questions are addressed:

1. What is the relationship between attention and executive function behaviors as determined by the correlation between subcomponent(s) of attention (sustained, selective, shifting/attentional control) and executive function behaviors?
 - a. What is the relationship between attention and parent ratings of executive function behaviors as determined by the correlation between subcomponent(s) of attention (sustained, selective, shifting/attentional control) and executive function behaviors?
 - b. What is the relationship between attention and teacher ratings of executive function behaviors as determined by the correlation between subcomponent(s) of attention (sustained, selective, shifting/attentional control) and executive function behaviors?
2. What is the relationship between attention and social/adaptive functioning as determined by the correlation between subcomponent(s) of attention (sustained, selective, shifting/attentional control) and social/adaptive functioning?
 - a. What is the relationship between attention and social/adaptive functioning as determined by the correlation between subcomponent(s) of attention

(sustained, selective, shifting/attentional control) and social/adaptive functioning?

- b. What is the relationship between attention and teacher ratings of social/adaptive functioning as determined by the correlation between subcomponent(s) of attention (sustained, selective, shifting/attentional control) and social/adaptive functioning?
3. What is the relationship between executive function behaviors and social/adaptive functioning?
4. How does the relationship between attention, executive function behaviors, and social/adaptive functioning differ (if any) by gender?
 - a. How does the relationship between parent ratings of attention, executive function behaviors, and social/adaptive functioning differ (if any) by gender?
 - b. How does the relationship between teacher ratings of attention, executive function behaviors, and social/adaptive functioning differ (if any) by gender?

Significance of the study

Neuropsychological research on normal, age-related changes has most often focused on the two extremes of the lifespan: infancy and aging populations. Although some normative studies have provided data related to school age children, there is a relative lack of theoretical interest in developmental changes occurring during school age years (Korkman, 2001). This study examined the ecological utility of a performance-based measure of executive function, specifically in the area of attention, in a normative

sample of school age children. The use of the TEA-Ch in this study attempted to contribute to the definition and understanding of separable attention subcomponents. The TEA-Ch is a unique test instrument that offers specific evaluation of attention and its subcomponents. Although research to date supports the ability of the TEA-Ch to assess specific attentional deficits in various clinical populations, only a limited number of studies exist, and even fewer of these studies have occurred within the United States. In addition, this study examined how attention influences various aspects of a child's daily functioning. In addition, as attentional difficulties are inherent in most school age children the information derived from a normative sample in regards to common weaknesses and strengths of attention is likely to be useful in determining the level necessary to warrant clinical significance.

Lastly, information gathered from this study is likely to facilitate a common language between parents, teachers, and psychologists in utilizing neuropsychological measures to supplement current assessments of executive functions and attention in the school and home settings. Primary caregivers and educators can collaborate in developing targeted interventions to address common attentional and related behavioral difficulties by analyzing executive functions with familiar terms such as planning, organization, study skills, and self-monitoring which are understood to be relevant to education and learning. Academic and behavioral success is increasingly dependent on students' ability to plan their time, organize, and prioritize information. Weaknesses in these core executive function processes are not easily identified, and modifications are clearly needed in diagnostic and teaching methods. The overarching goal of this study is to narrow the lingering gap between research and educational practice and to improve

methods of identifying and teaching students who present with weaknesses in executive functions and, specifically attention. Thus, knowledge regarding specific subcomponents of attention will lend further support for generating relevant interventions for success in the classroom and in everyday functioning.

Chapter 2

Review of the Literature

Introduction

The developmental trajectories in children's social, emotional, and behavioral spheres are embedded in ecological models that consist of important factors at the individual, family, school, and community levels (Riggs, Blair & Greensberg, 2003). Specifically, at the individual level there has been a remarkable increase of interest in the early development of executive functions and their associations with and influences by multiple other factors (Korkman, 2001). This trend may be due to the increased understanding of impairments in executive functions that are now thought to play a central role in a variety of developmental disorders (Clark, Prior & Kinsella, 2002; Hughes & Graham, 2002). Clinical evidence provides support that individuals with damage to the prefrontal cortex and associated regions of the brain experience problems with a range of executive tasks involving planning, flexibility, organization, and working memory (Beveridge, Jarrold & Pettit, 2002; Robbins, 1996).

Several lines of evidence also provide illustration of ongoing development of executive functions throughout childhood. Physiological research describes substantial development of the central nervous system to continue through adolescence and early adulthood with anterior regions of the cerebral cortex maturing later on in life (Robbins, 1996). Neuropsychological studies have confirmed similar types of growth spurts as

evidenced by distinct improvements in performance on tests purported to measure targeted executive functions. Furthermore, converging research suggests that physiological growth spurts may coincide with transitions in cognitive development, which reflect ongoing cerebral development (Korkman, 2001). The lack of ability to plan, reason, utilize abstract and flexible thinking is likely to impinge on a child's capacity to learn and benefit from the environment and the classroom setting. During the preschool and school age years in particular, the impact of environmental stimuli and formal instruction is perhaps greater than in any other period of life (Korkman, 2001).

At present, there are few but growing numbers of valid and appropriate tests of executive functions available for childhood populations. Of those that are currently available, many were originally designed for adult populations and lack adequate child norms precluding accurate interpretation of developmentally appropriate levels of performance. In addition, many of these instruments lack standardized administration and scoring procedures (Anderson, 1998; Riggs, Blair & Greenberg, 2003). Establishing valid, reliable assessments of executive function in children is likely to provide additional insight into the pattern of development of specific executive skills present in childhood.

This literature review will examine the widespread impact of executive function with a specific emphasis on attention in school age children. Issues that will be considered include differences in profiles of executive functions as they manifest across the developmental age span as well as differences in presentation based on gender. In addition, child outcomes associated with deficits of executive functions and attention will be discussed and reviewed. Topics will cover areas examining the ecological validity of neuropsychological assessments with focus on a specific performance-based measure of

attention and the importance of obtaining ratings from teachers and parents in multi method, multi modal assessments of executive functions and attention. Limitations of the studies reviewed will be discussed in an attempt to direct future research needs.

Executive Function Deficits and Academic Outcomes

Studies of psychiatric, neurologic and other developmental disorders have repeatedly demonstrated significant impairments in functional outcomes, and thus strongly support the critical role of executive functions for complex human behavior (Biederman et al., 2004). Substantial evidence indicates that executive functions play an important role in learning during childhood (St. Clair-Thompson & Gathercole, 2006). St. Clair-Thompson and Gathercole (2006) demonstrated that the specific executive functions of shifting, updating, and inhibition were related to achievement in the areas of English, Mathematics, and Science. In addition, achievement in these academic areas was further influenced by verbal and visuo-spatial working memory tasks. Researchers imply the need for a greater understanding for the importance of structured learning activities to prevent working memory overload and reduce processing and storage requirements by providing manipulatives and external memory aids (St. Clair-Thompson & Gathercole, 2006).

Biederman and colleagues (2004) also support the association between executive function deficits, academic, and psychosocial impairments in groups of children diagnosed with ADHD. Assessments of psychosocial, cognitive, and neuropsychological functioning indicated a correlation with deficits in these areas, and an increase in the risk for grade retention, learning disabilities, and lower academic achievement. Control participants who met criteria for executive function deficits (EFD) were also diminished

in their level of academic outcomes as compared to control participants. This provides support for the importance of assessing executive functioning in normative groups as well as vulnerable groups. Additionally, the analysis of age as a modifying factor did not provide evidence that the developmental trajectories of neuropsychological functioning influenced academic or psychiatric outcomes (Biederman et al., 2004).

Furthermore, Waber, Gerber, Turcios, Wagner and Forbes (2006), demonstrated a clear and systematic relationship with behaviors indicative of executive functioning as obtained from the BRIEF and children's performance on high stakes achievement testing. Teacher reports of executive functions, as manifested by everyday behavior were highly correlated with achievement test scores. Neuropsychological measures accounted for 30-40% of the variance in test scores. However, children also performed at or above normative expectations on laboratory measures of working memory, processing speed, planning, and motor coordination. Externalizing and internalizing behavioral measures were also well within normal limits. Overall, these findings highlight the potential dissociations between traditionally administered laboratory measures from ecological measures of neuropsychological functioning. Specifically, the BRIEF appeared to be more sensitive to children's everyday classroom functioning that was particularly relevant to children's ability to obtain higher scores on a high stakes test. In sum, although the participants of this study were in no means identified as presenting with diminished psychosocial adjustment or executive functions, they appeared to experience a marked decrease in rate of performance on an achievement test despite their competence on neuropsychological measures, which are often purported to indicate risk for learning problems. These findings have potential implications for educational

approaches. Executive functions, particularly metacognitive skills, appear to be susceptible to both environmental influences and targeted interventions.

Executive Functions and Behavioral Implications

According to prominent neuropsychological theories of executive function, deficits not only interfere with social and academic functioning but are also related to the successful control of one's behavior through self-initiation, strategic planning, cognitive planning, and impulse control (Barkley, 1997; Brocki & Bohlin, 2006; Mullane & Corkum, 2007). These findings suggest that executive dysfunction and in particular, deficits with inhibition are consistent with the executive dysfunction theory of ADHD as most prominently outlined by Barkley (1997). Barkley proposes that the core deficit in ADHD is behavioral inhibition, which in turn affects the development of executive functions that are necessary for self-regulation of behavior, cognition, and emotions. This hierarchical model hypothesizes that behavioral inhibition consists of the ability to inhibit a prepotent response, to interrupt an ongoing response, and resist interference by extraneous stimuli during the intervening interval (Barkley, 1997; Brocki & Bohlin, 2006; Mullane & Corkum, 2007). According to Barkley (1997), adequate inhibitory control must initially develop and is essential for the development and function of the other identified subtypes of executive functions. Another component of Barkley's theory addresses the developmental dimension, which suggests that rudiments of inhibition are present in children as young as five years of age. Furthermore, fully matured inhibitory control has been suggested to develop between the ages of 8 and 12 years (Barkley, 1997; Brock & Bohlin, 2006; Hughes & Graham, 2002; Mullane & Corkum, 2007).

In order to further examine the impact of executive function deficits on behavioral outcomes, Brocki and Bohlin (2006) conducted a study investigating the normal developmental change in the relation between executive functions and the core behavioral symptoms most closely associated with diagnostic criteria for ADHD (hyperactivity, impulsivity, and inattention). In addition, symptoms that most often co-occur with childhood hyperactivity (externalizing and internalizing problems) were also incorporated into this study. Sample participants consisted of 92 children aged 6-13 years. Executive functions were assessed by administering various cognitive measures examining disinhibition, speed/arousal, verbal working memory, non-verbal working memory, and fluency. Results indicated that although disinhibition was positively related to hyperactivity/impulsivity and inattention mainly for the youngest age group, there were no significant age effects. However, age effects were demonstrated between speed/arousal and inattention as well as between verbal working memory/fluency and inattention. For the oldest age group poor performance on cognitive measures was associated with high ratings of inattention (Brocki & Bohlin, 2006). In summary, the results from this study highlight the importance of developmental analysis of normal change in cognitive processes and behavioral profiles in understanding the nature of childhood disorders. Although findings suggest that symptoms change with maturation in the manifestation of symptoms related to ADHD, it appears that the key to understanding this disorder as either a developmental or categorical disorder lies in comparing the development in clinical and normative samples.

With similar goals of studying executive function and behavior, Riggs, Blair, and Greenburg (2003) aimed to investigate the link between inhibitory control, sequencing

ability, and the behavioral development of early school age children. Concurrent and 2-year longitudinal relationships were examined between two aspects of executive function and both parent and teacher reports of externalizing and internalizing symptoms of behavior. Participants included 60 regular education classroom students aged 6-years 9-months to 9-years, 2-months (32 males and 28 females). Assessment measures included the Stroop test, portions of the WISC-R, Trail Making, and parent/teacher ratings on respective versions of the Child Behavior Checklist (CBCL; Achenbach, 1991). Results provided evidence that children's ability to perform on tasks of executive ability during the 1st and 2nd grade predicted change in level of behavioral problems over a 2-year period. These findings are indicative of a possible developmental lag between children's acquisition of neurocognitive capacities and the behavioral patterns associated with them. Lastly, this study indicated that when compared to children with executive function deficits at the time of initial assessment, children with proficient executive skills appeared to demonstrate fewer behavior problem symptoms over a 2- year period.

One implication of such findings is that executive function deficits place young children "at risk" for developing behavior problems later on. Therefore, it may be beneficial to intervene with early school age children who demonstrate with weaknesses in executive functioning to enhance behavioral development and prevent the potential future onset of behavioral difficulties. Lastly, researchers suggest the consideration of placing children with poor executive function skills in environments that promote the development of such skills. For example, schools may utilize small classroom environments and decrease distractions in the classroom to enhance children's ability to

focus their attention and to successfully inhibit and sequence behavior (Riggs, Blair & Greenberg, 2003).

Relationship between Executive Functions and Daily Functioning

The linkage of laboratory and clinical measures to real world functioning has been a reoccurring topic of investigation (Burgess, Alderman, Evans, Emslie & Wilson, 1998; Stavro, Ettenhover & Nigg, 2007). It has been largely assumed that individuals experiencing difficulties in everyday functioning were also likely to reflect a similar degree of difficulty to that observed in a testing situation (Burgess et al., 1998). There is now emerging evidence to suggest that executive abilities as assessed through neuropsychological testing has implications for behavior in various contexts outside of clinical settings (Stavro, Ettenhofer & Nigg, 2007). However, it is unknown as to what extent the executive function deficits detected on neuropsychological testing are related to performance in real-world activities, primarily because little is known about executive function in outside settings (Lawrence et al., 2004). Since current understanding of executive function deficits are typically derived from neuropsychological testing conducted in clinical settings researchers support further examination of the generalizability of current neuropsychological theories of childhood disorders to performance on tasks in outside environments (Lawrence et al., 2004).

Lawrence et al. (2004) set out to determine whether children diagnosed with ADHD exhibited cognitive deficits as evidenced by difficulties with tasks of executive functions and processing speed as measured by neuropsychological tests and real world activities. Overall aims were to examine the relationship between cognitive deficits observed during neuropsychological testing and real-world activities. Assessment

measures included the completion of two neuropsychological and two real life tasks: the Stroop test, WCST, videogames, tasks at the zoo, and four subtests administered from the WISC-III. Consistent with stated hypotheses, the clinical group exhibited executive function deficits on both neuropsychological tasks and real world activities. Children diagnosed with ADHD exhibited similar problems while playing a highly motivating adventure videogame, visiting the zoo, and during the administration of a standard neuropsychological test. This finding mitigates the argument for the lack of motivation leading to deflated performance rather than executive function deficits. Furthermore, results of this study support the hypotheses that executive functions and speed of processing are impaired in ADHD and evidenced across a wide variety of activities and contexts in addition to testing situations.

Clark, Prior, and Kinsella (2002) also investigated the extent to which executive function capacities were linked to everyday adaptive outcomes. Significant relationships were found between all test performances on executive measures, adaptive behavior, and reading ability in adolescents. Multiple regression analyses indicated that verbal ability predicted communication and reading scores while executive function abilities contributed significant variance to the prediction in the adaptive behavior, communication, and socialization domains. Researchers propose that the associations demonstrated between adaptive and neurocognitive impairments add to the insights necessary to understand the bases of various disorders. Future studies are needed to study the generalizability of these results with other samples including community and clinical groups as well as female participants, for addressing potential gender differences. In

addition, studies with younger population are necessary in order to determine the onset of relationships between executive measures and social/adaptive behavior.

Models of Attention

One of the most pervasive yet obscure behavioral deficits encountered in educational and clinical settings is the symptom of impaired attention (Mirsky, 1991; Posner & Peterson, 1990). Thus far, the construct of attention has received much less behavioral, theoretical, and statistical attention than that of research examining other neuropsychological constructs such as memory, learning, and language, for example. However, it has been estimated that approximately 5-20% of children suffer from some form of impairment in attention (Mirsky, 1991). Other estimates report figures reaching as high as 30% of all school age children. In addition, impairment of attention is commonly characteristic of many psychiatric as well as neurologic and metabolic disorders. Thus, it is then plausible that clinical populations in conjunction with classroom identified problems with concentration and learning may indeed contribute to a notable population of children suffering from impaired attention at one time or another (Mirsky, 1991; Posner & Peterson, 1990).

Although varying models of attention exist according to interpretation and differing emphasis on various components of the multidimensional construct, attention is oftentimes conceptualized using a 4-factor model. Mirsky and colleagues (1991) developed this neuropsychological model of attention to consist of separate elements of attention including selective or focused attention, attentional shift, sustained attention, and divided attention (Heaton et al., 2001; Mirsky et al., 1991; Wu, Anderson & Castiello, 2002). These factors are assumed to exist as separable factors that can be

measured individually but operate cohesively within the attentional system (Posner & Peterson, 1990). Sustained attention involves maintaining attention over extended periods of time. Selective or focused attention refers to an individual's ability to select target information and attend to one relevant component while ignoring other distracters. Attentional shift is described as the ability to change attentional focus flexibly and adaptively. Lastly, divided attention refers to an individual's ability to focus on all simultaneously occurring stimuli (Heaton et al., 2001; Mirsky et al., 1991). In sum, this model of attention attempts to organize a rather diffuse and global concept as a more manageable group of processes or elements. Extended research elsewhere has attempted to link these elements to organization of cerebral structures and systems (Mirsky et al., 1991; Wilding, 2005).

The statistical development of Mirsky's model of attention consisted of obtaining neuropsychological test scores from adult and child sample populations. The initial effort of the researchers in deriving their assessment battery of attention was designed from collaborating targeted neuropsychological tests used routinely in clinical settings. The results of the data analyses yielded four factors that identified distinct components of attention ultimately conforming to the multi-element model. Results of the principal component analysis revealed similar patterns of component skills identified in both the adult and child samples to support the elements of focus-execute, sustain, encode, and shift to reflect pertinent and distinct components of attention (Mirsky et al., 1991).

In conclusion, and in regards to the findings of this study, researchers assert that attention can be viewed as a process involving the four above mentioned independent elements and serve the purpose for testing neuropsychological hypotheses related to

disorders of attention. Future research is encouraged to compare this model of attention with other existing models to confirm the proposed elements of this model and/or to revise current definitions of attention. Particularly, for childhood populations the goal of developing a model for conceptualizing the components or elements of attention are in understanding the relation of attention to aspects of academic performance and behavior difficulties. These concepts will be further discussed throughout this review.

Relationship of Attentional Deficits to Future Outcomes

Attentional capacity is a critical dimension of many psychological, social, and cognitive problems. Individual differences in childhood and adolescent attention problems vary along a continuum. Attention problems are oftentimes associated with learning disabilities, psychosocial outcomes such as deficits with social skills, academic and occupational performance, and decreased global adaptive functioning (Friedman et al., 2007; Palfrey, Levine, Walker & Sullivan, 1985). Anderson, Jacobs and Harvey (2000) investigated the effects of prefrontal lesions with respect to attentional abilities. Selective subtests were administered from the Test of Everyday Attention for Children (TEA-Ch) as well as parent ratings from the Behavioral Rating Inventory of Executive Function (BRIEF) to assess everyday executive and attentional function. Overall, results indicated lower performance across all of the components of cognitive and behavioral measures of attention that were investigated. These results are consistent with expectations from adult based studies, which suggest that the anterior regions of the brain are responsible for shifting and divided attention. Aspects of processing speed reflect higher levels of attentional resources, which are required to perform effectively on such tasks.

The implications of these deficits for both cognitive and everyday functioning are vast as they suggest that children with frontal lobe pathology are likely to have difficulties coping with a range of everyday activities, and more so with those requiring greater cognitive resources such as self-monitoring and cognitive flexibility. The early onset of prefrontal dysfunction as evidenced by deficits in performance on attentional tasks may underlie at least some cases of psychopathology for both clinical and normative groups (Anderson et al., 2000). If specific deficits are identified early on, there is a greater chance that further decline and significant impact on various other areas of functioning may be avoided or mitigated through targeted strategies and interventions.

In order to study the emergence of attention deficits in early childhood, Palfrey and colleagues (1985) documented the occurrence of poor concentration, distractibility, behavioral disorganization, self-monitoring, and overactivity in a sample population consisting of 174 children enrolled in an early education program. The children were followed prospectively from birth to school entry. Children who presented with early onset and persistence of attention problems were reported to have consumed the greatest amount of special education services in school including various therapies, and resource programs. This study indicates that in a large number of children, precursors of attention problems are present and identifiable during early childhood years and as a result, vigilance for early signs of attention deficits may be justified as a component of preventive pediatric care.

Much of the evidence for a link between everyday attention problems and executive function comes from clinical studies of individuals diagnosed with ADHD. This population may be considered an extreme on the continuum of individual

differences in attentional control and behavioral self-regulation (Friedman et al., 2007). The few studies that have explored the impact of attentional deficits in normative samples have found similar impairments on tasks of executive functions. Studies thus far have failed to address how developmental stability and change in attention problems over time relate to later levels of executive functions and attention (Warner-Rogers et al., 2000). Inattentive behavior is a predominant feature of many psychiatric disorders, however, little is known about the relative developmental risk associated with attentional deficits and if and when it occurs in isolation from other maladaptive patterns of behavior. In some respects, this lack of understanding and research may be linked to the difficulties in conceptualizing and accurately measuring attention (Warner-Rogers et al., 2000).

In order to address some of the gaps related to the consequences of attentional deficits in normative populations, Friedman et al. (2007) investigated the impact of attentional difficulties in relation to three separable executive functions (inhibiting, updating, shifting) across an eight year time span. Researchers also examined the predictability of later impairment in overall functioning as influenced by developmental stability and change in attention problems. Participants were 866 individual twins (422 male, 444 female) recruited from the Colorado Longitudinal Twin Study at the Institute for Behavioral Genetics. Attention problem ratings were obtained from the 20-item Attention Problems scale included on the Teacher Report Form (Achenbach, 1991). In addition, subjects were administered the Wechsler Adult Intelligence Scale (WAIS-III; Wechsler, 1997), and tasks of executive functions at the ages of 16 and 17 years.

Overall, results indicated average attention problems scores to be low as were expected given the unselected sample of participants. However, correlations among

attention problem scores at different ages were moderate to high despite different teachers rating each individual across the 8-year time span. These data suggest that attention problems exhibited during school age years are quite stable. In addition, correlations computed between attention problems at age seven years with later executive functioning, IQ, and the consistency of the correlations between these factors across the years were low to moderate. Researchers raise the possibility that it may be one's initial level of attention problem rather than the change across time that is related to future executive function skills and IQ. Furthermore, results indicate that individual differences in executive function abilities are important in understanding normal variations in attention. Lastly, these findings illustrate the external validity of current cognitive models of executive control and attention that although are developed through laboratory based research are applicable towards understanding everyday problems.

