EXECUTIVE FUNCTIONING IN CHILDREN WITH ADHD: RELATIONSHIPS BETWEEN RATING SCALES AND STANDARDIZED TESTS

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by

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EXECUTIVE FUNCTIONING IN CHILDREN WITH ADHD: RELATIONSHIPS BETWEEN RATING SCALES AND STANDARDIZED TESTS

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Impairment of executive functioning is exhibited in children with Attention-Deficit/Hyperactivity Disorder. Executive functioning has traditionally been measured with standardized tests such as the Wisconsin Card Sorting Test. However, two rating scales to measure executive dysfunction have been developed and may be a useful adjunct to traditional measures. This study proposes to examine two such scales, the Brief Rating Inventory of Executive Function and the Children's Executive Functions Scale, as well as measure their relationship with two standardized measures. Implications of possible outcomes of the study are then discussed.

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CHAPTER ONE
Introduction

The considerable interest in executive functions (EF) that exists today is not surprising given the crucial role they perform every day, for everyone. While EFs are a multifaceted topic, EFs can be concisely defined as a collection of interrelated functions that are responsible for purposeful, goal-directed behavior, and are generally considered to be primarily mediated by the prefrontal cortex of the brain (Anderson, 1998; Gioia, Isquith, & Guy, 2001). EF consists of four theoretical domains that perform in an integrative fashion: attentional control, information processing, cognitive flexibility, and goal setting (Anderson, 2002).

The majority of EF research in the past has heavily focused on adult populations. This focus on adulthood is primarily due to three factors. First, the prefrontal cortex was thought to become functionally mature only in late development, around adolescence. Second, early research on head injuries suggested that the consequences of prefrontal lesions in childhood did not become apparent until adulthood. Finally, standard EF tests were designed to be difficult and therefore developmentally inappropriate for use with children. However, recent years have seen a dramatic expansion of EF studies with childhood populations (Hughes & Graham, 2002).

This increase of interest in early EF has led to studies examining the developmental course of EFs in clinical populations and normally developing children, and the creation of new assessment methods. Especially relevant to the present study, new research suggests impairments of EF play a key role in a variety of developmental disorders, although the evidence is strongest for Attention-Deficit/Hyperactivity Disorder (ADHD) (Hughes & Graham, 2002).

While many standardized EF tests are available, they do have limitations. Perhaps the biggest problem with standardized EF tests is the questionable nature of their ecological validity. The standard testing environment is highly structured and interactive; the examiner provides structure, organization, and guidance (Anderson, 2002). This situation may relieve some of the demands of the child's own EFs, thus providing an overestimate of the examinee's true executive functioning. Thus, while a child may function appropriately in the testing situation, in real life there may be significant EF impairments in the absence of overt structure and guidance. It is for this reason that an EF evaluation must extend beyond the testing environment into the real world.

The most straightforward and efficient way to accomplish this real-life assessment is to utilize rating scales. Rating scales are completed by the child's parents and teacher based on observations of the child's behavior at home and at school, and provide an invaluable source of information. However, while many behavior rating scales exist, few were designed to specifically provide an assessment of EF as manifest in behavior.

The Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kensworthy, 2000) and the Children's Executive Functions Scale (CEFS; Silver, Kolitz-Russell, Bordini, & Fairbanks, 1993) are two rating scales that were created to measure EF in children. Each scale consists of a parent form and a teacher form, and they measure behavior in domains such as problem-solving, initiative, and inhibition.

The proposed project will attempt to bridge the gap between standardized EF measures and real-life behavior in children with ADHD by examining the relationships between two standardized tests, the Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993) and the Visual Attention subtest from the NEPSY (Korkman, Kirk, & Kemp, 1998), and two rating scales, the BRIEF (Gioia et al., 2000) and the CEFS (Silver et al., 1993). The level of agreement will be analyzed not only between the standardized tests and the rating scales, but also between the parent and teacher ratings. This study will provide valuable information regarding the degree of executive dysfunction found in a testing environment compared to a real-world environment in ADHD children. It will also provide an examination of parent and teacher concordance in rating children's behavior, a subject on which little research exists.

CHAPTER TWO
Review of the Literature

To give executive function (EF) a simple, concise operational definition would not do justice to its engrossing and complex nature. Once regarded as a unitary concept, EF has evolved into an umbrella term encompassing a multidimensional range of skills and processes. While accurate, conceptualizing EF as "the skills necessary for purposeful, goal-directed activity" (Anderson, 1998, p. 319), tells nothing of the concepts and skills that constitute EF. Lezak (1993) states, "executive functions consist of those capacities that enable a person to engage successfully in independent, purposive, self-serving behavior" (p. 42). Lezak also distinguishes between cognitive abilities and executive skills; cognitive abilities involve specific functions or functional areas, whereas EFs are more global and act upon all aspects of behavior. Although Lezak's description clarifies EF further, it still lacks a foundation; a theoretical model is needed to understand EF at a fundamental level.

Drawing on the views of Alexander and Stuss (2000) and current clinical neuropsychological knowledge, Anderson (2002) has developed a neuropsychological model of EF. This model conceives of EF as four distinct domains: attentional control, information processing, cognitive flexibility, and goal setting. While each domain is considered a discrete function, they perform in an integrative fashion to execute certain tasks and are all inter-dependent.

The domain of attentional control involves two kinds of attention: selective attention, that is, the ability to attend selectively to specific stimuli and inhibit other responses, and sustained attention, the ability to focus attention for an extended period of time. Also included in this domain is the regulation and monitoring of actions, which allows for three capabilities: to execute plans in the correct order, to identify errors, and to achieve goals. Impairments in this domain are likely to be manifested by impulsivity, a lack of self-control, failure to complete tasks, failure to correct procedural mistakes, and failure to respond appropriately (Anderson, 2002).

