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Concurrent Deficits in Behavior Inhibition, Non-verbal Working Memory and Psychological Sense of Time in ADHD

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Concurrent Deficits in Behavior Inhibition, Non-verbal Working Memory and Psychological Sense of Time in ADHD

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Dissertation Approval

This is to certify that the thesis presented to us by Roya McCloskey on the 20th day of December, 2001, in partial fulfillment of the requirements for the degree of Doctor of Psychology, has been examined and is acceptable in both scholarship and literary quality.

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ABSTRACT

According to the Hybrid Model of Executive Function for Attention Deficit Hyperactivity Disorder (ADHD), hyperactive and combined types, a delay in behavior inhibition causes secondary deficits in four executive function; non-verbal working memory, verbal working memory, reconstitution and self-regulation of affect/motivation/arousal. The deficit in non-verbal working memory causes a deficit in psychological sense of time, which in turn impairs self-regulation in those with ADHD. This single case study investigated concurrent deficits in behavior inhibition, non-verbal working memory and psychological sense of time in a 10-year-old male with ADHD, combined type. Three interrelated components of behavior inhibition were measured by the Continuous Performance Test-II, The Wisconsin Card Sorting Test, and the Stroop Test. Non-verbal working memory was measured by using the Rey-Complex Figure Test and Recognition Trial, and the psychological sense of time was measured by the Time Perception Test, which is a time reproduction task. The results of this case study supports the Hybrid Model of Executive Function as concurrent deficits in behavior inhibition, non-verbal working memory and psychological sense of time were found in a subject with ADHD, combined type. The implications of these findings for treatment and future research are discussed.

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CHAPTER 1

INTRODUCTION AND RATIONALE FOR THE STUDY

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common reasons American children are referred to mental health professionals (Barkley, 1996), and its recognition as a public health concern has been expanding worldwide (Brown, 2000). The prevalence of ADHD varies depending on the definition and objective assessment measures, but recent epidemiological studies (Hinshaw, 1994) state that about 1% to 7% of children have ADHD. Significant rates of ADHD have been reported in New Zealand (Anderson, Williams, & McGee, 1987; Fergusson, Horwood, & Lynskey, 1993a); Germany (Baumgaertel, Wolraich, & Dietrich, 1995); Italy (Galluci, Bird, & Berarni, 1993); China (Leung, Luk, & Ho, 1996; Tao, 1992); Japan (Kanbayashi, Nakata, & Fujii, 1994); India (Bhatia, Nigam, & Bohra, 1991); and Puerto Rico (Bird, Canino, & Rubio-Supec, 1988).

Follow-up studies suggest that children with ADHD are at risk for developing other significant psychological problems later in life (Rutter, 1989; Cantwell & Hanna, 1989). This disorder, once known as the behavioral disorder in young boys, is now recognized as commonly existing in young girls (Arnold, 1996; Biederman, Faraone & Mick, 1999; Gaub & Carlson, 1997; McGee & Feehan, 1991), persisting into adolescence (Barkley, 1990; Biederman et al., 1996b, 1998; Schughency, McGee, Raja, Feehan, & Silva, 1994; Weiss & Hechman, 1986, 1993; Wilson & Marcotte, 1996), and adulthood (Biederman, et al., 1993; Millstein et al., 1997; Spencer, Biederman, & Wilens, 1994; Wender, 1995). The genetic contribution of ADHD is significant, suggesting that this disorder will not go away, and, in fact, is passed on from generation to generation. Research shows that 10% to 35 % of immediate family members of children with ADHD also have ADHD (Biderman et al., 1992; Biederman, Keenan, & Faraone, 1990; Pauls, 1991). If a parent has ADHD, there is a 57% chance of the offspring also having ADHD (Biederman et al., 1995). Higher rates of ADHD prevelance have been reported in the biological parents of hyperactive children as compared to adoptive parents (Cadoret & Stewart, 1991; Cantwell, 1975; Van den Oord, Boomsma, & Verhulst, 1994). Twin studies (Edelbrock, Rende, Plomin, & Thompson, 1995; Gillis, Gilger, Pennington, & DeFries, 1992; Goodman & Stevenson, 1989; Levy, Hay, & McStephen, 1997; Sherman, McGue, & Iacono, 1997) using larger sample sizes have concluded concordance rates as high as 81% in Monozygotic twins and 29% in Dizygotic twins for diagnosis of ADHD.

The impact of ADHD and the poor self-regulation associated with it are significant in terms of financial cost, stress on the families, school distruptions, alcohol and substance abuse, and criminal activity (Mannuzza, Klein, Konig, & Giampino., 1989). Considering the prevalence and impact of ADHD, clinicians rely on research for effective theoretical, diagnostic, and treatment frameworks. However, despite the large volume of research available on ADHD, the research in this area has been atheoretical with a few exceptions (Barkley, 1997b; Brown, 1995; Quay, 1988a, b; Schachar, Tannock & Logan, 1993; Sergeant & Van der Meere, 1988). Until recently, there has not been an adequate understanding of the underlying mechanisms involved in ADHD; therefore there has not been a strong consensus among clinicians as how to best assess and treat this disorder. A comprehensive theory of ADHD is needed that can shed light on the etiological variables of this disorder and bridge the gap in literature from various sources. Such a theory can be used as a scientific tool to explain the existing data, make explicit predictions, and lead future research activity. Theories of ADHD that have gained popularity in recent years address executive function (EF) deficits that are involved in this disorder (Barkley, 1997b; T. E. Brown, 1995). Barkley (1997a) has developed a hybrid model of executive function for ADHD, hyperactive (ADHD+H) and combined (ADHD-C) types. According to Barkley, it is not inattention, but the deficiency in behavioral inhibition and poor self-regulation that distinguishes ADHD from other developmental disorders. He proposes that delay in the development of behavioral inhibition in ADHD+H and ADHD-C causes secondary deficits in the development of executive functions and an adequate psychological sense of time, which, in turn, disrupt performance of self-regulation and goal-directed behavior.

Behavioral inhibition, a function of the prefrontal cortex, facilitates goal-directed behavior by providing an opportunity for cost-benefit analysis and resistance to temptation and interference control. Several studies have established that poor behavioral inhibition and self-regulation are differentiating features of ADHD with hyperactivity or combined type (Achenbach & Edelbrock, 1983, 1986; Barkley, 1990; DuPaul, Anastopoulos, Power, Reid, Ikeda, & McGoey, 1996). Studies using the stop-signal paradigm have provided evidence that children with ADHD have a slower inhibitory response initiation (Manassis, Tannock, & Barbosa, 2000; Oosterlaan & Sergeant, 1995, 1996; Schachar & Logan, 1990; Schachar, Tannock, & Logan, 1993; Schachar, Tannock, Marriott, & Logan, 1995; Schachar, Mota, Logan, Tannock, & Klim, 2000). The performance on the go no go signal tasks have provided further evidence for the inhibitory deficit in those with ADHD (Iaboni, Douglas, & Baker, 1995; Milich, Hartung, Martin, & Haigler, 1994; Yong-Liang et al., 2000). Self-regulation involves the execution of self-directed behaviors with the goal of changing the probability of subsequent behaviors in order to maximize future gains. Therefore, the individual must delay immediate gratification and develop a preference for long-term outcomes. Poor self-regulation in those with ADHD has been documented through the difficulty in delaying responses, impulsivity, and resistance to temptation. Some studies requiring children with ADHD to delay responding (Sonuga-Barke, Houlberg, & Hall, 1994; Songua Barke, Taylor, & Hepinstall, 1992; Songua-Barke, Taylor, Sembi, & Smith, 1992; Weyandt & Willis, 1994) have found that these children tend to be more impulsive in their responding, and that they have a difficult time restricting their behavior when asked (Barkley & Ullman, 1975; Ullman, Barkley & Brown, 1978). Adequate interference control and cognitive flexibility are other necessary functions that promote self-regulation. Studies by Schachar and Tannock (1995) and Oosterlaan and Sergeant (1988) also showed that children with ADHD have a hard time re-engaging in a task after an interruption. Other studies (McBurnnett et al., 1993; Pliszka, Borcherding, Spratley, Leon, & Irick, 1997; Reader, Harris, Schuerholz, & Denckla, 1994; Seidman, Biederman, Weber, & Quellette, 1996) using the Wisconsin Card Sort Test (WCST; Heaton, 1981) have shown that ADHD children are unable to stop an ongoing response pattern or to shift their response to a correct one after feedback.

According to the hybrid model of executive function, the impairment in behavioral inhibition causes a secondary deficiency in the four executive functions: verbal working memory, reconstitution, regulation of affect and arousal, and non-verbal working memory. Barkley (1997a) and others (Fuster, 1989; Goldman-Rakic, 1995a, 1995b) stress the role of non-verbal working memory in internalization of behavior and self-regulation. Non-verbal working memory provides a covert sensing to one's self through the representation of past events and contingencies associated with them. As the individual matures, past representations which are based on previous experiences provide a great deal of information that help the individual develop hindsight which is then used to guide future behavior and the development of forethought (Barkley, 1997a; Fuster, 1989; Goldman-Rackic, 1995a, 1995b). Due to the problem with non-verbal working memory, those with ADHD do not store previous experiences that they can draw from later; therefore, they do not anticipate the consequences of their actions as well as those without ADHD. Additionally, these individuals have a difficult time sequencing their experiences in the correct temporal order. Similar to those with frontal lobe injuries (Godbout & Doyon, 1995; McAndrews & Milner, 1991; Sirigu et al., 1995), they seem to be insensitive to time constraints, have inadequate hindsight and forethought, poor goal directed behavior and planning abilities, difficulty with delaying immediate gratification, and insensitivity to punishment.

Despite some inconsistencies (Fischer, Barkley, Edelbrock, & Smallish., 1993; Reader et al., 1994; Weyandt & Willis, 1994), significant evidence exists for non-verbal working memory deficits in those with ADHD (Douglas & Benezra, 1990; Grodzinsky & Diamond, 1992; Mariani & Barkley,1997; Nigg, Hinshaw, Carte & Treuting, 1998; Sadeh, Ariel, & Inbar, 1996; Seidman et al., 1997). The non-verbal working memory facilitates self-directed behavior through its retrospective and prospective functions and by cross-temporal organization of time delays among event, response, and outcome (Barkley, 1997a; Barkley, Koplowwicz, Anderson, & McMurray, 1997; Denckla, 1994; Fuster, 1989). The sense of time develops as the individual gains the ability to estimate the duration between the events and responses and to keep this duration in mind as the results of non-verbal working memory (Michon, 1985; Brown, 1990). Therefore, the non-verbal working memory helps the development of a sense of time. This process does not happen automatically; it requires attention and retention of temporal information that is vulnerable to distractions and competing events (Brown, 1985; Zakay, 1990, 1992). Therefore, there is need for interference control (Gerbing, Ahadi, & Patton, 1987; White et al., 1994). Non-verbal working memory relies on behavioral inhibition for its interference control to facilitate the development of a sense of time. Barkley (1997a, 1997b & Barkley, Koplowwicz, Anderson, & McMurray1997) considers sense of time as the seat of the executive functions and as the most essential component to self-regulation and goal-directed behavior. Through the internalization of a sense of time, the individual learns to anticipate the changes in the environment and to adjust his or her own preparatory behavior accordingly (Barkley, 1997a). Therefore, he or she becomes future oriented and purposive (Michon & Jackson, 1984). The deficits in non-verbal working memory in ADHD restrict this temporal span (Barkley, 1997a, 1997b, Barkley, Koplowwicz, Anderson, & McMurray, 1997), and this is why the preparatory action is not taken until the last minute. This delay does not provide a long enough interval for the individual to conduct a sufficient cost-benefit analysis or to choose the best course of action.

Psychological sense of time in those with ADHD has been studied in different ways. Grskovic, Zentall and Stormont-Spurgin (1995) assessed the retrospective recall of routine daily tasks in ADHD children. The results indicated a poor performance by the ADHD children as compared to the normal control group. Retrospective recall, however, is found to be a less accurate measure of sense of time than recall and reproduction tasks because it involves retrieval of information and storage (Zakay, 1992). Estimation and reproduction of time intervals are considered to be better measures of sense of time than recall tasks (Zakay, 1990). Children with ADHD have been found to make significantly greater errors in both tasks as compared to normal controls (Barkley, Murphy, & Kwasnik, 1996; Barkley, Koplowwicz, Anderson, & McMurray, 1997; Cappella, Gentile, & Juliano, 1977; Gerbing, Ahadi, Patton, 1987; Senior, Towne, & Huessy, 1979; White et al., 1994; White, Barratt & Adams, 1979). Across these studies, individuals with ADHD showed a less accurate sense of time. They perceive that time progresses more slowly than the normal controls, particularly at shorter intervals. The tasks that involved auditory or visual distractions further decreased their ability to estimate the time interval accurately.

Research thus far has provided separate evidence for deficits in behavioral inhibition, in non-verbal working memory and deficits in psychological sense of time in those with ADHD+H and ADHD-C; however, no research to date has explored the concurrent deficits in all three areas in the same subject. Therefore, although we have evidence for these deficiencies in those with ADHD, we have no evidence that these deficits co-exist together as hypothesized by Barkley (1997b) in the hybrid model of executive function theory regarding ADHD.

The case study chosen here investigates these concurrent deficiencies in a single subject with ADHD-combined type. This clinical case study attempts to provide clinical data that help test and possibly support one of the proposed theories of ADHD. Another purpose of this clinical case study is to demonstrate the importance of a comprehensive assessment of ADHD grounded in a specific theory of this disorder. This assessment includes the psychological sense of time and the neuropsychological deficits involved in this disorder. The specific aims of this clinical case study are (a) to assess whether the subject with Attention Deficit Hyperactivity Disorder-Combined Type (ADHD-C) has a lower than average behavioral inhibition and non-verbal working memory functioning level, as well as an inaccurate psychological sense of time; (b) to examine whether there is a concurrent deficit in the behavioral inhibition and the non-verbal working memory, as well as an inaccuracy in the psychological sense of time in this subject; (c) to implement a five-session psycho-education treatment program that involves the child, parents, and teacher. This treatment program is designed to help the subject develop compensatory skills for the expected deficits in behavioral inhibition, non-verbal working memory, and inaccuracy in the psychological sense of time. These skills are expected to improve the subject's daily functioning at home and at school. Through this research we expect to evaluate the applicability of Barkley's Hybrid Model of Executive Function for Attention Deficit Hyperactivity Disorder-Combined Type (ADHD-C) in a subject with ADHD-C. Specifically, our hypothesis predicts concurrent deficits in behavioral inhibition and non-verbal working memory, as well as an inaccuracy in the psychological sense of time in the subject with ADHD-C.

Prior to discussing the current case study, a review of literature is provided. This review summarizes the history, symptoms, and etiology of ADHD in addition to Barkley's Hybrid Model of Executive Function. This literature review is limited to the theoretical implications of ADHD. The clinical implications of Barkley's Hybrid Model of Executive Function and ADHD will be discussed in the third chapter, which focuses on the treatment of the subject with ADHD-C.

History

The history of ADHD reviewed here illustrates how better understanding of frontal lobe involvement and behavioral inhibition in ADHD has developed over time. The very first reference made to ADHD was by the German physician Hoffman (1865) when he described a hyperactive child, "fidgety Phil." Later, Still (1902) described 43 children in his practice as aggressive, defiant, and emotional, who exhibited little "inhibitory volition." He hypothesized that deficits in inhibition, moral consciousness, and sustained attention were all related to an underlying neurological deficit (Barkley, 1998).

In the early 1900s, with a rise in encephalitis, children who survived this disease exhibited problems similar to those with ADHD resulting from head injury, birth trauma, exposure to toxins, and other infections. Researchers (Pasamanick, Rogers, & Lilienfield, 1956) began to study the association between brain disease and behavioral pathology; thus the concept of "brain-injured child" became popular. Later this concept changed into "minimal brain damage" due to the lack of evidence for brain damage in many who exhibited similar behavioral symptoms. Instead, it was theorized that early, mild, and undetected brain damage accounted for the behavioral and learning disabilities in these children. One of the most important findings during this time was the similarity between hyperactive children and the behavior of primates with frontal lobe lesions (Blau, 1936; Levin, 1938). These studies found that damage to the frontal lobe of primates resulted in excessive restlessness, poor sustained attention, and other behavioral changes; therefore, frontal lobe brain structures became the area of focus related to hyperactivity. Later studies (Chelune, Ferguson, Koon, & Dickey, 1986; Lou, Henriksen, & Bruhn, 1984; Lou, Henriksen, Bruhn, Borner, & Nielsen, 1989) followed up on the role of frontal lobe and provided more evidence that frontal lobe damage resulted in similar symptoms as previously indicated.

In the 1950s, the neurological mechanisms underlying behavioral disturbances were studied. At this time, Laufer, Denhoff, & Solomons (1957) referred to ADHD as Hyperkinetic Impulse Disorder because of the Central Nervous System deficit in the thalamic area. He further differentiated between hyperactive "impatient" children and non-hyperactive impatient children. In the early 1960s, the global label of brain damage syndrome was questioned (Birch, 1964; Herbert, 1964; Rapkin, 1964), because many of the children had neurological symptoms in the absence of any brain damage.