Relationship of Attention to Behavior and Academic Achievement

Although performance on tasks designed to measure various attentional components are frequently compared to ratings of ADHD it is less frequently compared to global measures of maladjustment despite its relationship to attention difficulties. The presence of deficits in attention and executive functions in the development of psychopathology and overall impact on future outcome has been well-documented (Pennington & Ozonoff, 1996). For young children, attention deficits have frequently been investigated by evaluating the role of early hyperactive and inattentive behaviors with difficulties related to behavior and academic performance (Barkley, 1997). In a longitudinal study conducted by Palfrey et al. (1985) researchers examined the occurrence of concentration, distractibility, behavioral disorganization, self-monitoring,

and hyperactivity in a sample of 174 children followed from birth to the time of school entry. Participants were assessed by multiple behavior ratings and observations. Overall, findings indicated a greater presence of socio-emotional difficulties, lower academic achievement, and greater need for special education services for children who were rated with greater attentional difficulties as compared to children who presented with less persistent or normal capacities of attention. Significant levels of attention problems were identified in 5% of all children assessed. Over the period from birth to kindergarten, 40% of the preschool children were rated to display some difficulties with attention, however, the majority of children were not rated to reach levels that would warrant further concern. The findings of this study highlight the importance of the association of persistent attentional concerns and the potential long-term consequences of early-detected attention problems.

With similar aims, Warner-Rogers and colleagues (2000) elicited a large community-based sample to compare the developmental functioning, social, and environmental backgrounds of children presenting with purely inattentive behaviors as compared to children presenting with overactive behaviors and combined problems of inattention and hyperactivity. Parents and teachers were interviewed in order to obtain information in the areas of learning, behavior, self-esteem, following directions, and teacher/peer relations relevant to the home and school settings. General psychometric measures and measures of cognitive functioning were administered including the WISC-R, CPT, a central-incident learning task (CIL), paired associates learning task (PAL), and the 20-item Matching Familiar Figures Task (MFFT; Cairns & Cammock, 1978). Results indicated that elevated rates of inattentive behaviors as reported by teachers and

parents had unique implications for behavior and academic functioning. In brief, inattentive behaviors were closely associated with adjustment problems in the classroom, specifically lowered self-esteem and the need for repeated instructions. Intellectual functioning overall, particularly in the area of reading was evidenced by lower performance as compared to other sample groups. In addition, children who exhibited greater problems with attention were more likely to have received speech therapy and have had language delays in their early developmental histories. In regards to behavioral differences, inattention was more closely linked to problems with social interaction whereas hyperactive groups were more likely to have had problems with conduct.

This study has important clinical and research implications. Although children with attentional deficits were noted to exhibit general cognitive impairments, reading problems and poor adjustment in the classroom, it is hypothesized that these children will be less likely to receive support through appropriate interventions in the classroom since they do not typically exhibit externalizing problems. Thus, authors report the need for formal evaluations of cognitive, academic, and parent/teacher reports in addressing the needs for children who display predominantly inattentive behaviors so that the neglect of children who exhibit attentional deficits may be prevented. A discussion of the limitations of this study is warranted as the generalizability of the findings is not likely. The inclusion of other age ranges as well as enrolling female participants is necessary in the study of attentional deficits. Overall, the presence of deficits with attention in early childhood may be viewed as a developmental risk factor considering the potential impact on later academic functioning and behavior. More research is needed to identify what, if any are the long-term implications of inattentive behavior. Lastly, the previous studies,

which have examined the effects of attentional deficits on academic achievement and behavior, have consisted mainly of observations, interviews, rating scales, and standardized measures of cognitive functioning. Although problems with attention appear to impact functioning in these specific areas it is also important to determine the effect on a child's everyday functioning outside of the clinical setting.

Executive Function in Attention-Impaired Groups

The shift in the emphasis on the frontal lobe dysfunction theory in relation to attention difficulties has resulted in the use of various neuropsychological tests to evaluate for specific deficits in children diagnosed with ADHD (Barkley, 1997, Heaton et al., 2001). Neuropsychological testing of children diagnosed with ADHD seeks to assess multiple frontal lobe abilities including response inhibition, ability to set shift (cognitive flexibility), and planning/organization (Heaton et al., 2001). Specifically, ADHD has been associated with executive functioning and specific deficits with sustained and divided attention. Although the reliance on executive functions in a theory of ADHD assists in unifying attentional and inhibitory deficits that are commonly highlighted in the diagnosis of ADHD, there is also growing dissatisfaction with the all-encompassing characteristics of this concept (Wu, Anderson & Castiello, 2007). Thus, it is necessary to establish conceptual and theoretical clarity in the study of executive functions and to develop measures that are sensitive and specific for measuring them. Existing studies assessing executive functions and attention in ADHD vary widely as a result of many variables including sample size, age, comorbidity, gender, IQ, and selection criteria (Wu, Anderson & Castiello, 2002; Pasini et al., 2007). In many cases, these additional factors fail to be addressed appropriately. Furthermore, previous studies of attention and

executive functions have yet to study various domains of executive function and attention in the same sample population. Therefore, up to this point it has been difficult to generate conclusions about the executive function and attention profile in ADHD based on the current literature (Pasini et al., 2007).

In an attempt to address the above-mentioned challenges and methodological difficulties, Pasini et al. (2007) conducted a study to assess executive functions in relation to control variables such as IQ and basic neuropsychological performance. Overall, results comparing clinical and normative samples did not generate differences on tasks for age. However, clinical and normative groups performed with significant differences in the areas of divided attention, inhibition of response, variability of reaction times, phonological, and visual working memory. With similar goals, Wu, Anderson and Castiello (2002) also conducted a study investigating multiple aspects of executive functioning in children diagnosed with ADHD. A battery of neuropsychological tests that allowed analysis of specific cognitive processing mechanisms including attentional components, impulsivity, planning, and problem solving were administered. Overall, findings indicated that children diagnosed with ADHD had slower verbal responses and deficits in sustained attention. These results indicate that the various measures used were successful in measuring different but related variables and are consistent with the notion of the multifaceted construct of executive functions.

Guidelines for the Assessment of Attention and Executive Functions

Although historically ADHD has been categorized as a psychiatric disorder, educational systems are being required to become more cognizant of its impact on school functioning and the challenges with identifying and providing accommodations for

children diagnosed with disorders of attention (Angello et al., 2003; Koonce, 2007). However, the assessment, diagnosis, and treatment of children diagnosed with ADHD continues to be perceived as a complex task due to issues of comorbidity, developmental changes, gender sensitivity, and the multidimensional nature of attention (Koonce, 2007). Thus, the multi faceted nature of ADHD has served as a catalyst for generating a wealth of curiosity and research towards increasing understanding of this disorder. Various methods of assessment include the use of clinical interviews, behavior rating scales, and psychological tests (Mandal et al., 1999; Simonsen & Bullis, 2007). Many endorse the use of a multi-method assessment protocol involving a clinical interview with caregivers, behavioral observation of the child, behavior rating scales to be completed by multiple informants, and administration of clinic-based measures (Barkley, 1997; Frazier, 2004; Koonce, 2007; Mandal et al., 1999; Simonson & Bullis, 2007). In summary, there is currently not an endorsed gold standard battery of approved instruments for assessing attention disorders. Consequently, there remains great uncertainty and a number of questions regarding the instruments that provide the best utility and performance for assisting in the identification of children with significant deficits in attention (Frazier et al., 2004).

Angello and colleagues (2003) recommend the use of a multi-method assessment approach in capturing a child's behavior and pervasiveness of impairment across settings. Instruments and strategies that have commonly been employed throughout this assessment include behavior ratings, direct observations, review of school records, and assessment of academic skills (DuPaul & Stoner, 1994; Mandal et al., 1999). Combining various assessment strategies assist in minimizing the limitations that are associated with

the use of any one method or instrument. Researchers caution that rating scales do not provide exhaustive information about the child, environmental variables, or information relevant to response function. Thus, behavior rating scales have limited utility in rendering a formal diagnosis and are inappropriate for use in conducting functional behavioral assessments specifically related to hypothesis testing. Lastly, clinicians are cautioned from relying on personal preference for a particular scale in determining its selection for assessment. Further research is warranted to link assessment information to specific intervention strategies as well as determining guidelines for appropriateness and effectiveness of various rating scales in treatment monitoring activities. Finally, authors suggest that research is necessary in identifying the best method for aggregating data from multiple informants and multiple sources in making diagnostic decisions (Angello et al., 2003; Frazier et al., 2004).

With respect to efficiency among all of the different assessment tools available there is great variability in regards to the format, amount of information collected, time required for administration, and degree to which they are practical and efficient in a school setting (Frazier et al., 2004; Simonsen & Bullis, 2007). According to past studies, only behavioral rating scales were considered to be highly useful and efficient tools in the assessment of attention deficits in the school setting (Simonsen & Bullis, 2007). Although relevant within a comprehensive assessment in conjunction with interviews, observations, etc., behavior rating scales alone are insufficient for making an informed decision about diagnosis. Due to the large and increasing numbers of referrals for attention problems, it is necessary to develop and evaluate a system of assessment that balances effectiveness and efficiency (Simonsen & Bullis, 2007).

Simonsen and Bullis (2007) advocate for the use of a multiple gating system as an ideal solution for addressing this need. Multiple gating is defined as a way to identify a set of screening measures with established predictive validity with each measure adding uniquely to identify children with specific disorders and diagnoses. The measures are administered sequentially so that the least intensive measures are given first (e.g., checklists), and more intensive measures are administered later (e.g., interviews, observations). This approach is proposed to balance the costs and benefit of an in depth assessment by reserving the most comprehensive assessment for children who are most likely to be identified with ADHD or other disorders of attention. Preliminary results from this study indicated that children with ADHD could be classified with the appropriate subtype on the basis of parent/observer ratings of student behavior with 88% accuracy. Future studies are needed to validate this system with a larger sample size and to establish cut scores indicating the need to progress to the next gate of assessment and when further assessment is unnecessary. Despite limitations, this study proposes to take an initial step in addressing the need for a standard assessment protocol in the assessment and intervention of attention and ADHD.

Similarly lacking in research is the recommended use of specific assessment tools and measures within an assessment protocol in examining attention. Given the wide variability in preference with respect to adherence and application of diagnostic methods Koonce (2007) incorporated a case scenario that specified the age range and gender of a fictitious child and attempted to identify school psychologists' assessment practices with children presenting with attention symptoms. Variables such as time spent on performing specific activities, frequency of test use, percentage of attention referrals, and types of

test batteries were among factors explored. School psychologists selected several systems of direct behavior observations thus reflecting the importance of gathering information across multiple settings to provide a better understanding of the child's behavioral strengths and areas of concerns. The majority of respondents (92%) noted that traditional psychological assessments were an important part of the assessment battery; however, there is limited evidence supporting their usefulness in diagnosing attention disorders. It is hypothesized that since there is a relatively high incidence of learning problems among children with deficits in attention the consideration of intelligence and academic achievement testing may be warranted. Finally, respondents did not rate the endorsement of neuropsychological tests and use of CPTs with high frequency. However, it appears that school psychologists are becoming more sensitive to the emerging literature regarding the importance of neuropsychological testing in the evaluation of attention and executive functions.

Certainly, current research highlights the relevant role of cognitive deficits and particularly impairments in attention and executive functions to be considered a core part of ADHD (Barkley, 1997; Koonce, 2007). The results of this investigation emphasize the importance of identifying the current assessment and decision-making methods that school psychologists are employing in their practice. In addition, it may also be useful for researchers to develop strategies to introduce neuropsychological tests in a way that would be conducive for use in school settings, which are typically the primary work settings of school psychologists. The inclusion of such assessment tools will enable school psychologists to utilize current research findings in the assessment of attention and

executive functions for which the literature has continued to highlight as a central role in ADHD and disorders of attention (Barkley, 1997; Koonce, 2007; Angello et al., 2003).

Developmental Changes in the Assessment of Executive Functions and Attention

As previously mentioned prevalence figures of individuals exhibiting general “attentional difficulties,” are substantial. In a study conducted by Kellam et al. (1975) between 15% and 25% of an epidemiological sample of low socioeconomic status (SES), urban African American 1st grade children were reported to exhibit moderate to severe attentional problems as indicated by teacher reports. Furthermore, Rutter, Tizard and Whitmore (1970) report approximately 30% of an epidemiological population of school age children as presenting with attentional difficulties (Rebok et al., 1997). The limited data in regards to the developmental changes in attention of normative samples indicate that the ability to sustain attention and inhibit extraneous distractions appear to increase with age particularly between the ages of eight and 10 years, with skills reaching adult levels by adolescence. Additional research supports that sustained attention reaches rates of stabilization between the ages of eight and 10 years but increases significantly between the ages of 11 years through adulthood (Rebok et al., 1997). Given such variability in results, it is important to demonstrate the extent of normal change and continuity of various subtypes of attention over time.

In an attempt to examine the developmental trajectory of attentional performance by subtype and the possible influence of gender on the development of attention, Rebok and colleagues (1997) followed a cohort of 435 urban children, who had previously participated in an epidemiological study of attention, into early adolescence. Assessment measures that were utilized include the NIMH Laboratory of Psychology and

Psychopathology (LPP) battery which consisted of 12 standard tests that were designed to measure four different aspects of attention (focus, execute, shift, encoding) according to the Mirsky model of attention (1991). Correlation analyses were conducted to assess the degree of stability of attentional performance across time. Results indicated significant reductions in omissions errors and improvement in reaction times from ages 8-13 years on different administrations of the Continuous Performance Task (CPT), a measure of sustained attention, with effects varying by task difficulty level and gender. In addition, there were significant improvements across age on measures of attentional focus and response execution. Overall, the most rapid changes in attention occurred between the ages of eight and 10 years with more subtle changes occurring between the ages of 10 and 13 years. In examination of the effects of task, gender, and interaction across age groups, gender was purported to make a significant contribution to change in reaction time from age 10-13 years with females outperforming males. Researchers indicate that results highlight the importance of developmental epidemiological approaches for assessing and predicting the normal development of attentional function in school age children (Rebok et al., 1997).

Similarly, Klenberg, Korkman, Lahti-Nuutila (2001) conducted a study in an attempt to provide more insight into the developmental progression of attention and executive functions in preschool and school age children. Researchers sought to replicate the results of previous developmental studies by using a new set of neuropsychological measures proposed to tap into the functions of both attention and executive functions. The participants consisted of 400 Finnish children, aged 3-12 years who had previously participated in the standardization of the Finnish version of the NEPSY (Korkman et al.,

1997, 1998). Each age group consisted of 38 to 41 children and was composed of approximately 50% boys and 50% girls. Relative maturity was noted by leveling off in performance across the age groups which first occurred at the age of six years on the Statute subtest, which is a subtest assessing the inhibition of movements or vocalizations. Additionally, relative maturity was observed at the age of seven years on tasks of shifting attention, and at the age of eight years on the Tower subtest. Lastly, at the age of 10 years researchers indicated that relative maturity was achieved in the subtests of focused attention as well as visual and auditory attention tasks. These results are in accordance with Rebok et al. (1997) who also found rapid changes in several components of attention to occur between ages eight and 10 years of age and only gradual changes to occur beyond this age.

Overall, the present results parallel beliefs proposed by Barkley's (1997) model of inhibition, sustained attention, and executive functions. According to this theory, inhibitory functions are thought to serve as basic functions for more complex executive functions. The observed developmental stages provide further support for the multidimensional nature of attention and executive functions. In collaboration with previously presented literature and as an overall review of the executive function and attention literature, there is general implication that attention is an evolving cognitive process (Cooley & Morris, 1990). A critical trend in the early development of attention is a shift from external to voluntary control. There is considerable evidence to indicate that age influences executive functions and specifically attentional performance. For example, the capacity to sustain attention for longer durations of time, inhibit inappropriate responses, and shift attention are skills that have been shown to become more efficient

throughout childhood and adolescence (Pascualvaca et al., 1997). Furthermore, as children mature they increase in their ability to maintain their responsiveness longer, and are more flexible and discriminating in their processing of information towards more systematic and logical methods of exploration (Warner-Rogers et al., 2001). Many studies examine children from a wide age range and thus inconsistencies in the literature are hypothesized to be heavily influenced by age-related variables (Warner-Rogers et al., 2001).

Anderson and colleagues (2001) plotted the development of executive skills through late childhood and early adolescence to address gaps in the literature. Participants were divided into six groups based on age (11-11.11 years, 12-12.11 years, 13-13.11 years, 14-14.11 years, 15-15.11 years, 16-17.11 years). Utilized measures included tests of intellectual ability, and measures designed to assess executive function skills in the areas of attentional control, attentional shifting, memory, and goal setting. Overall, results indicated a relatively flat developmental trajectory for executive functions during late childhood and early adolescence, in comparison to the rapid maturation that has been documented in early and middle childhood. Gender differences offered some suggestions for a crossover effect occurring around ages 12 and 13 years when females appeared to become more efficient than males on a range of tasks. The results of this study support the multidimensional nature of executive functions and the importance of assessing the range of skills across the developmental time span with sensitivity to differences across age ranges. Despite the difficulties with operationalizing the measures used to study different components of attention, the review of these studies provide information concerning the developmental progression of attention and executive

functions. Comprehension of the progression of development allows researchers to appropriately assess specific attention and executive functioning abilities with relevant age groups.

In attempting to target developmental changes occurring within a subcomponent of attention, Betts, McCay, Maruff and Anderson (2006) focused on the development of sustained attention in children. The capacity to sustain attention plays a key role in children's school performance, influencing the child's ability to maintain concentration over long periods of time in order to integrate large amounts of information. Therefore, impairments in sustained attention are likely to influence the child's capability to acquire and integrate new skills and knowledge (Betts et al., 2006). Participants were divided into three age groups: 5-6 years, 8-9 years, and 11-12 years. All participants completed a computer-administered battery of nine neuropsychological subtests that were designed to tap into aspects of attention and information processing reported to be sensitive to the subtle changes in performance. Rapid growth was observed to occur from five to six years and eight to nine years of age. A developmental plateau was evident from eight to nine and 11-12 years with only minor improvements occurring during the latter school age years. Overall, increasing age was associated with improved performance with five to six year old children presenting with the greatest degree of variability in performance.

These differential findings were interpreted to suggest that the skills underpinning performance on measures of sustained attention display varying developmental trajectories. Performance decreased on the higher loaded tasks regardless of age. These findings are consistent with the adult literature, which has established a trend featuring a decrease in correct responses and an increase in reaction time as task load increases.

These data demonstrate that when task demands become too great, participants are unable to cope thus leading to deterioration in performance. The current research has applications in educational settings where this knowledge can be employed to design schedules that most effectively use the limited hours in a school day. It is suggested that children best attend when small amounts of information are presented through effective presentation, such as computers and classroom games (Betts et al., 2006).

Gender Considerations in the Assessment of Attention and Executive Functions

Despite the pervasiveness of attention deficits and their detrimental effects on child functioning, little is known about the factors that influence attentional performance in typically developing children (Pascualvaca et al., 1997). There have been few studies addressing the impact of certain characteristics such as age, gender, and environmental factors including socioeconomic status, and family background on attentional performance. The majority of the studies on attentional performance in children have failed to adequately address gender and the few available studies have utilized single measures. Since these tests measure specific components of attention, results cannot be generalized to other attention processes. Furthermore, evidence from various lines of research suggest that boys and girls may present with differing attentional profiles and in disorders that are characterized by attention problems. ADHD is not only more commonly diagnosed in boys but the disorder is now implied to be expressed differently between genders (Pascualvaca et al., 1997). Understanding the role of gender on attentional performance may help researchers in differentiating normal gender differences from variations in the manifestation of disorders characterized by impaired attention.

Pascualvaca et al. (1997) conducted a study with 435 first and second-grade participants (214 boys, 221 girls) between the ages of seven and eight years selected from a larger sample who had participated in a collaborative study by the Prevention Research Center of the Johns Hopkins University and Baltimore City Public Schools. The objectives of the study focused on assessing the differences in attentional capacities in boys and girls in a nonclinical, unselected sample. Measures that were selected for use in this study were based on the theoretical model proposed by Mirsky and colleagues (1991) suggesting that four separate processes or elements of attention include the ability to *focus*, maintain or *sustain* focus over time, change or *shift* attention, and *encode* information. Specifically, measures that were administered include selected subtests on the WISC-R (Digit Cancellation, Coding, Arithmetic, Digit Span), the Continuous Performance Test (CPT), WCST, and the Peabody Picture Vocabulary Test-Revised as an estimate of verbal intelligence. A series of ANCOVAs controlling for age were computed to compare boys and girls on the various attention measures.

Overall results indicated that gender did indeed have an impact on attentional performance. Findings suggested that girls were more skillful at focusing their attention on a particular target, ignoring distractions, and executing a rapid response. Authors purport that some of the gender differences, particularly characteristics reflecting impulsivity or disinhibition may reflect differences in maturation rate. Other gender differences in attentional performance were alleged to reflect differences in brain organization since some of the brain regions involved in the support of attentional functions are not fully myelinated until adolescence (Robbins, 1996). Authors offer the argument that since girls appear to perform better on tasks designed to assess attentional

performance, only girls who present with the most severe degree of difficulty may be identified or diagnosed with attentional disorders and thus, more girls may benefit from treatment than simply those who are identified as reaching clinical levels. Future studies exploring differential norms for boys and girls presenting with attentional problems are encouraged since according to the findings of this study girls may not be identified as often as boys since they tend to perform better on measures of attention.

Ecological Validity of Performance-based Tests

The evaluation of an individual's ability to function adaptively in the real world is reported to be directly assessed by less than half of clinicians who conduct comprehensive neuropsychological assessments (Price, Joschko & Kerns, 2003). Rather, tests of various cognitive domains are used in an attempt to acquire insight about daily functioning abilities. "Ecological validity" is defined as the predictive and functional relationship between an individual's performance on a set of neuropsychological measures with the individual's behavior across common settings including home, work, school, and community (Price, Joschko & Kerns, 2003). In addition, the term "veridicality" refers to the extent to which tests can predict functioning in real world settings. According to researchers, in order to establish such ecological validity various relationships should be established including: (1) the relationship between individual cognitive functions and the specific targeted behaviors to be predicted, (2) the relationship between cognitive functions and psychological test scores, and lastly (3) the relationship between test scores and the specific targeted behaviors (Price, Joschko & Kerns, 2003). In an attempt to improve the ability to assess and capture an individual's functional abilities beyond that accounted for by scores on tests of intelligence, adaptive

behavior measures have been formulated to provide objective assessments of everyday functioning. Adaptive functioning refers to the daily activities that are required for personal and social self-sufficiency and is typically measured through checklists or interview format (Price, Joschko & Kerns, 2003). Overall, although a number of studies have attempted to determine the ability of neuropsychological tests to predict functioning in real world settings they have primarily been conducted with adult populations.

In order to assess the ecological validity of tests of executive functions, Burgess et al. (1998) conducted a study that aimed to compare the ecological validity of 11 measures of executive function taken from six different tests, and relate findings to a set of behavioral characteristics indicative of daily functioning. Research participants consisted of adult patients with varying neurological disorders (e.g., head injuries, dementia, cerebrovascular accidents, etc.). Overall findings indicated lower performance by patients across all measures of executive function as compared to the control group. In addition, performance on neuropsychological executive function test measures reflected impairments in everyday life as evidenced by significant correlations with observers' ratings of patient problems in daily living. Furthermore, such correlations were higher as compared to values obtained between tests of memory, reading, and naming. As per findings, authors suggest utilizing clinical interviews, questionnaires, ratings scales, or other measures of behavior change to describe daily functioning not readily measurable by commonly used neurological tests of executive functions. Although adult studies are important in providing guidance and informing child studies, ecological validity of neuropsychological tests must also extend to younger populations.