Information processing refers to efficiency, fluency, and speed of processing. The quality of the information processing domain is contingent on the integrity of neural connections and functional integration of frontal systems. As such, information processing can be measured by speed, quantity, and quality of output. Individuals with impairment in this domain are likely to have reduced output, delayed responses, hesitancy, and slowed reaction times (Anderson, 2002).

The cognitive flexibility domain includes the ability to shift between response sets, learn from mistakes, formulate alternative strategies, divide attention, and process multiple sources of information simultaneously. Deficits in this domain include rigid thinking and perseverative behavior (Anderson, 2002).

Goal setting is composed of the capability to develop new initiatives and concepts, along with the capacity to plan in advance and undertake tasks in an efficient and strategic way. Inadequate planning, disorganization, difficulties developing strategies and implementing new strategies, and poor conceptual reasoning are all associated with impairments in the goal setting domain (Anderson, 2002).

Although Anderson (2002) includes the concept of initiation in the goal setting domain, it is necessary to elaborate, as this is a deficit involved in many disorders of EF.

Initiation refers to beginning a task or activity, as well as generating independent ideas, responses, or problem-solving strategies (Gioia et al., 2000). Initiation also "affords the execution of future behavior according to the needs perceived in the present," (Hart & Jacobs, 1993. p. 2). Impairments in initiation may result in decreased spontaneity, decreased productivity, and a decrease in the rate at which behavior is produced (Lezak, 1995). While many observers may regard individuals with initiative impairment as lazy, poor initiation usually does not reflect noncompliance or disinterest; instead, individuals typically want to succeed at a task, they simply cannot get started (Gioia et al., 2000).

Returning to Lezak's (1995) description of EF being global, it should be noted that the term "global" implies that EF is an all-compassing construct. In fact, "global" executive impairment is relatively rare; impairment usually manifests itself in several specific executive processes. It is for this reason that a model describing these specific processes has been introduced and will be used as a foundational frame of reference in the present study.

To fully appreciate the complex concept of EF, it is necessary to consider three theoretical contexts and models of EF: historic linkage of EF to prefrontal areas of the brain, the clinical convenience of the term, and the developmental course of EF in children. Each of these will be discussed in turn.

Historically, executive functioning has more of a neuroanatomical connection than a theoretical one; the prefrontal regions of the brain have traditionally been linked to EF (Denckla, 1996). This linkage is due to observations that damage to the prefrontal areas typically result in deficits in executive function. Newer research in functional neuroimaging also supports this view by illustrating activation within the prefrontal cortex in individuals performing EF tasks (Anderson, 2002). This association creates problems on several fronts. First, the prefrontal regions are not the only areas that contribute to EF. Other parts of the brain, particularly certain subcortical white matter tracts that project to the prefrontal cortex, also influence EF. Were any of these circuits to be damaged, it is feasible that EF would be affected despite the lack of specific damage to the frontal areas (Alexander & Stuss, 2000). Secondly, the prefrontal regions are responsible for other functions besides EF. These areas are also linked with certain social, emotional, and personality aspects of the self (Denckla, 1996). Perhaps a more accurate neuroanatomical reference would be to describe the prefrontal cortex and descending systems as the *theoretical* location of EF.

Another contributing factor to the theoretical context of EF is rooted in clinical practice. As Denckla (1996) explains, "EF is a convenient shorthand that captures the problems of a group of patients evaluated by clinicians" (p. 264), for example, children who for all reasons should be doing well in school, with average to above average intelligence and no domain-specific processing deficits, but who are yet not good students. Evidence has shown these children may have a weak EF system. While many of these children may qualify for a diagnosis of Attention-Deficit/Hyperactivity Disorder (ADHD) according to the DSM-IV (American Psychiatric Association, 1994), some will not. For individuals such as these, it is convenient to diagnosis them with EF impairment, as it applies to domain-general control processes (Denckla, 1996).

The cerebral regions associated with EF are relatively immature in early childhood, but development of EF occurs rapidly throughout childhood and into adolescence. While the developmental course may be different for different components of EF, some generalizations can be made. Because EF is dependent upon the soundness of the frontal lobe systems, it is reasonable to assume that neuropsychological developments coincide with development of EF. This is true to a large extent; however, "early claims that executive processes did not emerge functionally until the frontal lobes reached maturity in the second decade of life (Golden, 1981) have now been refuted" (Anderson, 2002, p. 76). Therefore, it is possible to assess functional EF in children despite the absence of a fully developed brain. Even so, it must be emphasized that a child's EF is not comparable to that of an adult, a fact to be discussed later in the topic of assessment.

Despite the paucity of specific EF developmental studies, some observations about particular components of EF can be made from those that do exist. The following information is found in a review of these studies by Anderson (2002). In the domain of attentional control, inhibition of a certain behavior and the ability to shift to a new response set is acquired by 12 months of age in most infants and continues to develop until, by age 9, children are able to monitor and regulate their actions well. Information processing response speed and verbal fluency begin to improve between 3 and 5 years of age. Improvement continues through adolescence, with significant gains in processing speed occurring between 9 and 12 years of age. With respect to cognitive flexibility, while perseverative errors are common in infancy, they decline in middle and late childhood, and are rare in adolescence. Multi-dimensional task switching ability improves greatly between ages 7 and 9, and continues to improve throughout middle childhood and adolescence. Planning and organizational skills develop rapidly from ages 7 to 10; by age 11, strategic behavior and reasoning abilities are more organized and efficient. In summary, despite different developmental trajectories, these four areas of EF, while not fully established, are relatively mature by age 12.