By the late 1970s, the volume of published studies and written textbooks on hyperactivity (e.g., Cantwell, 1975; Safer & Allen, 1976; Trites, 1979; Weiss & Hechman, 1979; Wender, 1971) was significant. During this time, Wender's Theory of minimal brain damage and Douglas's model of attention and impulse control were the two models available to explain ADHD. Wender (1971) believed that attention and activation difficulties were directly related to poor inhibition, but he did not specify the nature of this relationship (Barkley, 1998). Virginia Douglas made a significant contribution to the understanding of ADHD by using behavioral and cognitive measures to identify that it was not hyperactivity, but poor sustained attention and impulse control that most likely explained the problems of children with ADHD (Campbell, Douglas & Morgenstern, 1971). Sustained attention requires adequate behavioral inhibition to reduce impulsivity, avoid distractions, and delay immediate gratification (Barkley, 1997b). Campbell, Douglas, and Morgenstern (1971) demonstrated that hyperactive children were not more distractible than normal children and that the problem with sustained attention could occur in the absence of distractions. Friebergs & Douglas (1969) and Parry & Douglas (1976) found that hyperactive children could perform at a normal level of sustained attention when continuous and immediate reinforcement was available. Another significant observation by Weiss & Hechtman (1986) noted that although many children's hyperactivity level diminished as they approached adolescence, their problems with impulsivity and poor sustained attention continued. Other studies (Barkley, Fischer, Edelbrock, & Smallish, 1990; Brown & Borden, 1986; Gittelman, Mannuzza, Shenker, & Bonagura, 1985; Mendelson, Johnson, & Stewart, 1971) have confirmed these previous findings.

As a result of Douglas's work (1980a, 1980b, 1983; Douglas & Peters, 1978), symptoms of sustained attention and impulse control became the focus of research regarding the symptom of hyperactivity. Douglas's model of hyperactivity was the primary reason why the disorder was named Attention-Deficit Disorder in the *DSM-III* (American Psychiatric Association, 1980). The *DSM-III* acknowledged that attention deficit disorder applies to a cluster of symptoms that may or may not include hyperactivity. This was the first recognition given to the symptoms of inattention by this publication. It became clear that the symptoms of hyperactivity were quite situational (Rutter, 1989) and not specific to ADHD. Hyperactivity can be seen in such other psychiatric disorders as anxiety, mania, and autism. Although in the *DSM-III* classification the deficits in sustained attention and impulse control gained significance over the hyperactivity symptoms in the diagnoses of this disorder, the empirical data with regard to the symptoms of inattention were still limited, and acknowledgement for the inattentive symptoms came indirectly from the diagnosis "Undifferentiated ADD." It was not until 1991 that Lahey and Carlson provided empirical data supporting factually the validity of the Attention-deficit Disorder, Predominantly Inattentive Type, diagnosis.

A few years later, it was better known that ADHD was not a disorder of attention (see Douglas, 1988, for reviews; Draeger, Orior, & Sanson, 1986; Sergeant & Van der Meere, 1989; Van der Meere & Sergeant, 1988a, 1988b), and the situational variability was re-emphasized (Douglas & Peters, 1978; Rosenthal & Allen, 1978). Motivational factors provided a better explanation for the presence and the degree of ADHD symptoms (Glow & Glow, 1979; Rosenthal & Allen, 1978). Research findings in neuroanatomical studies suggesting lower activation of brain reward centers (Lou et al., 1984; Lou et al., 1989) and their consistency with the studies of the functions of Dopamine pathways in incentive and operant learning (Benninger, 1989) gave motivational factors an even stronger stance (Barkley, 1998).

During the 1980's, Quay adopted Gray's neuropsychological model of anxiety (Gray, 1982, 1987) to explain poor inhibition in ADHD (Quay, 1987, 1988, 1997). Gray identified two critical components to understanding emotion: behavioral inhibition and behavioral activation systems. Quay explained that in children with ADHD, a diminished activity exists in the behavioral inhibition system; therefore, these children are less sensitive to signals of impending punishment. This does not mean that ADHD children do not respond to punishment, but that they are less responsive to conditioned punishment cues and signals.

The 1990's brought more research exploring the neurological and genetic basis of ADHD. Numerous neuropsychological studies showed performance deficits in the areas of the brain governed by the frontal lobe or executive functions (see Barkley, 1997b, Barkley, Grozinsky, & Diamond, 1992; Goodyear & Hynd, 1992, for reviews). Further psychophysiological research indicated that the frontal lobe maybe involved in the deficiencies related to ADHD (Hastings & Barkley, 1978; Klorman, 1992). Recently, particular attention has been paid to the behavioral inhibition deficit and its impact on self-regulation that seem to distinguish ADHD from other psychiatric disorders (Barkley, 1997b; Pennington & Ozonoff, 1996; Schachar, Tannock, & Logan, 1993). Frontal lobe functions and behavior inhibition have been used to formulate a theory about the etiology of ADHD (Barkley, 1997b).

Prior to the discussion of ADHD etiology, the following section reviews the symptoms of ADHD. ADHD is characterized by symptoms of hyperactivity, impulsivity, and inattention that persist past the age that is developmentally appropriate for the child.

Symptoms

Inattention

Inattention, a combination of diverse, but related cognitive functions (Parasurman, 1998), is a multidimensional construct that applies to alertness, arousal, selectivity, sustained attention, and distractibility (Barkley, 1998). Additionally, T. E. Brown (1995, 1996) has identified activation/arousal and affective/emotional components to attention. The review of neuroimaging studies of the human brain (Posner & Raichle, 1994) have shown at least three anatomic networks that function separately but together to support the attention system as a whole, first, the orienting network that consists of the parietal, midbrain, and the thalamic circuits; second, the executive attentional system that includes the left frontal lobe and the anterior cingulate, and third, the vigilance network that includes the right frontal lobe, the right parietal lobe, and the locus coeruleus.

The research on ADHD children's attention is somewhat contradictory. Jonkman et al (2000) have concluded that children with ADHD do not suffer from a shortage of attentional capacity, but from a problem with capacity allocation. Several researchers have found that children with ADHD are not necessarily more distractible (Campbell, Douglas, & Morganstern, 1971; Cohen, Weiss, & Minde, 1972; Douglas, 1983; Rosenthal & Allen, 1980; Jonkman et al., 2000; Steinkamp, 1980), but that they have difficulty in their persistence of effort or sustaining their attention on tasks in the absence of external or environmental rewards (Barkley, 1989, 1997a). The difficulty with sustained attention is noticeable even during free-play settings by frequent change in the selection of toys (Barkley & Ullman, 1975; Routh & Schroeder, 1976;

Zentall, 1985). This difficulty is most pronounced when the tasks are repetitive (Barkley, DuPaul & McMurray, 1990; Luk, 1985; Shelton et al., 1997; Zentall, 1985).

Filed studies (Lahey, Applegate, & McBurnett, 1994) have emphasized the attentional components of ADHD and that an individual with ADHD may have ADD without hyperactivity or impulsivity. The longitudinal study of Hart, Lahey, Loeber, Applegate and Frick (1995) showed that hyperactive symptoms in boys with ADHD seemed to diminish with age while the inattentive symptoms continued. Further studies (Levy et al., 1997) have demonstrated the separatability of hyperactivity and inattention. The inattentive symptoms are known to continue into adolescence and adulthood (Achenbach, Howell, & McConaughy, 1995), and often create problems with school, work, and social relationships (Biederman et al., 1998; Millstein et al., 1997).

Impulsivity/Behavioral Inhibition

Impulsivity is defined as a deficiency in inhibiting behavior in response to situational demands as compared to other children of the same mental age and gender (Barkley, 1998). Similar to attention, impulsivity is multidimensional (Kindlon, Mezzacappa, & Earls, 1995; Milich & Kramer, 1985). The form of impulsivity most often associated with ADHD is the inability to delay a response to gratification (Barkley, 1997a, Campbell, 1987; Rapport, Tucker, DuPaul, Merlo, & Stoner, 1986). Poor sustained attention (Barkley, 1997a; Gordon, 1979), fast and inaccurate responses to tasks (Brown & Quay, 1977), and the inability to regulate or to inhibit behavior according to the standards of social situations (Barkley, 1985; Kendall & Wilcox, 1979; Kindlon et al., 1995) are among other forms of impulsivity often seen in those with ADHD. Studies that have analyzed impulsive behavior in combination with inattention and hyperactivity have not differentiated impulsivity from hyperactivity (Achenbach & Edelbrock, 1983; Barkley, 1991; DuPaul, 1991; Lahey et al., 1994; Milich & Kramer, 1985), and have found that impulsive children are also overactive and vice versa. It has been theorized that poor behavioral inhibition connects impulsivity and overactivity (Barkley, 1997a).

Studies have repeatedly shown that it is not inattention but poor behavioral inhibition and self-regulation that differentiate the ADHD children from the normal controls (see Barkley, 1997a; Barkley, Grodzinsky, & DuPaul, 1992; Halperin, Matier, Bedi, Sharma, & Newcorn, 1992; Pennington & Ozonoff, 1996 for review). Further field trials have shown that the behaviors related to poor behavioral inhibition discriminated the ADHD children best from the normal controls (Spitzer, Davies, & Barkley, 1990). Problems with inhibition may be the most stable symptoms across age groups and time (Hart et al., 1995) and can be used to effectively diagnose those with ADHD.

Hyperactivity

Hyperactivity is defined as developmentally excessive and inappropriate levels of activity. These activities include motor and vocal behavior (Barkley, DuPaul, & McMurray, 1990; Berk & Potts, 1991; Cammann & Michlke, 1989; Fischer, Barkley, Edelbrock, & Smallish, 1990), general restlessness, and fidgeting (Barkley & Cunningham, 1979; Luk, 1985). The overactivity of children with ADHD has been studied both during the day (Barkley & Cunningham, 1979; Barkley & Ullman, 1975; Porrino et al., 1983; Teicher, Ito, Gold, & Barber, 1996) and during their sleep (Barkley & Cunningham, 1979; Teicher, Ito, Glod, & Barber, 1996). Hyperactivity is very context-specific (Conners & Kronsberg, 1985), but objective measures have been used (Barkley, DuPaul, & McMurray, 1990; Corkum & Siegel, 1993; Grodzinsky & Diamond, 1992; Losier, McGrath, & Klein, 1996) to differentiate the activity level of ADHD children from normal controls. Yet, the difference in activity level alone does not adequately seem to distinguish these children from other clinically referred children (Firestone & Martin, 1979; Sandberg, Rutter, & Taylor, 1978).

Symptoms of ADHD have been attributed to a variety of etiological factors. The following section provides an overview of the etiological factors related to ADHD. However a greater emphasis has been put on the discussion of frontal lobe and its involvement in the etiology of ADHD.

Etiology

Although the etiology of ADHD is unknown, research results have indicated a variety of potential factors. Brain damage as the result of brain infections, trauma, other injuries, and complications during pregnancy or delivery has been proposed as the main causes of ADHD. Studies of low birth-weight factor and complications during birth have produced conflicting results; however, some studies (Nicholas & Chen, 1981) have indicated that low-birth weight children are at increased risk for hyperactivity, behavioral problems, and inattention. Thyroid disorder is another etiological variable that has produced inconsistent results (Hauser, 1993; Stein, Weiss, & Refetoff, 1995). Environmental toxins such as elevated lead level (Needleman, Shell, Bellinger, Leviton, & Alfred, 1990) and prenatal exposure to alcohol, and cigarette smoke (Streissguth, Bookstein, Sampson, & Barr, 1995) are among the etiological factors that have produced some small but significant results.

Psychosocial factors and poor parental management of the child's behavior are among etiological factors that have not been clearly supported by research. In terms of the biochemistry of the brain studies (Raskin, Shaywitz, Shaywitz, Anderson, & Cohen, 1984; Shaywitz, Cohen, & Bowers, 1977), researchers found a lower level of Homovanillic Acid, which is the main dopamine metabolite, in the cerebral spinal fluid of the children with ADHD compared to controls. Other studies have produced conflicting results (Shaywitz et al., 1986; Zametkin & Rapport, 1986) and indicate that no single neurotransmitter is exclusively involved in ADHD. A combination of a dopaminergic and an noradrenergic system in understanding the biology of ADHD has been suggested by others (Oads, 1987). Neurobiological studies have indicated a decreased dopamine and norepinephrine level in the cerebral spinal fluid in ADHD children as compared to normal controls (Raskin et al., 1984). Neuropinephnrine has been found to have a role in such prefrontal cortex functions as the working memory and attention through the postsynaptic functions (Pineda, Ardila & Rosselli, 1999). A recent genetic study investigated the dopamine receptor D4 (DRD4) gene located at chromosome 11p15.5 and ADHD (Swanson et al., 2000). This study focused on the relationship between a specific allete (the 7-repeat of a 48-bpin exon 3) and neuropsychological functions, such as reaction time measures in subgroups of subjects with ADHD. Those with the 7-present subgroup showed no neuropsychological deficits, but those with the 7-absent group did. This study concluded that the 7-present subgroup did not have the neuropsychological abnormalities that the 7-absent group did.

The etiological factor related to ADHD that has gained considerable research attention in recent years, is the prefrontal cortex. Research has emphasized the biological etiology in behavioral regulation and goal-directed behavior involved (Castellanos et al., 2000; Doyle, Biederman, Seidman, Weber & Faraone, 2000; Faraone et al., 1993, 1996; Fischer et al., 1993; Frost, Moffitt & McGee, 1989; Hall, Halperin, Schwartz, & Newcorn, 1997; Klorman et al., 1999; Koziol & Stout, 1992; Mealer, Morgan & Luscomb, 1996; Nigg et al., 1998; Oei & Rund, 1999; Pennington, Grossier & Welsh, 1993; Pineda, Ardila, & Rosseli, 1999; Seidman et al., 1997, 2000; Seidman, Biederman, Faraone, Weber, & Quellette, 1997; Speltz et al., 1999;

Swanson, Mink & Bocian, 1999; see Fergusson & Pappas, 1979; Hastings & Barkley, 1978 for reviews).

Those with ADHD have often been compared to human and animal subjects with frontal lobe injuries (Benton 1991; Heilman, Voeller, & Nadeau, 1991). Although some studies (Cruikshank, Eliason, & Merrifield, 1988; O'Dougherty, Noccchterlein, & Drew, 1984) have indicated that there is a higher rate of ADHD among those with brain damage and seizure disorders (Holdsworth & Whitmore, 1974), many children with ADHD do not have significant brain damage (Rutter, 1977). Direct evidence for the involvement of frontal lobe dysfucntion in ADHD comes from the studies of the frontostriatal network (Casey et al., 1997a; Castellanos et al., 1996; Filipek et al., 1997; Hynd, Semrud-Clikerman, Lorys, Novey, & Eliopulos, 1990; Rolls, 2000; Seidman et al., 2000). These networks are known to control attention and executive functions (Heilman,Voeller & Nadeau, 1991). Studies on blood flow of the brain have shown decreased blood flow to the prefrontal region of the brain and pathways connecting to the limbic system in ADHD (Lou, Hendriksen, & Bruhn, 1984; Lou, Hendricksen, Brauhn, Borner, & Neilsen, 1989). The blood flow to the frontal lobes increased after these children received Ritalin. Ritalin treatment also helped increase behavioral inhibition by decreasing blood flow to the primary sensory cortex and to the motor cortex. Using the Positron Emission Tomography (PET) scan, Zametkin et al. (1990) at the National Institute of Mental Health evaluated the brain metabolic activity rate in 25 adults with histories of childhood ADHD. The PET scan is a highly sensitive tool for studying brain activity level. Similar to other studies (Lou, Hendrickson, & Brauhn, 1984; Lou et al., 1989), the results indicated significantly reduced brain metabolic activity in ADHD subjects compared to normal controls. This study also showed reduction in cerebral glucose utilization in the right frontal area but increased utilization in the posterior medial orbital areas in parents of ADHD children subjects, as compared to the parents of children in the control group.

Other physiological measures such as Magnetic Resonance Imaging (MRI), have been used to evaluate total brain volume in children with ADHD. The results of these studies (Castellanos et al., 1996; Hynd, Semrud-Clickman, Lorys, Novey, & Eliopulis, 1990; Mataro, Garcia-Sanchez, Junque, Estevez-Gonzalez, & Pujol, 1997; Semrud-Clikeman et al., 2000) indicated abnormally smaller anterior cortical regions on the right side and the lack of normal right-left frontal asymmetry. Other studies using MRIs (Aylward et al., 1996; Castellanos, et al., 1994; 1996; Filipek et al., 1997; Heilman, Voeller, & Nadeau, 1991; Hynd et al., 1991; Lou et al., 1989; Pliszka, Liotti, & Woldorff, 2000; Swanson, Castellanos, Murias, LaHoste, & Kennedy, 1998) have shown that children with ADHD have a smaller left caudate nucleus, which is the opposite of the pattern seen in normal children. Mataro et al., (1997), using MRI measurement of the caudate nucleus in adolescents with ADHD, found that the ADHD group had a larger right caudate nucleus area compared to the control group. This structural difference was associated with poorer performance on measures of attention and higher ratings on the Conners Teacher Rating Scale. This study provided evidence that the caudate nucleus is involved in the neuropsychological deficits and the behavioral problems associated with ADHD. The larger caudate may be due to the maturational processes that lead to the volume reduction of this structure (Mataro et al., 1997). Further, in light of previously mentioned studies supporting structural differences in the left caudate area, there may be bilateral dysfunction in the caudate nucleus that contributes to poor attentional and behavioral problems associated with ADHD. Semrud-Clikeman et al., (2000) specifically observed the correlation between reversed caudate asymmetry and poor response inhibition, as well as poorer sustained attention on tasks with smaller volume of the right-hemispheric white matter.

Castellanos et al., (1994, 1996), Filipek et al., (1997) and Swanson et al., (1998) have indicated smaller anterior right frontal areas and smaller right globus pallidus and caudate nucleus in ADHD children compared to normal controls. Other studies have reached similar conclusions that the abnormalities in the prefrontal-striatal areas of the brain most likely are involved in the development of ADHD (Arnsten, Steere, & Hunt, 1996; Mattes, 1980; Mercugliano, 1995; Pontius, 1973). The prefrontal cortex has a role in inhibitory control (Alexander, Newman, & Symmes, 1976; Edinger, Siegel, & Troiano, 1975; Skinner & Yingling, 1977) and sustained attention (Hillyard et al., 1973; McCullum, Curry, Cooper, Pocock, & Papakostopulos, 1983; Woldorff & Hillyard, 1991; Wood, 1990). A study by Casey et al. (1997a) has demonstrated a correlation between the size of the brain regions indicated in the study by Castellanos et al (1996) and poor performance on measures of response inhibition. This data supports the involvement of the right prefrontal striatal circuitry in response inhibition and ADHD.