Neuropsychological assessments are frequently used by clinicians and assumed to relate to real world or adaptive functioning, however, there is limited data to support such predictions, particularly with child populations. It is also notable that among this existing database, the literature examining the relationship between adaptive functioning and attention tests are far scarcer. For this purpose, Price, Joschko and Kerns (2003) sought to determine the association between several types of attention and adaptive functioning in a heterogeneous clinical sample. Four components of attention, namely focused attention, sustained attention, verbal span, and complex working memory were assessed as separate components. Measures of attention were selected based on commonly administered tests purported to measure each of the four proposed subcomponents of attention. The Scales of Independent Behavior- Revised (SIB-R; Bruininks, Woodcock, Weatherman & Hill, 1996) was used to collect data related to adaptive functioning. The overall results of this study provide evidence suggesting that correlations between measures of attention and adaptive functioning are beyond the relationship between attention and intelligence, and between intelligence and adaptive functioning. Authors indicate the important implications of findings for neuropsychologists since conclusions and recommendations depend heavily on ecological validity of tests used. Future studies are called upon to provide further information on the meaning of commonly used neuropsychological tests as well as to consider the developmental differences in the assessment of various components of attention.

Performance Measures and Rating Scales

Thus far, the discussions of assessing attention and executive functions have focused solely on the administration of performance tasks. As such, they are brief

samplings of abilities designed to assess attentional capacities and are typically administered in laboratory settings utilizing manipulatives, paper and pencil, visual presentation via computer, or audiotape. Rating scales on the other hand, are used to record behaviors that reflect deficits in naturalistic settings (e.g., home, school, community) across a specified period of time (e.g., months, years). Behavior ratings of attention are pervasive in the child clinical literature and are frequently used in accordance with measures of attentional performance (Mandal et al., 1999). However, past studies examining attention and executive functions have oftentimes failed to use performance measures and rating scales collaboratively, presumably because they reflect different theoretical backgrounds and analyses (i.e., cognitive and behavioral) (Cooley & Morris, 1990). Despite their utility in assessing the development of attentional performance, there are limitations associated with performance measures. Specifically, there are concerns in regards to confounding processes and task impurity since attention can only be measured relative to another activity, derived or observed. Many of the available performance tasks involve other perceptual (verbal, spatial), cognitive (memory, semantic concept formation), and output systems (motor) (Cooley & Morris, 1990; Manly et al., 2001). Furthermore, the potential for confound is more relevant when assessing children who typically show a greater variability than adults along these overlapping dimensions. Thus, it is challenging to discriminate changes in attention from other general maturational processes or to determine normative progression through reliance on results obtained solely from performance measures (Manly et al., 2001).

Parent and teacher rating scales are most commonly used in the evaluation of attentional deficits. Some measures are designed specifically for the measure of behaviors

reflecting attention whereas others combine multiple dimensions of child psychopathology. Current research emphasizes the importance of including multi-informant, multimodal assessments and collaboration of data in describing a child's school, home, and community functioning particularly in the assessment of ADHD and impairments of executive functions (Mandal et al., 1999; Mares et al., 2007). However, it is cautioned that "more" does not necessarily equate with "better" assessments as multiple informants do not always result in adequate interrater reliabilities and are oftentimes subject to bias (Tripp, Schaughency & Clarke, 2006). Agreement between parents and teachers are typically modest at best when assessing symptomatology and oftentimes depend on the scales that are used (Achenbach, McConaughy & Howell, 1987; Mares et al., 2007). Discrepancies are also likely to occur from behavioral variability in different situations however, the question remains as to how best to integrate information for the purposes of decision-making. Despite the discrepancy in information obtained from multi-informants, collaborating teacher and parent reports are likely to enhance the likelihood of the early identification or in the very least recognition of executive function problems not otherwise recognized by clinicians. This provides the opportunity for teachers and parents to implement behavioral and academic programming prior to the onset of any learning, social, or behavioral problems (Mares et al., 2007).

Parent and Teacher Reports

Formal neuropsychological testing and clinical observations continue to indicate support for the growing consensus that executive function deficits are central in the impairments that are observed in individuals diagnosed with ADHD. This theory suggests that tasks and expectations for performance often differ across the home and school

environments due to the differing demands of executive functions (Mares et al., 2007). Across these different settings, children presenting with various deficits of executive functions tend to display observable behavioral differences relative to their peer group. To date, the BRIEF is the only behavioral rating scale that has been developed to explore childhood executive functions in home and school environments. In addition, the majority of the studies utilizing the BRIEF have primarily limited their scope to parent ratings while excluding perceptions of teachers.

Mares and colleagues (2007) found teachers overall to report greater levels of executive functioning impairment on all scales of the BRIEF as compared to parent ratings. Authors interpreted these results to suggest that either teachers may be better able than parents to identify executive function deficits in children diagnosed with ADHD or that children diagnosed with ADHD may experience more difficulties in a structured school setting than at home. Overall, parents and teachers agreed that impairments in planning, organizing, and inhibition were main indicators for a positive diagnosis. Tripp et al. (2006) found teacher ratings to be more sensitive, specific, and accurate in the overall classification of diagnostic groups (ADHD). Combining parent and teacher measures determined consistency overall with teacher ratings. However, results support the importance of including parent and teacher rating scales in the assessment of attention and ADHD. The use of rating scales with teachers and parents are encouraged for their cost efficient and least intrusive characteristics (Tripp et al., 2006).

Although specific measures are not recommended over others, information from both teachers and parents are strongly encouraged and are particularly important in determining strengths and weaknesses in child profiles (Dewey, Crawford & Kaplan,

2003). Previous research has suggested that when carefully elicited and interpreted parental concerns in particular can be just as accurate as developmental-behavioral screening tests in identifying children with disabilities (Glascoe, 2000). For clinicians, parents and teachers are valuable reporters since they are familiar with the child's history as well as current levels of functioning across multiple settings, which in many cases are necessary for the recognition and description of psychopathology and learning difficulties (Dewey et al., 2003). Most importantly, they can also identify strengths as well as weaknesses that are not always captured through standardized testing (Dewey et al., 2000; Koonce, 2007).

In order to examine the usefulness of parent report measures of children's cognitive functioning and academic abilities, Dewey and colleagues (2003) sought to determine whether parental reports were able to contribute information beyond that of data obtained from a standardized psychometric assessment. Researchers examined the role of parental reports of everyday cognitive functioning in the ability to distinguish between children with reading disabilities (RD), ADHD, and combined ADHD + RD. Parent reports resulted in a significant increase in the number of children correctly classified as compared to the use of psychometric measures alone. These findings are consistent with previous research indicating that psychometric assessments are not particularly useful in differential diagnosis of children with attentional deficits (Barkley, 1997). Moreover, laboratory measures of attention currently available may not be sufficiently sensitive to the heterogeneity of etiological factors contributing to attentional deficits (Warner-Rogers et al., 2001).

Ecological Validity of the BRIEF and Assessment of Attention

As previously highlighted in this review, a caveat in neuropsychological assessment has been the limited ecological validity among many neuropsychological assessment measures. Ecological validity has become an increasingly important focus in neuropsychological assessment and particularly relevant in the study of executive functions, which coordinate one's cognitive and behavioral capacities with real world demand situations (Gioia & Isquith, 2004). To date, support for the ecological validity of the TEA-Ch as a standardized measure in the assessment of attention has been presented. However, given the problems involved in the assessment of executive functions and attention with performance tasks, Gioia and colleagues (2000) sought to develop a structured behavior rating system, which successfully assesses psychological and neuropsychological functions while maintaining a high level of ecological validity.

In developing the BRIEF, emphasis was placed on the construction of an ecologically valid instrument (Gioia & Isquith, 2004). Researchers believed that teachers and parents possessed a wealth of information regarding a child's executive function behaviors across different settings. They report that the impetus for the development of the BRIEF originated from the clinical need to be more efficient and systematic in the collection of information on the child's everyday manifestation of executive function behavior across relevant settings (e.g., home, school, community) (Gioia et al., 2000). The behavior rating system of the BRIEF has several unique properties that contribute to its ecological validity, including: (1) the ability to collect information about a child's executive functions from observation of behavior in natural settings, (2) the ability of information across a variety of different executive subdomains to be gathered in a

relatively short period of time, (3) the ability to collapse observations of a child's executive functions over an extended time interval, and (4) the ability to readily translate scores to peer-reference normative data (Gioia et al., 2000).

A review of the existing empirical research examining the BRIEF generally supports the ecological validity of this instrument (Mangeot, Armstrong, Colvin, Yeates & Taylor, 2002; Gilotty et al., 2002; Gioia & Isquith, 2004) and has also predicted social adaptive behavior in different clinical populations (Mangeot et al., 2002; Gioia & Isquith, 2004). Gilotty et al., 2002 found significant relationships between measures of the Vineland Adaptive Behavior Scales (VABS) and BRIEF. Specifically, the subdomains of Initiate and Working Memory on the BRIEF were significantly correlated with almost all aspects of adaptive behavior as assessed by the VABS. Limitations of this study include the small sample size as well as the restricted data from only parents that are subject to interpretational bias. Although the limitations preclude the drawing of conclusions about causality, the findings emphasize the importance of further investigating the role of adaptive functioning and its relationship with behavior of executive functions.

Mangeot et al. (2002) conducted a study designed to examine the long-term executive dysfunction following a specialized population of childhood traumatic brain injury (TBI) patients using the BRIEF. Neuropsychological measures of executive functions demonstrated modest associations with parent ratings on the BRIEF. Parent ratings were however strongly related to measures of emotional and behavioral adjustment as well as adaptive behavior for children in all groups. Thus, findings indicate that deficits in the behavioral manifestations of executive functions are related to general measures of psychosocial and adaptive functioning lending further support to the

ecological validity of the BRIEF. Overall, the BRIEF appears to provide a more comprehensive understanding of daily executive functions than any one of the commonly used neuropsychological tests. Future studies are called to determine whether parent ratings of executive functions on measures such as the BRIEF are also related to results of neuroimaging and for various clinical populations. Implications of all these studies provide an important bridge toward understanding the impact of test-based deficits on a child's everyday adaptive functioning (Gioia & Isquith, 2004).

TEA-Ch and the Assessment of Attention

The assessment of ADHD has traditionally relied on information obtained from clinical interviews, behavioral observations, and data from parent/teacher behavior rating scales (Heaton et al., 2001). Although multi-informant questionnaires provide clinicians with useful information regarding children's attentional impairments in everyday settings that would otherwise be uninformed, objective test measures of attention can also provide clinicians with a more controlled, standardized first-hand assessment that is less susceptible to reporting bias (Heaton et al., 2001). Although neuropsychological testing of children diagnosed with ADHD has increased, tests that focus on attentional abilities typically continue to assess only one component of attention while neglecting other subcomponents proposed by various other models of attention. According to authors, although most researchers agree that attention exists as a multidimensional construct, the majority fail to incorporate this understanding into their assessment strategies (Cooley & Morris, 1990).

A relatively recent measure that has been alleged to have considerable potential for use in assessing various components of attention is the Test of Everyday for Children

(TEA-Ch; Manly, Robertson, Anderson & Nimmo-Smith, 1999). In developing the TEA-Ch, the aim of the authors was to adapt the measures that had previously been proven to be effective in assessing adult attention for appropriate use and application to children (Manly et al., 2001). Initially, researchers attempted to minimize the demands on memory, reasoning, task comprehension, motor speed, verbal ability, and perceptual acuity to avoid the interference of confounding factors while still maintaining the demands on the targeted attentional system (Manly et al., 2001). This measure presents several advantages when compared to current existing objective measures designed to assess attention. One distinct advantage of the TEA-Ch includes the assessment of multiple components of attention. Furthermore, the reliability of the TEA-Ch is enhanced by multiple subtests that assess each factor of attention. Most importantly, the dimensions of attention on this measure are model and theory driven. Neuropsychological tests that simultaneously assess multiple constructs and abilities such as memory, motor speed, and response inhibition in addition to attention run into the issue of potential confounds when attempting to assess the single construct of attention (Heaton et al., 2001). Thus, the TEA-Ch is hypothesized to be a more ecologically valid measure of attention as it uses tasks that attempt to simulate real world attentional demands. (Heaton et al., 2001; Manly et al., 2001). Authors are careful to note that the subtests of the TEA-Ch are not measures of attention; rather they are measures of auditory and visual detection, of counting, of response speed, etc. Separable attention processes are inferred constructs that are believed to contribute significantly to differences in performance on these tasks. In attempts to minimize complexity of instructions, incorporating practice sessions, and

reducing demands of perception, memory, and reasoning, the aim in developing this instrument was to minimize variability due to non-attentional factors.

In an attempt to provide support for the value of differentially assessing attentional functions, Manly and colleagues (2001) administered subtests of the TEA-Ch and WISC-III to a sample population of 24 boys all meeting diagnostic criteria for ADHD. Participants were administered the Score!, Score DT, Walk Don't Walk, Sky Search, Sky Search DT, and Opposite Worlds subtests of the TEA-Ch. In addition, all boys were administered the Vocabulary and Block Design subtests from the WISC-III. Results indicated deficits on performance across all subtests of the TEA-Ch that were designed to assess sustained attention and attentional control however, notably no deficits in performance on measures of speeded-visual search tasks. There are no hypotheses provided as to the differences in performance on two of three components of attention. However, it is noted that these results are in line with previous findings that have emphasized both sustained attention deficits as well as difficulties with the suppression of prepotent responses resulting from abnormalities in the right frontal systems for populations diagnosed with ADHD (Barkley, 1997).

Overall, there have been few published studies utilizing the TEA-Ch and although studies have been conducted with both Australian participants and sample populations from the United Kingdom, researchers have failed to examine the performance of children from the United States on this measure. Heaton et al. (2001) conducted a study to address this lack in research as well as to provide a more detailed examination of the utility of this measure in a clinical population of children diagnosed with ADHD. Participants in this study were divided into an ADHD group (n = 63) and a non-ADHD

clinical control group (n = 23) all between the ages of 6-15 years. Fifty-one subjects were male which reflects the greater prevalence of males as compared to females diagnosed with ADHD in clinical settings. Parents and teachers completed the Revised Connors' Parent and Teacher Rating Scales, and all children were administered the TEA-Ch, reporting nine of the 13 scaled scores which is supported for producing an ideal model as indicated in the manual.

Overall, results of the study indicated that the clinical ADHD group performed significantly worse than the clinical control group on subtests assessing sustained and attentional control/shifting while the groups performed comparably on the tasks assessing divided attention. These findings indicate that children diagnosed with ADHD show distinct deficits in attention rather than global deficits and note the importance of considering specific subcomponents of attention. Limitations of this study include the relatively low sample size as well as the use of stimulant medication by nearly half of the children included in the clinical ADHD group. Future studies examining the correlation between TEA-Ch performance and results obtained on various other tests of attention, executive function, and ratings on parent and teacher reports of behavior are warranted in further exploration of this instrument.

In an attempt to examine the validity of the TEA-Ch, Sutcliffe and colleagues (2006) compared children diagnosed with ADHD when on and off stimulant medication. This study examined sustained and attentional control by administering four subtests of the TEA-Ch and a reading assessment. Parent ratings were obtained at two different points in time via the SNAP-IV rating scale (Swanson, 1992) to indicate their child's attentional state on and off stimulant medication. Participants from the clinical group

performed significantly lower than controls on the TEA-Ch subtests when off stimulant medication. In contrast, when children were taking stimulant medication no significant differences were found on three of the four TEA-Ch subtests. There were no differences on measures of intelligence or reading between clinical and control groups and between clinical groups when on and off stimulant medication. Overall, results indicated some support for the sensitivity of specific subtests of the TEA-Ch in assessment of attention, however not all measures produced significant differences when medication status was change. Limitations of this study include the small sample size and therefore lack generalizability of these findings.

Purpose of the Study

Despite the wide variety of cognitive tests available that are purported to assess various executive functions, there has been little work to validate the use of these measures in predicting real world functioning, particularly in children where characterization of executive function deficits are specified to attentional difficulties. Although many performance-based measures and parent/teacher rating scales exist for assessing a wide range of behaviors and adaptive functioning in children, specific measures of attention and subcomponents of attention have not been fully explored. As previously highlighted, a current limitation in neuropsychological assessment is the concern with questionable ecological validity among many of commonly endorsed measures. More research and test development to improve the ecological validity of neuropsychological assessment measures is needed.

This study seeks to assess and further establish the ecological validity of the Behavior Rating Inventory of Executive Function (BRIEF) in conjunction with the Test

of Everyday Attention for Children (TEA-Ch) in a sample of school age children.

Although research to date supports the ecological validity of the BRIEF and the TEA-Ch in isolation and in conjunction with other measures, no current studies exist that correspond to the study of the TEA-Ch, BRIEF and assessment of adaptive functioning. Furthermore, this study will attempt to better define the relationship between behaviors indicative of executive functioning, attention, and adaptive functioning in a normative group of school age children. Currently, there is no commonly used measure of attention that can fully capture all proposed subcomponents of attention. Clinicians have previously relied on a wide variety of formal measures including clinical interviews, behavioral observations, and rating scales to gain a more thorough understanding of the child. It is likely that this study will bring to light the utility and appropriateness for the use of neuropsychological measures not only in clinic settings but also in the schools. Lastly, the inclusion of parents, teachers, and school psychologists in the assessment of attention and deficits of executive function deficits allow for a common language towards collaboratively generating interventions and strategies that will be applicable across the home, school, and community settings.

Chapter 3

Method

The purpose of this study was to investigate and to define better the relationship between attention and corresponding behaviors that have been designed to represent executive functions and social/adaptive functioning in a normative sample of school age children. More specifically, this study sought to explore the correlation between ratings of varying subcomponents of attention (e.g., selective attention, sustained attention, and attentional control/switching), executive function behaviors, and ratings of social/adaptive functioning that were obtained separately from reports by parents/caregivers and elementary school teachers. Additionally, gender considerations were examined with aims to determine how this factor may affect the degree of relationship between the proposed variables. This chapter presents information regarding participants who were involved in this study, the method through which data were collected, and the analyses conducted.

Participants

The participants in this study were 48 school age children ranging in age from 8-years, 0-months to 10-years, 11-months, a parent/caregiver per child, and his/her elementary school teacher. All students who took part in this study were enrolled in elementary schools housed within a large school district located in and around West Central Florida during the 2008-2009 school year. The established range for this study

included students who were enrolled in school during critical transition times in regards to the school curriculum during these specific ages and concurrent stages of development. Specifically in school, these transitions correspond with increased expectations for organizational demands and the introduction of tasks such as complex writing assignments, book reports, and multiple-choice tests that require coordination and integration of various skills and strategies (Meltzer, 2007). Researchers have also documented rapid advances in systematic problem solving, increased ability to think autonomously and the emergence of strategic and controlled self-regulation, skills of inhibition, and the ability to maintain attention on complex problems, planfulness, and reflection during this developmental period (White, 1965; Welsh & Pennington, 1988; Welsh et al., 1999).

The school district from which child participants were recruited is the eighth largest district in Florida and has 160 school sites and centers including 65 elementary schools. The most recently available student demographics for this particular school district were reported for the 2006-2007 school year. The district reported 90,284 students enrolled in school with 19,559 (22%) students noted to be eligible for free and reduced lunch. Statistics describe the population of students enrolled in this school district to be composed of 57.4% White, 19.3% Hispanic, 21.8% Black, 1.3% Asian/Pacific Islander, and 0.2% American Indian/Alaska Native. Comparatively, the sample population for this study was composed of 87.5% (42) White, 8.3% (4) Black, and 4.2 % (2) Hispanic. Similar to the district population, students who were eligible for free and reduced lunch composed 20.8 % (10) of the sample population. Of the 48

participants included in this study, 52% (25) were females and 48% (23) were males with a mean age of 9.04 years (Table 1).

Table 1

Distribution of Demographic Variables Across Child Participants

	<i>8-0 to 8-11</i> (N = 15)	<i>9-0 to 9-11</i> (N = 16)	<i>10-0 to 10-11</i> (N = 17)
<i>Gender</i>			
Female	9 (19%)	8(17%)	8(17%)
Male	6 (13%)	8(17%)	9(19%)

Note N= 48

Inclusion Criteria. Students between the ages of 8-years, 0 months to 10-years, 11 months of age were eligible to take part in this study. Furthermore, students who were only proficient in English and enrolled in the general education classroom setting for the majority of their academic studies (>75%) were included in this study. Elementary school teachers involved in this study were employed full time in the classroom allowing significant time for student interaction and observation. The purpose of this criterion ensured that teachers had adequate knowledge of the students’ skills and abilities considered representative of the student. A primary caregiver was defined as an adult with whom a child lives and the adult assumes responsibility for the child. Teachers and caregivers taking part in this study had continuous opportunities to observe the child across activities involved with daily functioning.

Exclusion Criteria. Students who were excluded from participating in this study were enrolled in their classrooms for less than six months; outside of the established 8-years, 0-months to 10-years, 11-months age range, and/or native speakers of a language

other than English. In addition, students who presented with evidence of deafness, blindness, specific learning disorders, and/or psychiatric disorders were also unable to participate in this study. Elementary school teachers who were excluded from this study were individuals who were not employed full time in the classroom or those who had been employed for less than six months in their current classrooms. Primary caregivers who were excluded from this study included individuals who did not live with the child or assume responsibility for the child. Furthermore, primary caregivers who were not fluent English speakers were also excluded from this study.

The number of child, teacher, and caregiver participants were selected based on the sample participants accessible to the researcher and through statistical determination. In an a priori power analyses (Cohen, 1988), sample size is computed as a function of the required power level ($1-\beta$), the pre identified significance level (α), and the population effect size to be detected with probability $1-\beta$. A power analysis was conducted a priori in order to determine the sample size necessary to obtain power of .80 for various effect sizes. A power analysis was generated for multiple regression analysis with three predictors (sustained, selective, shifting/attentional control attention) for two separate regression models (parent/caregiver and teacher). The alpha level was adjusted according to the Bonferroni adjustment in order to control for Type I error (Glass & Hopkins, 1996). The G*Power 3 power analysis program (G*Power 3; Faul, Erdfelder, Lang & Buchner, 2007) was used for this analysis. This is a computer program that was designed as a standalone application to consider several types of statistical tests commonly used in social and behavioral research (Faul et al., 2007). Cohen (1988) provides guidelines from which to interpret practical use for standardized effect sizes; a small effect size is defined

as $f^2 \leq .02$, a medium effect size is defined $f^2 = .15$, and a large effect size is defined as $f^2 \leq .35$ (Cohen, 1988; Faul et al., 2007). For example, the final sample size for this study included 48 parents/caregivers, 48 children, and their teachers, which is calculated to provide a statistically significant effect if an effect size of $f^2 \leq .35$ (large) is established (Table 2). The power analysis indicated a minimum sample size of 42 for a large effect size, a minimum sample size of 91 for a medium effect size, and a large effect size requiring a minimum of 651 participants. Based on the literature and current studies, a large effect size was expected thus the sample size was hypothesized to be sufficient according to the power analysis.

Table 2

Protocol of Power Analyses N for Small, Medium, and Large Effect Size at Power = .8 for $\alpha = .05$

Test	$\alpha = .05$	$\alpha = .05$	$\alpha = .05$
	Large effect	Medium effect	Small effect
	$f^2 \leq .35$	$f^2 = .15$	$f^2 \leq .02$
	N	N	N
Significant <i>r</i>	42	91	651

Research Design

The design of this exploratory analysis study is correlational. The independent variables were entered into a regression model in an attempt to account for variance in the dependent variable, and to identify the variables contributing most to the prediction of the dependent variable. Attention scores as measured by the TEA-Ch, posed as independent variables (predictor variables) while executive function behaviors as measured by the BRIEF-Teacher, BRIEF-Parent/Caregiver, and social/adaptive

functioning as measured by the ABAS-II Parent and Teacher represented the dependent variables (outcome variables).