These developmental trajectories are supported by studies which have found age trends on a common measure of EF, the Wisconsin Card Sorting Test (WCST; Heaton et al., 1993). The WCST is a measure of flexibility of thought and concept formation and was once thought to be particularly useful in discriminating between frontal and nonfrontal brain lesions in adults (Heaton, 1981). However, since the time the first WCST manual was published (1981) studies have found that both frontal and nonfrontal patients perform poorly on the test, and it is no longer used as a test to detect purely frontal deficits (Heaton et al., 1993; Levin, Eisenberg, & Benton, 1991). Nevertheless, the utility of the WCST as a measure of EF remains certain. Since providing normative data on children, the WCST has also been valuable in evaluating EF in children. Several studies have examined the developmental trends of children's performance on the WCST.

In general, 6- and 7-year-old children perform similarly to frontal damaged adults on the WCST, with normal adult-level performance achieved around age 10 (Chelune & Baer, 1986; Welsh, Pennington, & Groisser, 1991). Furthermore, Chelune, Ferguson, Koon, & Dickey (1986) found that performance on the WCST improved with age (measured by Categories Achieved, Perseverative Errors, and Percent Correct) in both children with ADHD and in controls. Interestingly, "the performance levels of the older AD[H]D groups tend to parallel those of the control groups two years their junior; that is, the performance of the 8-9 and 10-12 year old AD[H]D groups are comparable to the 6-7 and 8-9 year old control groups" (p. 226). Because of the absence of fully developed EFs before the age of

12, one might question the ability to distinguish between immature, or not fully established, EFs and genuine executive dysfunction (EDF), or deficits in EFs. Further complicating the issue is the fact that EDF is not a unitary syndrome; there is no singular, core disorder of EDF (Gioia et al., 2001). In children, cognitive deficits that may be associated with EDF include, but are not limited to, difficulty initiating tasks or activities, poor impulse control, perseveration or difficulty shifting, problems planning and organizing, difficulty monitoring performance, poor utilization of feedback, and diminished working memory (Anderson, 2002; Gioia et al., 2001). Due to this broad range of problems, it is critical that professionals understand the developmental expectations of the different constructs with EF to avoid labeling a behavior as primarily due to immature EF, when in fact it is EDF (Anderson, 2002).

EDF may affect not only cognitive processes, but also behavioral and emotional control. Children with this aspect of EDF may present as apathetic, unmotivated, impulsive, or argumentative. Some may exhibit socially inappropriate behavior or disregard for social conventions and consequences. Understandably, these children demonstrate poor interpersonal skills and difficulty sustaining meaningful social relationships (Anderson, 2002).

EF Disorders

Impairments in EF are distinctive features in a number of clinical disorders. However, EDF may present differently within a particular disorder or similarly across disorders. Thus, "the challenge is not identifying EDF, but determining the nature of the impairment and the underlying neural pathology, as this determination will greatly influence intervention and treatment plans" (Anderson, 2002, p. 72).

Attention-Deficit/Hyperactivity Disorder (ADHD) is a relatively common disorder among children and is characterized by hyperactivity, distractibility, and impulsivity (American Psychiatric Association, 2000). The third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-III*; American Psychiatric Association, 1980) changed the diagnostic category of "hyperkinetic reaction of childhood" to "attention deficit disorder" and distinguished between two types: with hyperactivity or without hyperactivity (Barkley, 1997). The disorder was then renamed again in the text revision of the *DSM-III* to "attention-deficit/hyperactivity disorder" (Barkley, 1997).

With the publication of the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV*; American Psychiatric Association, 1994), three subtypes of ADHD were suggested: predominately inattentive type, predominately hyperactive-impulsive type, and combined type; therefore, ADHD is currently viewed as having two major symptoms: inattention and hyperactive-impulsive behavior, although most children have both symptoms (American Psychiatric Association, 1994; Barkley, 1997; Gioia., Isquith, Guy, & Kensworthy, 2000).

In the *DSM-IV* (American Psychiatric Association, 1994), diagnostic criteria for inattention include such behaviors as failure to pay close attention to detail, difficulty sustaining attention, being easily distracted, losing things, and difficulty organizing tasks and activities (for exhaustive diagnostic criteria of inattention and hyperactivity, see *DSM-IV*, p. 83-84). Hyperactive behavior criteria include frequent fidgeting with hands and feet, difficulty engaging in activities quietly, and excessive talking. Impulsivity is characterized by blurting out answers before questions have been completed, difficulty awaiting turn, and frequent interruptions. All of the behaviors in these ADHD criteria must be maladaptive and inconsistent with developmental level.

Several investigators have found neuropsychological evidence that ADHD is associated with impairments in executive control (Chelune et al., 1986; Koziol & Stout, 1993; Reader, Harris, Schuerholz, & Denckla, 1994). A measure frequently used to assess executive function in the school-age population is the Wisconsin Card Sorting Test, mentioned previously (WCST; Heaton et al., 1993). The WCST, while originally developed for use with adult populations, has since been revised and now provides normative data on children aged 6.5 years through adults aged 89 years. Many publications have linked ADHD with task failures on the WCST (e.g., Chelune et al., 1986; Pineda et al., 1998), since impairments on the WCST may suggest impaired cognitive flexibility, impaired abstract reasoning, and difficulty generating problem-solving ideas (Heaton et al., 1993). Children with ADHD typically exhibit not only these symptoms but also other features of EDF: difficulty planning and sequencing complex behaviors, inability to pay attention to several components simultaneously, low resistance to distraction or interference, and inability to sustain behavioral output for prolonged periods (Pineda et al., 1998).