Neuropsychological factors and the role of executive functions in childhood disorders have been established through the investigation of the role of the Pre-Frontal Cortex (PFC). The central involvement of the PFC in human cognition has been debated throughout the history of neuropsychology (Pennington & Ozonoff, 1996), and from very early on there has been controversy around the specific role of frontal lobes in intelligence and cognition (see Benton, 1991 for review; Goltz, 1888; Munk, 1890). PFC has been recognized as the seat of the thinking process (Burdach, 1819 as cited in Barkley, 1998), and its involvement in executive functions and planning ability (Bianchi, 1922; Logan, 1985; Lauria, 1966). In the 20th century it was re emphasized that the frontal lobes have a special role in human cognition (see Fuster, 1989; Kolb & Wishaw, 1990; Shallice, 1988; and Stuss & Benson, 1986 for reviews). Similar to children and adults with frontal lobe lesions (Fuster, 1989; Grattan & Eslinger, 1991; Stuss & Benson, 1986), neuropsychological testing has found that those with ADHD have similar deficits in sustained attention, poor behavioral inhibition, poor goal-directed behavior, and deficits in temporal organization of behavior (Chelune, Ferguson, Koon, & Dickey, 1986; Conners & Wells, 1986; Epstein, Conners, Erhardt, March, & Swanson, 1997; Fischer, Barkley, Fletcher, & Smallish, 1990; Goodyear & Hynd, 1992; Grodzinsky & Diamond, 1992, Heilman et al., 1991; Mariani & Barkley, 1997; Seidman et al., 1997). The most consistent results have been found on the evoked response measures together with tests of vigilance (Frank, Lazar, & Seiden, 1992; Klorman, Salzman, & Borgstedt, 1988). These performances rely upon the prefrontal cortex and are improved with the use of stimulant medication (Klorman, Brumaghim et al., 1988; Kuperman, Johnson, Arnddt, Lindgren, & Wolraich, 1996).

Investigators (Fuster, 1989; Grattan & Eslinger, 1991; Stuss & Benson, 1986) have cited specific problems with sustained attention, regulations of emotion and motivation, and temporal organization of behavior in both children and adults who have suffered from frontal lobe lesions. Despite the existence of some inconsistencies, extensive neuropsychological testing of the frontal lobe functions in children with ADHD has documented deficits in sustained attention and temporal organization of behavior (Conners & Wells, 1986; Chelune, Ferguson, Koon, & Dickey, 1986; Epstein et al., 1997; Fischer, Barkley, Fletcher, & Smallish, 1990; Grodzinsky & Diamond, 1992; Heilman et al., 1991; Mariani & Barkley, 1997). Further research results suggest frontal lobe dysfunction in children with ADHD exhibited by diminished behavioral responses, difficulties with working memory, motor sequencing, planning ability and persaveration (Doyle et al., 2000; Seidman, Biederman, Faraone, Weber, & Quellete, 1997b; Speltz et al., 1999; Swanson, Mink, & Bocian, 1999; Weirs, Gunning, Sergeant, 1998).

Casey et al. (1997b) used MRIs to examine the relationship between specific fronto-striatal structures mainly prefrontal cortex and basal ganglia with response inhibition deficits in children with ADHD. The results showed a significant difference on three response inhibition tasks for the ADHD children as compared with age-matched normal controls. These three tasks tapped into response inhibition at different stages of attentional processing; sensory selection, response selection and response execution. The prefrontal cortex, caudate nucleus and globus pallidus volumetric measures correlated with task performance, while the putamen measures did not. Sensory selection task performances were specifically correlated with the right frontal and right caudate measures, but task selection and response execution tasks correlated with caudate symmetry and left globus pallidus measures. The prefrontal measures correlated with the inhibitory function of the tasks, while the globus pallidus and the caudate correlated more with the performance on the tasks. This data confirms previous findings (Alexander, Curtcher, & Delong, 1991; Alexander, Delong, & Strick, 1986; Fuster, 1989; Goldman-Rakic, 1987a, b) with regard to the role of right prefrontal cortex in suppressing attentional and behavioral responses that are salient to task, but the basal ganglia seem to be involved in the execution of the responses. The involvement of the fronto-striatal circuitry in response inhibition tasks is consistent with previous findings (Castellanos et al., 1994; 1996; Pardo, Fox, & Raiche, 1991). Furthermore, this study showed abnormalities in the prefrontal cortex, caudate nuclei and the globus pallidus of the ADHD children compared to the normals.

The role of pre-frontal cortex in memory tasks and prevention of environmental distractions has been indicated (Goldman-Rakic, 1995a, b; Milner 1963). Although patients with frontal lobe injuries are responsive to the stimuli in the environment, they are easily distracted by them (Drew, 1974 ; Milner,1963; Nelson, 1976). Earlier studies had suggested the dorsolateral involvement of the prefrontal cortex and memory tasks in monkeys (Funahashi, Bruce, & Goldman-Rakic, 1989; Fuster & Alexander,1971; Joseph & Barone, 1987; Niki, 1974; Quintana, Yajeya, & Fuster, 1988).The dorsolateral prefrontal cortex is the most evolved neocortical region in humans (Knight, Grabowecky & Sabini, 1995); therefore, it is likely that the damage to this area causes a complex series of cognitive disturbances, such as abnormalities in planning, temporal coding, metamemory, judgment, and attention capacity.

The work of Patricia Goldman-Rakic (1995a, 1995b; Williams & Goldman-Rakic, 1995) with the primate prefrontal cortex has contributed significantly to the understanding of the role of the prefrontal cortex in working memory or what she calls representational memory. Her studies have established that the dorsolateral prefrontal regions are essential in holding representations of events or tasks in the working memory. Using Positron Emission Tomography scans with primates performing delayed-response tasks, Goldman-Rakic (1995a) established that certain prefrontal neurons are activated only during the delay periods. Using neuroimaging studies, others (Shwartz, Rackic, & Goldman-Rakic, 1991) have studied the glucose metabolism rate in normal human subjects performing delayed tasks using abstract visual images. Although this study identified the involvement of a varied circuitry, in addition to the prefrontal cortex in memory tasks, it was the motor and pre-motor areas of the frontal lobe that were most active and survived stringent statistical analysis.

Further, frontal lobes are documented to have a role in the temporal organization of memory. The prefrontal cortex is believed to coordinate cognitive functions and to integrate cognitive-perceptual processes across time and space (Roberts and Pennington, 1996). Bilateral damage to the frontal region impairs performance on short term memory tasks, delayed response (Jacobsen, Wolfe, & Jackson, 1935) and delayed alteration (Jacobsen & Nissen, 1937). Milner, influenced by the work of Prisko (Milner, 1964), proposed that frontal lobe lesions might interfere with the ability to structure and separate events in the memory when a situation lacks strong contextual cues. Usually events seem to have a "time-tag" that allows discrimination of the time order of events, but frontal lobe damage seems to disturb the time-marking process and the serial order judgments (Milner, 1995; Pribram & Tubbs, 1967). Further studies have suggested that the prefrontal cortex is critical to bridging temporal discontinuities (McAndrews & Milner, 1991; Shimamura, Janowsky, & Squire, 1990). The deficits in the temporal bridging become more apparent in longer intervals when there is more chance for distraction by irrelevant stimuli (Knight, Grabowecky & Sabini, 1995). Patients with considerable frontal lesions do not have much concern for past or future events (Ackerly & Benton, 1947).

Barkley (1997b) has emphasized the role of prefrontal cortex in the development of behavioral inhibition, non-verbal working memory, and sense of time in self-regulatory behavior. The following section describes Barkley's Hybrid Model of Executive Functions and theory of self-regulation.

Barkley's Hybrid Model of Executive Functions and Theory of Self-regulation

Barkley (1997a) has proposed a theory of ADHD and executive functions with a strong emphasis on the physiological basis for the deficits in EF using studies of structural brain anomalies, specifically the role of prefrontal lobe functions. This theory is a developmental neuropsychological model of human self-regulation, which explains the nature of attention deficit hyperactivity disorder in the context of the studies of normal development. Barkley (1997a) has developed a hybrid model of executive function for ADHD, hyperactive and combined types. Barkley (1997a) has identified behavioral inhibition, a function of the frontal lobe, as an important and central impairment in ADHD, hyperactive and combined types. He extends his model to describe how the deficiency in behavioral inhibition causes secondary impairment in executive functions, and therefore results in poor self-regulation in those with ADHD.

Several studies have established that poor self-regulation is a major concern involved in ADHD with hyperactivity or combined type (Achenbach & Edelbrock, 1983, 1986; Barkley, 1990; DuPaul et al., 1996). Children with ADHD are known to have a higher level of activity (Barkley & Cunningham, 1979; Gomez & Sanson, 1994; Luk, 1985; Porrino et al., 1983; Teicher, Ito, Gold, & Barber, 1996), to have a tendency to talk more to others (Barkley, Cunningham & Karlsson, 1983), to talk to themselves out loud (Berk & Potts, 1991), and to make more noises in general than other children not diagnosed with ADHD (Barkley, DuPaul, & McMurray, 1990). Children with ADHD have a difficult time restricting their behavior when asked (Barkley & Ullman, 1975; Ullman, Barkley & Brown, 1978), and delaying gratification (Campbell, Pierce, March, Ewing, & Szumowski, 1994; Hinshaw, Heller, & McHale, 1992; Schweitzer & Sulzer-Azaroff, 1995).

Self-Regulation

Berkowitz (1982) defined self-control as being able to intentionally manipulate the covert mental events, especially self-speech and self-imaging, to control one's own behavior. Others emphasize the need for voluntary postponement of immediate gratification as the hallmark of goal-directed behavior (Mischel, Shoda, & Rodriguez, 1989). Barkley (1997b) expanded on the definition of self-control and self-regulation as a response or a series of responses that change the probability of a subsequent response to an event, and therefore alter the consequences related to that event. Self-regulatory responses are behaviors that are often directed at the person himself or herself, e.g., repeating directions to a task aloud to increase the chances of remembering the instructions and succeeding at that task. Sometimes self-regulation involves a series of behaviors that aim at altering the environment, e.g., removing visual and auditory distractions from the study room in order to increase the chance of attending to tasks. These responses are directed at the individual rather than the environment. These responses can be immediate or in the future, depending on which action maximizes the outcome.

Self-regulation usually is motivated by the anticipation of future outcomes, rather than the outcomes immediately following the behavior itself. Although many behaviors have both immediate and delayed outcomes associated with them, the main goal is to maximize the desired outcomes; often this demands the overlooking of immediate gains and delaying gratification to a later time. Therefore, self-regulation involves a preference for long-term versus short-term outcomes. The benefit of the later outcomes are often traded for the length of time the individual has to wait (Mazur, 1993). Preference for better but later outcomes increases with age (Green, Fry, & Meyerson, 1994). Self-regulation requires the individual to bridge time delays between the behaviors and the contingencies associated with them. Therefore, there is a need for a mental faculty that senses time and future before the individual can organize his or her behavior to maximize the gains from these behaviors (Barkley, 1997b). Additionally, there is a need for a capability to recall the past, analyze the patterns within a sequence of events and the consequences associated with them. This relies on a memory function that keeps this information on-line to be accessed as needed to move toward a goal. According to Barkley's model, self-regulation is executed through the executive functions.

Executive Function

There is not one unifying theory that explains executive functions (EF) fully. One of the more comprehensive theories (Brokowski, Milstead & Hale, 1988) of executive functions has used the information-processing model to explain this faculty. According to this model, as each child becomes exposed to different learning strategies and has the opportunity to implement them over time, he or she gradually learns to monitor his or her performance. The child learns to select some strategies but not others in specific situations, and this is when the higher-order executive processes emerge. This learning process is the beginning of self-regulation. Although executive functions begin to develop as early as infancy, a clear assessment of executive functions, using the tools available today, cannot be conducted in children younger than 5 years of age when the non-verbal working memory provides representations of old memories (Denckla, 1996). With the development of executive functions, the child learns to analyze the task at hand and to choose the most suitable solutions. As he or she succeeds at choosing effective strategies, a sense of efficacy develops. This is when the motivational aspects of executive functions are incorporated. Previous successes provide feedback to the child and increase the utilization of executive functions by increasing his or her motivation in strategy selection and monitoring processes.

Welsh and Pennington (1988) have defined executive function as the ability to exercise adequate problem solving in goal-directed behavior. This involves the ability to inhibit a response until a more appropriate time. This strategy that involves a sequence of events and the mental representation of the task at hand. The most essential component of executive function is the ability to integrate from all the cognitive domains and to select the best response from a pool of competing responses. Animal studies have shown that executive functions involve planning ability, the ability to shift and to maintain cognitive sets, interference control, response inhibition, working memory cross-temporal organization, and integration of information (Fuster, 1989; Goldman-Rakic, 1987a,b; Luria, 1966; Shallice, 1988).

Barkley (2000) states that the term executive functions in humans incorporates volition, planning, goal-directed action, inhibition and resistance to distraction, a change from being controlled by others to being self-controlled, and resistance to immediate gratification. He has identified four important executive functions: nonverbal working memory and sense of time, verbal working memory, self-regulation of affect/motivation/arousal, and reconstitution.

Despite the individual labels, executive functions are interrelated, and together they allow the individual to self-control and engage in goal-directed behavior. Behavioral inhibition and the four executive functions together control the motor system, rather than allowing the motor system to be influenced by the immediate environment.

The most important executive function is psychological sense of time, which is directly related to nonverbal working memory and deficient in those with ADHD. This ability to retain events in the correct sequence in the working memory is the essence of sense of time (Bronowski, 1967/1977). Barkley refers to the sense of time as the central executive. The executive function of the working memory gives the individual the ability to resense and to evaluate past information and events. This is how behavior is internalized. Through the internalization of behavior and re-experiencing the past, the person can make better decisions about the future. This process impacts the persistence on a task, working toward a goal, and directing the individual's motor responses, and, ultimately, self-control. Non-verbal working memory helps with the internalization of behavior. Sense of time helps store and organize internalized representations of past behaviors across time. Further, adequate sense of time facilitates the timely utilization of the internalized behaviors toward self-regulation. Through this process hindsight and forethought develop to guide future behavior. The ADHD hybrid model of executive function hypothesizes that the delay in the inhibitory processes and the delay in the development of sense of time disrupt the development and performance of self-regulation and goal-directed behavior. As a result of these deficits, individuals with ADHD seem to be insensitive to time constraints, have inadequate hindsight and forethought, poor goal directed behavior and planning abilities, difficulty with delaying immediate gratification, and insensitivity to punishment.

First, behavioral inhibition as presented by Barkley (1997b) will be discussed, and research evidence will be provided for his conceptualization.

Behavioral Inhibition

Recent evidence suggests that ADHD involves the failure to inhibit or to delay responses

(Achenbach & Edelbrock, 1983, 1986; Barkley, 1994; Barkley, 1997a; Trommer, Hopenner, & Zecher, 1991; Barkley, 1990; Douglas, 1972; DuPaul et al, 1996; Frick et al., 1994; Houghton et al., 1999; Jennings et al., 1997; Milich et al., 1994; Nigg, 1999; Oosterlaan & Sergeant, 1998; Pennington & Ozonoff, 1996; Purvis & Tannock, 2000; Quay, 1988a, 1988b, 1997; Schachar et al., 1995; Schachar & Logan, 1990; Schachar, Tannock, & Logan, 1993; Schachar & Tannock, 1995; Van der Meere & Sergeant, 1988a). The evidence for this deficiency in behavioral inhibition in those with ADHD comes from several sources. First, the parent and teacher ratings used to identify and to diagnose ADHD focus on a cluster of behaviors that are labeled as hyperactive-impulsive along a single dimension (Achenbach & Edelbrock, 1983, 1986; DuPaul et al., 1996; Goyette, Conners, & Ulrich, 1978; Hinshaw, 1987; Lahey et al., 1988, 1994). This dimension essentially refers to being undercontrolled or having a deficiency in behavioral inhibition and self-control (Barkley, 1998).

Second, studies that have used behavioral observation of children with ADHD concluded that these children are deficient in behavioral inhibition (Barkley, DuPaul, & McMurray, 1990; Barkley & Cunningham, 1979; Barkley, Cunningham, & Karlsson, 1983; Berk & Potts, 1991; Copeland, 1979; Cunningham & Seigel, 1987; Gomez & Sanson, 1994; Porrino et al., 1983; Teicher et al., 1996). Third, studies have shown that children with ADHD have a difficult time delaying gratification (Sonuga-Barke, Houlberg, & Hall, 1994; Songua-Barke, Taylor, Sembi, & Smith, 1992; Songua-Barke, Taylor, & Hepinstall, 1992; Weyandt & Willis, 1994) and restricting their behavior when asked (Barkley & Ullman, 1975; Milich & Loney, 1979; Routh & Schroeder, 1976; Ullman, Barkley & Brown, 1978).

A large body of research using computerized continuous performance with some exceptions (Campbell, Breaux, Ewing, & Szumowski, 1984; Mariani & Barkley, 1997) has documented that ADHD children have a difficult time restricting their responses (Barkley, DuPaul, & McMurray, 1990; Barkley, Grodzinsky, & DuPaul, 1992; Grodzinsky & Diamond, 1992; Reader, Harris, Schuerholz, & Denckla, 1994). Poor resistance to temptations (Campbell et al., 1994; Hinshaw, Heller, & McHale, 1992; Hinshaw, Simmel, & Heller, 1995) and delay of gratification (Campbell et al.; Schweitzer & Sulzer-Azaroff, 1995) are also among other evidence that show poor behavioral inhibition in those with ADHD when compared to normal controls.