Instrumentation

The measure and rating scales that were selected to assess the primary constructs of interest in this study included executive function behaviors, subcomponents of attention, and social/adaptive behavior. Three different measures were utilized for this study: a) two behavior rating scales (information to be provided by teachers and parents/caregivers); b) standardized neuropsychological measure of attention.

Behavior Rating Inventory of Executive Function (BRIEF). The Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al., 2000) was derived from theoretical and empirically based definitions of executive function and from items submitted by practicing clinical neuropsychologists (Malloy & Grace, 2005). The parent and teacher versions of the BRIEF were designed to assess executive functions in the home and school setting, respectively (Gioia et al., 2001). Each BRIEF questionnaire contains 86 items and requires approximately 15-20 minutes for completion. Children are evaluated on a 3-point Likert scale (*never, sometimes, often*). The BRIEF contains three general indices: Behavioral Regulation Index (consisting of three scales: Inhibit, Shift, and Emotional Control), Metacognition Index (consisting of the remaining five scales: Initiation, Task Organization/Planning, Environmental Organization, Self-Monitoring, Working Memory), and a Global Executive Composite (GEC) which combines the sum of all eight scales. The Behavioral Regulation Index (BRI) represents a child's ability to shift cognitive set and modulate their emotions and behaviors appropriately via inhibitory control. Behavioral regulation enables a child to successfully engage in active, systematic

problem solving, and supports appropriate self-regulation. The Metacognition Index (MI) represents the child's ability to initiate, plan, organize, and sustain future-oriented problem solving in working memory. Specifically, this index is interpreted as the ability to cognitively self-manage tasks, and reflects the child's ability to monitor his or her own performance (Gioia et al., 2000; McCandless & O'Laughlin, 2007). The MI is designed to relate directly to a child's ability to actively problem solve in a variety of contexts and situations. The GEC is a summary score that incorporates all eight clinical scales of the BRIEF. This standard score will be used as the main measure for representing executive function behaviors for this study and to which attention will be compared and related. All raw scale scores are transformed into t-scores for interpretation. Scale scores that are greater than $t = 65$ are considered clinically significant (Gioia et al., 2000; McCandless & O'Laughlin, 2007).

Specific items for the BRIEF scales were generated from actual descriptions of behavioral executive function difficulties obtained during clinical interviews with parents and teachers, ensuring good face and content validity. Item-category membership was determined by the sorting decisions of 12 clinical neuropsychologists, as well as statistical analyses (item-total correlation analyses, principal factor analyses, and interrater agreement; Gioia et al., 2000), to support each scale and index structure of the BRIEF. The normative data samples were obtained through public and private school settings across rural, urban, and suburban areas throughout the state of Maryland. Both parents and teachers for 296 children, permitting examination of agreement between raters, completed rating forms. The BRIEF Parent Form was normed on 1,419 children aged 5-18 years. The Teacher Form was completed by a sample consisting of 720

teachers. A specific breakdown of the Parent and Teacher Form normative samples by age and gender are provided in the manual (Gioia et al., 2000).

Factor analytic studies of the normative sample were conducted and provided support for two underlying factors, which were used to develop the MI and BRI indices (Gioia et al., 2000). The BRIEF scales have demonstrated strong psychometric properties with the majority of correlations falling in the moderate to high range. Internal consistency reflects the degree to which items in a single scale are measuring the same underlying construct (Glass & Hopkins, 1996). The typical internal consistency statistic that is reported is Cronbach's alpha (α), which is derived as the mean correlation of all possible sets of scales within a scale (Cohen, 1992). For both the Parent and Teacher Forms of the BRIEF reported internal consistency is high, ranging from .8 to .98. (Gioia et al., 2000; Malloy & Grace, 2005). Inter-rater reliability assesses the degree to which two independent observers rate a child in a similar manner (Glass & Hopkins, 1996). This measure provides an indication of scale stability across multiple informants as well as across multiple settings. The correlation (reliability coefficient) between parent and teacher ratings of the same child is typically lower (i.e., .3 to .5) than parent-parent or teacher-teacher inter-rater reliabilities for rating scales (Achenbach et al., 1987). The correlations derived between like scales of the BRIEF for parent and teacher raters were moderate (overall .32) for the normative group (Gioia et al., 2000; Malloy & Grace, 2005). Notably, correlations between parent and teacher ratings for two of the scales were significantly lower for Initiate ($r = .18$) and Organization of Materials ($r = .15$). Such findings are stated to be a result of the differences in environmental structure that exists between the home and school settings (Gioia et al., 2000).

Test-retest reliability indicates the stability of a measure over time for behaviors that are presumed to remain relatively constant (Glass & Hopkins, 1996). Test-retest reliability was examined in both clinical and normative subsamples for the Parent Form and in a subsample of the normative sample for the Teacher Form. The mean test-retest correlation across the clinical scales ranged from .76 to .85. Results were collected over a two-week period for the normative subsample rated by parents/caregivers. For the parent clinical subsample, the mean test-retest correlation for the clinical scales ranged from .72 to .84 over an average of three weeks. The test-retest correlations for the Teacher Form were the strongest and ranged from .83 to .92 over a three- to five- week interval (Gioia et al., 2000).

Validity refers to the accuracy with which an instrument measures the intended construct. Content validity is defined as the degree to which an instrument's item content reflects the constructs that it was proposed to measure (Glass, & Hopkins, 1996). The construct validity has been examined by correlating the BRIEF scales with a variety of other measures with which it theoretically should correlate. To explore the convergent and divergent validity of the BRIEF, the individual scales and summary indexes have been correlated in a variety of clinical samples with other rating scale measures of attentional and behavioral functioning. McCandless and O'Laughlin (2007) evaluated the validity and clinical usefulness of the BRIEF in identifying children diagnosed with ADHD, and to determine if select BRIEF scales could accurately differentiate the inattentive subtype from the combined subtypes of ADHD. In addition, the study also examined the interrater reliability and convergent validity between parent and teacher reports on the BRIEF by considering the relationship between teacher and parent reports

on the BRIEF with a broad-range behavior rating scale (BASC; Reynolds & Kamphaus, 1992). Correlations ranged from .24 (Shift) to .70 (MI) for the BASC Attention scale and from .26 (Shift) to .83 (Inhibit) for the BASC Hyperactivity Scale. Both the Inhibit and Emotional Control scales were more strongly correlated with the BASC Hyperactivity scale as compared to the Inattention scale. For teacher ratings, six of the eight BRIEF scales were significantly correlated with the BASC Inattention scale, and all of the BRIEF scales were significantly correlated with the BASC Hyperactivity scale. Significant correlations ranged from .26 (Shift) to .67 (Initiate) for the BASC Inattention scale and from .24 (Working Memory) to .59 (Inhibit) for the BASC Hyperactivity scale. Finally, the overall agreement between parents and teachers on the BRIEF, as indicated by the GEC, was minimal ($r = .13$). Parent and teacher ratings were significantly correlated for three of the eight BRIEF scales, including Inhibit, Plan/Organize, and the Monitor. Parent-teacher agreement was lowest for the Emotional Control, Initiate, and Organization of Materials.

This study provides support for convergent validity and clinical utility of the BRIEF as parent and teacher ratings on BRIEF scales were found to be significantly associated with both reports of inattention and hyperactivity as indicated on the BASC. In support of the clinical utility, the Working Memory scale was effective in distinguishing the ADHD groups from the nonclinical groups, whereas the Inhibit scale was able to distinguish between subtypes. With similar aims in the exploration of construct validity of the BRIEF, Sullivan and Riccio (2006) conducted a study examining the characteristics of the Frontal Lobe/Executive Control (FLEC) scale of the BASC Parent Rating Scales and its relationship with the BRIEF-Parent Form. Scores on the FLEC were

correlated with scores on the BRIEF-Parent Form, and the Conners' Parent Rating Scales Revised-Short Form (CPRS-Short Form) to determine the extent to which they were related. Scores on the FLEC were significantly correlated with all of the scales on the BRIEF-Parent Form and the CPRS-Short Form with correlations ranging from .45 (Organization of materials) to .83 (GEC) and .63 (ADHD Index) to .77 (Oppositional), respectively. Overall, the highest correlations between the BASC-FLEC scale and the BRIEF were obtained on the global scales of the BRIEF (i.e., BRI, MI, and GEC). Thus, authors concluded that the BRIEF and BASC-FLEC appear to measure the same dimensions including both the cognitive and behavioral dimensions of executive dysfunction and providing further support for the construct validity of the BRIEF.

Adaptive Behavior Assessment System-2nd edition (ABAS-II). The Adaptive Behavior Assessment System-2nd edition (ABAS-II; Harrison & Oakland, 2003a) is a comprehensive, multidimensional, norm-referenced behavior rating scale that is designed to assess the practical, everyday skills that are required by individuals to function and meet environmental demands, including those needed to effectively and independently care for oneself and to interact with others. Five ABAS-II forms are available for different age groups to be rated by different raters. The age range for the instrument is birth to 89 years. Ratings are determined by observations across various settings by multiple raters. This assessment instrument aids in the classification and diagnosis of disabilities as well as providing a profile of individual strengths and limitations in adaptive behavior and can function as an ongoing tool of progress monitoring of adaptive skills (Harrison, 1999). Furthermore, researchers support the use of the ABAS-II as a contribution of an ecologically valid instrument for assessing various adaptive

functioning skills of individuals. The ABAS-II may be used to evaluate individuals with learning difficulties, ADHD, and other impairments related to motor, speech and language, hearing, and neuropsychological disorders to determine how the individual is responding to daily demands from the environment. Included items are stated to be developmentally sensitive and appropriate for use with young children.

The ABAS-II is estimated to take approximately 15-20 minutes for the completion and scoring of the long version, and 5- 10 minutes for the short version. Since some adaptive skills are required in specific settings apart from others, or are more observable in particular settings, separate forms for teachers (daycare providers), parents (primary caregivers), and adults were designed. This allows for the assessment of the adaptive skills that are most suitable for the specific setting and type of informant (Harrison & Oakland, 2000). Additionally, two age-specific versions are available for the parent (contains 232 items) and teacher forms, one for children age 0-5 years, and the other for children and adolescents age 5-21 years.

The ABAS-II is currently the only instrument that incorporates the current American Association of Intellectual Disabilities (AAID) guidelines for evaluating the four general areas of adaptive behavior (Conceptual, Social, Practical, and General Adaptive Composite or GAC). The ABAS-II consists of the Conceptual Domain, which includes the skill areas of Communication, Functional Academics, Self Direction, and Health and Safety. The Social Domain includes the Social and Leisure skill areas. The Practical Domain includes the skill areas of Self-Care, Home Living, Community Use, Health and Safety, and Work. Motor skill area scores are available on the two forms appropriate for children up to age 5 years. The GAC compares an individual's global

adaptive skills to the adaptive skills of others in the same age group from the standardization sample. Composite scores are derived for each of the areas. For both forms, respondents have a four-choice option format (*Always or Almost Always When Needed, Sometimes When Needed, Never or Almost Never When Needed, or Is Not Able*) to rate the frequency that a behavior is correctly performed by the child when needed. All scores are based on age-related norms. The General Adaptive Composite and domain composite scores have a mean of 100 and a standard deviation of 15. Skill area standard scores have a mean of 10 and a standard deviation of 3. Age-based percentile ranks and test-age equivalents are included up to the test age of 22 years.

Procedures taken for test development and standardization are thoroughly described in the ABAS-II manual. The standardization sample was based on the United States census data provided in 1990 (School and Adult forms) and 2000 (Infant and Preschool forms). Thirty-one separate age groups with at least 100 participants in each group were assessed using the Infant-Preschool, School Age, and Adult forms. Further specification of groups, maps, and tables are provided in the manual. The ABAS-II was standardized between December 1998 and October 2002, however, there is no mention of the use of normative information from the original ABAS. In addition to typically developing participants, the standardization sample included 20 clinical samples as well (e.g., ADHD, autistic disorder, and visual impairment).

Reliability studies were conducted as part of the standardization process and provided evidence of a high degree of internal consistency. Furthermore, the majority of skill areas reported internal consistency coefficients of .90 or greater. The average internal consistency coefficient for the sample's GAC ranged from .97 to .99. Three

separate studies evaluating test-retest reliability from teachers and parents were conducted and support very high reliabilities. The test-retest interval was approximately 2 weeks. Tables by age group for each of the ABAS-II forms as well as for the various scores are included. Sample sizes were composed of 30 to 207 participants. The majority of the GAC correlations were above or near .9 for teacher, parent, and adult forms. Confirmatory factor analytic data indicate that unidimensional and multidimensional models most accurately describe the ABAS-II standardization results. All five forms were examined using a host of factor analytic techniques. Although the single-factor, GAC model proposed the closest fit with these data, there was additional evidence to also support the three-factor model (Conceptual, Social, Practical). The one-factor model is consistent with the construct of overall adaptive functioning therefore, the GAC summary score will be the score representing a child's social adaptive functioning for the purposes of this study.

According to the developers, the ABAS-II was founded upon the theoretical basis that each of its skill areas should be minimally related to each other, highly related to their respective adaptive domains, and strongly correlated with the GAC. Thus, the construct validity of the ABAS-II is supported by intercorrelational data across and among the skill areas, domains, and the GAC. Across all forms, the intercorrelations between the skill areas were in the moderate range (.4's to .7's). The correlations between the skill areas and their adaptive domains range between .55 and .78, whereas skill areas and the GAC are .64 to .82. Lastly, correlations between the adaptive domains and the GAC fall between .78 and .93. These results suggest that the ABAS-II fits the theoretical basis for which it was designed.

A number of specific validation studies are reported in the manual and support concurrent validity of this instrument with other frequently used measures. For the adaptive behavior-related scales, small samples (<60 children in each sample) were used to compare scores on the ABAS-II with the Vineland Adaptive Behavior Scale (VABS-CE), VABS Interview Edition (VABS-IE), Scales of Independent Behavior-Revised (SIB-R), and the BASC. Correlations reported between the Adaptive Behavior Composite on the VABS-CE and the GAC was .75 for the Teacher/Daycare Provider form and .84 for the Teacher Form. The correlation between the GAC and the VABS-IE Adaptive Behavior Composite was reported to be .7. The lowest correlation of .57 was reported between the GAC and the SIB-R Broad Independence standard score. Additionally, the correlation between the GAC and the BASC Adaptive Skills Composite was .8 for a sample of 37 preschool aged children.

The ABAS-II manual lists three negative correlations between the personality dimensions assessed by the BASC and the ABAS-II scores. However, it is expected that as behavior problems increase, adaptive behavior scores decrease. The correlation between the GAC and the BASC scales for Externalizing Problems was -.49, -.39 for Internalizing Problems, and -.66 for the Behavior Symptoms Index.

Additional studies including the relationship between the ABAS-II and various measures of intelligence (e.g., WPPSI-II, WAIS-II, WISC-IV) and achievement (e.g., WASI, WIAT) measures briefly noted moderate correlations ranging in the .4's to .5's and .6's respectively. This finding is consistent with previous research suggesting that adaptive behavior and cognitive functioning are separate but related constructs (Rust & Wallace, 2004).

As indicated by the current literature, by the instruments developers, and by test reviewers, the ABAS-II appears to be an important addition to the field of assessment of social adaptive behavior. In particular, a great deal of effort has been put forth to update a new test in order to expand the applicable age range and consider the revisions proposed according to AAID guidelines. There is an abundance of reliability and validity data included in the manual, which supports its high internal consistency and reliability. The ABAS-II is proposed to be an appropriate tool for screening, placement, diagnostics, and research purposes.

The Test of Everyday Attention for Children (TEA-Ch). The Test of Everyday Attention for Children (TEA-Ch; Manly et al., 1999) is a standardized clinical battery that was developed as a modification of the 8-subtest Test of Everyday Attention (TEA; Robertson, Ward, Ridgeway & Nimmo-Smith, 1996). This measure was designed to assess various components of attention in adults. Although this instrument was developed according to a model of attention that was originally proposed for adults, it has been modified accordingly for use with school age children as a measure of how well students can control their attention to achieve goals (e.g., paying attention to the teacher, focusing on a boring task, etc). The measures from the TEA that best represented these three factors of attention were considered in the design of the TEA-Ch and new tasks were added based on the research and current literature on children's attention (Manly et al., 1999).

The TEA-Ch is particularly relevant for identifying the patterns of attentional problems as well as to facilitate development of treatment and management programs in children diagnosed with or suspected of having attention difficulties. Thus, the distinct

advantage of the TEA-Ch relates to its inclusion of multiple components of attention which sets it apart from most other measures of attention (i.e., Continuous Performance Tasks, Speeded Classification Tasks, and the Wisconsin Card Sorting Tests), which generally examine only one component (Heaton et al., 2002). Differing patterns of attentional problems may be apparent, requiring separate assessment in order for a comprehensive description of an individual's difficulties and strengths. The TEA-Ch allows the assessment of the pattern of attentional difficulties and strengths by including a variety of activities that emphasize distinct types of attentional skill.

The TEA-Ch is normed for children ages 6-16 years and is composed of nine game-like subtests reported to assess three main domains of attention: focused (selective) attention, sustained attention, and attentional control/switching. The test employs various sensory modalities during test administration, including visual, auditory, and motor modalities. To further accommodate its use with children, practice items are included within subtests and standardized instructions require the child to paraphrase directions in order to ensure their comprehension. The reliability of the TEA-Ch is enhanced by devoting multiple subtests to each factor of attention. Five subtests assess sustained attention while two subtests assess selective attention and attentional control/switching. The TEA-Ch is comprised of a screener version and a full nine-subtest administration. The brief screener allows for an estimate of performance on each of the three factors of attention and dual task performance. The full administration is reported to take approximately one hour to complete and the subtest screener is composed of the first four subtests, which takes approximately 20-25 minutes. There are two parallel forms (A and B) included in the TEA-Ch that allow for retesting purposes. However, the developers

caution that attention skills measured by the TEA-Ch develop rapidly in childhood thus complicating the interpretation of a child's second performance unless it is reasonably close in time to the first assessment. Therefore, in assessing the reliability, all of the retests were conducted within 20 days of the first TEA-Ch administration. Test-retest reliability was assessed on a random subgroup of 55 children from across the age range. They were re-administered the TEA-Ch between 6 and 15 days following the first administration. Pearson's correlations were computed between raw performance scores at test 1 and test 2. The reported correlations ranged from .64 (Score!) to .92 (Opposite Worlds) and computed percentage agreement from 57-76.2% (Manly et al., 1999). In addition, correlations were computed while controlling for age due to the wide age range of the TEA-Ch sample and reports correlation coefficients falling between .65, and .87, with percentage agreements from 71-76.2%. These data do not provide an estimate of the long-term effects of prior completion of the TEA-Ch on subsequent performance over long periods of time, nor of more than one retest over any period of time. Therefore, it is cautioned that particular care should be used in making comparisons with the normative data under these circumstances.

In developing the TEA-Ch, the researchers aimed to adapt measures that had proven effective in adult attention to be applicable for use with children. Although it is difficult for neuropsychological tests to completely eliminate confounds, the developers of the TEA-Ch have attempted to minimize the demands on memory, reasoning, task comprehension, written expression, motor speed, verbal ability/comprehension (reading), and perceptual acuity, while maintaining the demands on the targeted attentional system, and thus providing a more objective measure of children's abilities. By comparison,

many other current neuropsychological tests assess multiple constructs and combined abilities including memory, response inhibition, motor speed, and various executive functioning skills, in addition to attention.

To date, there are very few published studies utilizing the TEA-Ch apart from the normative studies conducted by the test developers. Few studies have evaluated the ability of the TEA-Ch to assess subcomponents of attention in normative as well as clinical samples of children (Heaton et al., 2001; Manly et al., 1999). However, both construct and concurrent validity have been explored. As described in the manual the normative sample was composed of 293 children between the ages of 6 and 16 years recruited from state schools located in Melbourne, Australia. Equal numbers of boys and girls were tested and stratified into six age-bands (6-7 years, 7-9 years, 9-11 years, 11-13 years, 13-15 years, and 15-16 years), which takes into account the rapid development of attention skills in children. Exclusion criteria included previous head injury or neurological illness, developmental delay or sensory loss, and/or referral for attentional or learning problems, and the need for special education services. Additional information describing specific gender and age distribution of this sample is included in the manual.

An important question regarding the validity of the TEA-Ch is the extent to which the separate factors of selective attention, sustained attention, and attentional control/shifting identifies distinct patterns of performance. The relationship between the observed scores in the TEA-Ch and the three latent constructs defined were examined in a Structural Equation Model. This technique provides a number of measures that provide the best fit of the hypothetical model to the observed data. Three explanatory factors (latent variables) were entered as the a priori model (sustained, selective, and

shifting/attentional control). These were linked to variables designed to be representative of each subtest included in the TEA-Ch. The three-factor model, with the variables from the TEA-Ch linked to only one factor thus giving a close fit to the data and indicating a representative pattern of performance observed in a large group of children. Overall, it was reported that a unitary model of attention formed a poor fit to the observed variance, while a three-factor model of sustained attention, selective attention, and attentional control/shifting formed a significant and parsimonious fit. In summary, the dimensions of attention proposed and measured on the TEA-Ch are shown to have been model-based, and theory-driven. The scaled scores generated for each of the subtests representing sustained, selective, and attention control/shifting of attention will be used for the purposes of this study.

Although the TEA-Ch consists of nine subtests, 13 total scores are generated. The manual, however, reports that the results of the factor analysis yielded an ideal model using 9 of the 13 scores. Furthermore, according to the developers of the TEA-Ch, four scores comprising the screener may also be utilized to provide an estimate of the three attention factors and dual task performance. The current study will follow this model and utilize the following four scores: Sky Search Attention Score, Creature Counting Timing Score, Score!, and Sky Search DT. This screener also offers a plausible measure to be administered in the school setting where time restrictions are applicable. Each subtest represents a different subcomponent of attention and represent sustained, selective, attention control/shifting of attention, and dual tasks of attention.

According to the TEA-Ch manual, 96 children from the normative sample were administered the Stroop task (Trenerry, Crosson, Deboe & Leber, 1989), Trails Test

(Spreeen & Strauss, 1991), and Matching Familiar Figures Test (Arizmendi, Paulsen & Domino, 1981). Comparisons between measures of the TEA-Ch with these other tests of attention were made using partial correlations (controlled for age) on raw scores. Subtests of the TEA-Ch would be expected to correlate highly with instruments that are designed to measure similar components of attention while low correlations would be expected between these tests and other subtests of the TEA-Ch proposed to measure separate aspects of attention. The Stroop task, Trails A and B are designed to assess components of selective attention similar to Sky Search and Map Mission on the TEA-Ch. When the relationships between these tests were examined, correlations ranged from .31 to .69 and reported to show statistically significant relationships on this capacity of attention. In addition, non-significant relationships were observed with the other subtests of the TEA-Ch emphasizing the separable nature of the attention factors. Additionally, the MFFT, which places demands on a child's ability to resist impulsive responding, shows significant relationships with a number of TEA-Ch measures requiring similar capacities designed to measure attentional control and aspects of sustained attention (coefficients ranging from .2 to .4). In addition, non-significant correlations were derived for the remaining subtests of the TEA-Ch when compared to these measures.