In addition to the WCST, investigators have found EDF in children with ADHD on other EF assessment measures. The Tower of Hanoi (Simon, 1975) is an EF task measuring planning ability and working memory; the Stroop Color and Word Test (Stroop, 1935) assesses cognitive flexibility and response inhibition. Children with ADHD had been found to have deficient performance, relative to controls, both on the Tower of Hanoi (Aman, Roberts, & Pennington, 1998; Pennington, Groisser, & Welsh, 1993) and the Stroop (Boucugnani & Jones, 1989; Grodzinsky & Diamond, 1992). These results provide further evidence for executive impairment in ADHD.

In response to such evidence, models of EDF in ADHD have been proposed attributing the core deficit of ADHD to hyperactivity, inability to sustain attention, or disinhibition, three domains of EF (DeBonis, Ylvisaker, & Kundert, 2000). Barkley (1997) has recently proposed a theoretical model that states the central deficit in ADHD is not with the attentional domain, but with behavioral inhibition. Barkley (1997, 2000) maintains that ADHD is linked to four executive functions which govern self-regulation and goal-directed behavior: nonverbal working memory, verbal working memory, internalized emotion/motivation, and reconstitution. This model attempts to demonstrate that inhibition is the fundamental impairment behind all secondary deficits of other EFs. However, several recent studies (Mahone et al., 2002; Oosterlaan & Sergeant, 1998) which incorporated Barkley's (1997) model, failed to conform to a strict inhibition impairment notion. Rather, the studies emphasize that while inhibition is an important component in ADHD, EDF is more widespread involving several domains of EF.

An alternative explanation can be found in reconsidering Anderson’s (2002) model of executive functioning. In this model, the attentional control domain encompasses selective attention, self-regulation, self-monitoring, and inhibition. As some or all of these abilities may be impaired with ADHD, it seems likely that, according to this model, deficits of EF in ADHD could originate in this domain. Furthermore, because Anderson's (2002) four domains are inter-related and inter-dependent, impairment of attentional control would lead to difficulties in other domains, such as goal setting, which is responsible for planning.

EF Measurement

If attempting to describe and comprehend the concept of EF is an arduous task, equally challenging is characterizing the precise measurement of EF. Due to EF's dynamic, multidimensional quality, assessment of EF does not lend itself as easily to traditional pencil-and-paper methods as do the more specific domains of language, memory, motor, and visual/nonverbal abilities (Gioia et al., 2001). Instead, a task must be novel and complex to recruit EF; tasks that are familiar, pleasantly comfortable, or well automatized do not activate EF (Anderson 2002; Gioia et al., 2001). In fact, neuroimaging has demonstrated that a smaller region of the frontal lobes is activated during practiced or familiar tasks than is active during initial exposure to a novel task (Gold, Berman, Randolph, Goldberg, & Weinberger, 1996). Gold et al. (1996) also found the brain activation from a novel task was broader in the right frontal lobe, while the activation from a practiced task was more in the left frontal lobe.

This said, there are several concerns regarding the psychometric properties of EF measurements that must be considered prior to interpreting a particular test. Ecological validity is the extent to which results can be generalized to different contexts. This generalization is a particular problem in EF assessment because the typical evaluation setting is highly structured and interactive, in effect serving as the child's external executive control (Gioia, Isquith, Kenworthy, & Barton, 2002). Because the examiner provides structure, organization, and guidance, this situation may relieve some of the demands of the EFs; in fact, inconsistencies between EF measures and real-life behavior are often described

(Anderson, 2002; see Cripe, 1996 for review). For example, a child may be able to perform appropriately on the WCST, yet fail in strategically modifying his or her approach to complete a set of math problems in the classroom (Gioia et al., 2001). "A child with significant EDF can perform appropriately on well-structured tasks of knowledge on which the examiner is allowed to cue and probe for more information, thus relieving the child of the need to be strategic and goal-directed" (Gioia et al., 2001, p. 338). In other words, a person with even significant EDF and related real-life problems may perform very well on testing procedures (Cripe, 1996). In addition, a one-to-one setting, such as an evaluation, may enhance the child's motivation and performance (Anderson, 2002).

As an apt example of difficulties relating to ecological validity of EF tests, Eslinger and Damasio (1985) provide the case study of patient EVR. At age 35, EVR underwent a bilateral frontal lobe ablation to remove a large cerebral tumor compressing his frontal lobes. Postoperative neuropsychological examinations were all normal. EVR's test scores ranged from average to superior on tests assessing his intelligence, memory, language, personality, and EF. Of particular interest is his performance on the WCST and other EF tests; such tasks presented little difficultly to EVR and his performance was well within normal limits. Despite his excellent results, however, EVR could not meet his professional and personal responsibilities. Previously a comptroller for seven years for a home-building firm, he was fired from numerous jobs, lost all of his savings, and was left by his wife of 17 years, all occurring within two years post-surgery. It became apparent that while EVR could solve hypothetical social and ethical dilemmas, he was unable to analyze and integrate stimuli pertaining to real-life situations. Eslinger and Damasio (1985) note that "In artificial problems, the premises are furnished verbally, 'post-analysis,' within close temporal proximity; in real life, premises are often presented through different sensory modalities and at different times" (p. 1737). To summarize, in real-life situations, where overt external guidance did not exist, EVR had greater freedom to choose from behavioral options. He often conceived of and carried out inappropriate plans of action, usually with disastrous consequences. Unfortunately, this sort of behavior is often noted in other frontal lobe patients, and cannot be predicted on the basis of test data alone. Because behavior is a product of multiple controlling variables, it is essential to assess behavior in a contextually relevant situation, specifically, the environment where the behavior customarily occurs (Hart & Jacobs, 1993). "Without this contextual specificity, it is unlikely that the presenting problem will be defined with enough precision to allow for intervention," (Hart & Jacobs, 1993, p. 6).