Behavioral inhibition refers to three interrelated processes. The first process is inhibiting the initial response to an event or the prepotent response. The prepotent response is associated with immediate reinforcement, which is either positive or negative. Some prepotent responses are made to gain immediate positive reinforcement, while others are to escape an aversive condition. Both kinds of prepotent responses are difficult for individuals with ADHD (Barkley, 1997a). Evidence for poor inhibition of prepotent responses comes from the use of laboratory tests. Laboratory tests that have been used to measure deficit in inhibition of the prepotent response create a condition where there is conflict between responses that have been previously reinforced and now have to be restricted.

Stop-signal, and go-no-go tasks are among the laboratory tests used to measure inhibition of prepotent response. Studies using stop-signal paradigm (Jennings et al., 1997; Niggs, 1999; Oosterlaan & Sergeant, 1995, 1996a, 1996b; Pliszka et al., 1997; Pliszka, Liotti, & Woldorff, 2000; Purvis & Tannock, 2000; Schachar & Logan, 1990; Schachar, Tannock, Marriott, & Logan, 1995; Schachar, Tannock, & Logan, 1993; Schachar et al., 2000; Konrad, Gauggel, Manz, & Scholl, 2000; see also meta analysis by Oosterlaan, Logan, & Sergeant, 1998) have provided more evidence that children with ADHD have a slower inhibitory response initiation. Jennings et al. (1997) showed that although the boys with ADHD were able to attend to the control responses carefully, this control was more effortful and less effective than in those in the control group. These findings were similar to those of Schachar and Logan (1990). Studies using go or no-go signals further provide evidence for inhibitory deficit in individuals with ADHD (Iaboni, Douglas, & Baker, 1995; Milich, Hartung, Martin, & Haigler, 1994). Using laboratory tasks, some studies have found weaker evidence of inhibitory deficits in children with ADHD, (Sonuga-Barke, Taylor, & Heppinstall, 1992; Songua-Barke, Taylor, Sembi et al., 1992; Van der

Meere, Gunning, & Stemerdink, 1996). However these studies did not examine the strength of the reinforcement (Barkley, 1997a); therefore, in the studies that have failed to show an inhibitory deficit there was insufficient amount of conflict based on the established consequences (Van der Meere et al.).

Delayed response tasks have been used to study the inhibiton of prepotent response in those with ADHD. Kagan's Matching Familiar Figures Test (Kagan, 1964) is a delayed task that requires delay in responding, reflection, and deliberate delivery of a response to correctly match a picture to one of several similar pictures. Some studies have used this task and have shown that children with ADHD perform poorly compared to normal controls (Songua-Barke, Houlberg, & Hall, 1994; Songua-Barke, Taylor, Sembi et al., 1992; Weyandt & Willis, 1994). Continuous Performance Test (CPT) is also used to measure behavior inhibition in those with ADHD. ADHD children are known to produce more commission errors or to respond to stimuli when in fact they should restrict their response. Several studies have shown that CPT differentiates between ADHD and normal groups (Barkley et al., 1990; Barkley, Grodzinsky & DuPaul, 1992; Grant, Ilai, Nussbaum, & Bigler, 1990; Grodzinsky & Diamond, 1992; Raggio, Rhodes, & Whitten, 1999; Reader et al., 1994; See Losier et al., 1996 for review) with some exceptions (Corkum & Segal, 1993; Magee, Clark & Symons, 2000; Schachar, Logan, Wachsmuth, & Chajczyk, 1988; Werry, Elkind & Reeves, 1987).

The second function of behavioral inhibition is stopping or inhibiting an ongoing response and using a period of delay to decide to respond in a new way or to continue responding as before. By stopping or inhibiting the ongoing response, behavioral inhibition provides a period of delay and an opportunity to conduct a quick, cost-benefit analysis prior to responding again. Most individuals have a history of events and their consequences stored in their non-verbal working memory; this experience can help them make a beneficial and a quick decision either to respond as before or to respond in a new way. This stored memory creates sensitivity to errors. In those with ADHD however, due to the deficits in the non-verbal working memory, the experience does not guide the future behavior as it does in those without ADHD. The stop-signal tests described above have been used to show that ADHD children are slower and more variable in interrupting their ongoing behavior (Jennings et al., 1997; Oosterlaan & Sergeant, 1996; Schachar & Logan, 1990; Schachar et al., 1993, 1995)

Wisconsin Card Sorting test (WCST; Heaton, 1981) is another tool that has been used to study the ability to interrupt or inhibit ongoing response. WCST taps into the dorsolateral prefrontal cortex as indicated by neuroimaging techniques (Berma et al., 1995). In this test the subject is expected to stop an ongoing pattern of responding and to shift the attention to a different and accurate response pattern. ADHD subjects often show perseverative mistakes because they are unable to shift their attention easily. Using the Wisconsin Card Sorting Test (WCST; Heaton, 1981), several studies (Houghton et al., 1999; McBurnnett et al., 1993; Reader, Harris, Schuerholz, & Denckla, 1994; Seidman et al., 1996; Speltz et al., 1999) have shown that ADHD children are unable to stop an ongoing response pattern and to shift their attention to a correct one after feedback. Barkley, Grodzinsky, & DuPaul (1992) reviewed 13 studies that used WCST; they concluded that 8 out of the 13 studies discriminated the ADHD group from the normal controls based on their perseverative mistakes on the WCST. Other studies have not been able to show the same results (Nahri & Ahonen, 1995; Pennington et al., 1993; Weyandt & Willis, 1994).

Other tests have been used to demonstrate that ADHD subjects have a deficiency in the ability to shift their attention from one task to another or to interrupt an ongoing response. A more recent study (McDonald, Bennett, & Castiello, 1999) using directed attention to cued locations produced similar results. This study showed that ADHD children were unable to shift their attention easily from a cued location to an alternate location.

Card Playing Task is another test that has been used to study the ADHD subject's ability to interrupt an ongoing response pattern (Milich et al., 1994). During this task the subject bets money on whether the next card shown by the computer is a face card or not. At the beginning of this task, the likelihood of getting a face card is high; therefore, most subjects do make a bet. However, as the task progresses the likelihood of getting a face card decreases. Despite the knowledge of this possibility, the ADHD subjects continue to respond as before and to make bets that there will be a face card (Milich et al.).

The third function of behavioral inhibition is protecting the period of delay in order to protect the self-directed response from the interruption of competing events. This is referred to as interference control. Several studies (Doyle et al., 2000; Katz, Wood, Goldstein, Auchenbach, & Geckle, 1998; Speltz et al., 1999) have indicated that ADHD children show poor interference control to distractions. Interference control has been defined by Barkley (1997b) as the ability to inhibit one's response to sources of distraction and interference in order to stay on task. Children with ADHD struggle to persist against distractions from competing events. They are also more influenced by external variables than by the internal representations of past events. Voluntary postponement of immediate gratification is often essential to resistance to distractions and persistence at goals (Mischel, Shoda, & Rodrigue, 1989).

ADHD children seem to need external and consistent sources of reward and gratification. Tripp and Alsop (1999) have shown that children with ADHD were more sensitive to individual instances of reward versus response accuracy. Methylphenidate improved discrimination and decreased sensitivity to individual instances of rewards in children with ADHD. Studies have shown that when rewards are delayed, ADHD children do not perform as well as the normal control group (Rapport, Donnelly, Zametkin, & Carrougher, 1986). This is also the case when the rate of delivery of rewards is changed from a fixed interval to an intermittent schedule (see Barkley,1989; Douglas, 1983; Haenlein & Caul, 1987 for reviews; Songua-Barke, Taylor, Sembi & Smith, 1992; Zahn, Krusei, & Rapoport, 1991).

On the other hand, some studies (e.g., Oosterlaan & Sergeant, 1998) have argued against motivational explanations for response inhibition deficits in children with ADHD and that the presence of response contingencies did not enhance response inhibition. An individual cannot maximize later outcomes if he or she is acting to maximize a current one. Preference for long-term reward seems to increase across childhood (Green, Fry, & Meyerson, 1994), and this interest continues to grow until the early 30s; it then levels off (Green, Merson, Lichtman, Rosen, & Fry, 1996).

Interference control has been studied in those with ADHD using the Stroop Word-Color Test (Stroop, 1935), which requires the subject to inhibit the ongoing prepotent response to read the name of the color. Several studies (Leung & Connolly, 1996; Pennington et al., 1993; Seidman et al., 1995; Seidman et al., 1996) have used this test to study interference control in those with ADHD. Barkley, Grodzinsky, & DuPaul (1992) found five out of six studies that showed ADHD children made more errors and were unable to achieve higher scores on this test due to poor interference control. Recent neuroimaging studies (Bench et al., 1993; Vandrell et al., 1995) have shown that the orbital-frontal regions are involved in performance of this test.

This is the area of the brain that has been shown to be smaller and with less activity in children with ADHD (Castellanos et al., 1994, 1996; Lou et al.,1984, 1989). Anytime that self-regulation is required, there is a need for interference control. Tasks that require problem-solving, delay of response, organization across time, delay of reward or results, all demand interference control and the ability to sustain attention and effort on task.

Every individual constantly engages in acts of inhibition and self-control, but the degree varies depending on the event that the individual is attending (Barkley, 1998). The kinds of events that tax behavioral inhibition the most are as follows. First, whenever an individual is engaged in one set of behavior and is, at the same time, presented with a set of rules or verbal instructions, conflict is created between the presented rules and the ongoing behavior. The individual must decide between the verbal instructions or the rules and the behavior in which he or she was previously engaged (Hayes, Gifford & Ruckstuhl, 1996). The individual must inhibit the prepotent stimuli in order to attend to the verbal instructions or rules (Barkley, 1997b). This requires either the use of private speech or a covert sensing or seeing to oneself in order to decide how to respond next (Berkowitz, 1982; Hayes, Gifford, & Rockstuhl, 1996).

The second category of situations that demands behavioral inhibition occurs when there is a conflict between the immediate and delayed consequences of a response (Kanfer & Karoly, 1972). The delayed or the future event has not yet occurred, and the individual can only rely on conditioned signals of punishment from previous events to help him or her decide what to do next (Newman & Wallace, 1993; Quay, 1997). Similarly behavioral inhibition is required when time delays occur between the behavior and the delivery of the gratification associated with it. It is particularly difficult to delay the gratification when the sources of gratification are visible to the individual. This is resistance to temptation (White et al., 1994), and a dimension of impulsivity (Militch & Kramer, 1985). The more adaptive choices demand the individual to deprive himself or herself of immediate reward as a trade off for better future outcomes or avoidance of future aversive situations. This requires internal speech and the resistance to attend to the immediately gratifying behavior and escaping the behavior associated with the delayed reward (Barkley, 1997b).

Third, identifying a goal and a complex set of responses required to obtain it in the future demands behavioral inhibition and organization of one's activities across time delays. The last category of events that demands behavioral inhibition is a novel task requiring a novel response. Such a situation requires the individual to go through effortful problem-solving and cost-benefit analysis. During this process, the individual must learn from the old rules and potentially create new ones that better fit the current situation (Cerutti, 1989; Hayes et al., 1996).

Barkley's hybrid model connects the concepts of poor sustained attention and deficits in behavioral inhibition with the neuropsychological abilities referred to as executive functions or metacognitive functions because most, if not all, cognitive deficits associated with ADHD relate to the concept of self-regulation and executive functions (Barkley, 1995, 1996, 1997a, 1997b; Denckla, 1994; Douglas, 1988; Douglas, Barr, Desilets & Sherman, 1995; Grodzinsky & Diamond, 1992; Pennington & Ozonoff, 1996; Seidman et al., 1995; Welsh, Pennington & Grossier, 1991; Weyandt & Willis, 1994).

Behavioral inhibition simply creates the opportunity for the other executive functions to perform; it does not necessarily cause them to function (Barkley, 1997a). Barkley (1997b) proposes that the delay in the development of behavioral inhibition causes secondary deficits in the four executive functions. He divides executive functions into verbal working memory, reconstitution, regulation of affect, and arousal, and non-verbal working. These functions control the fifth ability, the motor system. Attention pertains to the individual's relationship with the event in order to make immediate change in the environment (Barkley, 1996). During this process, the individual learns to regulate his or her own behavior to impact future rather than immediate outcome. These self-directed actions include organization of behavior across time, self-directed speech, delayed gratification, and future goal-oriented behavior (Stuss, & Benson, 1986; Denckala, 1994; Torgesen, 1994; Welsh & Pennington, 1988). All these behaviors were overt and outer-directed in childhood, but they become private and covert forms of behavior as the individual matures into adulthood. They have been turned inward and internalized in order to help with self-control. Self-control behaviors are future directed and therefore goal oriented. These behaviors can control the motor system and shift the control of behavior by the external events to the control by the internally represented variables (Barkley, 1997b). Executive functions develop in stages as the individual matures. The development of neural networks within the prefrontal lobes allows for the establishment of neuropsychological abilities and specific skills needed in self-regulation (Bronowski, 1977; Fuster, 1989, 1995; Goldman-Rakic, 1995a, 1995b). Further, past successes will guide future self-regulatory behavior (Kanfer & Karoly, 1972). The child's socialization (Berk, 1992; Silverman & Ragusa, 1992), and the reinforcement of the individuals in the child's environment help establish executive functions (Hayes, 1989; Kopp, 1982; Skinner, 1953). Behavioral inhibition is the first to develop in parallel with the nonverbal working memory; later internalization of affect and motivation is followed by internalization of speech. The last to develop is the internalization of play and the reconstitution which involves analysis and synthesis of behavior (Barkley, 1997b).

The next section reviews non-verbal working memory as conceptualized by Barkley (1997b).

Non-verbal Working Memory

Despite some inconsistencies (Fischer et al., 1993; Reader et al., 1994; Weyandt & Willis, 1994; Williams, Stott, Goodyer, & Sahakian, 2000), evidence for non-verbal working memory deficits in those with ADHD comes from using spatial designs (Douglas & Benezra, 1990; Grodzinsky & Diamond, 1992; Mariani & Barkley, 1997; Niggs et al., 1998; Sadeh, Ariel, & Inbar, 1996; Seidman et al., 1997), and the organization and production of complex designs, as seen in Rey-Osterrieth Complex Figure Drawing Test (Keplan, Dewey, Crawford, & Fisher, 1998), and other non-verbal memory tasks (Acherman, Anhalt, & Dykman, 1986; Mealer, Morgan, & Luscomb, 1996). Some of these results indicate that, although those with ADHD do not have a problem with long-term retention of learned material, they do have an impairment in the initial learning. Non-verbal working memory is a function of the dorsolateral regions of the prefrontal cortex (Berman et al., Cummings, 1995; Fuster, 1989, 1995; Gold et al., 1996; Goldman-Rakic, 1995, 1996; Milner, 1995; Rubin et al., 1991; Osmon, Zigun, Suchy, & Blint 1996). Several functions that are essential to self-regulation rely on the non-verbal working memory. These functions are imitation, vicarious learning, development of hindsight, forethought, anticipatory behavior, and sense of time.

Non-verbal working memory is a covert sensing to oneself, which is essential to self-regulation; it involves all forms of sensory-motor behavior that are within human capabilities (Barkley, 1997b). However, the covert visualization and covert audition are two of the most important sensory functions related to non-verbal working memory and self-regulation. These two sensory processes provide the individual with the ability to see to oneself and to hear to oneself. Through this process of re-sensing, the individual can evaluate past behaviors and experiences and learn from them. Unlike long-term memory, non-verbal working memory has a limited storage capacity; therefore, the events cannot be stored in their entirety, and only mental representations of these events are stored. These mental representations are snapshots of the event, along with the set of consequences related to them. It is important to emphasize that it is not only the stored information about the events that is important to self-regulation, but also the ability to reactivate, to re-sense, and to manipulate the information, along with all its accompanying affective and motivational components and contingencies related to them. The information from re-sensing of past experiences can be held on-line to be used toward formulating a future directed response. Without this process, the individual will not self-regulate well; he or she will react to events rather than respond to them in a well planned and well-thought-out manner. Planning relies on non-verbal working memory.

Non-verbal working memory promotes self-regulation through imitation, vicarious learning, development of hindsight and forethought, and sense of time. Imitation is a fundamental learning tool for new behavior in humans. To imitate a behavior, the individual must have the ability to keep a mental representation of that behavior in mind. Usually these representations are kept in mind through covert imagery and audition. Vicarious learning requires imitation, and retaining and re-sensing the entire behavioral contingency that accompanies that behavior. After reactivating sensory representations of the past events, there is a need for prolonging their existence to influence future responses. This is what Bronowski (1977) called hindsight. Fuster (1989) refers to it as retrospective function or the ability to bring information from the past forward during the delay period, provided by behavioral inhibition, to influence and guide consecutive responses. The delay period is critical to utilization of hindsight, and to sensitivity to errors.

A temporally symmetrical function of hindsight is forethought (Barkley, 1997b; Fuster, 1989). This process involves the reactivation of previous sensory representations which in turn activates the motor response patterns. Therefore, while hindsight or retrospective function help reactivation of the mental representations of the past events, forethought or the prospective function connects that information with the motor aspects of the behavior (Fuster, 1989; Goldman-Rakic, 1995a, 1995b). This process then transfers the feedback from the past experiences held within the individual's thoughts into the real world to be implemented as future response and to set the stage for the individual to act. The recollection of the past helps the anticipation of a hypothetical future. The ability to plan and to self-regulate relies on anticipation of future; this is the anticipatory set which primes a set of motor responses toward the future (Barkley, 1997b). The anticipatory set is known to be a function of right prefrontal regions (see Dehaene & Chageux, 1995; Goldberg & Podell, 1995 for a discussion).