Additional assessments of validity were undertaken to determine whether TEA-Ch subtests reflect general ability and academic achievement as opposed to specific areas of attentional functions. If relationships between tests of intellectual ability and subtests of the TEA-Ch are obtained it may be interpreted that an additional assessment of attention apart from general intellectual ability may be redundant. However, given that IQ measures average performance across cognitive domains, attention would be expected to

contribute additionally to the variance of scores. Pearson correlations were derived between the scaled scores for the TEA-Ch variables and four WISC-III scaled scores (Vocabulary, Similarities, Block Design, Object Assembly) for 160 children. Overall, IQ accounted for little of the variance across TEA-Ch subtests for children with average IQ scores, and thus IQ scores were not reported to accurately predict how a child may perform on the TEA-Ch (Manly et al., 1999). Coefficients ranged from $-.002$ to $.31$. The highest correlation obtained was between Creature Counting accuracy, where children are instructed to switch repeatedly between counting upward and counting downward according to the printed arrows, and overall IQ ($.31$). These results suggest that overall the TEA-Ch is assessing abilities that are not otherwise accounted for by measures of general ability.

Similar to the comparison between subtests of the TEA-Ch and the WISC-III, researchers compared measures of academic achievement to subtests of attention by administering the Reading, Spelling, and Arithmetic scales on the Wide Ranging Achievement Test-Revised (WRAT; Justak & Wilkinson, 1984). Overall, subtests of the TEA-Ch that were designed to assess selective attention did not show strong relationships with tests of academic achievement ($.09$ and $.13$). However, the subtests from the TEA-Ch that were designed to measure sustained attention did indicate correlations across each of the scores of academic achievement. This finding suggests that a relationship exists only between the ability to focus and sustain attention with achievement in the areas of Reading, Writing, and Spelling, but not with selective and shifting attention.

In summary, the previously discussed studies indicate the usefulness of the TEA-Ch for assessing important subcomponents of children's attention. The TEA-Ch has

demonstrated its relation to other measures of attention, intellectual ability, and academic achievement in addition to construct validity. An exploration of the technical properties of the two previously presented rating scales of executive function behaviors (BRIEF) and social/adaptive functioning (ABAS-II) indicate that scores obtained on these instruments are adequately reliable and valid. The technical properties of these instruments, along with their specificity, lack of intrusiveness, and appropriateness for the characteristics of this sample make them viable instruments for use in this study.

Procedures

Ethical considerations. Several steps were taken to protect all research participants. Approval was obtained from the University of South Florida Institutional Review Board (IRB), Polk County Schools Office of Assessment, Accountability, and Evaluation, and from the principals of each of the participating elementary schools before data collection and contact with classroom teachers, parents/caregivers, and students was made. Parents were provided an informed consent form to sign describing the purpose of the study, rights of the participants, nature of their involvement, measures to ensure participant anonymity, methods in which data were to be collected, and a description of how data will be stored during and after research completion. The explanation of participants' rights included information regarding confidentiality, ability of participants to withdraw, refusal to answer any question, and emphasis on voluntary participation. Teachers were informed of the purpose of the study, confidentiality procedures, and voluntary participation in a similar manner. Rating forms completed by teacher/parent pairs and test protocols were assigned a number. Identifying information were removed

from these documents. All of the forms and letters that were distributed to parents were thereafter organized according to student number and entered into a computer database.

Training Activities.

Training of test administration. The author and co-authors of the TEA-Ch were contacted by the primary investigator in regards to best practices and recommended methods for becoming trained in, and training other professionals on the administration of the TEA-Ch. The primary investigator was trained in the administration of the TEA-Ch by referring to and adhering to the standardized conditions and administration rules as indicated in the manual. Furthermore, the primary investigator observed the administration of the TEA-Ch by licensed clinical psychologists and administered the measure under supervision across numerous occasions. In addition, practice administrations were completed with fellow graduate students and school age children between the ages of 8-0 years and 10-11 years. In order to ensure integrity of scoring procedures, all protocols were scored, and reviewed by a licensed clinical psychologist. An overview of the TEA-Ch and data collection procedures to the administration and educators employed in the targeted school district specific to the current study are provided below in Table 1. Training activities related to administration and utility of the TEA-Ch were developed by referring to and considering the guidelines set forth by the American Educational Research Association and the American Psychological Association.

The study was introduced to the district Psychological Services, Senior Manager and to the school psychology faculty in the summer of 2008 to familiarize potential TEA-Ch administrators and data collectors with the purpose and methods of this study.

Following this brief overview, a detailed workshop was conducted for the purposes of providing training on the TEA-Ch including administration, scoring, and interpretation. Lastly, an Integrity Checklist was composed, reviewed, and distributed to school psychologists for the purposes of collating the data and employing consistent information and record gathering procedures across all researchers.

Table 3
Overview of TEA-Ch Training Activities and Data Collection

Training Activity	Purpose	Data Collected
Study Introduction (Summer 2008)	Power Point Presentation for School Psychologists (school district) Purpose of Study/Rationale 1. Literature Review 2. Data Collection 3. Test Measures	School District Letter of Support (Senior Manager of Psychological Services)
TEA-Ch Training and Workshop (In collaboration with District Research Committee and Standardized Test Review Committee) (Fall 2008)	1. TEA-Ch Overview <ul style="list-style-type: none"> • Development and Standardization • Clinical and Research Strengths • Validity and Reliability 2. TEA-Ch Administration <ul style="list-style-type: none"> • Description of Subtests • Materials/Administration • Model and Role Play 3. Protocol Scoring <ul style="list-style-type: none"> • Review Scoring Sheet • Scoring Rules 4. Interpretation <ul style="list-style-type: none"> • Limitations • Confidentiality 5. Discussion and Questions	
Data Collection (District Research Committee) (Winter 2008-Spring 2009)	Integrity Checklist 1. Overview 2. Data Collection Procedures	Teacher Consent Form Parent Consent Form Child Assent Form BRIEF- Parent/Teacher ABAS-II Parent/Teacher TEA-Ch protocol

Recruitment of schools for participation. The district currently houses 64 elementary schools. Each of the principals from these schools were contacted by the primary investigator to participate either via email or phone. However, only seven (10.9%) principals agreed to allow their teachers to participate. All teachers designated to 3rd through 5th grade classes were contacted by the primary investigator or school psychologist either in person, via telephone, or through email and invited to participate after permission from the principals of each school was obtained. From 79 eligible 3rd through 5th grade teachers, 17 agreed to participate (21.5%). Teachers were selected based on voluntary participation and also based on whether students enrolled in their classrooms met inclusion/exclusion criteria according to age, duration of enrollment, presence of any handicapping conditions, and native language spoken by the parents/caregivers and students. Teachers were requested to select eligible students according to inclusion and exclusion criteria as predetermined for this study to send home consent forms. Only those students returning parent consent forms were included in the study. Only one parent declined to participate in the study (2%).

Teachers were consulted regarding the best approaches for collecting information from parents/caregivers, and the times most convenient for the researcher to collect rating forms, and consent forms from the teachers. After the investigator consulted with teachers, standard procedures were developed and followed throughout the data collection process and across all sites. Modes of communication consisted of sending letters home with students via teachers in the morning and afternoons during drop off and pick up times. When letters, consent forms and rating packets were completed and returned, teachers from each of the sites were requested to contact the investigator via

email or through direct communication. Preparatory to receiving data forms, the investigator then contacted the chairperson of the Research Committee via intra-district courier who was designated to receive all consent forms and behavior rating forms from teachers via intra-district courier.

Parent data collection. Parental consent forms were provided to consenting classroom teachers and distributed to parents/caregivers who were nominated by their teachers according to the caregiver and student inclusion criteria for participation in this study. The consent forms reiterated confidentiality of all responses and further stated that the purpose of data collection was strictly for research use. Parents/caregivers were then asked to return consent forms to their child's classroom teacher. All rating scales were requested for completion by one parent, legal guardian, or primary caregiver per child participant. Consenting parents/caregivers were sent a packet through means of the classroom teacher, which included the ABAS-II Parent and the BRIEF Parent version forms. All rating scales were counterbalanced to decrease possible bias resulting from order effects. Parents of students who were assigned an even number in the database were instructed to fill out the ABAS-II first while parents and teachers of students assigned an odd number were instructed to first complete the respective BRIEF version. The completion time was predicted to range from 20-30 minutes for the completion of both rating scales. All sets of child measures were requested for completion within a two-week span and the investigator arranged for the completed forms to be sent to the chairperson of the Research Committee via intra-district courier. If parents/caregivers giving consent to participate in the study did not return rating scales by the due date indicated in the cover letter, an additional letter was sent out as a reminder. All parents/caregivers

returning completed behavior rating forms were given a \$10 Wal-Mart gift card as a token of appreciation for their time and input.

Teacher data collection. Teachers received the ABAS-II Teacher, and the BRIEF teacher versions to complete for children for whom parental consent was obtained. Rating scales were counterbalanced in a similar fashion through procedures described above for parents. The completion time for teachers was predicted to range from 20-30 minutes. All sets of child measures were requested for completion within a two-week span and the investigator arranged for the completed forms to be sent to the chairperson of the Research Committee via intra-district courier. Teachers were given a \$10 Wal-Mart gift card for each set of behavior rating forms completed (one per student).

Student data collection. Informed written assent was obtained the day of the TEA-Ch administration. During this time, the investigator, who completed all test administrations, picked the child up from his/her classroom and walked them down to the predetermined testing area (e.g., office, library, conference room, etc.). The research project was introduced to the student and they were asked whether they were interested in participating. If interest was expressed, the investigator proceeded to obtain assent, which consisted of reviewing the entire protocol of the study, obtaining signatures authorizing assent, explaining confidentiality, and answering any questions that arose. Students received a copy of the assent form. The total time estimated for the administration of the nine subtests of the TEA-Ch (Form A) was proposed to be approximately 20 minutes. Students were given the opportunity to ask questions throughout the testing as well as to take breaks. In addition, students were provided the opportunity to terminate testing if

they wished to do so without experiencing any repercussions. None of the students opted to terminate testing and all components of the TEA-Ch were administered in one session.

Integrity Checklist. Data collection steps and integrity were measured by the Integrity Checklist (see Appendix C). This checklist described and outlined the individual steps required in the distribution and collection of protocols, rating scales, and consent/assent forms. This reference form was posted on the front of each packet including teacher and parent/caregiver rating forms. In composing the Integrity Checklist, each step of the data collection process was broken down and individual steps were analyzed and defined. Individual steps were defined in terms of adherence (were the correct data collected from the appropriate individual) and quality (were the data collected as planned in the order planned). The primary investigator designated that all steps would be adhered to and implemented in the order designated for acceptable treatment and test administration integrity. All study materials were collected by the district Research Committee and once each step of the process was completed and checked off on the Integrity Checklist, completed scales were sent via courier to the designated individual. The Research Committee documented and tracked all forms received through means of an electronic spreadsheet, which was continually updated. This dataset was sent to the primary investigator to ensure accuracy of tracking. Furthermore, each TEA-Ch administration was completed by the primary investigator. Overall, a high level of consistency and integrity was maintained across the data collection phase as evidenced by electronic tracking, consistent test administration, and reference to the Integrity Checklist.

Scoring of Protocols. Teachers were requested to briefly review parent and teacher completed rating forms to ensure that all questions were completed. On two occasions parent completed rating forms were returned home due to skipped items. Thus, this initial checking method ensured that none of the data had to be thrown out due to missing data. All scores obtained on the protocols were entered into a database according to an assigned student number. All of the rating scales and TEA-Ch assessments were originally scored and re-scored by the primary investigator. However, to ensure the highest level of integrity of scoring procedures and to obtain inter-rater reliability, 25% of the protocols were also randomly selected and re-scored by a licensed school psychologist. Inter-rating reliability was generated through calculation of Cohen's kappa coefficient (Agreements/Agreements + Disagreements) (Cohen, 1960). Only scores producing 100% agreement according to the inter-rater reliability formula were included in this study. In cases where 100% agreement failed to be attained protocol noted that the data would be re-scored by both raters until this level of agreement was achieved. All data that were collected for the purpose of this study reached 100% agreement as demonstrated by equivalent scores acquired from both raters.

Data Analyses

The primary objective of this current study was to determine if an individually administered measure of attention and report forms of executive function and social/adaptive functioning are significantly related. In addition, this study examined the ability of the TEA-Ch and its separate factors to predict outcomes representative of executive function behaviors and social/adaptive functioning. The analyses were conducted separately for teacher and parent measures to examine the relationship

between the sets of variables of the BRIEF and the corresponding version of the ABAS-II. Separate analyses were conducted for all relationships between the BRIEF-Parent Form and the ABAS-II Parent/Caregiver version and between the BRIEF-Teacher Form and ABAS-II Teacher version. For all analyses in this study, the significance level was preset to $p < .05$.

Internal Reliability

In order to assess the reliability of scores on the BRIEF, ABAS-II and the TEA-Ch the reliability estimates of internal consistency were calculated. In situations where multiple raters are requested, an approach to computing a consistency estimate of interrater reliability is to compute Cronbach's alpha coefficient (Stemler, 2004) which was used for this study. Cronbach's alpha coefficient is a measure of internal consistency reliability and is useful for understanding the extent to which the ratings from multiple raters measure a common dimension. If Cronbach's alpha estimate among raters is low, then this implies that the majority of the variance in the total composite score is due to error variance, and not true score variance (Stemler, 2004). The reliability coefficient will describe the degree to which the BRIEF, ABAS-II, and TEA-Ch will represent something other than measurement error. In essence, if two sets of parallel measures agree perfectly then the computed coefficient should be 1. The reliability coefficients that are provided for each of the measures estimates the correlation between the obtained scores from parents and teachers and the score on a parallel form of the measure (Glass & Hopkins, 1996). Landis and Koch (1977) suggest that coefficient values from .41–.6 are moderate, and that values above .6 are substantial. If the systems demonstrate poor reliability, then the information that is produced from the scales will not be meaningful. However, if the

scales produce strong reliabilities, the information is suggested to be much more meaningful (Glass & Hopkins, 1996). Based upon the data acquired from this study, Cronbach's alpha values ranged from .661 to .94. These scores suggest an adequate level of reliability (Field, 2009). Specific data for each assessment and rating scale are presented (Table 4).

Table 4
Cronbach's Alpha Scores for Each Questionnaire

Measure	Alpha
Subscore	Scores
Behavior Rating Inventory of Executive Function (BRIEF)	
Global Executive Composite (GEC)-Parent Form	.922*
Global Executive Composite (GEC)-Teacher Form	.878*
Adaptive Behavior Assessment System-2nd edition (ABAS-II)	
General Adaptive Composite (GAC)- Parent/Caregiver	.940*
General Adaptive Composite (GAC)- Teacher	.878*
The Test of Everyday Attention for Children (TEA-Ch)	
Sky Search (selective attention)	.661*
Score! (sustained attention)	.731*
Creature Counting (attentional control/switching)	.881*
Sky Search DT (dual task)	.721*

* indicates an adequate level of internal reliability (Aron & Aron, 1997)

Univariate and Bivariate Analyses

For each measure, descriptive data were collected and provided for the entire sample population. The mean, median, standard deviation, skewness and kurtosis values of scores on the three measures are reported in tabular form. Procedures to screen for outliers and linear relationships were instituted through preliminary data checking methods. Bivariate (Pearson's coefficient) zero-order correlation coefficients between all

variables included in the study were examined. In addition, data were run through a statistical program with and without the inclusion of all possible outliers. This was to ensure that outlier values were not due to coding errors.

Descriptive data for each measure are provided (Table 5). In order to ascertain that the distribution of scores was approximately normal, values of skewness and kurtosis were examined. As indicated below the majority of kurtosis values were computed to fall near zero. Typically, positive values of skewness indicate an abundance of low scores in the distribution whereas negative values indicate a buildup of high scores. Similarly, positive values of kurtosis indicate a pointy and heavy-tailed distribution, whereas negative values indicate a flat and light-tailed distribution (Field, 2009). The further the value is from zero, the more likely that the data are not normally distributed. After converting scores to z-scores (dividing by standard error), the majority of values were determined to fall below the critical value $z \pm 1.96$, with the exception of the BRIEF-Parent (GEC) which was slightly leptokurtic. Overall, kurtosis values in the residuals were not indicated to be significant thus, results inform a relatively normal distribution.

Table 5

Sample Sizes, Means, and Standard Deviations of Variables

	Mean	SD	Skewness	Kurtosis	Min	Max
Score!	9.38	3.68	-.141	-.845	2	15
Sky Search	10.33	2.68	-.026	-.124	5	16
Creature Counting	9.83	3.30	-.490	.074	1	15
Sky Search DT	6.67	3.62	-.133	-1.180	1	13
BRIEF-Parent (GEC)	56.58	11.69	.035	-1.258	35	77
BRIEF-Teacher (GEC)	58.56	11.48	.302	-.495	41	86
ABAS-II-Parent (GAC)	97.71	12.89	.145	-.803	74	120
ABAS-II-Teacher (GAC)	105.48	11.50	-.678	-.485	80	120

Note N=48

Multiple Regression Analysis

Multiple regression and correlation techniques were applied to answer the proposed research questions. Interaction effects and main effects were examined in order to determine whether specific independent variables had an effect on the dependent variables of attention, behaviors of executive function, and social/adaptive behavior. A complete description of the statistical procedures for each research question is presented below.

Research Question 1: What is the relationship between attention and executive function behaviors as determined by the correlation between subcomponent(s) of attention (sustained, selective, shifting/attentional control) and executive function behaviors? Separate multiple regression analyses were conducted to determine if there was a relation between each subcomponent of attention with parent/caregiver and teacher ratings of behaviors informing executive functions. Before conducting the analyses, assumptions of multiple regression analysis were considered including independence and collinearity. Data were graphed to determine linearity. The general purpose of multiple regression is to examine the relationship between several independent or predictor variables and a dependent or criterion variable (Glass & Hopkins, 1996). Customarily, the degree to which two or more predictors (independent or X variables) are related to the dependent (Y) variable is expressed in the correlation coefficient R . In multiple regressions, R can assume values between 0 and 1 (Glass & Hopkins, 1996). Thus, according to the research questions proposed, data analyses evaluated whether the TEA-Ch scores were able to significantly predict variance in scores representative of executive function behaviors as rated by parents/caregivers and teachers.

Research Question 1a: A correlational design and separate multiple regression analyses were conducted for each subcomponent of attention (selective, sustained, shifting/attentional control). The predictor variables were scaled subtest scores from the TEA-Ch (selective, sustained, shifting/attentional control subcomponents) derived from child performance. The outcome variable for each of the analyses was the Global Executive Composite (GEC), BRIEF-Parent form.

Research Question 1b: A correlational design and separate multiple regression analyses were conducted for each subcomponent of attention (divided, shifting/attentional control, sustained). The predictor variables were scaled subtest scores from the TEA-Ch (devoted to selective, sustained, shifting/attentional control subcomponents) derived from child performance. The outcome variable for each of the analyses was the Global Executive Composite (GEC), BRIEF-Teacher form.

Research Question 2: What is the relationship between attention and social/adaptive functioning as determined by the correlation between subcomponent(s) of attention (sustained, selective, shifting/attentional control) and social/adaptive functioning? The ecological validity of the TEA-Ch scores was determined by assessing its ability to predict social/adaptive functioning in a sample of school age children. As such, the greater the predictive power of the TEA-Ch, the greater the ecological validity as defined in this study.

Research Question 2a: A correlational design and separate multiple regression analyses was conducted for each subcomponent of attention (devoted to selective, sustained, shifting/attentional control). The predictor variables were scaled subtest scores from the TEA-Ch (selective, sustained, shifting/attentional control subcomponents)

derived from child performance. The outcome variable for each of the analyses was the Global Adaptive Composite score (GAC) obtained on the ABAS-II Parent/Caregiver version.

Research Question 2b: A correlational design and separate multiple regression analyses were conducted for each subcomponent of attention (selective, sustained, shifting/attentional control). The predictor variables were scaled subtest scores from the TEA-Ch (devoted to selective, sustained, shifting/attentional control subcomponents) derived from child performance. The outcome variable for each of the analyses was the Global Adaptive Composite score (GAC) obtained on the ABAS-II Teacher version.

Research Question 3: What is the relationship between executive function behaviors, and social/adaptive functioning? In order to determine the extent to which ratings on the BRIEF-Parent and Teacher Forms were related with the ABAS-II Parent/Caregiver and Teacher versions a correlational matrix was constructed. Values from this analysis determined the relationship between index scores obtained from the BRIEF composed of the Metacognition Index (MI), Behavioral Regulation Index (BRI), and the GAC of the ABAS-II. This particular analysis examined the overall significance of the relationship between specific executive function behaviors and social/adaptive functioning and examined whether the overlap between the instruments were greater than that expected by chance.

Research Questions 4: How does the relationship between attention, executive function behaviors, and social/adaptive functioning differ (if any) by gender? The question of the statistical significance of main effect and interaction for gender and each of the dependent variables was examined by means of an *F*-test. Interaction effects are

often referred to as moderator effects because the interacting third variable, which changes the relation between two original variables, is a moderator variable, which can alter the original relationship (Field, 2009). This analysis was conducted to examine whether the performance of males to females on child performance of attention and teacher and parent/caregiver measures differed.

Research Question 4a: The influence of gender on dependent measures was individually tested by examining the interaction effect between attentional performance as measured by the scaled subtest scores derived on the TEA-Ch and parent/caregiver ratings on the GEC, GAC, respectively.

Research Question 4b: The influence of gender on dependent measures was individually tested by examining the interaction effect between attentional performance as measured by the scaled subtest scores derived on the TEA-Ch and teacher ratings on the GEC, GAC, respectively.

Chapter 4

Results

The purpose of this chapter is to provide the results of data analyses that were conducted to answer the research questions. Data analysis, data screening, considerations of assumptions and results are presented in this chapter. The relationship between attention and executive function behaviors as determined by the correlation between subcomponents of attention (sustained, selective, shifting/attentional control), and executive function behaviors are presented. The variables used to assess this relationship included the subtest scores from the TEA-Ch, BRIEF-Parent (GEC), and BRIEF-Teacher (GEC).

The dimensions of attention on the TEA-Ch are model-based and theory-driven. Specific subtests from the TEA-Ch battery were ascribed to different attentional factors determined by a structural equation model to provide support for its validity with the three-factor model giving a close fit to the data (Heaton et al., 2001). The Score! subtest was identified as a measure of “sustained attention,” which describes attention that requires the active maintenance of a particular response set under conditions of low environment support (e.g., when there are few triggers to the relevant behavior, when the task lacks interest or reward) (Manly et al., 2001). The Sky Search subtest was associated with “selective attention,” which is designed to assess the child’s ability to attend to target stimuli in the presence of distracters (Heaton et al., 2001). The Creature Counting

subtest was purported to measure “attentional control/shifting attention,” and is associated with switching from one task or mental set to another (Manly et al., 2001). Lastly, the Sky Search DT task was presented as a measure of dual “sustained attention,” and “attentional control/shifting attention.” According to past research, performance decrements under dual task conditions tend to form sensitive measures of neurological impairment and thus the TEA-Ch combines two of its subtests for such purposes (Manly et al., 2001).