The fact that a task must be novel to tap EF also poses a problem for test-retest reliability. Once someone has been exposed to a novel task, a second administration will no longer be novel. Therefore, the demands of the task the second time are no longer considered to be "executive" due to practice effects. While this concern warrants caution regarding performance validity and reliability, fortunately, the majority of tasks have other sound psychometric properties, such as being able to discriminate adequately between clinical and normative samples; in this way, tasks retain their clinical utility (Gioia et al., 2001).

Because evidence now exists that EF emerges in childhood, it is feasible to measure EF in children. However, many of the existing EF tests used in pediatric assessment are extensions of adult measures that have been developed and validated on adult populations.

Tests such as these pose a problem with interpretation because they often lack suitable normative data to differentiate between normal and abnormal performance in a developmental context (Anderson, 2002). Accordingly, it is opportune that "in the last decade a number of tests have been devised specifically for particular age ranges through childhood" (Anderson, 2002, p. 75). Examples of such tests include the EF subtests from the NEPSY (Korkman et al., 1998), the Matching Familiar Figures Test (Kagan, 1965), and the Children's Paced Auditory Serial Addition Test (Johnson, Roethig-Johnston, & Middleton, 1988).

Since these psychometric problems are pervasive in the area of EF assessment, it may be quite advantageous to supplement standardized EF measures with rating scales, particularly in an ADHD evaluation. Observations of the child's overt behavior in the home or at school provide an invaluable source of information, especially because diagnostic criteria state that the symptoms must be present in two or more settings (American Psychiatric Association, 1994; Gioia et al., 2001). Rating scales, completed by parents and teachers, measure not only the presence of symptoms, but also, because most instruments are norm-referenced, their severity and extent of developmental deviance (Anastopoulos & Shelton, 2001; Power et al. 1998). Studies examining behavioral reporting scales typically are not focused on the relationship between parent and teacher reports, but instead concentrate on comparisons between the self-report of the child and adult (parent and teacher) reports. Thus, the research on direct comparisons of parent and teacher reports is limited. Despite this, however, some conclusions can be made. Studies have shown moderate levels of agreement between parent and teacher reports, with a correlation coefficient around

.41 (e.g. Kolko & Kazdin, 1993; Power et al. 1998). Interestingly, severity of child dysfunction is inversely related to the degree of parent-teacher concordance, possibly because those children who are more temperamentally easy function more consistently across the home and school contexts (Victor, Halverson, & Wampler. 1988). Power et al. (1998) revealed that combining parent and teacher reports of ADHD symptoms was more accurate in predicting the presence of ADHD than a single informant approach.

While many behavior rating scales exist (e.g., Conners, 1997; DuPaul, Power, Anastopoulos, & Reid, 1998), few specifically provide an assessment of EF as manifest in behavior. The Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al., 2000) and the Children's Executive Functions Scale (CEFS; Silver et al., 1993) were designed to achieve the foregoing in children aged 5-18 and aged 6-12, respectively. Both the BRIEF and the CEFS utilize parent and teacher reports.

Behavior Rating Inventory of Executive Function.

The BRIEF consists of eight executive function clinical scales that measure the extent to which the respondent reports problems that the child exhibits with different types of behavior: Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor (Gioia et al., 2000). These eight domains, along with their respective definitions and sample items, are provided in Table 1.

Table 1

Eight Clinical Scales of the Behavior Rating Inventory of Executive Function

Scale	Behavioral Description	Sample Items
Inhibit	Control impulses; appropriately stop own behavior at the proper time.	Interrupts others. Blurts things out. Acts wild or "out of control."
Shift	Move freely from one situation, activity, or aspect of a problem to another as the situation demands; transition; solve problems flexibly.	Becomes upset with new situations. Resists change of routine, foods, places, etc. Does the same thing over and over again for no apparent reason.
Emotional Control	Modulate emotional responses appropriately.	Overreacts to small problems. Has explosive, angry outbursts. Mood changes frequently.
Initiate	Begin a task or activity; independently generate ideas.	Is not a self-starter. Has trouble getting started on homework or chores. Complains there is nothing to do.
Working Memory	Hold information in mind for the purpose of completing a task; stay with, or stick to, an activity.	Has a short attention span. Needs help from an adult to stay on task. Has trouble remembering things, even for a few minutes.
Plan/Organize	Anticipate future events; set goals; develop appropriate steps ahead of time to carry out an associated task or action; carry out task in a systematic manner; understand and communicate main ideas or key concepts.	Does not bring home homework, assignment sheets, materials, etc. Becomes overwhelmed by large assignments. Starts assignments or chores at the last minute.
Organization of Materials	Keep workspace, play areas, and materials in an orderly manner.	Leaves playroom a mess. Cannot find things in room or school desk. Leaves messes that others have to clean up.
Monitor	Check work; assess performance during or after finishing a task to ensure attainment of goal; keep track of the effect of own behavior on others.	Does not check work for mistakes. Is unaware how his/her behavior affects or bothers others. Has poor understanding of own strengths and weaknesses.