Another self-regulatory function that relies on non-verbal working memory is self-awareness. Self-awareness has been described as using information from one's past to inform and regulate current behavior toward anticipated future events, and to attempt to maximize future outcomes (Barkley, 1997b). Self-awareness relies upon non-verbal working memory (Humphrey, 1984; Kopp, 1982). Reactivation of representations of past events and prolongation of these images help prepare for the future. This is how an individual gains awareness of self, sees the self as change agent and experiences the process of self-control.

Self-awareness has been conceptualized (Barkley, 1997b) as a survival mechanism. The same behaviors that were public and outer-oriented become covert and private in order to protect the individual from selection pressure and social competition. Further, the covert sensing and the use of anticipatory set help the individual test out the hypothetical situation privately and present the advantage to choose the more adaptive solution (Dennett, 1995). Self-awareness not only helps individuals to anticipate events in their own lives, but also to learn to predict others' intentions and their behavior (Humphrey, 1984).

Another function of non-verbal working memory in self-regulation is through its direct association with sense of time (Barkly, 1997b; Bronowski, 1977; J.W. Brown, 1990; Michon, 1985). It is not simply the storage of information and representation of the past events that are self-regulatory functions of non-verbal working memory, but also the retention of events in the correct sequence and the correct temporal duration (Michon & Jackson, 1984). Hindsight and forethought require the ability to sense time (Bronowski, 1977; J. W. Brown, 1990; Michon & Jackson, 1984) and the cross temporal organization of behavior which are important components of non-verbal working memory (Barkley, 1997a).

As mentioned above, perception, attention, and working memory all have limited storage capacity. No one is incapable of noticing all the events that occur in his or her environment, and attention shifts from event to event. Through our perception, moments of events are selected and sequenced together to make the representation of a given event (Davies, 1995). The perception of events as a sequence relies upon a sense of spacial locations and any changes in locations across time. This process is not automatic and requires effort that relies on working memory. Self-directed and regulatory behavior involves time delays between event-response-outcome; therefore, it involves cross-temporal organization of behavior (Barkley, 1997a). This capacity is an important function of the prefrontal lobes (Fuster, 1989, 1995). In order to sense time, one must sense changes in the relative position of things and in what makes the next change different from the last one. These moments are kept in mind in sequence, and comparisons are made among them. Bronowski (1977) and others (Michon, 1985; Brown, 1990) have stated that psychological awareness of time is the result of the ability to keep sequences of events in mind; therefore, time perception is directly related to the function of the working memory (Barkley, 1997a). Through such comparisons, the sense of time develops with a direction and with the ability to estimate the duration among them (Brown, 1990). The information from the past events, and their contingencies, must be kept in the memory and accessed to help create future behavior. The stored information about the patterns of past event sequences creates a sense of future event sequences and the ability to anticipate and to mobilize the motor system accordingly. As the individual matures and can store longer durations in mind, he or she develops the ability to anticipate events that may occur further in time (Barkley, 1997b).

In addition to remembering the correct sequence of events, the individual must have adequate sense of the temporal duration. In order to judge temporal duration well, there is a need for increasing the attention on estimating the duration and the ability to decrease attention to distracting events (Zakay, 1990, 1992). This is when behavioral inhibition and non-verbal working memory combine to achieve this task (White et al., 1994; Gerbing, Ahadi, & Patton, 1987). Self-regulation and adaptive behavior rely on the sense of future created with the help of non-verbal working memory. In essence, before an individual can persist toward a goal, behavioral inhibition is needed to reduce impulsivity, increase reflectivity, resist distractions including temptations, anticipate and close the time delays between events, responses, and consequences to keep the individual on track and persistent toward a goal (Fuster, 1989). Therefore, for self-control and organization of behavior across time delays to occur, there is a need for a mental faculty that senses time (Barkley, 1997a).

Self-regulation generally takes place based on the concept of time and the anticipation of future through the reconstruction of the past. Cost-benefit analysis of the past and the formulation of the future response all take place based on the concept of time. Everyday social interactions and adaptive functioning rely heavily on time, and the timely application of adaptive skills is a problem in those with ADHD (Barkley, 1997a). This is similar to what has been shown in patients with prefrontal cortex injuries (Dellis, Squire, Bihrle, & Massman, 1992; Stuss & Benson, 1996).

Through the internalization of behavior, the individual internalizes the sense of time and therefore anticipates the changes in the environment and adjusts one's behavior accordingly (Barkley, 1997a). Through this process, the individual becomes future oriented, dependable, and purposive (Michon, Jackson, & Vermeeren 1984). The process of sequential perception of events or temporal information requires effort, and it does not happen automatically (Michon & Jackson, 1984; Michon, Jackson, & Vermeeren, 1984), and involves attention. Both attention and retention of the temporal information are vulnerable to distraction by other events (J. W. Brown, 1985; Zakay, 1990, 1992). For a sense of time to develop, there is need for protection from distracting events. This is how behavioral inhibition and interference control are involved in the accurate estimation and reproduction of time (Gerbing, Ahadi, & Patton, 1987; White et al., 1994).

Working memory and its involvement in sense of time has shown to impact the individual's need for immediate or delayed gratification (Green et al., 1994, 1996). The ability to delay gratification is evidence for the development of hindsight and forethought. Self-control is based on the ability to maximize on future rewards by delaying gratification; it is safe to assume that adequate self-control depends on sense of time and the involvement of the working memory (Green et al., 1996). Without a concept of time and non-verbal working memory, any individual will constantly react to the contingencies of the external world. This is variable that controls our decisions and self-regulation (Barkley, 1997a).

Increasing with age and experience, the temporal span of hindsight and forethought increases. Through this process past and present are connected to the future. This serves several purposes. First, future events will initiate current preparatory actions. In those with ADHD, the future will not stimulate preparatory action until that time frame is much closer rather than in a distant future. This may serve to explain why those with ADHD wait until the last minute to prepare for events to come. Such a method of coping is often insufficient in dealing with many life events.

Second, consideration of future events allows for the cost-benefit analysis of various responses. The time span considered by those with ADHD is much shorter. The delayed consequences of the response are more discounted; therefore, the actions of those with ADHD often seem impulsive and not very well thought out. Those with ADHD fail to avoid negative consequences by anticipating events and outcomes in the future. Also, due to the problems with the working memory, they do not seem to have a collection of prior experiences or the internally represented sources of reward to draw from or to guide their current actions. As a result, these individuals are more susceptible to environmental distractions and external contingencies (Barkley, 1997a). The individuals with ADHD have a more difficult time storing information in the working memory and also have a difficult time sequencing the information in the correct temporal order. This concept has been examined in those with frontal lobe injuries (Godbout & Doyon, 1995; McAndrews & Milner, 1991; Sirigu et al., 1995). These patients had a difficult time with sequencing the information accessed from the long-term memory and with retaining the proper temporal order of the incoming information. The problem of sequencing information in the right temporal order may impact the proper sequencing of the motor behavior in those with ADHD.

Sense of time has been studied in different ways in those with ADHD. Grskovic, Zentall, and Stormont-Spurgin (1995) compared children rated high on ADHD symptoms by their teacher to normal controls on a measure retrospective time estimation. The children were asked to recall how long it would take to plan, organize, and perform routine daily tasks. The results indicated a poor performance by children with ADHD, other emotional problems, and learning disabilities as compared to the normal controls. Retrospective recall however is found to be a less accurate measure of sense of time because it is confounded by difficulties with storage and retrieval of information (Zakay, 1992).

Individuals with ADHD have been shown to be deficient both in their ability to estimate and to produce temporal duration when compared to the normal age group. Gerbing, Ahadi and

Patton (1987) proposed that such deficits may be due more to impulsivenes, and the findings of White et al. (1994) have confirmed such impulsiveness. Other studies have found more direct evidence for the impairment in the sense of time in children with ADHD. In a pilot study by Cappella, Gentile, and Juliano (1977), hyperactive children made significantly greater errors in estimating time intervals compared to the control group. As the duration of time intervals increased, the hyperactive children made greater errors. In a second study, these investigators compared the ability to reproduce time intervals in hyperactive children as compared to the normal controls. The hyperactive children again made significantly greater errors than the normal controls. Similarly, White, Barratt, and Adams (1979) found that adolescents with hyperactivity were less accurate in their estimation of two-minute time intervals than the controls. Senior, Towne, and Huessy (1979) found that students with ADHD and emotional disturbances had shorter time production for 30-second intervals. Similarly, Walker (1982) showed that students identified as impulsive had a significantly shorter time production on 12-second intervals than those students identified as reflective. The results of studies by Walker (1982) and Senior, Towne & Huessy (1979) provide more evidence that the individuals with ADHD experience time to progress more slowly than it actually does. These individuals overestimate when asked to verbally estimate an interval, but they under-produce when asked to physically reproduce an interval. These studies have had several methodological limitations, but despite their limitations they all have concluded similar findings.

Several other studies support deficits in sense of time in those with ADHD. These studies indicate that delays in tasks negatively impact performance of those with ADHD (Chee, Logan, Schachar, Lindsay, & Wachsmuth, 1989; Gordon, 1979; Songua-Barke, Taylor, & Hepinstall, 1992; Van der Meere, Vreeling, & Sergeant, 1992; Zahn, Krusei, & Rapoport, 1991). However, others have suggested that the temporal delays may lead to boredom and therefore engagement in more off-task behavior (Zentall, 1985).

Barkley believes that time reproductions are the most difficult tasks to perform; he therefore finds this procedure to be more rigorous in studying time estimation. Barkley et al., (1996b) studied time estimation and time reproduction in a small sample (N=23) of adults with ADHD. During the time estimation tasks, the subjects were presented with intervals of 2, 4, 12, 15, 45, and 60 seconds, and they were asked to state the duration of the interval. In the reproduction task, the subjects were told the duration of the interval and asked to reproduce the interval. The results showed a marginally significant difference ($p<.09$), in that adults with ADHD overestimated the intervals compared to the normal control group. On the time production tasks, both groups showed less accuracy in their time production as the intervals increased. The failure to detect a difference may be due to the small sample size of this study, the low statistical power, and that time production is one of the easiest tasks in assessing sense of time (Barkley, 1997a).

Barkley, Koplowitz, Anderson, and McMurray (1997c) also studied 32 ADHD and 32 control children in reproducing 6- and 10- second intervals without distractions and 10- and 16- second intervals with distractions. The ADHD children made significantly greater errors on all tasks compared to the normal children. In a second study, 12 children with ADHD and 26 normal children were studied in their ability to reproduce intervals of 12, 24, 36, 48, and 60 seconds. Half of the trials included distractions. Similar to the previous studies, the results showed that the ADHD subjects made greater errors in reproducing all these intervals. The distractions impacted the ADHD subjects but not the normal controls. The control group underproduced as the intervals increased, but the distractions made no difference in their production. The ADHD subjects, significantly overproduced the shorter duration, but they under-produced as the intervals increased. The distractions increased the overproduction at 12 and 36 intervals. Based on these results, the ADHD children were less accurate in their reproduction of time intervals. Zakay (1992) states that the individual's time reproduction ability reflects his or her sense of time; therefore, based on the results of the study by Barkley et al. (1997c), the ADHD children are less accurate in their sense of time. These children perceive that time progresses more slowly than the normal children do, particularly during the shorter intervals below 36 seconds.

Verbal Working Memory

Verbal working memory is the second executive function proposed by Barkley (1997b). In addition to the role of non-verbal working memory and sense of time in internalization of behavior and self-regulation, the internalization of speech or the vebal working memory has a role in self-regulation as well. Skinner (1953) hypothesized that language affects behavior in three stages. First, the language of others can control one's behavior. Second, self-talk and private speech of the individual gain progressive control over one's behavior. Third, self-imposed rules as result of self-questioning gains control over ones' behavior. According to Berk and Potts (1991) and Vygotsky (1987), internalization of speech is important to making behavior private and developing self-control. Similarly, Barkley's model considers the process of self-directed speech as important in reflection, self-questioning, problem-solving, developing rules (Bronowski, 1977), meta-cognitive abilities (Flavell, Miller & Miller, 1993), and motor behavior (Berk, 1992, 1994; Berk, & Potts, 1991).

Delay in internalization of speech and behavior associated with ADHD impacts negatively upon children's ability to problem solve (Douglas, 1983; Hamlett, Pelligrini and

Conners, 1987; Tant & Douglas, 1982), and to develop rule-governed behavior (Berk, 1992; Certutti, 1989; Hayes, 1989). Rule-governed behavior is the development of rules that help guide individual's behavior during a problem–solving task. Those with ADHD do not exhibit efficient rule-governed behavior. Also those with ADHD show more rigidity in response versus flexibility. The ADHD behavior is often associated with intense emotional component and appears to be less conscious, deliberate and goal-directed. These behaviors are more impulsive, automatic, and random. The ADHD individuals are delayed in the development of rule-governed behavior because they do not track their behaviors and experiences well. The deficiency in hindsight does not help the ADHD individual to predict the future. Hindsight and forethought are instrumental in self-motivation and the development of rule-governed behavior (Barkley, 1997b). Rule-governed behavior sustains behavior across temporal gaps involving contingencies and, therefore, guides goal-directed behavior. Unlike rule-governed behavior, the behavior of those with ADHD is more variable, depending on the environmental contingencies. Immediate contingencies often are more tempting and therefore more powerful in controlling the ADHD individual's behavior.

Self-Regulation of Affect/Motivation and Arousal

We self-regulate through the use of private self-talk, re-sensing events to ourselves, and through privately motivating ourselves. The self-regulation of affect/motivation and arousal is the third executive function hypothesized by Barkley. This provides the internal sense of drive to move forward in cross-temporal behavior toward self-regulation when there are no external rewards available. As children grow older, they learn to delay immediate gratification and to persist at tasks. They rely less on the presence of external rewards and more on internal sources of motivation. To persist at tasks, one must learn to delay gratification, which is a function of behavioral inhibition. Adequate behavioral inhibition has been shown to be necessary in development of emotional and motivational self-regulation (see Garber & Dodge, 1991; Kopp, 1989; Mischel et al., 1989 for reviews). Barkley's model predicts that ADHD children do not perform as well as normal children when there is no reward or minimal reward in the environment. Covert, self-controlling functions are critical in sustained attention when external reinforcers are absent, but this does not necessarily apply when external reinforces exist in the environment (Barkley, 1997a). ADHD children do not rely on covert representations of events; they mainly rely on external environmental rewards, and they have shown to perform poorly when rewards are delayed (Rapport, Donnelly, Zametkin, & Carrougher, 1986) or when fixed reinforcement intervals are changed to intermittent sources of reinforcement (see Barkley, 1989; Douglas, 1983; Haenlein & Caul, 1987 for reviews; Songua-Barke, Taylor, Sembi & Smith, 1992; Zahn et al., 1991).

Response to reduction in schedule of reinforcement varies depending on the degree of task difficulty and task duration. Some studies show that ADHD children show less drive in performance of goal-directed behaviors, particularly when tasks are repetitive and involve minimal reinforcement or none at all (Barkley, 1990; Douglas, 1972, 1983, 1989). The results on studies involving changes in partial reinforcement schedules are mixed (Douglas & Parry, 1983, 1994; Parry & Douglas, 1983; Pelham, Milich & Walker, 1986; Tripp & Alsop, 1999). Adequate behavioral inhibition and the ability to delay gratification have been correlated with such adaptive behaviors as higher level of education, persistence toward a goal, occupational level, and financial saving (Green et al., 1996).

The prefrontal cortex is hypothesized to be directly involved in the development and execution of executive functions (Barkley, 1997b). More specifically, the orbitofrontal cortex is involved in regulating emotional responses to stimulus-reinforcer associations (Damasio, 1994). The stimulus-reinforcement association learning provides the basis for emotional learning, therefore, the orbitofrontal cortex is important in motivational and social behavior (Rolls, 1999a).

A more recent study (Rolls, 2000) has provided more evidence for Barkley's theory. Rolls showed more specifically that damage to the orbitofrontal cortex in humans has been known to impact on learning of stimulus-reinforcement associations. The clinical implication of this finding is that the correction of behavioral responses may not be applicable when reinforcement contingencies change. Normal children seem to be able to bridge the temporal delays between actions and rewards through their executive functions. Through the working memory, self-directed speech, self-regulation of affect, motivation and arousal, the individual can persist at a given task (Mischel et al., 1988; Pelham, Hoza, Kipp, Gnagy, & Trane, 1997). However, as Barkley (1997b) has hypothesized, children with ADHD will rely on more immediate and external resources to regulate their affect, arousal, and motivation.

Research on Psychophysiology (Brand & van der Vlugt, 1989; Hastings & Barkley, 1978; Klorman, Salzman, & Borgstedt, 1988; Niggs et al., 1998; Rosenthal & Allen, 1978) suggests that the central and autonomic nervous systems of children with ADHD seem to under-react to stimulation, and this function is known to be associated with the frontallobe (Klorman, 1992; Klorman, Salzman, & Borgstedt, 1988; Knight, Grabowecky, & Sabini, 1995). Children with this profile also seem to show less anticipatory activation on EEG tests (Hastings & Barkley, 1978; Niggs, et al., 1998). They have less internal control over their state of arousal, affect, and motivation to help them through goal-directed behaviors.

Barkley's hybrid model of executive function combines Bronowski's (1977) separation of affect and Damasio's (1994, 1995) theory of somatic markers. Thus, through non-verbal working memory, the person recalls events of past experience and the emotional markers associated with them. Emotions result from the continual appraisal of events (Clore, 1994; Lazaraus, 1994; Gray, 1994) and have motivational and reinforcement qualities (Frijda, 1994). Self-regulation involves the ability to induce emotions to bring motivation and drive for goal-directed behavior (Barkley, 1997b). On the other hand, just as important as it is for the individual to delay a response, it is also important for the individual to be able to delay the emotions associated with that event in order to modify it into a more appropriate public response (Kopp, 1989). Such delay allows the individual to gain objectivity (Bronowski, 1977) and to develop a sense of social perspective.