Pearson Product-Moment Correlation coefficients (PPMCC) were calculated to measure the relationships between the dependent variables and child performance on the TEA-Ch. The variables found to be significantly correlated with the GEC score from the BRIEF-Parent were the subtest scores from Sky Search ($r=-.331$, $p=.05$), Score! ($r=-.289$, $p=.05$), and Creature Counting ($r=-.424$, $p<.01$). Furthermore, the variables that were found to be significantly correlated with the GEC score from the BRIEF-Teacher were the subtest scores from Sky Search ($r=-.302$, $p=.05$), Score! ($r=-.482$, $p<.01$), and Creature Counting ($r=-.537$, $p<.01$) (Table 6). Teacher ratings of executive functions were most highly correlated with child performance on tasks assessing components of sustained attention and shifting/attentional control.

Table 6

Intercorrelations Between TEA-Ch Subcomponents and BRIEF-Parent and Teacher (GEC) Forms

Variable	1	2	3	4	5	6
<i>TEA-Ch Subcomponents</i>						
1 Sky Search		.361*	.387**	.093	-.331*	-.302*
2 Score	.361*		.37**	.232	-.289*	-.482**
3 Creature Counting	.387*	.37*		.607**	-.424**	-.537**
4 Sky Search DT	.093	.232	.607**		.039	-.135
<i>BRIEF(GEC)</i>						
5 BRIEF-Parent (GEC)	-.331*	-.289*	-.424**	.039		-.572**
6 BRIEF-Teacher (GEC)	-.302*	-.482**	-.537**	-.135	.572**	

Note N=48

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Data screening. Next, a multiple regression analysis was conducted to assess the relative contribution of each variable to the total GEC scores from the BRIEF-Parent and BRIEF-Teacher while holding all other variables constant. Assumptions of regression analysis were reviewed prior to running the analyses. Regression is relatively robust to the assumption that the predictor variables are fixed. The scales that were used to measure the predictor variables were determined to have adequate reliability levels as previously indicated. Furthermore, Variance Inflation Factors (VIF), which indicates whether a predictor has a strong linear relationship with the other predictors, were examined in the assessment of multicollinearity and values were not noted to approach or exceed ten providing support that collinearity was valid for this model (Myers, 1990). In addition, examination of the correlation matrix did not indicate substantial correlations between predictors ($r > .9$) which is also indicative of violation of multicollinearity.

Cook's distance ranged from .000 to .121, and .000 to .276 suggesting that outliers did not significantly influence the results of either data analysis. Finally, the Durbin-Watson statistic was generated which informs whether the assumption of independent errors is tenable. According to the acquired data, the generated Durbin-Watson statistics were 1.47 and 1.863, which falls in between the recommended guidelines of 1 and 3 (Field, 2009). Results implied that all the variables included in the model were properly measured. In addition, each of the predictor variables and the associated residuals were understood to be independent in the population and both of the estimates of regression coefficients and the significance tests were unbiased. The normality assumption was investigated by examining histograms and corresponding p-p plots of standardized residuals for linearity and homoscedacity (constant variance of residual terms at each level of predictor variables) (Field, 2009). Each histogram and the accompanying p-p plot demonstrated that the normality assumption for each predictor variable was not violated.

Research Questions

Research Question 1a. All of the TEA-Ch subtest scores were included in the regression model in order to determine which subcomponents of attention contributed substantially to the model's ability to predict BRIEF-Parent GEC scores. Results indicated that TEA-Ch subtest scores accounted for 35% of the variance in the total GEC score of the BRIEF-Parent ($R^2=.346$, R -adj. =.285, $F(4, 43) = 5.675$, $p < .001$). This analysis revealed that Creature Counting and Sky Search DT contributed significantly to the variability of BRIEF-Parent GEC scores (Table 7). Thus, parent ratings of executive functions were most predicted by measures assessing attentional control/shifting attention and a dual task combining sustained attention and selective attention.

Consequently, a forward stepwise multiple regression analysis was conducted using these two predictors to define the subsequent regression model. Creature Counting accounted for 18% of the variation in BRIEF-Parent GEC scores. When Sky Search DT scores were included this value was increased to 31.8% indicating that the dual task of sustained and selective attention accounted for an additional 13% of the variation in parent ratings of executive function behaviors (Table 8).

Table 7

Multiple Regression Examining the Relationship of Each TEA-Ch Variable to BRIEF-Parent GEC Scores While Holding All Other Variables Constant

Variable	Unstandardized Coefficients		Standardized Coefficients		
	Regression Coefficient (β)	Standard Error	Regression Coefficient (β)	t-value	Sig.
(Constant)	76.188	6.37		11.956	.000
Sky Search Score!	-.376	.617	-.086	-.609	.546
Creature Counting	-.431	.438	-.136	-.986	.33
Sky Search DT	-2.175	.615	-.614	-3.539	.001†
	1.457	.512	.451	2.846	.007†

Note N=48

† indicates significance at the $\alpha=.05$ level

Table 8

Forward Stepwise Multiple Regression Examining the Relationship of Creature Counting and Sky Search DT to BRIEF-Parent GEC Scores

Outcome Variable	Predictor Variable(s)	R^2 , Adjusted R^2	F-statistic, Probability
BRIEF-Parent GEC	Creature Counting	$R^2 = .18$, Adj. $R^2 = .162$	$F(1, 46) = 10.071$, $p = .003$
	Sky Search DT	$R^2 = 0.318$, Adj. $R^2 = .288$ R^2 change = .139	$F(1,45) = 9.169$, $p = .004$

Note N=48

Research Question 1b. In order to examine the ability of TEA-Ch subtest scores to predict teacher ratings of executive function behaviors all of the children's performance scores were included in the regression model. Performance on all subtests of attention accounted for 44% of the variance in the total teacher ratings of executive function behaviors ($R^2=.441$, R -adj. =.389, $F(4, 43) = 8.487$, $p < .001$). The results of the multiple regression analysis revealed that three independent variables (Score!, Creature Counting, and Sky Search DT) contributed significantly to the variability of BRIEF-Teacher GEC scores (Table 9). Overall, tasks of sustained attention, attentional control/shifting attention, and a dual task combining these tasks of attention accounted for the greatest degree of predictability in teacher ratings.

A forward stepwise multiple regression analysis was conducted using these three predictors to define the subsequent regression model. Creature Counting, which assesses attentional control/shifting attention, accounted for 28.8% of the variation in BRIEF-Teacher GEC scores. Furthermore, when the Score! subtest scores associated with sustained attention were included, this value increased to 38.1% accounting for an additional 9.3% of the variability in teacher ratings of executive function behaviors. Lastly, when the Sky Search DT subtest scores, representing a measure of dual attention, were included results accounted for an additional 5.9% of the variability in teacher ratings (Table 10).

Table 9

Multiple Regression Examining the Relationship of Each TEA-Ch Variable to BRIEF-Teacher GEC Scores While Holding All Other Variables Constant

Variable	Unstandardized Coefficients		Standardized Coefficients		
	Regression Coefficient (β)	Standard Error	Regression Coefficient (β)	<i>t</i> -value	Sig.
(Constant)	81.672	5.782		14.125	.000
Sky Search	.118	.56	.028	.211	.834
Score!	-1.057	.397	-.338	-2.662	.009†
Creature Counting	-2.128	.558	-6.12	-3.816	.000†
Sky Search DT	.991	.464	.313	2.134	.0363†

Note N=48

† indicates significance at the $\alpha=.05$ level

Table 10

Forward Stepwise Multiple Regression Examining the Relationship of Creature Counting and Score! to BRIEF-Teacher GEC Scores

Outcome Variable	Predictor Variable(s)	R^2 , Adjusted R^2	<i>F</i> -statistic, Probability
BRIEF-Teacher GEC	Creature Counting	$R^2 = .288$, <i>Adj. R</i> ² = .273	$F(1, 46) = 18.606$, $p < .001$
	Score!	$R^2 = 0.381$, <i>Adj. R</i> ² = .354 R^2 change = .093	$F(1,45) = 6.788$, $p = .012$
	Sky Search DT	$R^2 = 0.441$, <i>Adj. R</i> ² = .402 R^2 change = .059	$F(1,44) = 4.663$, $p = .036$

Note N=48

Research Question 2a. The relationship between attention and social/adaptive functioning was examined by computing a correlation matrix between subcomponent(s) of attention (sustained, selective, shifting/attentional control) and social/adaptive functioning. The variables used to explore this relationship included four subtest scores from the TEA-Ch and ABAS II-Parent/Caregiver (GAC). Pearson Product-Moment Correlation coefficients (PPMCC) were calculated to measure the relationships between the dependent variables and child performance on the TEA-Ch. The variables found to be significantly correlated with the GAC score from the ABAS-II-Parent/Caregiver were the subtest scores from Sky Search ($r=.356$, $p=.05$), and Creature Counting ($r=.396$, $p<.01$). Parent ratings of social/adaptive functioning were most highly associated with tasks representing selective attention and attentional control/shifting attention.

Initially, all of the TEA-Ch subtest scores were included in the regression model. However, only scores obtained from the Creature Counting subtest significantly contributed to the variability of parent ratings of social/adaptive functioning behaviors. This finding notes a high degree of predictability from child performance on tasks assessing attentional control/shifting attention. A linear regression analysis revealed that Creature Counting was a significant predictor of parent social/adaptive functioning scores ($\beta = .387$, $p = .048$), accounting for 16% of the variance in the total ABAS-II-Parent/Caregiver GAC scores ($R^2=.156$, $F(4, 43) = 2.925$, $p<.001$) (Table 13). Therefore, child performance on a measure of attentional control/shifting attention was identified to have the greatest ability to predict measures of parent ratings of social/adaptive functioning and skills related to daily living.

Table 11

Intercorrelations Between TEA-Ch Subcomponents and ABAS-II-Parent/Caregiver and Teacher (GAC) Versions

Variable	1	2	3	4	5	6
TEA-Ch Subcomponents						
1 Sky Search		.361*	.387**	.093	.356*	.204
2 Score	.361*		.77**	.232	.188	.631**
3 Creature Counting	.397**	.37**		.607**	.396**	.522**
4 Sky Search DT	.093	.232	.396**	.132		.189
ABAS-II (GAC)						
5 ABAS-II-Parent/Caregiver	.356*	.188	.396**	.132		.189
6 ABAS-II-Teacher	.204	.631**	.522**	.278	.189	

Note N=48

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Table 12

Multiple Regression Examining the Relationship of Each TEA-Ch Variable to ABAS-II Parent/Caregiver GAC Scores While Holding All Other Variables Constant

Variable	Unstandardized Coefficients		Standardized Coefficients		
	Regression Coefficient (β)	Standard Error	Regression Coefficient (β)	t-value	Sig.
(Constant)	75.028	7.7		9.744	.000
Sky Search	1.057	7.46	.219	1.415	.164
Score!	-2.24E-02	.529	-.006	-.042	.966
Creature Counting	1.512	.743	.387	2.035	.048†
Sky Search DT	-.435	.619	-.122	-.703	.486

Note N=48

† indicates significance at the $\alpha=.05$ level

Table 13

Forward Stepwise Multiple Regression Examining the Relationship of Creature Counting to ABAS-II-Parent/Caregiver GAC Scores

<i>Outcome Variable</i>	<i>Predictor Variable(s)</i>	<i>R², Adjusted R²</i>	<i>F-statistic, Probability</i>
ABAS-II-Teacher GAC	Creature Counting	R ² = .156 Adj. R ² = .138	F(4, 43) = 2.925, p < .001

Note N=48

Research Question 2b. The relationship between attention and social/adaptive functioning was examined by computing a correlation matrix between subcomponent(s) of attention (sustained, selective, shifting/attentional control) and social/adaptive functioning. The variables used to explore this relationship included four subtest scores from the TEA-Ch and ABAS II-Teacher (GAC). Pearson Product-Moment Correlation coefficients (PPMCC) were calculated to measure the relationships between the dependent variables and child performance on the TEA-Ch. The variables found to be significantly correlated with the GAC score from the ABAS-II-Teacher were the subtest scores from Score! ($r=.631$, $p<.01$), and Creature Counting ($r=.522$, $p<.01$). Teacher ratings of social/adaptive functioning were most highly associated with tasks representing sustained attention and attentional control/shifting attention (Table 11).

Once again, a multiple regression analysis was conducted to assess the relative contribution of each variable to the total GAC score from the ABAS-II-Teacher and the four subtest scores from the TEA-Ch while holding all other variables constant. Assumptions of regression analysis were again reviewed prior to running the analyses. VIF values were examined and collinearity was determined to be tenable (Myers, 1990). In addition, the correlation matrix did not indicate substantial values between predictors ($r >.9$). Cook's distance values ranged from .000 to .28, and from .000 to .211 suggesting

that outliers did not significantly influence the results of either data analysis. Finally, the Durbin-Watson statistics generated values of 2.299 and 1.07 which falls in between the recommended guidelines (Field, 2009) indicating that this assumption was met for both analyses. Histograms and normal probability plots were also examined for linearity and homoscedacity. Data indicated favorable conditions allowing the analyses to proceed without violation of assumptions.

All of the TEA-Ch subtest scores were simultaneously included in the regression model and accounted for 52% of the variance in the total GAC score of the ABAS-II-Teacher ($R^2=.515$, R -adj. $=.47$, $F(4, 43) = 11.424$, $p < .001$). The results of the multiple regression revealed that the Score!, ($r = .631$, $p < .01$) and Creature Counting ($r = .522$, $p < .01$) subtests significantly contributed to the variability of teacher ratings of social/adaptive functioning behaviors (Table 14). These components of attention are associated with sustained attention and attentional control/shifting attention. The stepwise forward multiple regression analysis using these two predictors indicated that Creature Counting accounted for 28.8% of the variation of teacher ratings of social/adaptive functioning indicating the importance of attentional control/shifting attention in accounting for the variability of teacher ratings. When Score! subtests scores were included, this value increased to 35.4% thus noting components of sustained attention to account for an additional 9.3% of the variation in teacher ratings of social/adaptive functioning (Table 15). However, it should be noted that in the review of histograms for the residuals as well as normal probability plots data indicated non normal distribution of the residual values. Although most tests (specifically the F-test) are quite robust with

regard to violations of this assumption, conclusions should be interpreted with caution and limitations to generalization of data are applicable.

Table 14

Multiple Regression Examining the Relationship of Each TEA-Ch Variable to ABAS-II Teacher scores GAC Scores While Holding All Other Variables Constant

Variable	Unstandardized Coefficients		Standardized Coefficients		
	Regression Coefficient (β)	Standard Error	Regression Coefficient (β)	t-value	Sig.
(Constant)	83.384	5.391		15.468	.000
Sky Search	-.666	.533	-.155	-1.276	.209
Score!	1.71	.37	.547	4.62	.000†
Creature Counting	1.536	.52	.441	2.954	.005†
Sky Search DT	-.323	.433	-.102	-.747	.459

Note N=48

† indicates significance at the $\alpha=.05$ level

Table 15

Forward Stepwise Multiple Regression Examining the Relationship of Score! and Creature Counting to ABAS-II-Teacher GAC Scores

Outcome Variable	Predictor Variable(s)	R^2 , Adjusted R^2	F-statistic, Probability
ABAS-II-Teacher GAC	Creature Counting	$R^2 = .288$, Adj. $R^2 = .273$	$F(1, 46) = 18.606$, $p < .001$
	Score!	$R^2 = 0.381$, Adj. $R^2 = .354$ R^2 change = .093	$F(1,45) = 6.788$, $p = .012$

Note N=48

Research Question 3. The relationship between executive function behaviors, and social/adaptive functioning was also explored. The variables used to examine the strength of this relationship included the index scores from the BRIEF-Parent, BRIEF-Teacher (MI, BRI), ABAS II-Parent/Caregiver, and ABAS-II Teacher (GAC) scores. Pearson Product-Moment Correlation coefficients (PPMCC) were calculated to measure the relationships between the dependent variables and indexes of the BRIEF. Both index scores from the BRIEF-Parent forms were found to be significantly correlated with the GAC scores from the ABAS-II-Parent/Caregiver. Results indicated correlations with the MI ($r=-.374$, $p<.01$), and BRI ($r=-.286$, $p=.05$) (Table 16) scores. Furthermore, all variables from the BRIEF-Teacher were also found to be significantly correlated with the GAC scores from the ABAS-II-Teacher. Results from this correlational analysis also indicated MI ($r=-.527$, $p<.01$), and BRI ($r=-.525$, $p<.01$) parent rating scores to correlate highly with ABAS-II Teacher ratings. Although ABAS-Parent/Caregiver GAC scores were not significantly correlated with either of the teacher ratings from the BRIEF, the ABAS-II Teacher scores were significantly correlated at the $p<.01$ level for the BRIEF-MI Teacher ($r=-.673$), and BRIEF-BRI Teacher ($r=-.513$) (Table 16).

Table 16

Intercorrelations Between ABAS-II-Parent/Caregiver and Teacher (GAC) Versions and BRIEF-MI and BRI Parent/Teacher Forms

	BRIEF-MI Parent	BRIEF-BRI Parent	BRIEF-MI Teacher	BRIEF-BRI Teacher
<i>ABAS-II (GAC)</i>				
ABAS-II-Parent/Caregiver	-.374**	-.286*	-.168	-.181
ABAS-II-Teacher	-.527**	-.525**	-.673**	-.513**

Note N=48

**Correlation is significant at the 0.05 level (2-tailed)*

***Correlation is significant at the 0.01 level (2-tailed)*

Research Questions 4. The effect of gender on the performance of assessments purported to measure components of attention was explored. The statistical significance of main effect and interaction for gender and each of the dependent variables were examined by means of a multivariate analysis of variance (MANOVA) to compare the subtests scores from the TEA-Ch as achieved by males to the performance of females.

Data Analysis

Multivariate analysis of variance (MANOVA) was selected for data analysis to determine if the groups differed significantly on the set of dependent variables. MANOVA incorporates information about several outcome measures and therefore informs of whether groups of participants can be distinguished by a combination of scores earned on several dependent measures (Field, 2009). Furthermore, an advantage of MANOVA analysis is that it allows the researcher to gain power, which may detect differences that univariate analyses alone may not detect. The null hypothesis was posed to communicate no significant differences existing between performances according to gender. The significance level was preset to $p < .05$.

Descriptive statistics. The dependent variables that were examined include child performance on the subtests of the TEA-Ch. Differences across these subtests were examined across gender. Means and standard deviations of each dependent variable by group and of the whole sample ($N=48$) are presented (Table 17).

The results of the MANOVA were significant at the $\alpha=.05$ level ($\Lambda =.728$, $F(4, 43) =4.01$, $p<.05$), indicating a significant effect of gender on performance of subtests on the TEA-Ch. Furthermore, based upon results from the Box's M Test of Equality of Covariance Matrices, the equality of variances assumption was considered to be tenable (Box's $M=15.503$, $F(10,9945.813)=1.403$, $p=.172$), noting that the F value calculated by the MANOVA is considered robust thus not likely contributing to Type I error. Furthermore, Levene's Test of Equality of Error Variances was not significant for any of the dependent variables thus the assumption of equality of covariance matrices was met.

Table 17

Means and Standard Deviations for Dependent Variables by Gender

Dependent Variable	<u>Female</u> (n =25)	<u>Male</u> (n =23)	<u>Total</u> (n=48)
TEA-Ch			
Sky Search	9.56(2.53)	11.17(2.62)	10.33(2.68)
Score!	8.56(4.09)	10.26(3)	9.37(3.768)
Creature Counting	10.28(3.52)	9.35(3.05)	9.83(3.3)
Sky Search DT	6.52(3.34)	6.83(3.97)	6.67(3.62)

Note $N=48$

**Note: Standard Deviations in parentheses*

ANOVA Results. Given the significant results of the MANOVA, post hoc analyses were conducted in the form of separate univariate analysis of covariance (ANOVA) with the outcome variables. Post hoc t tests were conducted to assess for individual differences

between groups on each measure while accounting for the difference in-group variances. A modified Bonferroni was utilized while examining the significance of the t scores. The significance value for these analyses was set to $p < .025$ to maintain a conservative estimate of statistical significance with two groups. However, results noted that none of the ANOVA analyses were found to be statistically significant at the adjusted level (Table 18). Overall, results informed that the null hypothesis could not be rejected and significant differences between scores based on gender could not be obtained on the TEA-Ch subtests.

Table 18
Results of ANOVA for Each Dependent Variable

	Source	Sum of Squares	Mean Square	F-value	p
Sky Search	Model	31.202	31.202	4.699	0.035
	Error	305.464	6.641		
	Corrected Total	635.25			
Score!	Model	34.655	34.655	2.654	0.11
	Error	600.595	13.056		
	Corrected Total	635.25			
Creature Counting	Model	10.409	10.409	.953	0.334
	Error	502.257	10.919		
	Corrected Total	512.667			
Sky Search DT	Model	1.122	1.122	.084	0.773
	Error	615.544	13.381		
	Corrected Total	616.667			

Note N=48

Summary

This chapter described the data analysis, screening, and results in the exploration of the ability of specific components of attention to predict executive function behaviors and social/adaptive functioning. In brief, results of multiple regression and correlational analyses revealed child performance on specific measures of attention predict executive function and social/adaptive functioning behaviors. As parent/caregiver and teacher ratings of executive function behaviors increased, child performance on measures of selective attention, sustained attention, and attentional control/shifting were reported to improve. Results indicate that children with highly rated acquisition and implementation of executive function behaviors possess a greater number of skills related to shifting cognitive set, modulating their emotions and exhibiting inhibitory control, and systematic problem solving.

Furthermore, children were also rated to have higher tendencies to initiate, plan, organize, and sustain future-oriented problem solving in working memory, behaviors associated with the MI index of the BRIEF. Measures purported to assess attentional control/shifting attention (e.g., Creature Counting), and simultaneous assessments of sustained attention and selective attention (e.g., Sky Search DT) were able to account for a significant amount of the variability of parent/caregiver ratings of executive functions. Similarly, sustained attention and simultaneous sustained and selective attention measures were also noted to predict higher teacher ratings of executive functions. Finally, a sole measure of sustained attention (e.g., Score!) was identified as a critical predictor in teacher ratings.

Based on parent/caregiver ratings of social/adaptive functioning, children who were noted to perform a greater number of independent living skills earned increasingly adept scores on measures of selective attention and attentional control/shifting attention. Teacher ratings of social/adaptive functioning indicated proficient abilities for children earning higher scores on measures of sustained attention and attentional control/shifting attention. In the use of attention measures to predict social/adaptive functioning, measures of attentional control/shifting, sustained attention, and simultaneous sustained attention and selective attention were identified as significant predictors of parent/caregiver ratings.

Furthermore, parent/caregiver and teacher ratings of executive function and social/adaptive functioning behaviors were significantly related across measures. That is, informants agreed that higher levels of executive function behaviors were related to greater acquisition and performance of daily living skills and social/adaptive functioning abilities. Finally, gender differences did not differentiate between child performance on measures of attention.

Chapter 5

Discussion

Overview of Study Objectives

Attention is a commonly used term in education, psychiatry, and psychology. It is often defined as an internal cognitive process by which one actively selects environmental information (i.e., sensation) or actively processes information from internal sources (i.e., visceral cues or other thought processes). In more general terms, attention can be defined as an ability to focus and maintain interest on a given task or idea, and that, which includes managing distractions (DeGangi & Proges, 1990).