The majority of the individual items were generated by clinical interviews with parents and teachers and additional items were added that were behaviorally consistent with each of the domains. Item-category membership was validated by the sorting decisions of nine clinical neuropsychologists and by statistical analyses (Gioia et al., 2000).

Although the BRIEF may be used with a number of clinical groups, including children with traumatic brain injury, pervasive developmental disorders, and Tourette's Disorder, it is particularly useful for distinguishing between symptoms and subtypes of ADHD. Isquith & Gioia (1999) found evidence that diagnosis of the inattentive subtype of ADHD was most strongly related to the initiating, sustaining, planning, organization, and working memory domains. Children with the hyperactive-impulsive and the combined subtypes of ADHD displayed deficits in the inhibiting, self-monitoring, and emotional control domains. Therefore, the authors of the BRIEF consider the Working Memory and Inhibit scales to have the highest overlap with diagnostic criteria for inattentive and hyperactive-impulsive subtypes of ADHD, respectively (Gioia et al., 2000).

Children's Executive Functions Scale.

The CEFS consists of five clinical subscales which measure the extent to which the respondent reports the presence of the child's specific behavior compared to that of their same-aged peers: Social Appropriateness, Inhibition, Problem Solving, Initiative, and Motor Planning (Silver et al., 1993). These five subscales, along with their respective definitions and sample items are shown in Table 2. Developed by members of the National Academy of Neuropsychology Research Consortium, the items on the CEFS were constructed on the basis of theory and the developers' clinical experience with children with EDF.

Table 2

Five Clinical Scales of the Children's Executive Functions Scale

Scale	Behavioral Description	Sample Items
Social Appropriateness	Display age-appropriate and situation-appropriate behavior with others; regulate emotional responses.	Laughs at the wrong time. Is not able to adapt play to older or younger children. Hurts others' feelings without meaning to.
Inhibition	Control impulses; stay on task.	Is easily distracted. Is overactive. Does not complete school assignments.
Problem-Solving	Assess own performance during task; carry out task in systematic manner; use feedback to monitor and adapt behavior as situation demands.	Does not understand unspoken rules. Gets caught up in details and misses the big picture. Gets stuck on an idea or a certain behavior.
Initiative	Independently begin task or activity; move freely from one situation or task to another.	Needs prompts to change activities. Has trouble resuming work once interrupted. Cannot think up new activities or games.
Motor Planning	Control of hand movements.	Runs off the page when he/she draws or writes. Does not construct puzzles or models well. Has handwriting that is messy, poorly spaced, or has odd slant.

A study of children with ADHD revealed low to moderate correlations between the CEFS Total Score and the WCST. When the CEFS was correlated with WCST perseverative errors, a low correlation (*r*=.27) was obtained, and when the CEFS was correlated with WCST failure to maintain set, a moderate correlation (*r*=.385) was obtained (Molho, 1996). In a similar study using a heterogeneous group of children with neurological impairment, the WCST perseverative error score was significantly correlated with the CEFS Inhibition domain, Problem-Solving domain, and the Motor Planning domain (Goulden, 1998). The CEFS Total Score has also been found to correlate highly with both the Conner's Parent Rating Scale (*r*=.746) and the Child Behavior Checklist (*r*=.771), two ADHD rating scales (Goulden, 1998).

CHAPTER THREE
Purpose and Hypotheses

Purpose of Study

One purpose of the present study is to examine the relationship between the BRIEF and the CEFS. Both are scales designed to measure executive functioning in children, but the BRIEF is the only published scale. Because the BRIEF has been standardized and has published reliability and validity, it is of interest to see how the CEFS compares.

A second purpose is to find the degree of correlation between each of the two rating scales and two other direct measures of executive functioning, the WCST and the Visual Attention subtest from the NEPSY test battery for children. The WCST will be used as a measure of flexibility of thought and problem-solving, and the NEPSY subtest will function as a measure of attention. Difficulties with flexibility of thought, problem-solving, and attention are three frequent EF symptoms in children with ADHD. A parent and teacher will complete both the BRIEF and the CEFS for each child participating in this study, and each child will be administered the WCST and the NEPSY Visual Attention subtest.

A third purpose is to examine the degree of agreement between parent and teacher behavior ratings. This examination will provide information on the variability of a child's behavior between two real-world settings, as well as determine if it is necessary to gather ratings from two different sources or if one source is sufficient.

Hypotheses

Hypothesis 1:

A high level of agreement will be found between the BRIEF Total Score and the CEFS Total Score because both rating scales utilize similar questions, and therefore exhibit similar content and face validity. Content validity is determined by the degree to which the items on the test are representative of the construct the test was designed to sample (Gregory, 2000). Based on the ideas of Lezak (1995), face validity is the quality of appearing to measure what the test purports to measure. Although no previous research has examined the strength of agreement between EF rating scales, the BRIEF and the CEFS scales appear to measure the same construct, EF.

Hypothesis 2:

High levels of agreement will be found between comparable BRIEF domain scores and CEFS domain scores. Specifically, the BRIEF Inhibit domain will correlate with the CEFS Inhibition domain; the BRIEF Emotional Control domain will correlate with the CEFS Social Appropriateness domain; the BRIEF Initiate domain will correlate with the CEFS Initiative domain; and the BRIEF Monitor domain will correlate with the CEFS Problem-Solving domain. This is expected, again, due to the BRIEF and the CEFS both appearing to measure the same construct.