Emotions similar to language are originally used as a form of communication of needs (Levenson, 1994; Scherer, 1994); however, with maturation similar to self-directed speech, self-directed emotions become progressively private and covert. Therefore emotions become internalized and will be displayed publicly based on the emotional charge of a situation and the level of difficulty that the person experiences (Barkley, 1997a).

Barkley has hypothesized that the deficiencies in inhibitory control in those with ADHD caused such problems in self-regulation of affect as decreased empathy, increase in the intensity of response to a provoking situation, decreased ability to foresee emotional reaction to future events, and decreased ability to regulate emotional state to promote goal directed behavior. ADHD children are known to have more negative levels of affect (Lufi & Parish-Plass, 1995; Ramirez et al., 1997) and variable mood (Shea & Fisher, 1996). A recent study by Braaten and Rosen (2000) showed that boys with ADHD were less empathetic, and had more depression, anger, and guilt than those without ADHD. The ADHD group also showed more behavioral manifestations of sadness, guilt and anger than boys without ADHD.

Reconstitution

The last executive function hypothesized by Barkley in execution of self-regulation is reconstitution, which is the ability to take apart and put back together a sequence of behaviors. Neurological research has substantiated that prefrontal cortex has an important synthetic function in verbal and nonverbal forms. Lesions to the prefrontal cortex negatively impact the proper sequencing of behavior (Fuster 1980, 1989; Godbout & Doyon, 1995; Milner, 1995; Sirigu et al., 1995; Stuss & Benson, 1986). Events must be kept in mind through non-verbal working memory in order to be taken apart, to identify the previous contingencies, and then to be able to create new behavioral sequences based on these contingencies. This is how new behaviors, diverse behaviors, and rules are created.

As noted by Bronowski (1977), reconstitution involves two significant interrelated activities, analysis and synthesis. Fuster (1989) described behavior in terms of units of behavior that can be recombined to develop new sequences of response and more complex behavior. Similarly the complex sequences of behavior can be broken down to form simpler forms of behavior. The delay in the prepotent response allows an opportunity for analysis and synthesis to take place and for different responses to be tested out before one is selected (Dehaene & Changeux, 1995). Reconstitution affects behavioral flexibility, creativity, planning, and verbal fluency in goal-directed behavior (Barkley, 2000). Reconstitution is necessary to rapidly and effectively taking apart and reassembling units of language to create verbal fluency. This is also the case with behavioral fluency and motor behavior other than speech (Bronowski, 1977). Reconstitution helps the individual use the hierarchy of previously learned behaviors to generate novel and complex behaviors that are instrumental in obtaining a goal. Measures of reconstitution in children with ADHD (Carte, Nigg, & Hindshaw, 1996; Grodzinsky & Diamond, 1992; Tannock, 1996; Tannock, Purvis, & Schachar, 1992; Zentall, 1988), show that these children are known to produce less speech on tests of verbal fluency and in a confrontational conversation than do normal children (Ludlow, Rapoport, Brown, & Mikkelson, 1979; Tannock, 1996; Zentall, 1988), and to do less well in verbal problem-solving tasks (Douglas, 1983; Hamlett, Pelligrini & Conners, 1987). Reconstitution depends on the capacity to organize information across temporal delays and to act upon previously learned contingencies that have been stored in the working memory.

Planning ability relies on reconstitution. Schnolnock and Friedman (1993) have defined planning as utilizing previous knowledge to obtain a goal. Planning involves at least the use of five components. First, planning involves the use of mental representations of past events, current state, and potential future states of the goal. Second, the selection of a goal. This selection process accesses the self-regulation of affect/motivation and arousal (Damasio, 1994, 1995). The third stage involved is delaying the response in order to conduct a cost-benefit analysis to make sure that moving toward the goal is worthwhile. The fourth stage is the ability to keep a fluency of decisions and actions to keep moving toward a goal. This requires reconstitution. The fifth stage is monitoring the execution of the plan through feedback.

Motor Control

As discussed above, the four executive functions control the fifth ability known as motor control (Barkley, 1997b). As the covert, internalized forms of self-directed behaviors increase over the course of development, the executive functions impact the behavioral responding and the motor control. As goal-directed plans are generated, they are transferred to the motor system, and with enough motivation and drive, more deliberate and goal-directed motor responses are maintained. As the execution of goal-directed behaviors proceeds, the non-verbal working memory holds responses in memory to permit feedback for subsequent responses. This is how sensitivity to errors and behavioral flexibility are promoted in order for the individual to be able to respond to interruptions and to be able to reengage in the goal-directed behavior (Barkley, 1997a). In those with ADHD, behavioral flexibility is interrupted, perseveration replaces behavioral flexibility (Fuster, 1995; Knight, Grabowecky, & Sabini, 1995; Milner, 1995), and there is an insensitivity to errors (Oosterlaan & Sergeant, 1995; Sergeant & Van der Meere, 1988).

Similar findings have been shown in those with frontal lobe injuries (Kesner, Hopkins, & Fineman, 1994). Deficits in inhibition are associated with delays in motor control (Leth-Steensen, Elbaz, & Douglas, 2000; Schonfeld, Shaffer, & Barmack, 1989). Motor problems in those with ADHD have been documented within the research literature (Barkley, DuPaul, & McMurray, 1990; Douglas, 1972; Hartsough & Lambert, 1985; Stewart, Pitts, Craig, & Dieruf, 1966; Szatmari, Offord, & Boyle, 1989), but never discussed within a theoretical model with the exception of Denckla (1985), who discussed the delayed development of motor inhibition (Barkley, 1997a). ADHD children are known to be less coordinated in fine motor performances

(Mariani & Barkley, 1997; Moffitt, 1990; Shaywitz & Shaywitz 1984; Ullman et al., 1978). Other studies (Sergeant & Van der Meere; 1990) have found ADHD children to be more sluggish and have greater variability in their motor preparation.

Evidence for Executive Function Deficits in Those with ADHD

Children with ADHD exhibit a deficit in such various tasks of executive functions as set shifting, planning, organization, complex problem-solving, response inhibition, vigilance, verbal learning, and memory, (Barkley, 1997; Barkley, Gordzinsky, & DuPaul, 1992; Grodzinsky & Diamond, 1992; Houghton et al., 1999; Seidman, Benedict et al., 1995; Seidman, Biederman et al., 1995; Seidman et al., 1997a; Seidman et al., 1997b). Several studies have established that executive function deficits are the hallmark of ADHD (Castellanos et al., 2000; Hall et al., 1997; Klorman et al., 1999; Mealer, Morgan, & Luscomb, 1996; Nigg et al., 1998; Seidman et al., 1997a; Seidman et al., 2000; Speltz et al., 1999; Wiers, Gunning & Sergeant, 1998).

Executive functions have been studied in different ways; e.g., within the subtypes of ADHD. Houghton et al., (1999) suggest that while both the ADHD inattentive and the combined types without any comorbid disorders showed more perseveration and poor response inhibition than the control group, it was primarily the ADHD combined type that showed executive function deficits on tests of frontal lobe measures. Initially more studies had focused on the executive function deficits involving boys with ADHD (Mealer, Morgan & Luscomb, 1996); however, more recent studies have documented similar executive functions impairments in girls with ADHD (Castellanos et al., 2000; Seidman et al., 1997). Other studies have focused on the heredity factors related to executive functions and ADHD. These deficits are also seen in siblings of ADHD children. Seidman et al., (2000) and Faraone, Biederman, Mennin, Gershon, & Tsuang (1996) have studied the neuropsychological functioning of the siblings of ADHD children. The results suggest that compared to the siblings of the controls, the siblings of those with ADHD were significantly impaired on the measures of executive functions such as the Stroop Color-Word test and Test of Verbal Learning and Memory. Further studies have focused on teasing out whether executive function in those with ADHD is related to comorbid disorders, such as reading disabilities (Klorman et al., 1999; Pennington, Grossier & Welsh, 1993; Hall et al., 1997; Purvis & Tannock, 2000) or antisocial behaviors (Nigg et al., 1998). The results suggest that the executive functions deficit exists in children with ADHD independent of the comorbidity with reading disabilities or antisocial features (Pineda, Ardila, & Rosselli, 1999; Doyle et al., 2000). Other studies have compared the neuropsychological deficits of ADHD with those of other disorders, e.g., Schizophrenia (Oei & Rund, 1999). The results suggested that Schizophrenia appears to have more of a general pattern of brain dysfunction, while the impairments in the ADHD children were specific to the tests that measured the frontal lobe function.

CHAPTER 2

CLINICAL CASE STUDY

Research to date supports the hypothesis that children with ADHD have difficulties with self-regulation and goal-directed behavior due to the secondary deficits in executive functions, particularly the sense of time and nonverbal working memory (Barkley, 1997b; Niggs et al., 1998; Epstein et al., 1997) caused by the delay in the development of behavioral inhibition. However, none of the studies has assessed the impairment in sense of time along with assessment of executive functions and behavioral inhibition. The proposed clinical case study in this paper investigates Barkley's Hybrid Model of Executive Functions and theory of self-regulation.

Hypothesis

Considering the theoretical and empirical differences between ADHD+H and ADHD-H, it is important to keep in mind that the scope of this study is limited to the ADHD+H and ADHD-C subtypes. As mentioned above, Barkley in theory of ADHD+H and ADHD-C proposes a deficit in behavioral inhibition, which causes secondary deficits in executive functions such as non-verbal working memory and its most essential component, sense of time. The case study chosen for this paper is divided into two sections, the assessment section and the treatment section. The assessment section will investigate Barkley's theory in order to learn whether there are simultaneous deficits in behavioral inhibition, non-verbal working memory and sense of time in a subject with Attention Deficit Hyperactivity-combined type. The deficits in behavioral inhibition will be measured by Stroop Color-Word Test (Golden, 1987), the Continuous Performance Test-II (Conners, 2000), and the Wisconsin Card Sorting Test (Heaton, 1981). Non-verbal working memory will be measured by the Rey complex figure Test and Recall Trial (Meyers & Meyers, 1995), and the Wisconsin Card Sorting Test. The deficit in sense of time will be measured by the Time Perception Test. The specific aims of this study are (a) to conduct a comprehensive evaluation of a client who has ADHD with hyperactivity or combined type; the evaluation includes intelligence screening, parent and teacher rating scales, diagnostic clinical interview, measurements of executive functions with an emphasis on the non-verbal working memory, and perception of time (b) to assess comorbid psychiatric disorders in addition to ADHD, and (c) to incorporate the assessment results into a five-session treatment plan that includes adaptive self-regulatory skills such as externalization of time, e.g., timers, point-of-performance incentive system, and increased self-awareness to address specific problems with the deficits in non-verbal working memory sense of time involved in ADHD. In addition to the individual session, the treatment includes parent and teacher training.

Method

Participant

The inclusion criteria

1.) Meeting full DSM-IV diagnostic criteria for either ADHD with Hyperactivity, or ADHD, combined type.

2.) Rating Scale-IV hyperactivity scores at the 93rd percentile or higher.

3.) Rating Scale-IV inattentive scores at the 93rd percentile or higher.

4.) Ages 7 to 13 years old.

The exclusion criteria

1.) Any child with IQ scores of less than 70.

2.) Any child with present or past episodes of psychosis.

3.) Any child with the diagnosis of ADHD, Inattentive type.

4.) Any child younger than age 7 and older than age 13.

5.) Any child who is currently taking Wellbutrin.

Subject Recruitment

A letter was sent to the school counselors and psychologists in the Southern Chester County elementary schools stating the need for a single subject for a research project investigating ADHD. The school counselors discussed the letter with prospective parents. The families that agreed to participate in this study and called the investigator, received the consent form and the initial ADHD screening questionnaires discussed below. The first child and family that qualifies for the study criteria was chosen for this study.

The Initial Screening

The screening questionnaires completed by the parents included the Home Situation Questionnaire and the ADHD Rating Scale-IV. The School Situation Questionnaire and the ADHD Rating Scale-IV were completed by the subject's teacher. After their completion, these questionnaires were returned to the investigator in self-addressed stamped envelopes. The first subject who met the criteria for ADHD with hyperactivity or combined type based on the screening questionnaires was given the option to participate in this study.

Source of Referral

B. was referred for this study by the counselor at H. Elementary School in Southern Chester County. Initially B.'s mother called the responsible investigator on Friday, January 12, 2001, to volunteer her son for this study. An initial appointment was scheduled for Mr. and Mrs. B. on Saturday, January 20^{th} at 1:00 p.m. pending B.'s qualification for the study after the completion, return, and evaluation of the ADHD Rating Scale-IV and the consent forms. The ADHD Rating Scale-IV, parent and teacher forms, and the consent forms were mailed to the family on January 12, 2001. The responsible investigator received the completed forms on Friday, January 19, 2001.

Site

This clinical study was conducted in a private practice setting.

Measurements

No clear and quick tests establish the existence of ADHD; therefore, when assessing for ADHD, there is a need for collection of data from multiple sources. Patients themselves often are not reliable judges of their behavior and the level of impairment caused by ADHD (Quinlan, 2000). Children, in particular, are typically not capable of providing the clinician with a complete developmental history. The assessment of ADHD is a clinical process that involves the clinician's judgment in weighing what the patient, parents, and teachers have observed about the patient. This process is not problem-free, and the observers may be limited by the problems that they observe and their own bias; for example, an anxious parent may have a different criteria against which he or she evaluates her child (Quinlann, 2000).

The assessment data should provide information about the child's strengths and weaknesses of the child with regard to academic skills, social skills, support system, financial resources, and psychological/ psychiatric variables (Barkley, 1998). The child's strengths can be used in treatment to build upon and to develop new capabilities. Considering that there is not a single instrument sufficient enough to establish the diagnosis of ADHD, the clinicians use structured diagnostic interviews, psychometric tests of cognitive functioning, checklists and other assessment tools to make the assessment process more efficient and systematic. The following section describes the diagnostic measures used in the current study.

Interview Instruments

A structured interview helps the clinician to inquire about a broad range of issues in a systematic way to eliminate digression from topic to topic. However there is a need for flexibility depending on the circumstances and individual needs of the interviewee (Barkley, 1998). Due to the high comorbidity of ADHD with other disorders, the goal of the assessment includes establishing the presence or absence of any comorbid disorders in addition to ADHD.

Structured Clinical Interview (Barkley & Murphy, 1998) - This interview is based on the DSM-IV diagnostic criteria specific for ADHD. This interview was selected because it not only provides a structured way to gather biographical information, developmental and medical history, school history, psychological and social strengths, and family history of mental illness, but also it provides a screening for the DSM-IV childhood disorders, and parental management methods of the child's behavior. This information is necessary prior to generating a treatment plan, because comorbid disorders and more effective parental management methods are to be included in the treatment plan.

Anxiety Disorders Interview Schedule for DSM-IV (Silverman & Albano, 1996) - This structured interview has been designed to assess for current episodes of anxiety, mood, somatoform, and substance use disorders. This interview also allows for screening of psychotic and conversion symptoms.

Questionnaires

The Home Situation, and the School Situation Questionnaires (HSQ, SSQ; Barkley & Murphy, 1998) - The HSQ requires the parents to rate the child's compliance level with 16 different situations, e.g., getting dressed or complying with chores. The compliance rating scale ranges from 1- (mild) to 9 (severe). Similarly the SSQ requires the teacher to rate the child's compliance behavior in 12 school-related situations, e.g., individual deskwork or recess behavior on a scale of 1 to 9.

Rating Scales

The rating scales that are helpful for ADHD diagnosis are either broad spectrum or more specific to ADHD. The examples of more general rating scales are Achenbach's Child Behavior Checklist (Achenbach, 1991), Behavior Assessment System for Children (Reynolds & Kamphaus, 1992), and Child Symptom Inventories (Gadow & Sprafkin, 1994). For this study, the investigator did not choose any of these general scale; instead she chose a scale specific to ADHD, because the use of a specific ADHD rating scales allows the clinician to collect specific information about the symptoms of ADHD from multiple sources. The general information about the child's behavior and characteristics were gathered by using the above structured clinical interview and the ADIS. Although there are a number of rating scales specific to ADHD, e.g., The Conners Rating Scales-Revised (Conners, 1997), Brown Attention Deficit Scales (T.E. Brown, 1996a), and Wender Utah Rating Scales (Ward, Wender, & Reimherr, 1993), The ADHD Rating Scals-IV (Dupaul, Power, Anastopoulos, & Reid, 1998) was chosen. This scale is based on the DSM-IV criteria and is a brief yet reliable and valid instrument in assisting with the diagnosis of ADHD.

ADHD Rating Scale-IV (Dupaul, Power, Anastopoulos, & Reid, 1998) - This is an 18-item parent and teacher-rating scale designed to assess nine symptoms of hyperactivity-impulsivity as described in the DSM-IV. Items on this scale were taken from DSM-IV; however, in many cases they were reworded to increase their clarity. Each item is rated on a 4-point scale (0=not at all, rarely; 1=sometimes; 2=often; 3=very often). Factor analyses of both the home and school versions of the ADHD Rating Scale-IV have shown that the factor structure of this scale is similar to the theoretical structure described in the DSM-IV (DuPaul et al., 1997; DuPaul et al., 1998). Parent and teacher ratings on this measure were found to be internally consistent and stable over a 4-week period. They also correlate significantly with observations of classroom behavior, task accuracy, and corresponding subscales of the Conners' Parent and Teacher Rating Scales (DuPaul, et al, 1998). Both the parent and teacher versions include the normative data collected in a large national sample stratified according to geographic region and ethnic group (DuPaul et al., 1997; DuPaul et al., 1998).