According to some researchers, (DeGangi & Proges, 1990; Manly et al., 2001) one model of attention identifies three subcategories including selective attention, attentional control/shifting attention, and sustained attention. The TEA-Ch was designed to assess these domains of attention, which are commonly applied by children in their daily activities.

The purpose of this study was to investigate and to define better the relationship between attention and corresponding behaviors that represent executive functions and social/adaptive functioning in a normative sample of school age children. This research was initiated in hopes of providing evidence to establish the TEA-Ch as an ecologically valid instrument for use with children. The impetus for this research was the dearth of evidence-based research supporting the ecological validity of pediatric

neuropsychological assessment tools (Gioia & Isquith, 2004). Ecological validity was assessed by determining the degree to which the TEA-Ch subtests could predict important aspects of a child's everyday functioning by assessing the general strength of association to outcome domains (Gioia & Isquith, 2004). Critical to ecological validity is the concept of veridicality, the degree to which a measure predicts a particular aspect of a child's everyday functioning (Burgess et al., 1998). Thus, social/adaptive behavior and behaviors of executive function were selected as important aspects of daily functioning.

Data were collected and analyzed from a sample composed of 48 school age children ranging in age from 8-years, 0-months to 10-years, 11-months, a parent/caregiver, and his/her elementary school teacher. Rapid changes in different components of attention are known to occur in children between ages 8 to 10 years (Rebox, 1997) which define the age range of this study's sample population. This chapter provides a description of the results, interpretation, and the implications of these results as they pertain to the assessment of attention and executive functions in children. The discussion concludes with limitations of this study and recommendations for future research.

Attentional Performance and Executive Function Behaviors

(Research Questions 1a and 1b).

The results of this study suggest that attentional control/shifting attention, or the ability to switch attentional focus is the most significant predictor of executive function behavior ratings accounting for 18% and 28.8% of the variability, respectively. These findings are supported by previous researchers who report that attentional control is not only an important component of executive functions; the ability to shift often serves as a

critical underlying ability for the emergence of “*higher order*” skills such as cognitive flexibility, working memory, and self-monitoring skills (Anderson et al., 2001). For example, Blair (2002) reported that children who consistently exhibited negative emotionality were more likely to experience difficulty in the application of these “*higher-order*” cognitive processes due to their inability to shift attention away from a negative source, and practice planning and reflective problem solving in social situations. That is, emotional control may also stem, in part, for a child’s ability to shift attention away from a negative feeling or thought, in order to retain and implement skills from a set of ethical codes or principles (Feifer & Rattan, 2007). In addition, students with poor executive functioning skills have difficulties adapting their behavior to the constant changing of social circumstances, particularly where frustration and anger must be tempered for the pursuit of attaining a goal (Feifer & Rattan, 2007). Overall, studies consistently indicate that executive function skills (and specifically the ability to switch attention in a flexible manner in order to adjust one’s behavior and response) are of critical importance for establishing and maintaining socially appropriate interactions within a classroom setting. These skills allow students to self-monitor emotional impulses and to regulate motor related processes for successful adaptation to their learning environment (Feifer & Rattan, 2007).

Furthermore, in a study describing the developmental sequence of attention and executive functions in a child population ranging in age from 3 to 12 years, inhibitory functions followed by maturation of auditory and visual attention functions were noted to have developed by the age of 10 years. However, the development of fluency and shifting of attention continue into adolescence. This research provides support for the acquisition

and development of attentional control/shifting attention by teachers and parents in the selected age group. According to the research, the other components of attention including inhibition and sustained attention appear to serve as prerequisites for more complex forms of attention such as attentional control/shifting attention (Klenberg, Korman, Lahti-Nuutila, 2001).

The variability of parent/caregiver and teacher ratings of executive function behaviors was also accounted for by subtests assessing sustained attention and a dual task combining sustained and selective attention. Previous studies have noted that sustained attention is stable between the ages of 8 and 10 years but increases significantly from age 11 through adulthood which may explain the lower degree of accountability although parents/caregivers and teachers continued to endorse this component of attention to predict levels of executive functions (Rebok et al, 1997). The amount of variance accounted for by subtests of the TEA-Ch utilizing the BRIEF as an outcome measure provides a degree of support for ecological validity. Studies conducted using the BRIEF have provided compelling evidence with its use with various clinical populations (e.g., ADHD, mild and severe TBI, Autistic Spectrum Disorders, and other medical and developmental conditions) (Gilotty et al., 2002; Gioia et al., 2002). An approach to establishing the ecological of neuropsychological measures is to relate test scores in a given cognitive domain to scores on measures of everyday tasks within that same domain across situations. Measures assessing components of executive functions would be related to measures of everyday executive functioning across situations (Chaytor & Schmitter-Edgecombe, 2003). Thus, the high degree of association between the BRIEF

and TEA-Ch subtests indicate support for ecological validity using this type of approach in support of use of the TEA-Ch in examining specific components of attention.

Attentional Performance and Social Adaptive Function Behaviors

(Research Questions 2a and 2b)

Attention is a multifaceted construct that influences the efficiency of many other cognitive processes including adaptive functioning. Attention problems are likely to pose as a challenge in performing multi-step or complex adaptive tasks as a result of difficulties with processing information efficiently or inattention to details (e.g., social cues). Children with attention problems may become discouraged more easily and seek assistance from an adult. In general, neuropsychological tests have been purported to account for a significant proportion of the variance in measures of adaptive functioning and particularly tasks that involve complex cognitive processing (Price et al., 2003). Specifically, research conducted on various clinical and nonclinical child populations provide support for an association between attention deficits and adaptive functioning.

Similar to previous research (Price et al., 2003; Rebok et al., 1997), this study demonstrated a measure of attentional control/shifting to be most predictive of parent/caregiver and teacher ratings of social/adaptive functioning. In addition, a measure of sustained attention was also predictive of teacher ratings. The current study extends existing research by providing associations between adaptive behavior and specific components of attention with sustained attention and attentional control/shifting attention providing the greatest degree of predictability across teacher and parent ratings. Although previous studies have employed a number of cognitive domains in the assessment of neuropsychological functions and adaptive behavior, few if any have sampled a domain

using more than one measure or task (Price et al., 2003). Therefore, the use of the TEA-Ch in the assessment of separable components of attention and in relation to social/adaptive functioning provides further support to the literature in highlighting the importance of comprehensive assessments of one specific domain of neuropsychological functioning.

There are important implications of the association between skills of social/adaptive functioning and attention. Parent report measures have been shown to be advantageous as they offer a higher degree of ecological validity than can be easily attained with direct assessment in testing conditions (Papazoglou et al., 2009). Additionally, scores on the Attention Problems subscale of the Child Behavior Checklist (CBCL) have been shown to be significantly associated with deficits of attention on neuropsychological testing in child populations (Papazoglou et al., 2009). Thus, parent report measures of behavior might serve as an effective screen to identify children at risk for later delays in adaptive functioning so that more comprehensive evaluations may be conducted.

Executive Functions and Social/Adaptive Behavior (Research Question 3)

Significant correlations between the BRIEF MI and BRI indexes and composites of social/adaptive behavior were found across parent/caregiver and teacher ratings. ABAS-II Parent/Caregiver scores were related to parent ratings of metacognitive abilities as well as behavioral regulation but were not highly associated with teacher ratings of these same measures. Many of the individual items from the parent ABAS-II are contextually specific to the home setting (i.e., cooks his or her own food, uses a washing machine to wash clothes) and are behaviors that are characteristically far removed from

the school setting. Thus, there is little overlap across many of the behaviors assessed in the parent ABAS-II and those that a teacher may typically observe at school.

Furthermore, parents/caregivers are likely to observe children engaging in many social/adaptive functioning behaviors that exceed expectations and behaviors exhibited in the school environment.

Teacher and parent ratings of social/adaptive functioning were significantly correlated with the BRI and MI executive function indexes. The strongest correlations were between the MI indexes from both teacher and parent/caregiver ratings and the social/adaptive composite scores (GAC) as completed by the teachers. As neuropsychological measurement of executive functioning are providing information predictive of daily functioning these data may lead to more effective interventions and recommendations because clinicians will be better adept to predict the types of difficulties a child may present considering his or her own unique cluster of cognitive performance. Early neuropsychological assessment may lead to the detection and thereby prevention of emotional and behavioral consequences of executive function deficits. Suggested findings from this study may yield information that is critical in promoting specific classroom wide strategies in support of strengthening these types of skills rather than assuming natural acquisition. In practice, neuropsychologists are asked to identify functional strengths and weaknesses to translate findings into implications and predictions for the child in his or her everyday milieu.

Furthermore, pediatric neuropsychologists are often requested to assess a child's cognitive profile to inform referral questions regarding academic placement, necessary interventions and accommodations, Individualized Education Plan (IEP) goals,

implications for school and community functioning, and future behavioral and emotional developments that may be expected in the course of a child's development (Gioia & Isquith, 2004). Results from the present study imply that both indexes and scales of the BRIEF provide important data regarding the interplay between executive functions and social/adaptive functioning behaviors thus providing support from the predictive ability of executive functions as they relate to the everyday environment.

Gender Effects within TEA-Ch Measures (Research Question 4a and 4b)

Overall, no significant differences between the performance of male and female participants were identified on any task of sustained, selective, attentional control/shifting or dual task of attention. These results support previous research conducted using the TEA-Ch (Chan et al., 2008; Heaton et al., 2001). Studies of attentional capacities have produced inconsistent data although the similarities between males and females have tended to be more notable than the differences particularly in the younger and school age populations (Korkman, 2001). The few studies that have explored the component of gender are limited merely because many report results based on only one measure of attention.

Although many studies have found results similar to the findings of the current study indicating a lack of gender differences, Pascualvaca et al. (1997) noted that both gender and intelligence had an impact on performance on various tasks of attention. Their findings indicated higher level of performance by female participants on the Continuous Performance Test, Digit Cancellation task, and the Coding subtest of the WISC-R. Conclusions of this study noted that females were found to outperform males on tasks requiring focus of attention on a particular stimulus, ignoring irrelevant stimuli, and

making a rapid response. However, differences were not found in participants' capacity to shift attention as evidenced by performance on the WCST. These results should also consider the limitations of the measures used in assessing 'pure' attention as most tasks of attention and executive functions inadvertently measure more than one aspect of behavior and cognition (Manly et al., 2001). The TEA-Ch is purported to present tasks that have been designed for specifically minimizing demands on memory, reasoning, task comprehension, motor speed, verbal ability, and perceptual acuity while maintaining the demands on the targeted attentional system (Manly et al., 2001).

In addition, females are thought to mature earlier than males (Tanner, 1962) and variations in physical maturation have been associated with changes in behavior and cognitive performance. Klenberg and colleagues (2001) found significant effects of gender across all subtests of attention with females outperforming males from ages 8, 9, and 12 years of age. Gender differences in activity level and impulsivity also appear to be mediated by maturation (Pascualvaca et al., 1997). Gale and Lynn (1972) found that females made fewer errors on a vigilance task at 7, 8, and 12 years of age but did not differ from males between 9 and 11 years of age. The majority of participants that were included in the current study fall within this age range thus supporting a lack of disparity in performance on tasks related to vigilance including shifting attention and selective attention.

Furthermore, the ages at which females tend to outperform males coincide with "spurts" in brain development (Epstein, 1974; Hudspeth & Pribram, 1992) with females tending to progress faster along the developmental pathway. Other gender differences in attentional performance have reported to reflect differences in brain structure and

organization. According to this formulation, different attentional functions are supported by distinct cerebral regions. Research addressing the differences between males and females associated with cognitive abilities indicate that males have typically outperformed females on tasks of mathematical reasoning and complex visual-spatial skills whereas females consistently excelled on tasks of verbal fluency, manual dexterity, and visual scanning (Gouchie & Kimura, 1991). However, some of the brain regions involved in the support of attentional functions are not fully myelinated until adolescence, suggesting that gender differences become more pronounced at puberty. This evidence supports current findings, inasmuch as participant ages from this sample fall largely in the prepubertal stages of development (Hudspeth & Pribram, 1992; Pascualvaca et al., 1997).

Implications

Results from the current study highlight the importance of assessing executive function behaviors and separable components of attention. In regards to application of findings in the schools, interventions that enhance attention have been identified in the literature, and implementing them has led to some success in improving specific skills. Developmental psychologists are keenly aware of the importance of adapting learning environments for children with varying cognitive profiles. A fundamental premise of most neuropsychological assessment and intervention is that children present with specific strengths and weaknesses in their profiles of learning and social/adaptive functioning. In consideration of individual performance, appropriate educational programs should acknowledge and support these profiles (Waber et al., 2006). The main objective of a school psychologist working with a child and his/her family is to identify

the problem, and then develop and implement interventions with the highest likelihood of success. The results of this study may assist in developing interventions by identifying specific target variables. In some cases a detailed clinical interview or structured questionnaire may provide sufficient information to adequately answer the referral question. However, data derived from behavioral rating scales and questionnaire data only pertains to the informant's knowledge of the child's ability to cope with existing cognitive demands. Furthermore, there are many non-cognitive reasons that a child may have difficulty functioning in everyday situations including psychiatric or medical illness. Neuropsychological assessments such as the TEA-Ch can assist with uncovering whether a child's functional difficulties are a result of cognitive deficits (Chaytor & Schmitter-Edgecombe, 2003).

Evaluating the ecological validity of neuropsychological assessments has become an increasingly important research topic of research over the past decade (Chaytor & Schmitter-Edgecombe, 2003; Rabin, Burton & Barr, 2007). Ecological validity has become an especially important focus in neuropsychological assessment with particular relevance for executive functions that coordinate an individual's cognitive and behavioral capacities with real world demand situations (Gioia & Isquith, 2004). The advent of brain imaging techniques has also shifted the role of neuropsychological testing data from diagnosis of brain pathology and lesion localization to the assessment of functional capacities at home, work, school thereby elevating the importance and emphasis on generating ecologically valid measures of neuropsychological constructs (Chaytor & Schmitter-Edgecombe, 2003; Rabin, Burton & Barr, 2007).

However, the neuropsychological tests that are most commonly utilized have not changed concurrently with the referral questions and thus the same tests that were previously developed to answer diagnostic questions are now utilized to answer questions regarding real world functioning with very little empirical evidence to support this practice (Chaytor & Schmitter-Edgecombe, 2003). Research indicates that the everyday manifestation of executive functioning impairment may differ in important ways from executive functioning deficits captured by neuropsychological tests in the laboratory (Chaytor & Schmitter-Edgecombe, 2007). Because the recommendations that clinicians generate are to address everyday functioning and can have far-reaching consequences for patients' lives, it is important to demonstrate that neuropsychological measures have ecological validity.

In their recent review, Chaytor and Schmitter-Edgecombe (2003) defined ecological validity as the degree to which task performance corresponds to real world performance and argued that ecological validity does not necessarily describe a task; rather it describes the inferences that are drawn from task performance. Similarly, Burgess et al., (2006) defined ecological validity as a measure of the "representativeness" of the task or the correspondence between the task and real-life situations and the "generalizability" of the task or the degree to which task performance predicts problems in real-life settings. Franzen and Wilhem (1996) refer to the "verisimilitude" of tasks, or their resemblance to demands in the everyday environment as measured by the degree to which the cognitive demands of a task theoretically resembles the cognitive demands in everyday functioning. The verisimilitude approach to increasing the ecological validity of neuropsychological assessment has led to the development of several standardized

clinical tests including the TEA-Ch (Chaytor & Schmitter-Edgecombe, 2003). This test attempts to simulate everyday tasks that require specific components of attention including searching a map or a telephone directory, listening to lists of spelling words, organizing several activities, following rules, and planning problem solutions.

Veridicality is another approach used to assess the degree of ecological validity of neuropsychological assessment measures. This term refers to the degree to which existing tests are related to measures of everyday functioning (Franzen & Wilhem, 1996).

Typically, this type of research involves the use of statistical techniques to relate to performance on traditional neuropsychological tests to measures of real world functioning including employment status, questionnaires, or clinician ratings. More recent approaches to improving the ecological validity in the assessment of executive functions has been to examine the veridicality of standard executive function tests and to favor those measures which show a positive relationship with important everyday outcome variables (Chaytor & Schmitter-Edgecombe, 2003).

A measure's veridicality is also influenced by the everyday outcome variable selected. Although in the past, the majority of studies examining veridicality have used general measures including, job performance or adaptive behavior (Gilotty et al., 2002), while others have incorporated measures of behavior more specifically related to executive control (Burgess et al., 2006). The present study incorporated both a measure of adaptive behavior as well as a measure specifically related to executive function in order to provide further support for its utility and application to real world settings. Results from this study indicate significant associations of the TEA-Ch with specific measures of executive functions as well as adaptive functioning thus providing support

for ecological validity. Neuropsychologists are often called to assist in predicting the impact of behavioral and cognitive deficits on functioning across environments (Rabin, Burton & Barr, 2007). This study provides preliminary data in support of its use in identifying strengths and weaknesses in attentional profiles and potential for use in predicting specific skills of attention in everyday settings.

Early Intervention and Prevention

Findings from this study also have implications for early identification and prevention techniques for children at risk for difficulties with executive function and attention. The concept and definitions of executive functions and their association with various disorders are important knowledge areas for individuals working in education, health, and mental health fields. It is particularly important for providers to have an understanding of the basic issues related to assessment and remediation of executive function deficits and areas of weakness (Calhoun, 2006). Delays in executive functions appear to present as symptoms of many disorders (e.g., Autistic spectrum disorders, ADHD, conduct disorder, phenylketonuria, Tourette's syndrome, brain injury) (Calhoun, 2006). Furthermore, Gioia and colleagues (2001) discuss the association between deficits of executive functions and language disabilities.

The integration of school psychology and neuropsychology is particularly relevant to the early childhood population. During this critical period of development, timely identification of neurologically based risk indicators and special needs, followed by the reliable implementation of evidence-based interventions, can ameliorate learning and behavioral difficulties that may otherwise compromise a child's successful attainment of critical skills. For example, while children with early problems with decoding are

readily identified for reading interventions, students with deficits in executive functions may not be considered at risk for difficulties with academics or behavior until their deficits become frankly apparent in the later elementary grades or beyond. Early monitoring and training in the acquisition and implementation of executive function behaviors and components of attention may prevent students in the normative population from experiencing more entrenched academic and behavioral difficulties. For example, rudimentary forms of working memory and inhibitory control are present relatively early in life and show a rapid development throughout preschool and early school age years (Anderson et al., 2001; Korkman, 2001; Rebok et al., 1997).

A recent study conducted by Thorell and colleagues (2009) explored the possibility of implementing interventions intended to improve abilities of working memory and inhibition. This study reported that brief visuo-spatial working memory training had significant effects on both previously trained and non-trained working memory tasks in both the verbal and spatial domains. However, interventions that targeted inhibition only affected performance on previously trained tasks with no evidence of generalization. Such findings suggest that attentional functions appear to differ in terms of how amenable they are to training.

Similarly, Barkley (1996) also discusses a technique that attempts to explicitly teach the executive functions related to delayed responding (e.g., inhibition, planning, etc.). This method involves delaying a response to a situation to increase the time allotted in objective goal setting, systematic screening for appropriate responses, and response selection and enactment. Delayed responding is a skill that must be overtly taught through discrete instruction, modeling and reinforced in natural settings. It is consistent

with many interventions that focus on decreasing impulsive actions by reinforcing a brief “think time” before proceeding with a response.

In regards to the application of findings to the practice of educators and school psychologists, it has been well established in the literature that difficulties with attention and behavioral control represent the most common reason for school referrals (Angello et al., 2003; Koonce, 2007). Therefore, it is important for school psychologists to acquire the knowledge and skills that are necessary to conduct a comprehensive assessment of attention that should not be limited to behavioral rating scales, observational data, and interviews (Angello et al., 2003; Koonce, 2007). The utility of rating scales in guiding the treatment development process are limited in providing a means for assessment information to be linked to specific intervention strategies. Angello and colleagues (2003) reported that although the most commonly used rating scales in the assessment of attention symptoms offer a brief and convenient method for obtaining information about symptomatology, only a few provided sufficient evidence to justify their use for inclusion in a school based assessment (Angello et al., 2003). Findings from this study provide additional support for potential use and benefit of a performance-based assessment specific to attention as well as executive function behaviors based on growing evidence in support of the ecological validity of these recently developed measures.

Limitations

The degree to which the conclusions of a study can be generalized to individuals outside of the study is dependent upon the limitations inherent in the study. Overall, the number of participants recruited and the instruments used are limitations of this study. Results should be interpreted with these two limitations in mind. The first limitation of

the current study is that analyses were conducted on a relatively small sample (i.e., <100 participants). Ideally, the current model should be tested on a larger sample that includes racial/ethnic, and socioeconomic diversity to determine the reliability of results and to increase the power to allow analyses to be conducted by age bands.

In addition, potential for bias was introduced into the study through the sampling methods employed. Participants were voluntary, offered a gift card, and representative of a limited geographical area. This convenience sample does not ensure that the sample is representative of the population at large. Therefore, the results obtained, though characteristic of the sample, may not generalize to the larger group from which the sample was accessed.

Finally, additional demographic data were not collected for the participants that may have better explained the results from the data analyses. For example, cognitive abilities, reading level, parent education, nor teacher experience were assessed, even though each could significant implications for interpretation of items included on rating scales as well as child performance on tasks of attention. Recent findings suggest that neuropsychological functions, especially executive functions are by no means “hard-wired,” particularly for children reared in communities of low socio-economic status. For these children, environmental factors may play a far greater role in outcome than they are for children from backgrounds of greater social and economic advantage (Waber et al., 2006). Similarly, although information in regards to age was collected the impact of this factor was not investigated due to limited sample size. Therefore, these additional factors and the impact on executive functions and attention should be further explored on larger and more diverse child populations.

Last, one problem related to the use of a normative population to study development is related to the inherent limitations of psychological assessments. Floor and ceiling effects may weaken the conclusiveness of the findings. Furthermore, it may not be possible to establish with certainty the degree to which age-related changes in the performance of specific tests indicate a true developmental trajectory or whether it is a reflection of the test's ability to calculate the normal variance across age bands (Korkman, 2001).

The second limitation is in regards to the tools that were used for this study. The BRIEF and ABAS-II are vulnerable to several limitations ubiquitous to behavior rating inventories (Pelham, Fabiano & Massetti, 2005). Such limitations include susceptibility to inter-rater variance as well as parent/caregiver and teacher bias (Meyer et al., 2001). For example, one specific study indicated that maternal depression influenced ratings by endorsing a greater number of symptoms associated with ADHD in a child who otherwise failed to meet diagnostic criteria (Chi & Hinshaw, 2002). Further, rater bias is a pervasive question when utilizing self-report measures. Often, caregivers completing questionnaires sometimes provide ratings that make their children appear more socially acceptable. Future studies would also benefit from measuring executive function and attention skills of interest using a variety of methods including behavioral testing, additional parent and teacher report, and classroom observation to create more robust estimates of these skills.

In addition, the psychometric properties of the TEA-Ch may limit the reliability of the findings from this study. Although it has been normed for use with children recruited from an Australian population, the ongoing normative study for use in the

United States has not yet been completed. Furthermore, in spite of the support for the validity of measures, it is not possible to validate fully measures of attention and executive functions, because the components of these functions are still unknown. In addition, the literature also suggests that the test's validity may also be dependent on the age of the participants, which is a factor that was not explored in the current study. At a certain age, one type of performance may separate strong and weak performance more sensitively as compared to other ages (Klenberg, Korkman, Lahti-Nuutila, 2001).