Hypothesis 3:

Children with ADHD in the current study will be impaired on the WCST and the Visual Attention subtest from the NEPSY. Past research has demonstrated children with

ADHD characteristically have impaired performance on measures of EF (Chelune & Baer, 1986; Chelune et al., 1986; Koziol & Stout, 1993).

Hypothesis 4:

Impaired performance on the WCST and the Visual Attention subtest from the NEPSY will have a low to moderate correlation (about r=.30) with the degree of EDF, as measured by the BRIEF and by the CEFS. Impaired performance on the WCST and the Visual Attention subtest from the NEPSY indicates EDF. However, these correlations are expected to be low due to previous research that has suggested a limited relationship between performance on standardized tests of EF and real-world functioning (Cripe, 1996).

Hypothesis 5:

Consistent with previous studies (Kolko & Kazdin, 1993; Power et al. 1998), a moderate level of agreement (about r=.40) will be found between the parent and teacher ratings for both the BRIEF and the CEFS Total Score. A moderate level of agreement will also be found between the parent and the teacher ratings for each of the domain scores on the BRIEF and on the CEFS.

CHAPTER FOUR
Methodology

Participants

Thirty children, ages 8 years to 12 years, will be recruited for the study. Children with ADHD will meet the following inclusion criteria: (a) a diagnosis by a psychologist or neuropsychologist of ADHD, Inattentive, Hyperactive, or Combined subtypes, according to DSM-IV criteria (b) a rating of at least 1.5 standard deviations above the mean for the child's age on the Revised Conners Teacher Rating Scale Total Score (as suggested in Kendall & Braswell, 1985), and (c) a rating of at least 1.5 standard deviations above the mean for the child's age on the Revised Conners Parent Rating Scale Total Score. Children with cognitive functioning limiting their understanding of any of the tasks will be excluded. Children with severe visual or hearing impairments which affect testing, other neurological conditions, and severe psychiatric disorders will also be excluded. If the child is currently receiving stimulant medication, the child's parent will be instructed to abstain from administration on the day of evaluation.

Measures

Four measures will be used to assess executive functioning. The Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al., 2000) and the Children’s Executive Functions Scale (CEFS; Silver et al., 1993) will be the two rating scales used. Two standardized tests will be used to measure two domains of executive functioning. The Wisconsin Card Sorting Test (WCST; Heaton et al., 1993) will assess flexibility of thought and problem-solving capabilities, while the Visual Attention subtest from the NEPSY

(Korkman et al., 1998) will be used to measure attention.

The BRIEF consists of a parent report form and teacher report form, each with 86 questions. The measure consists of eight executive function clinical scales: Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor. The BRIEF also contains two validity scales, Inconsistency and Negativity. Questions are answered on a three-point scale: Never, Sometimes, Often. Test-retest reliability across all clinical scales for the parent form was .82, with a range of .76 to .88. The manual reports predictive validity of ADHD compared with a control group according to the Working Memory and the Inhibit scales. The Parent Rating Scale correctly predicted 84% of group membership on the Working Memory Scale and 85% correct on the Inhibit Scale. Teacher ratings on the Working Memory scale predicted 80% correctly and 79% correctly on the Inhibit scale.

The CEFS was designed as a 99-item parent report. The CEFS contains five domains: Social Appropriateness, Inhibition, Problem-solving, Initiative, and Motor Planning. Ratings for each item are based upon the relative presence of specific problem behaviors (0=never, 1=sometimes, 2=very much); thus, the CEFS yields a total possible range of 0 to 198 points. The test-retest reliability of the CEFS Total Score is .92, with reliabilities of the domain scores ranging from .81 to .90. The validity of the CEFS was demonstrated by a discriminant analysis of scores from an ADHD group and control group, producing correct classification of 89% of the ADHD children and 92% of the controls (Molho, 1996). A 99-item version was developed for use with teachers.

The WCST is among the most commonly used measures to assess problem-solving capability and thinking flexibility. The WCST requires the examinee to sort cards according to one of three rules (color, form, number). He or she then receives feedback after every response regarding his or her accuracy. Once the child has made ten correct consecutive responses, the sorting principle changes without the child's knowledge. Chelune et al. (1986) found, using perseverative errors and failure to maintain set scores, that the WCST correctly classified 85.4 % of ADHD children and control children. The data will be reported in terms of failure to maintain set and number of perseverative errors.

The NEPSY is a comprehensive neuropsychological test battery for children. This study will use the Visual Attention subtest from the NEPSY, a subtest which requires the child to scan an array of pictures (cats and faces) and mark the target pictures as quickly and accurately as possible. The data will be reported in terms of accuracy (hits minus false alarms) and time. Children with ADHD may perform poorly due to impaired selective and sustained attention, cognitive domains necessary to complete the task accurately. The test-retest reliability for the Visual Attention subtest is .62 for ages 5-12 (Korkman et al., 1998).

Procedure

Children will be recruited from three outpatient clinical settings specializing in assessment and treatment of neurological disorders. The directors of these sites have agreed to explain the study and ask for participation from new patients. Approval for the study was obtained from the Institutional Review Board at The University of Texas Southwestern Medical Center. All parents will be required to sign a consent form explaining the purpose of the study and their right to withdraw at any time without consequences.

Children will individually be administered the NEPSY Visual Attention subtest and the WCST, in this order, in one sitting lasting approximately 30 minutes. While the children are completing the tests, the parent will fill out the BRIEF and CEFS parent report forms. Parents will also be given the BRIEF and CEFS teacher rating forms along with a stamped envelope. The parent is to give the forms to the child's teacher, who will complete them and return to the investigator. Because the rating scales are intended to be completed based on a child's behavior while not receiving stimulant medication, teachers will be instructed to rate the behavior of the child prior to the initiation of medication. Those children who participate in the study during the beginning of the school year and who have begun taking stimulant medication over the summer will be evaluated by the teacher from the previous school year.