Test of Time Reproduction

Time Perception Test (TPT; University of Massachusetts Medical Center, 1996) - TPT is a research tool with standardized administration and norms in development. This is a computerized test that measures the person's psychological sense of time and his or her ability to estimate and to reproduce time intervals set by the experimenter. The test is divided into visual and auditory trials. The visual trials test the subject's time perception via visual cue, which is a lit light bulb. The auditory tests provide a tone for the subject. The subject is to listen or to watch the cues carefully. The subject is then asked to repeat the tone or the lit bulb by pressing and holding down the space bar on the computer for the same duration as the visual or the auditory cue.

1. Visual Test Without Distraction - During this test a light bulb is presented on the left side of the window. Before the light bulb is lit, the word "WATCH" appears. The subject is to watch the light bulb very carefully. When the lit interval is ended, the light bulb on the left side of the computer will be in the UN-LIT state. At the same time, another unlit light bulb will be displayed on the right side of the display. This light bulb is for the subject, and the words "YOUR TURN" will appear under this light bulb. The subject is then to press and hold the space bar to light the second bulb for the same interval as the first light bulb was lit. The time intervals chosen by the examiner will be presented to the subject randomly on all four tasks. Each test has 10 trials.

2. Visual Test With Distraction - This test is exactly the same as the test above, but a random visual distraction, such as a butterfly, is displayed across the main window during the computer's interval. This distraction does not appear while the subject is reproducing the task.

3. Auditory Test Without Distraction - The auditory tasks are similar to the visual tasks, but rather than introducing a light bulb, a tone is used. Just prior to the computer tone, the word "LISTEN" appears on the left side of the blank screen. Two seconds later the tone is introduced for the duration set by the examiner. Then the words "YOUR TURN" appears on the screen. The subject is to press and hold the space bar to reproduce the tone for the same duration.

4. Auditory Test with Distraction - This test is the same as the auditory test without distraction, except as the computer produces the tone, random auditory distractions occur in addition to the main tone. The distractions include noises, such as clapping or a train whistle. Despite the distractions, the main tone is audible at all times. These distractions do not occur when the subject is reproducing the tone. Temporal organization and the perception of time are the function of the dorsolateral loci (Fuster, 1995).

Psychometric Testing/ Screening for Cognitive Abilities

One of the main goals of using a psychometric test is to assess the subject's cognitive abilities by re-creating a setting that may resemble what the subject experiences at his or her academic setting (Quinlann, 2000). These testing results will provide a sample of the subject's behavior and performance in the actual daily setting. The recreation of such settings is not an easy task, and as much as the examiners attempt to re-create a typical daily situation when testing the subject, the subject may react in other than a typical manner. Sometimes a subject may feel anxiety about being put on display to perform, and his or her performance may not measure up to his or her typical performance ability. On the other hand, some subjects may welcome the opportunity to demonstrate their capabilities (Hallowell & Ratey, 1994) and may invest greater effort than typically seen in his or her daily situations. In the current study the investigator was mindful that the subject's comfort level and the extent of rapport between her and the subject had an influence on the subject's performance level. The test chosen for this study was Wechsler Abbreviated Scale of Intelligence (WASI); which is not an extensive measure of the subject's cognitive abilities, but rather a screening measure to rule out subjects with below average cognitive ability.

Wechsler Abbreviated Scale of Intelligence, 1999 (WASI) - This test is an individually administered short, reliable, and valid estimation of fluid and crystallized intelligence (Horn, 1995; Kaufman, 1994). The WASI is often used for screening purposes, e.g., attention-deficit/hyperactivity disorder, learning disabilities, mental retardation or giftedness. This test can be administered to individuals ages 6 to 89; the administration time is about 30 minutes. The WASI is nationally standardized and provides three scores for Verbal, Performance and Full Scale IQ. The subtests of WASI are Vocabulary, Block Design, Similarities and Matrix

Reasoning. These subtests are similar to their corresponding subtests in WISC-III, and their correlation coefficient ranges from .69 to .74. The coefficient for the IQ scales as compared to the WISC-III, range from .76 to .87. The WASI subtests have the highest loadings on general intellectual functioning (g) (Brody, 1992; Kamphaus, 1993; Kaufman, 1990; Sattler, 1988; Wechsler, 1991; 1997). In addition to the g factor loadings, these subtests were chosen for their ability to tap into cognitive functioning, such as verbal versus nonverbal and fluid versus crystallized abilities.

Neuropsychological Measures

Several studies have shown differences in the neuropsychological functioning of those with ADHD compared to normal controls (e.g., Seidman et al., 1997b). Pennington and Ozonoff (1996) reviewed several studies. A significant difference between ADHD and controls on measures of executive function were found in 15 out of 18 studies. Executive functions similar to IQ have many interacting complex components. Most measures that tap into tasks central to the Prefrontal Cortex (PFC) are often used to measure executive function. The problem with these tasks may be that although they tap into the PFC executive functions, they may also tap into the non-executive components that are not necessarily specific to the PFC (Anderson, Damasio, Jones, & Tranel, 1991; Grafman, Jones, & Salazar, 1990; see Heaton, Chelune, Talley, Kay, & Curtiss, 1993; Pennington & Ozonoff, 1996 for review). Although there are no pure measures of executive function, the assessment tools chosen for the current study have effectively discriminated ADHD from the control group.

The Rey Complex Figure Test and Recognition Trial (Meyers & Meyers, 1995) - This is a test of perceptual organization, which relies on the non-verbal working memory. Patients with frontal lobe lesions have been shown to perform poorly on this task (Lezak, 1995). Furthermore, this test has effectively differentiated ADHD subjects from normal controls (Douglas & Benezra, 1990; Grodzinsky & Diamond, 1990; Grodzinsky & Diamond, 1992; McGee, Williams, Moffitt, & Anderson, 1989). This test requires the subject to copy a complex abstract design accurately. This is followed by a recall after a 3 minute, and then again after a 30 minute, delay period. In addition to the recall components, this test involves a recognition trial immediately followed by the 30-minute recall. The recognition trial involves the introduction of 24 geometric figures, 12 of which are components of the initial complex figure that was previously presented to the subject. The subject then identifies only the figures that he or she has seen before in the original complex figure. The scoring criterion used here is based on the criteria developed by Rey (1941). Rey's scoring system divides the complex figure into 18 components; each component receives an individual score of 0, 0.5, 1 or 2. These values are assigned to each component based on accuracy and placement criteria. The obtained values are then compared to the norms indicated for the subject's age group.

The Stroop Color-Word Test (Golden, 1987) - This test is based on the concept that it takes longer to call out the color name of colored patches than to read the words. It takes even longer to name the color when the printed word is in a different color than the word suggests. This task measures the subject's ability to inhibit one set of responses and to be able to use selective attention. The patient is first asked to read the name of colors on the first trial, and then to name the color of four continuous X's. The last trial requires the subject to name the color of the word when the words spell a different color. Most subjects show the tendency to read the word, rather than name the color, but this tendency is even stronger in those with ADHD. Several studies (Boucugnani & Jones, 1989; Gorenstein, Mammato, & Sandy, 1989; Grodzinsky, 1990; Hopkins, Perlman, Hechtman, & Weiss, 1979; Pennington et al., 1993; Weyandt & Willis,

1994) have shown that the Stroop is particularly sensitive to differentiating ADHD subjects from normal controls. Neuroimaging studies (Bench et al., 1993; Vendrell et al., 1995) have shown that the orbital-prefrontal regions particularly the right prefrontal region are involved during the performance on the Stroop Test.

The Wisconsin Card Sorting Test_(Heaton et al., 1993) – The investigator used the computerized version of the WCST. The subject is presented with four cards varying in color, shapes of figures, and the number of figures. Each of 128 stimulus cards is to be matched to one of the four cards. The principle sorting can be based on the color, shape, and the number of the figures. The subject hears either correct or incorrect feedback after each card is placed. After 10 correct responses, the criteria for the sorting shifts without informing the subject. After three criteria have been completed, the criteria are then shifted to the first criterion. The WCST requires the ability to generate and to utilize the correct sorting rules, to be able to incorporate the computer's feedback, and to shift to a new sorting rule with flexibility. WCST scores that are particularly sensitive to those individuals with ADHD are: perseverative errors, failure to maintain set, and number of categories completed. The primary response measure was the number of perseverative errors defined as responses that would have been correct according to the previous sorting rule. The failure to maintain set is defined as an interruption of the correct sorting strategy after five consecutive correct responses. The number of categories achieved is used to gauge how well the subject grasps the concept of sorting to different categories. WCST measure has been found to discriminate among those with prefrontal damage and other kinds of brain damage (Heaton, 1981). More specifically, WCST results have discriminated ADHD children from normal children (Chelune et al., 1986; Gornstein, Mammato, & Sandy, 1989; Loge, Staton, & Beatty, 1990; McGee et al., 1989) with some exceptions (Loge, Staton, &

Beatty, 1990). Individuals with ADHD show greater frequency of perseveration and failure to maintain set errors. WCST perseverations are a significant discriminator of ADHD (Pennington, Grossier & Welsh, 1993; Weyandt & Willis, 1994). WSCT performance is the function of the dorsolateral loci (Fuster, 1995; Goldman-Rakin, 1995).

The Continuous Performance Test –II (Conners, 2000) - This test is used to assess vigilance and attention to stimuli over an extended period of time. The orbital frontal loci are indicated on response inhibition tasks such as the CPT. The CPT-II function is similar to the previous CPT (DOS version), with the exception of increased sensitivity to vigilance (Conners, 1994a, 1994b). The reliability of CPT-II has been established through split-half reliability (range from .73 to .95) on its various measures (Conners, 1994). The validity of CPT-II is established through a thirty multiple site studies (e.g., Conners, 1994a; Robertson, Datta, Bird, & Kutcher, 1999; Woodin 1999), as well as meeting the requirement for the Standards of Educational and Psychological Testing (AERA, APA, & NCME, 1999).

The CPT-II is a computerized test that presents the subject with different letters, one at a time. The subject is previously informed that he or she is to press the bar tab every time a non-targeted letter appears and to withhold response when the targeted letter X appears. The test duration is about 14 minutes. The scores include errors of omission, commission, reaction time, and variability of responses during the task. Research has shown that ADHD children perform more poorly than the normal controls on the CPT and CPT-II measures (Losier et al., 1996; Sitarenios & Conners, 2000). Losier et al., (1996) did a meta-analysis of 26 studies that used the CPT in children with ADHD. They found that the ADHD children showed more omission and commission errors. However, caution should be taken in interpreting the results of the CPT for the following reasons. First, similar to any other single assessment tool, a definite diagnosis of

ADHD cannot be made using solely the results of the CPT. Second, it has been suggested (Barkley, 1990) that the CPT is more sensitive to the impulsivity involved in ADHD hyperactive and combined type, versus the inattentive type. Third, CPT is sensitive to a broader variety of disorders such as schizophrenia and other neurological conditions and is not just specific to ADHD. Fourth, some individuals may be capable of responding positively to the novelty and the stimulation of the new task and perform better under higher arousal levels; therefore, this tool should be used as a supplement to a battery of tests to assess ADHD.

Assessment

This section includes a summary of each assessment session, followed by the results of the assessment, and the discussion of the results.

Session #1: Parent Interview

Parent information is a necessary component of ADHD assessment because although the direct observation of the child can be helpful to the diagnosis of ADHD, the child's behavior in the practitioner's office most likely is not a reliable sample. Children often behave better in a clinical setting (Sleator & Ullma, 1981). Further, research shows a discrepancy between the child and the parent's report of the presenting problems (Edelbrock, Costello, Dulcan, Conover, & Kalas, 1986; Loeber, Green, Lahey, & Stouthamer-Loeber, 1989; Reich & Earls, 1987; Welner, Reich, Herjanic, Jung, & Amado, 1987) in a mental health setting. Nevertheless, the parent(s) is the more reliable historian who can shed light on the duration of the child's problems, as well as the general family history. Therefore, parental reports of the child's behavior and its impact on the family are important (Barkley, 1998). As a result, the first task of the parent interview was to establish rapport with the parents and to gain their cooperation.

The responsible investigator met with the subject's parents for an initial two-hour session. The investigator first obtained treatment consent after reviewing the Consent for Treatment form with the parents, Mr. and Mrs. B. Then Barkley's Structured Clinical Interview was completed. The parents were questioned about the child's legal history, family composition, parental concerns about the child, including developmental delays, health history, school-related problems, and social interactions. Using the same structured interview, the parent management methods of the child and family history of any mental health problems were assessed.

The second structured questionnaire administered was the parent versions of the Anxiety Disorders Inventory Scale-IV (ADIS). This structured interview was used to rule out the DSM-IV childhood disorders, e.g., oppositional defiant disorder, anxiety and mood disorders. The parents were generous with providing detailed answers to questions asked. Although the subject's father was involved in providing the necessary information, B.'s mother provided the majority of answers to the questions. Mr. B. corrected Mrs. B. on two occasions. He reminded Mrs. B. that feeding B. and keeping him on a regular sleep schedule were very difficult due to his colic in infancy. Both parents seemed fatigued during the last half-hour of the session, but they remained cooperative and declined to take a break. An appointment was scheduled for B., the subject, by his parents. The responsible investigator requested that Mr. and Mrs. B. explain to B. that he would come to the office to meet with her for two hours the next week. They were asked to explain to B. that he would be asked a number of questions, and he simply needed to respond in the best way that he was able.

Session #2; Child Interview

In this study, the extent to which the subject is interviewed depending on his age, communication skills, intellectual capability, cooperation, and level of insight into his own issues and the environment was considered. For younger children, there is also the level of impulsivity and poor awareness of self to consider (Hinshaw, 1994). Self-report measures/structured interview forms such as the ADIS-Child Version (Silverman & Albano, 1996) were used to structure the session.

The second assessment session was with B. was for two hours, on Wednesday, January 31, 2001. B.'s mother brought him to the session. He was pleasant and seemed eager to learn more about the study. The Child Agreement Form was reviewed with B., and his signature was obtained. He seemed comfortable saying goodbye to his mother. He was aware that his father would come to the office in two hours to take him home. B. was cooperative and remained seated; there were no signs of fidgeting or restlessness. He had taken his last dose of Ritalin, 10mg at noon. The session began at 5:00 p.m. He was asked by the investigator to relax and just do the best that he could do. The WASI was administered first followed by the Stroop Color-word Test, and the Rey Complex Figure Test and Recognition Trial. The last item administered was the ADIS-IV, child version. The two hours ended prior to the completion of the ADIS. The second half of the interview was completed at the following session.

Session #3: Child Interview

This session was scheduled on Sunday, February 4, 2001 at 1:00 p.m. B.'s mother called at 1:00 p.m. stating the B. was at a sleepover at a friend's house and had forgotten to come home on time; therefore, he was about 30 minutes late for his appointment. B. had received his last dose of Ritalin 24 hours prior to this session. His father brought him to the session. He seemed comfortable enough to walk up to the office by himself. His father was to return for him after two hours. B.'s behavior during this session was considerably different from the last session. He was fidgeting with his hands, squirmed in his seat, and often asked how much longer was left on each test. The tests were administered in the following order: Wisconsin Card Sorting Tests, Conners Performance Test-II, Time Perception Test, and the second half of the Anxiety Disorders Inventory Scale-IV-child version. B. was particularly restless during the CPT, e.g. frequent shifting in his seat and sighing heavily.

Session #4: Debriefing Session

The debriefing session was scheduled by phone. During this phone conversation, the investigator explained to Mrs. B. that one of the tests (Time Perception Test) had to be re-administered to B. using longer duration. Mrs. B. did not think that B. would have a problem with retaking the test. The investigator met with Mr. B., Mrs. B., and B. on Wednesday February 28, 2001, 7 p.m. While the investigator met with B.'s parents for debriefing, the Time Perception Test (TPT) was re-administered to him in the office next door. The parents seemed interested in the feedback provided regarding the assessment results.

The following issues were discussed with the parents during the feedback; (a) B.'s overall strengths including his Above Average IQ; (b) his occasional difficulty in generating a specific equivalent word in the vocabulary subtests. The parents were told of the benefits, of teaching B. to identify specific equivalent words at home. The investigator explained that this process may help B. on his vocabulary tests as well as his writing composition; (c) B.'s difficulty in dealing with larger and more complex tasks was discussed. The benefit of teaching him to break larger tasks down to smaller and more manageable parts was explained; (d) the noticeable discrepancy in B.'s behavior between the first and the second assessment sessions was discussed and mainly attributed to the medication; no other causes were identified. B.'s parents agreed that they, too, have noticed the significant impact of Ritalin on his behavior; (e) B.'s difficulty in incorporating feedback into his responses as reflected by the WCST was discussed. The role of non-verbal working memory in this process was emphasized. B.'s relative weakness in non-verbal working memory was discussed. The investigator suggested that verbal mediation may help B. in learning and working with visuospacial information. The parents were informed that non-verbal working memory and the ability to incorporate feedback into future actions are important in the ability to comply and follow through with various directions or requests. They were made aware of the possibility that what may seem to them as B.'s noncompliance due to Oppositional Defiant Disorder may simply be forgetfulness; (f) B.'s separation anxiety was discussed. The investigator suggested that B.'s parents encourage him to rely more on himself for self-regulation, e.g., the parents were encouraged to teach B. to problem-solve rather than deliver the answers to him. As a result, B. may feel more confident in his own abilities, and have less anxiety when he is not with them; (g) B.'s strength with regard to confronting rather than avoiding, anxiety-producing social situations was discussed; (h) B.'s scores on the ADHD Rating Scale-IV teacher and parent ratings were reviewed. It was emphasized that B.'s high scores lend themselves to a more accurate diagnosis of ADHD-Combined Type; and (I) Treatment strategies based on the results of the assessment were discussed. The parents seem interested in specific strategies, e.g., using a timer in the morning to get ready for school. After the debriefing of the parents, B. was brought into the office to give him feedback about the assessment results. B.'s strength in confronting his fears, his Above Average IQ, and his patience with the testing process were highlighted. This session completed the assessment process. At the end of the session, the investigator made an appointment for Mr. and Mrs. B. for the first treatment session, the parent training session.