Although some continuity appears to exist in cognitive capacity from one age to another, particularly as cognitive expectations increase, longitudinal tests across all ages for more specific types of performance are not yet well established. It is therefore important to evaluate neurocognitive development via comprehensive methods by utilizing a wide set of tasks. Accordingly, when using data acquired from several age groups, the factors obtained in this study may also reflect the influence of age. Most likely, correlations among attention and executive functions task performance change during development and the associations between factors are likely to be different for various age groups. This significantly impacts the generalizability and interpretability of the data collected for this study. Further research is required before the TEA-Ch can be fully utilized as a reliable and valid measure for the assessment of attentional performance in typically developing children and specific clinical cases.

Future Directions for Research

Several questions need to be explored in future research. Evidence of continual change and maturation of executive function skills from early childhood into early and late adolescence emphasizes the need for neuropsychologists and educators to gain an

understanding of the normal development of attentional capacity (Anderson et al., 2001). Significant improvements across ages have been found including the ability to focus attention, to execute a response, to shift attentional focus, and to encode information in memory. Researchers are called upon to examine low scores on measures of attention as antecedents of a broader set of maladaptive developmental consequences aside from adaptive behavior as identified in this study to include psychiatric symptomatology, drug use, school dropout, suspension, etc. (Rebok et al., 1997). In addition, although current results suggest some evidence of gender differences that differ in younger as compared to adolescent populations further exploration is required to replicate and delineate such findings.

The study of attentional training is a relatively new area of research and future studies should identify which attentional functions can be trained. Furthermore, attentional training should be examined across the developmental age span in order to determine essential time periods in which this type of training should be considered and fostered. This exploration would extend current knowledge in regards to the effects of cognitive training and determine how it can be generalized to other cognitive, behavioral, attentional, and executive function behaviors (Thorell et al., 2009). Cognitive functions appear to differ in terms of how easily they can be trained. Thus, differences might be explained by modifications in the anatomical basis and time course of the underlying psychological and neural processes of working memory and inhibition.

In summary, the TEA-Ch has demonstrated its utility as a test of attention that may be used across a wide range of clinical populations (Baron, 2001). Questions about the construct validity, positive predictive power, negative predictive power, diagnostic

sensitivity, specificity, and neuroanatomical correlation need to be further investigated. In this study, the four-subtest screener was utilized which also spurs additional research to assess the difference in accuracy with which it can differentiate between various clinical populations in a manner that is similar to or distinct from results obtained on the full battery. In addition, it remains to be seen whether the TEA-Ch dual tasks of attention correlate highly with other dual task performance tests.

Additionally, as interest in developing ecologically valid measures of executive functions grows future researchers may consider administering the TEA-Ch under normal testing conditions as well as administering the alternate form under conditions with distractions (e.g., music, classroom noise, etc.). For example, though listening to and repeating a list of words bears theoretical similarities to learning that occurs in school, the controlled rate of presentation, isolated and sterile assessment setting, guided practice over trials, and cues to organize the information may not approximate classroom demands. The more likely environment where listening and remembering is required is one in which there are distractions, the presentation rate is varied, there is limited opportunity for rehearsal, and there may be additional demands including note taking. While these modifications would provide only qualitative data and may not be reliable, considering such variables could increase the clinician's ability to provide support for issues related to ecological validity (Gioia & Isquith, 2004). Although much remains to be investigated, developers of the TEA-Ch appear to have produced a clinical instrument that continues to accumulate support for its use in various child populations.

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Appendices

Appendix A: TEA-Ch Subtest Descriptions

Sustained Attention Subtests

- *Score!*

Children are required to silently count the number of target tones that are presented on a 15 minute audiotape. There are 10 total trials, with varying interval tones ranging in number from 9 to 15. This is a good test of the child's ability to self-sustain his or her own attention due to the long gaps in between tones and the redundancy of the task.

- *Sky Search DT*

This is a "dual task" that requires children to simultaneously perform tasks from the Sky Search and Score! Subtests. As such, this subtest involves simultaneously identifying visual targets present among distracters, and counting tones on an audiotape.

- *Score DT*

This is a "dual task" which combines a task of counting the number of tones presented with another listening task. The child is required to listen for an animal name during an audiotaped news report as they count the number of tones presented. After each of the 10 trials the child is asked to report the number of tones counted and the name of the animal.

- *Walk, Don't Walk*

Children are asked to mark steps along a paper path with a pen each time they hear a tone on the tape, but refrain from marking a step if the tone is immediately followed by a second tone. The rate of the tones increase as the child progresses through the 20 trials.

- *Code Transmission*

Children are asked to listen to a long, monotonous series of spoken numbers, listening for two '5s' to be presented in a row. When this pattern is noted, the child is asked to state the number presented prior to the target '5s.'

Selective Attention Subtests

- *Sky Search*

In this brief, timed subtest children are instructed to find target spaceships present among similar distracter spaceships. The second part of this subtest involves no distracter stimuli and serves as a control for motor function. Subtracting the score obtained on part 1 from part 2 gives a measure of the child's ability to make this selection that is relatively free from the influence of motor function.

- *Map Mission*

Children are given one minute to quickly locate small targets in an array of distracters.

Attentional Control/Switching

- *Creature Counting*

Children are required to switch between counting forward and backward in response to visual stimuli (creatures in a tunnel). Speed and accuracy are factored into the scoring.

- *Opposite Worlds*

In the “Same World” scenario, children are asked to name digits 1 and 2 scattered along a path. In the subsequent “Opposite World” task, children must say ‘1’ when they see ‘2’ and ‘2’ when they see ‘1.’

Appendix B: TEA-Ch Administration and Scoring by Subtest

Subtest 1: Sky Search

In this brief, timed task children are instructed to find and circle targets present among similar distracter targets. The second part of this subtest involves no distracter stimuli and serves as a control for motor function. Subtracting the score obtained on Part 1 from Part 2 provides a measure of the child's ability to indicate a response free from the influence of motor function.

MATERIALS: Stopwatch, non permanent marker, small Sky Search practice sheet, large Sky Search test sheet (version A or B), Sky Search small Motor Control sheet

Subtest 2: Score!

Children are required to count silently the number of target tones that are presented on a CD. There are 10 total trials, with varying interval tones ranging in number from 9 to 15.

MATERIALS: CD player, CD

Subtest 3: Creature Counting

Children are required to switch between counting forward and backward in response to visual stimuli. Speed and accuracy are factored into the scoring.

MATERIALS: Stimulus book, stopwatch

Subtest 4: Sky Search DT

This is a "dual task" that requires children to simultaneously perform tasks from the Sky Search and Score! subtests. This task involves simultaneously identifying visual targets present among distracters, and counting tones that are presented on a CD.

MATERIALS: CD player, CD, stopwatch, non-permanent marker

Subtest 5: Map Mission

Children are given one minute to quickly locate small targets in an array of distracters.

MATERIALS: Large map (version A or B), non-permanent marker, stopwatch

Subtest 6: Score DT

This is a “dual task” of attention. The child is instructed to listen for an animal name during a news report as they count the number of tones presented. After each trial the child is asked to report the number of tones counted and the name of the animal.

MATERIALS: CD player, CD.

Subtest 7: Walk, Don't Walk

Children are asked to mark steps along a paper path with a pen each time they hear a tone on the tape, but refrain from marking a step if the tone is immediately followed by a second tone. The rate of the tones increase as the child progresses through the 20 trials.

MATERIALS: CD player, CD, non-permanent marker, Walk Don't Walk sheet

Subtest 8: Opposite Worlds

In the “Same World” scenario, children are asked to name digits 1 and 2 scattered along a path. In the subsequent “Opposite World” task, children must say ‘1’ when they see ‘2’ and ‘2’ when they see ‘1.’

MATERIALS: Stimulus book, stopwatch

Subtest 9: Code Transmission

Children are asked to listen to a long, monotonous series of spoken numbers, listening for two ‘5s’ to be presented in a row. When this pattern is noted, the child is asked to state the number presented prior to the target ‘5s.’

MATERIALS: CD player, CD

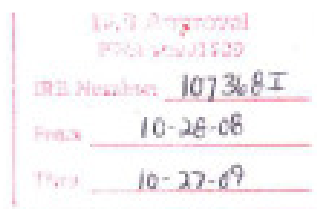
Appendix C: Integrity Checklist

Please be sure to review and complete all steps in the outlined order before turning in protocols and consent forms. This Integrity Checklist is provided for the purposes of ensuring consistent methods for data collection across all participating school psychologists.

- ___ Make contact with elementary school teachers and distribute the **Teacher Informed Consent to Participate in Research** form to those who indicate possible interest.
- ___ Obtain signed **USF Teacher Informed Consent to Participate in Research** form from elementary school classroom teacher.
- ___ Distribute **USF Parental Informed Consent to Participate in Research** form to teachers to pass out to parents.
- ___ Collect **Teacher Informed Consent to Participate in Research** and **Parental Informed Consent to Participate in Research** within one week from date of distribution.
- ___ Distribute Parent and Teacher packets of rating forms (pre-made) to elementary school classroom teachers (includes BRIEF, ABAS-II) for distribution to parents.
- ___ Consult with classroom teacher regarding best time/place for TEA-Ch administration (allot 30-35 minutes per testing session).
- ___ Review and obtain signed child's **Assent to Participate in Research** form on date of testing.
- ___ Administer the TEA-Ch according to guidelines and rules provided in the packet.
- ___ Collect Parent and Teacher packets of rating forms (BRIEF and ABAS-II) within the two weeks as indicated on the consent forms.
- ___ Send all protocols, ratings forms, and consent forms as one packet as provided in the manila envelope to designated Research Committee member via district courier.

Thank you for your participation and hard work! Please feel free to contact me via email (eunyeop@mail.usf.edu) or phone (716-908-1921) for any questions, comments, or concerns.

Appendix D: Consent and Assent Forms



Parental Informed- Consent to Participate in Research

Information to Consider Before Taking Part in This Research Study

IRB Study # _____

Dear Parent/Caregiver:

The following information is being provided to help you decide whether you would like to take part in a research study. Please read this carefully. If you do not understand something, please feel free to contact the person in charge of the study.

The goal in conducting this study is to learn about the ways in which different types of attention (sustained, selective, attentional control/shifting) are related to children's behaviors and independent functioning at home and at school. The study is entitled:

"An Exploratory Analysis of the Ecological Validity of a Performance-Based Assessment of Attention "

- ✓ **Why We've Sent This Letter to You:** You are being asked to participate in this study because you are a parent or caregiver of a child (ages 8-10 years) who is enrolled in a Polk County School District Public School. All parents/caregivers, students (ages 8-10 years) enrolled for a minimum of 6 months in a Polk County School, who primarily speak English, and their full time elementary school teachers are being included in this study. The researcher has obtained consent from the principal and the classroom teacher has agreed to take part in this study as well.
- ✓ **Why You Should Participate:** By taking part in this research study, you have the opportunity to increase your understanding of the importance in ways in which a child pays attention and how strengths and weaknesses in attention are related to various behaviors and independent functioning in the school and home. It may also be interesting to learn about how attention may differ in the school and home settings.
- ✓ You may also find that factors of attention, behavior, and independent functioning are easy concepts to address with your child's classroom teacher. In addition, you may find it helpful to speak to them about your child's behavior and academic performance in school by referring to specific skills mentioned on the rating scales.

- ✓ Also, according to the rating forms you may learn about important skills that children the same age of your child are expected to learn and perform in the home and school. You may discuss with their teacher different ways to improve attention, behavior, and independent functioning through home/school strategies and interventions.

Attention has been shown to be related to behavior and academic performance. Attention is an important skill that children can work on when they are young through the help of home/classroom interventions/strategies and their parents/caregivers and teachers.

- ✓ Completing the Survey: You will be asked to fill out two rating forms describing your child's behavior and level of independent functioning for this study during times that are most convenient for you. It is estimated that it will take 20-25 minutes for completion. After receiving parent/caregiver permission, teachers will be asked to complete similar rating forms. You will be asked to hand in your forms to the classroom teacher when you are finished filling them out. We would like for you to hand them in within two weeks of receiving them.
- ✓ Test Administration: You will also be asked to indicate times when you prefer your child to be tested. The test consists of nine game-like sections and will take approximately 30-40 minutes. Your child will be asked to participate in tasks such as listen to recordings, counting objects aloud and silently, making marks on paper, and looking at different pictures. You will have the option of choosing before/after school, during lunch, during specials/block time, weekends, or other times you would like for your child to participate.
- ✓ Please Note: Your participation and your child's participation are completely voluntary. By returning the survey to the classroom teacher at your child's school, you are agreeing that you consent to participate in this research and allow your child to take part in this study as well. If you or your child choose not to participate, or choose to withdraw at any time, it will in no way affect your relationship with your child's school, Polk County School District, USF, or any other party.
- ✓ Confidentiality of Your Responses: There is *minimal* risk to you and your child for participating in this research. Your privacy and research records will be kept confidential to the extent of the law. Authorized research personnel, employees of the Department of Health and Human Services, and the USF Institutional Review Board, and others working on their behalf may inspect the records from this research project. Your individual responses will not be shared with any other school system

| APPROVED |

personnel or anyone other than Eun-Yeop Lee after they are collected from your teachers. All names will be removed and replaced with a number to protect the privacy of your responses.

- ✓ What We'll Do With Your Responses: It is expected that this study will add useful information to the research available on how young children pay attention and how we may be able to help them work on this skill when they are young. The results of this study may be published. However, the data obtained from you will be combined with data from many other people in the publication. The published results will not include your name or any other information that would in any way personally identify you or your child. Teacher, parent/caregiver ratings, and child test results will not be used for any purposes beyond the study without the request to and permission of the parent/caregiver.
- ✓ Questions? If you have any questions about this research study, please contact Eun-Yeop Lee, MA. at (716) 908-1921, or eunyeop@mail.usf.edu. If you have questions about your rights as a person who is taking part in a research study, you may contact a member of the Division of Research Compliance of the University of South Florida at 813-974-5638.
- ✓ Want to See the Results? The researcher will be more than happy to share results of this study. In addition, the completed doctoral dissertation will be kept on reserve at the USF Library.

Thank you for taking the time to participate!

Sincerely,

Eun-Yeop Lee, MA
USF Graduate Student

APPROVED

Consent to Take Part in This Research Study

By signing this form I agree that:

I have fully read or have had read and explained to me this informed consent form describing this research project.

I have had the opportunity to question one of the persons in charge of this research and have received satisfactory answers.

I understand that I am being asked to participate in research. I understand the risks and benefits, and I freely give my consent to participate in the research project outlined in this form, under the conditions indicated in it.

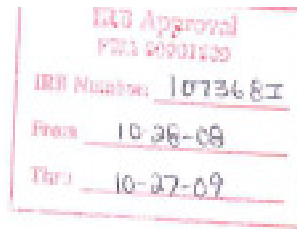
I have been given a signed copy of this informed consent form, which is mine to keep.

Signature of Participant

Printed Name of Participant

Printed Name of Child Participant

Date



Teacher Informed Consent to Participate in Research

Information to Consider Before Taking Part in This Research Study

IRB Study # _____

Dear Classroom Teacher:

The following information is provided to help you decide whether you would like to take part in a minimal risk research study. Please read this carefully. If you do not understand something, please feel free to contact the person in charge of the study.

The goal in conducting this study is to learn about the ways in which different types of attention (sustained, divided/selective, attentional control/shifting) of young children are related to their behaviors and independent functioning in the home and at school. The study is entitled:

“An Exploratory Analysis of the Ecological Validity of a Performance-Based Assessment of Attention”

- ✓ Why We’ve Sent This Letter to You: You are being asked to participate in this study because you are a teacher of a child (ages 8-10 years) who is enrolled in a Polk County School District School. Primarily English speaking parents/caregivers, students (ages 8-10 years) enrolled for a minimum of 6 months in a Polk County School classroom, and their full time elementary school teachers are being included in this study.
- ✓ Why You Should Participate: By taking part in this research study, you have the opportunity to increase your understanding of the importance in ways in which a child pays attention and how strengths and weaknesses in attention are related to various behaviors and independent functioning in the school and home. It may also be interesting to learn about how this differs in the school and home settings.
- ✓ You may also find that factors of attention, behavior, and independent functioning are easy concepts to discuss with parents of your children. In addition, you may find it helpful to speak to them about a child’s behavior and academic performance in school by referring to specific skills mentioned on the rating scales.

- ✓ Also, according to the rating forms you may learn about important skills that children of this age group are expected to learn and perform in the home and school. You may discuss with their parents different ways to improve attention, behavior, and independent functioning through home/school strategies and interventions.

Attention has been shown to be related to behavior and academic performance. Attention is an important skill that children can work on when they are young through the help of home/classroom interventions/strategies and their parents/caregivers and teachers.

- ✓ Completing the Survey: You will be asked to fill out two rating forms describing your child's behavior and level of independent functioning for this study during times that are most convenient for you. It is estimated that it will take 20-25 minutes for completion. You will be requested to hand in your forms to the school psychologist when you are finished filling them out. We would like for you to hand them in within two weeks of receiving them.
- ✓ Test Administration: Parents will be asked to indicate times when they prefer their child to be tested. The test consists of nine game-like sections and will take approximately 40-50 minutes to complete. Each child will be asked to participate in tasks such as listen to recordings, counting objects out loud and silently, making marks on paper, and looking at different pictures. Parents will have the option of choosing before/after school, during lunch, during specials/block time, etc.
- ✓ Please Note: Your participation and is *completely voluntary*. By returning the survey to the school psychologist at your school, you are agreeing that you consent to participate in this research. If choose not to participate, or choose to withdraw at any time, it will in no way affect your relationship with your child's school, Polk County School District, USF, or any other party.
- ✓ Confidentiality of Your Responses: There is *minimal* risk to you for participating in this research. Your privacy and research records will be kept confidential to the extent of the law. Authorized research personnel, employees of the Department of Health and Human Services, and the USF Institutional Review Board, and others working on their behalf may inspect the records from this research project. Your individual responses will not be shared with any other school system personnel or anyone other than Eun-Yeop Lee after they are collected from your teachers. All names will be removed and replaced with a number to protect the privacy of your responses.

- ✓ What We'll Do With Your Responses: It is expected that this study will add useful information to the research available on how young children pay attention and how we may be able to help them work and strengthen this skill when they are young. The results of this study may be published. However, the data obtained from you will be combined with data from many other people in the publication. The published results will not include your name or any other information that would in any way personally identify you or your child. Teacher, parent/caregiver ratings, and child test results will not be used for any purposes beyond the study without the request to and permission of the parent/caregiver.

- ✓ Questions? If you have any questions about this research study, please contact Eun-Yeop Lee, MA. at (716) 908-1921, or eunyeop@mail.usf.edu. If you have questions about your rights as a person who is taking part in a research study, you may contact a member of the Division of Research Compliance of the University of South Florida at 813-974-5638.

- ✓ Want to See the Results? The researcher will be more than happy to share results of this study. In addition, the completed doctoral dissertation will be kept on reserve at the USF Library.

Thank you for taking the time to participate!

Sincerely,

Eun-Yeop Lee, MA
USF Graduate Student

Consent to Take Part in This Research Study

By signing this form I agree that:

I have fully read or have had read and explained to me this informed consent form describing this research project.

I have had the opportunity to question one of the persons in charge of this research and have received satisfactory answers.

I understand that I am being asked to participate in research. I understand the risks and benefits, and I freely give my consent to participate in the research project outlined in this form, under the conditions indicated in it.

I have been given a signed copy of this informed consent form, which is mine to keep.

Signature of Participant

Printed Name of Participant

Printed Name of Child Participant

Date



Assent to Participate in Research
University of South Florida

IRB Approval	PT21 20201420
IRB Number:	1073681
From:	10-28-08
Thru:	10-27-09

Information for Individuals under the Age of 18 years Who Are Being Asked to Take Part in Research Studies

TITLE: "An Exploratory Analysis of the Ecological Validity of a Performance-Based Assessment of Attention."

WHY AM I BEING ASKED TO TAKE PART IN THIS RESEARCH?

You are being asked to take part in this research study because you are in the 3rd, 4th, or 5th grade, and between the age of 8 and 10 years. Your teacher, principal, and parents have given me permission to work with you. If you take part in this study, you will be one of about 100 other students working with me for this study.

WHO IS DOING THE STUDY?

The person in charge of this study is Eun-Yeop Lee and she attends the University of South Florida in Tampa, FL. Her professor, Dr. Harold Keller, is helping her with this research.

WHAT IS THE PURPOSE OF THIS STUDY?

This study is about how children pay attention, behave, and take care of themselves in school and at home. By doing this study, we hope to learn about how paying attention is related to how you act and take care of yourself.

WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?

The study will be take place at your school. You will come to a room or office at your school for testing with your parent/caregiver. You will only have to come in one time for about 40 minutes and can ask for a break at any time.

WHAT WILL I BE ASKED TO DO?

You will be asked to count things in your head and aloud, circle things on paper, and listen to things that will be played for you on a cd. Your answers will help us with our research and help us see how you and other children like you do on this test of attention.

WHAT THINGS MIGHT HAPPEN THAT ARE NOT PLEASANT?

To the best of our knowledge, the things you will be doing will not harm you or cause you any unpleasant experiences.

DO I HAVE TO TAKE PART IN THE STUDY?

You should talk with your parents or anyone else that you trust about taking part in this study. If you do not want to take part in the study, that is your choice and ok. You should take part in this study only because you really want to volunteer. If you do not think you want to take part in this study, you should talk this over with your parents and decide together.

IF I DO NOT WANT TO TAKE PART IN THE STUDY, WHAT WILL HAPPEN?

If you do not want to be in the study, nothing else will happen. That is perfectly fine!

WILL I RECEIVE ANY REWARDS FOR TAKING PART IN THE STUDY?

You will be able to choose an item from my treasure box. If you like to stop before the study is over you will still get the chance to pick a toy from the treasure box.

WHO WILL SEE THE INFORMATION I GIVE?

Your information will be added to the information from other children taking part in the study so no one will know who you are or that you participated in this study other than you, your parents and people in charge of this study.

CAN I CHANGE MY MIND AND QUIT?

If you decide to take part in the study, you can later change your mind. No one will think badly of you if you decide to stop. Also, the people who are running this study may need you to stop. If this happens, I will tell you why.

WHAT IF I HAVE QUESTIONS?

You can ask questions about this study at any time. You can talk with your parents, other adults that you trust, and the person asking you to volunteer about this study.

Assent to Participate

I understand what the person running this study is asking me to do. I have thought about this and would like to participate in this study.

Name of person agreeing to take part in the study

Date

Name of person providing information to subject

Date

About the Author

Eun-Yeop Lee received a Bachelor's Degree in Psychobiology from Binghamton University in 2003 and a M.A. in School Psychology from the University of South Florida in 2005. She earned a graduate certificate in Aging and Neuroscience from the University of South Florida in 2007. Following her doctoral internship through the Polk County Public Schools she completed a clinical internship in Pediatric Neuropsychology. Ms. Lee has also worked in a variety of settings including public schools, outpatient clinics, and university affiliated hospitals. Her research interests include neuropsychological assessment as well as behavioral and cognitive implications of Autism Spectrum disorders, genetic disorders, and medical disorders.