Some children may have previously been administered the WCST in an assessment, a situation which would defeat the novelty of the task. If administration occurred up to 6 months prior to the current evaluation or the child clearly remembers the principles of the test, the data from the earlier administration will be used.

Statistical Analyses

Hypothesis 1:

The level of agreement between the BRIEF Total Score and the CEFS Total Score will be examined, for both the parent and teacher versions, using a Pearson *r* correlation.

Hypothesis 2:

The specified BRIEF domains will be correlated with the specified CEFS domains by generating a correlation matrix to search for relationships between the BRIEF and CEFS domains for both the parent and the teacher versions.

Hypothesis 3:

Children's impairment on the WCST and the Visual Attention subtest from the NEPSY will be reported using descriptive data from the sample, including means, standard deviations, and percentages of children whose scores are in the impaired range. In addition, a single sample t-test will be used to test whether the ADHD children's performance is significantly different from that of the standardization sample.

Hypothesis 4:

Scores on the WCST and the NEPSY will be correlated with the BRIEF Total Score standard scores; additionally these neuropsychological test scores will be correlated with the CEFS raw scores, which are not corrected for age.

Hypothesis 5:

The parent forms will be correlated with the teacher forms for the BRIEF Total Score and the BRIEF domains, and also for the CEFS Total Score and the CEFS domains.

CHAPTER FIVE
Implications

Hypotheses one and two postulate a high degree of correlation between both the BRIEF and the CEFS Total Scores, as well as between comparable BRIEF and CEFS domains. The BRIEF's reliability and validity were established prior to its publication, and it is assumed to represent a fairly accurate profile of a child's EF. Many of the psychometric properties of the CEFS have yet to be determined, but both scales exhibit similar content and face validity. Regardless of whether or not these hypotheses are supported, the results will provide an impetus for further research with the CEFS. Should the BRIEF and CEFS correlate highly with each other, it would suggest the CEFS does indeed measure EF and that perhaps an appropriate follow-up action would be the development of normative data. If analyses demonstrate a more modest or low correlation, it would indicate that one of the rating scales somehow provides a different representation of EF than the other scale. Follow-up research would then attempt to resolve how the two scales are different and if one scale provides a more complete representation of EF than the other scale.

Hypothesis three contends that children with ADHD will have impaired performance on both the WCST and the Visual Attention subtest from the NEPSY. Many studies have demonstrated such executive dysfunction on tasks; replicating those results in the present study would provide further support to the view that some degree of executive impairment exists with ADHD. However, some studies have failed to find such an association (e.g., Fischer, Barkley, Fletcher, & Smallish, 1993; Loge, Staton, & Beatty, 1990). Instead, these studies propose the attentional deficits which accompany ADHD are accounted for by right hemisphere dysfunction, a topic which has received more interest of late (e.g., Stefanatos & Wasserstein, 2001).

While both the BRIEF and the CEFS correlate highly with other ADHD rating scales, hypothesis four predicts they will have a low to moderate correlation with examiner-administered EF measures. Such results, indicating a disparity between EF measures and reported real-world behavior, would not be unheralded, as inconsistencies between performance on structured tests and performance in real life are often described in the literature (Anderson, 2002; Cripe, 1996). However, as Cripe (1996) aptly questioned, "Why does such a chasm exist between our tests and reality?" (p. 186). While authors (e.g. Acker, 1990) have implicated factors such as the differences between the clinical setting and real life, the nature and complexity of executive functions, and a focus on outcome scores and a neglect of process, the ultimate question rests with what can be done about such discrepancies.

Executive function assessment has attempted to control its ecological validity problems with the addition of rating scales to traditional structured measures. Affirming the results of low to moderate correlations between the two types of measurement in this study would suggest that, indeed, each assessment method provides the diagnosing clinician with qualitatively different forms of valuable data that need to be observed, analyzed, and integrated.

Future investigations may attempt to determine the degree to which each type of information is weighted when making such a diagnosis as ADHD. Perhaps such controlled studies as Offord et al.'s (1996) effort to compare statistical strategies of integrating data are needed to establish the best method of synthesizing qualitative data, such as observation rating scales, with the quantitative data obtained from traditional structured tasks.

Few studies have examined the relationship between parent and teacher reports on rating scales; most studies, instead, concentrate on comparisons between the child's self-report and the adult report. Hypothesis five, presuming a moderate correlation between parent and teacher ratings, is therefore based on the studies that do report results of such comparisons (Kolko & Kazdin, 1993; Power et al. 1998). Whether this hypothesis is supported with moderate correlations (about r=.40) or if the correlations are found to be low, the implications are the same: the parent and teacher reports each provide potentially valuable clinical information.

Offord et al. (1996) examined different strategies of integrating data from different informants reporting on the same individual. They concluded that rather than combining the informant data in a systematic way, clinicians should conceptualize child psychiatric disorders as informant-specific, considering every informant's data individually. High correlations between parent and teacher ratings would indicate that the informants agree with each other on the type, frequency, and severity of the child's behaviors. Although these results are unlikely given the results of previous studies and the fact that children's behavior often changes from setting to setting, such agreement would indirectly signify that a child's behavior is highly similar between the home and school environments. Obtaining these results would imply that acquiring behavior ratings from only one source (parent or teacher) may be sufficient to aid a clinician in an ADHD diagnosis.

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VITAE

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