Results

Social and Developmental History

Mrs. B. stated that her pregnancy with B. was normal with some exceptions. There was no bleeding, excessive weight gain, toxemia, Rh factor incompatibility, serious injury, drinking or smoking while she was pregnant with B. However, during the last trimester of her pregnancy, she developed gestational diabetes and was treated with insulin. She was also put on bed rest during this pregnancy due to premature dilation of her cervics. B. was born at 37 ½ gestation weeks. The delivery was a normal vaginal delivery without the use of forceps. As an infant, B. was described as alert, cheerful, affectionate, and sociable by his parents. However, he developed a problem with acid reflux at three months of age. As a result, he experienced disturbed sleep, and it was difficult to comfort him.

B. reached most of the early developmental milestones within the expected age range. He sat up alone at 7 months, crawled at 9 months, walked alone at 11 ½ months, and had complete bowel and bladder training by 27 months. The only developmental delay was language. His health history indicates that he has had chicken pox, broken bones, severe cuts requiring stitches, chronic ear infections and surgery to insert ear tubes. Problems with fine motor coordination difficulties involving handwriting and difficulty falling sleep were also noted.

Social Development

Although B. is often uncomfortable with meeting new people or going to a friend's house for the first time, he recognized that he cannot let his fears impact his social life, e.g. stop visiting with friends. More often than not, he manages to expose himself to these uncomfortable situations until he feels more at ease. B. is involved in a variety of sports, e.g., baseball, hockey, and basketball. He has a number of close friends with whom he socializes on a regular basis. His favorite subjects at school are science, computers, spelling, math, and language arts; his least favorite subjects are social studies, library, and writing.

Wechsler Abbreviated Scale for Intelligence (WASI) Results

On the Wechsler Abbreviated Scale of Intelligence, B. achieved a Full Scale IQ of 111. This result indicates that he is currently functioning within the High Average range of intelligence, at approximately 77th percentile compared with other children his age. The chances are about 90 out of 100 that his true Full Scale IQ falls between 106 to 115. Considering the high correlation between the results of WASI and the WISC-III, there are 90 out of 100 chances that B.'s Full-Scale IQ score on WISC-III would fall between 97 to 121. The present measures of B.'s intellectual functioning appear reliable and valid.

The verbal domains measured expressive vocabulary, verbal knowledge, and the ability to use abstract verbal reasoning. B.'s verbal skills range from the Average to the High Average. The performance domains measured visual-motor coordination, perceptual organization, and nonverbal fluid reasoning. B.'s scores were within the High Average range of performance on these skills.

Table 1. The Results of the WASI

Subtest	Raw Score
Vocabulary	9
Similarities	15
Block Design	12
Matrix Reasoning	12

Table 1. (Continued)

Verbal IQ=109, 73rd Percentile

Performance IQ=109, 73rd Percentile

Full Scale IQ=111, 77th Percentile

ADHD Rating Scale-IV Results

B.'s current 4th-grade teacher, his mother, and his father evaluated him on the ADHD Rating Scale-IV. His teacher rating places him at the 89th percentile for children his age. His mother's rating places him at the 99th percentile and his father's rating places him at the 97th to 98th percentile. Consistent with previous studies, teacher-rating above 80th percentile and parent-ratings at or above 85th percentile are optimal for predicting ADHD-Combined Type.

Table 2. The ADHD Rating Scale-IV Results

	Teacher Rating	Mother Rating	Father Rating
Inattentiveness	14	24	20
Hyperactivity	16	24	19
Total ADHD	30	48	39
Total Percentile	89	99	98

Anxiety Disorders Interview Schedule for DSM-IV Results

The results of the parents' interview using ADIS-parent version revealed that B. meets criteria for Separation Anxiety Disorder, Specific Phobia, Attention-Deficit Hyperactivity Disorder (ADHD)-combined Type, and Oppositional Defiant Disorder. However, during the debriefing session with the parents, it became apparent that they have often attributed B.'s lack of follow through with their requests to defiance, rather than to forgetfulness or a problem with non-verbal working memory. The results of the interview with B. using the ADIS-Child version revealed that he meets criteria for Separation Anxiety Disorder, Social phobia, Specific Phobia, and ADHD- combined Type.

Wisconsin Card Sorting Test Results

B. had a significantly higher total percentage of errors (T=60), a total percentage of perseverative responses (T=60) and total percentage of perseverative errors (T=61) compared to his normal age group. He had a high percentage of conceptual level responses (T=59), which indicates that he has good overall insight into the sorting principles and was able to complete all six categories. However, it took B. longer to learn the correct sorting principles at the first trial, as reflected by the higher number of trials that it took him to complete the first category (2-5%). B.'s score of three on the failure to maintain set was higher than those in his age group. This result shows that on three occasions he was able to make five or more consecutive correct matches, but he then forgot the correct sorting principle and made an error. Although his learning to learn score of .13 indicates that he had some capacity to learn from his mistakes, he was unable to incorporate that information into his ongoing performance and to be able to produce more correct responses. This pattern is not uncommon in children with ADHD.

Table 3. Wisconsin Card Sorting Test Results

		Age	Demographically corrected	
WCST Scores	Raw Scores	Standard Scores	T Score	%tile
Trials Administered	114			
Total Correct	92			
Total Errors	22	110	57	75
% Errors	19	115	60	84
Perseverative Responses	10	112	58	79
% Perseverative Responses	9	115	60	84
Perseverative Errors	9	113	59	81
% Perseverative Errors	8	117	61	87
Non-Perseverative Errors	13	103	52	58
% Non-Perseverative Errors	11	105	53	63
Conceptual Level Responses	87			
% Conceptual Level Responses	76	113	59	81
Categories Completed	6			>16
Trials to Complete 1st Category	35			2-5

Table 3. (continued)

Failure to Maintain Set	3	2-5
Learning to Learn	0.13	>16

Continuous Performance Test-II (CPT-II)

The CPT-II administration was a valid administration. There were no indications of any timing difficulties or respondent non-compliance. B. made fewer than average omission or failure to respond errors. He also made fewer commission or response to non- target-letter errors. His overall mean reaction time was typical in comparison to the normative group. The consistency of B.'s response speed was typical in comparison to the normative group average. His detectability of X from non-X letters was better than average. His perseveration rate was lower than average. He did not show a problem with sustained attention on the CPT-II. However, his overall hit rate was faster than normal (T<50), suggesting impulsivity, and his ADHD index was higher than the normative sample; therefore, his overall profile resembles more of an ADHD profile rather than that of a non-clinical respondent. The chances are 55 out of 100 that clinically significant problems with ADHD exists.

Table 4. The CPT-II Results

Impulsivity Summary (against general population norms)

	Value	T-Score	Percentile	Guidelines
# Commissions	14 (38.9%)	32.09	3.67	OK
Hit Rate	402.8	49.44	47.78	OK

Table 4. (continued)

Perseverations	1	43.03	24.29	OK
Inattention Summary (against general population norms)				
# Omissions	5(1.5%)	43.27	25.08	OK
# Commissions	14(38.9%)	32.09	3.67	OK
Hit Rate	402.8	49.44	47.78	OK
Hit Rate Std. Error	8.7	46.87	41.55	OK
Variability	14.7	47.88	45.54	OK
Detectability (d')	0.6	39.90	18.16	OK
Hit Rate ISI Change	0.09	50.85	57.35	OK
Hit Se ISI Change	0.09	47.50	40.14	OK
Vigilance Summary (against general population norms)				
Hit Rate Block Change	-0.02	41.23	19.05	OK
Hit SE Block Change	-0.02	40.98	21.14	OK

The Rey-Complex Figure Test and Recognition Trial

The recognition total correct score of 17 and the copying raw score of 27 (2-5th percentile) indicate that B. has reduced visual perceptual and visuomotor integration skills. The low immediate (T=35, 7thpercentile) and delayed recall (T=36, at the 8th percentile) scores suggest reduced visuospacial recall ability. The low total recognition trial T score of 29, at the

2^{nd} percentile, suggests below average ability to retrieve visuospacial material when given retrieval cues. Although B.'s memory profile pattern resembled a normal memory pattern, his T scores are more than 1 SD lower than the normal mean scores.

Table 5. The Rey-Complex Figure Test and Recognition Trial Results

	Raw Score	T-Score	Percentile
Copy	27.0		2-5
Immediate Recall	12.5	35	7

Table 5. (continued)

	Raw Score	T-Score	Percentile
Delayed Recall	13.0	36	8
	Recognition Trial		
True Positive	8		
False Positive	3		
True Negatives	9		
Recognition False Negatives	4		

The Time Perception Test (TPT)

The Time Perception Test (TPT) is a standardized test and a research tool with norms in development. On the CPT, B. showed a tendency to overproduce time intervals in more instances rather than to underproduce them. Similarly, underproduction means that B. produced shorter duration than produced by the computer. Overproduction means that B. produced longer duration than the duration produced by the computer. There was no particular within task pattern with regard to over or underproduction.

Overall, B.'s absolute discrepancy error was much higher for the auditory tasks regardless of the presence or absence of distracters as compared to the visual tasks. The absolute discrepancy error is the value of the difference between the sample duration presented by the computer and the subject's reproduction of that time interval. The presence of distracters, both visual and auditory seem to interfere with a more accurate reproduction of time. Presence of distracters for visual tasks increased absolute discrepancy error at 48 and 24 seconds but decreased absolute discrepancy error at 36, 12 and 6 seconds. Absolute discrepancy error for auditory tasks with distractions increased at 48, 24 and 6 seconds, but decreased at 12 seconds.

Table 6. Mean Absolute Discrepancy Error (ADE) on the Time Perception Test

Presented Duration (in seconds)	6	12	24	36	48
ADE, Auditory Without Distractions	1.85	6.21	12.40	11.15	34.82
ADE, Auditory With Distractions	2.70	4.92	15.16	27.37	39.11
ADE, Visual Without Distractions	5.25	1.35	0.82	9.88	9.61
ADE, Visual With Distractions	0.28	0.62	2.29	8.05	19.24

Stroop Color-word Test Results

B.'s pattern of Raw scores for word, color and color-word seem to follow the normal pattern, Word>Color>Color-word. His interference control score of 0.4 suggests that he has adequate within task interference control with visual material.

Table 7. Stroop Color-Word Test Results

	Raw Score	Age Corrected Score	T-Score
Word Color (W)	62	96	44
Color Score (C)	40	64	40
Color-Word Score (CW)	23	39	

Predicted Color-Word Score(CW')=38.6

CW-CW' = 0.4

Discussion

The results of this assessment have provided evidence for deficiencies in non-verbal working memory, inaccuracy in the perception of time, and deficiency in some components of behavioral inhibition in a patient with ADHD-Combined Type. The support for deficiency in behavioral inhibition was limited to deficiencies in stopping a prepotent response, in cost-benefit analysis, and in incorporation of feedback into consecutive responses. The interference control component of behavioral inhibition was adequate in the subject studied here; therefore, the deficiency in interference control was not supported by the current results. As a result, the current study supports this investigator's hypothesis. Based on Barkley's Hybrid

Model of Executive Function, there is a concurrent deficit in behavior inhibition, non-verbal working memory, and perception of time in the subject diagnosed with ADHD –C. The only exception is the interference control component of the behavioral inhibition.

Using the CPT-II, WCST and the Stroop Color-Word Test, the first variable studied here was behavioral inhibition. Numerous studies (Barkley, DuPaul, & McMurray, 1990; Grant, Iilai, Nussbaum, & Bigler, 1990; Grodzinsky & Diamond, 1992; Krener et al., 1993; See Losier, McGrath & Klein, 1996 for review; Raggio, Rhodes, & Whitten, 1999; Reader et al., 1994), with some exceptions (Corkum & Segal, 1993; McGee, Clark & Symons, 2000; Schachar et al., 1988; Werry, Elkind & Reeves, 1987), support the CPT-II as an effective measure of behavior inhibition that differentiates those with ADHD from normal controls. While the CPT-II results suggest impulsivity in response rate, it did not suggest problems with sustained attention. The impulsivity in response provides evidence for the inability to interrupt the prepotent response, which is the first component of behavioral inhibition. The lack of support for sustained attention may be due to one, or a combination of the following reasons. The CPT-II is a fast-paced, speeded visual task (Shapiro & Herod, 1994); therefore, it is quite possible that the subject may have found this task exciting and rewarding. As mentioned before, children with ADHD do not show a deficit in sustained attention when they find a task rewarding. The second explanation may be that comorbid anxiety disorders in the present subject provided a protective factor and improved the level of behavior inhibition as seen in others with ADHD (Pliszka & Borcherding, 1995; Oosterlaan & Sergeant, 1996, Quay, 1988a, 1988b). The results of the subject and parent interviews on the ADIS-IV showed that B. meets criteria for Separation Anxiety Disorder, Specific Phobia, and Social Phobia. Future studies may consider repeating this study, using anxiety as a variable to study. Separate samples of subjects with ADHD, hyperactive or combined type with and without anxiety disorders may be compared to study the level of deficiency in behavior inhibition.

The second variable studied here was non-verbal working memory. The results of the WCST and the Rey-Complex Figure and Recognition Trial support the conclusion that B. has a deficiency in his non-verbal working memory compared to the norms obtained for his age group. WCST involves the identification of ambiguous rules as well as the ability to identify the change in the rules by incorporating feedback received from previous responses. Mirsky (1996) labeled this function as flexibility. This synthesis of rules, and the ability to hold the feedback in mind in order to construct a new rule and to shift the behavior in a new direction reflects the reliance on non-verbal working memory and reconstitution (Bronowski, 1977; Marenco, Coppola, Daniel, Zigun, & Weinberger, 1993). The WCST requires hindsight (Bronowski, 1977; Fuster, 1989; Goldman-Rakic, 1995a, 1995b), forethought (Bronowski, 1977), and the anticipation of future events or the anticipatory set (Fuster, 1989), which are qualities of non-verbal working memory.

On the WCST, B. 's score of .13 on the learning to learn indicates the capacity to learn from his mistakes, but he was unable to better incorporate that information into his performance or to finish the total task with more correct responses. He was able to verbalize that he knew some of his responses were wrong, but he had difficulty incorporating this knowledge and coordinating his motor responses on time to produce the correct answers. This pattern is consistent with the existing literature (Houghton, 2000; Militch et al., 1994; McBurnett et al., 1993; Reader, Harris, Schuerhold, & Denckla, 1994; Seidman et al., 1997b) on ADHD subjects.

B's WCST scores, compared to the ADHD, to clinical samples identified by brain lesion location, and to the normal group, indicate that his total number of trials completed, the ability to maintain set and number of trials to complete the first categories better matched the ADHD, diffuse and frontal plus group rather than the normal group. Unlike the previous findings in ADHD subjects (Chelune, et al., 1986; Seidman, 1997b), B. did not have a low score in categories completed. This may be explained by his adequate sustained attention as previously explained.

Another support for B.'s difficulties with the non-verbal working memory comes from the results of the Rey Complex Figure Test. The low copying raw score, immediate recall, and delayed recall scores suggest reduced visual-perceptual and visuomotor integration skills and reduced visuospacial recall ability. The low total-recognition trial score suggests lower ability to retrieve visuospacial material when given retrieval cues. In order to recognize familiar patterns or to copy the previously presented figure from memory, there is a need for non-verbal working memory to help keep a representation of the pictures on-line in mind.

The second piece of evidence for poor behavioral inhibition in B. comes from the WCST results. Schachar et al., (1995) state that the deficiency in the engagement in alternative response after inhibiting an ongoing response is more typical of ADHD children with perseverative symptoms. B. showed more perseverative mistakes, which are commonly seen in those with ADHD due to cognitive rigidity and difficulty in shifting attention from one task to another.

The third test of behavioral inhibition was the study of interference control using the Stroop Color-Word Test. On this test, the subject must inhibit the ongoing prepotent response to read the word and instead name the color of the ink. Interference control is an important part of behavioral inhibition. This function protects attendance to the primary task by providing resistance to distractions. Task interference occurs when the disrupting event elicits a prepotent response or the extent to which the task requires executive function and self-regulation (Barkley, 1997b). The distractions that are part of a task are more likely to interfere with task performance (Leung & Connaly, 1996). Several studies (see Barkley, Grodzinsky & DuPaul, 1992 for review; Leung & Connally, 1996; Pennington et al., 1993; Seidman et al., 1995a; Seidman et al., 1996) have provided evidence that children with ADHD do not perform well on the Stroop Color-Word Test. However, on this administration, B.'s pattern of raw scores for word, color and color-word seems to follow the normal pattern Word>Color>Color-word (see table 7), and the interference score of .4 indicates that he has adequate within task interference control. Therefore, results of this test did not support that B. has a problem with within task interference control.

One explanation for these results may be that although The Stroop Color-Word Test was administered six hours after the last Ritalin administration, B. may have continued to benefit from the residual effect of this medication. A noticeable difference in B.'s behavioral display was evident between the first and the second session. The first testing session was held five hours after the last administration of B.'s Ritalin. During the first session, B. was pleasant, cooperative, maintained appropriate eye contact, spoke clearly, and showed minimal fidgeting behavior.

The second possible testing session was held on a Sunday, 24 hours after B.'s last Ritalin administration. During this session, B. was fidgety in his seat, played with his fingers, and often asked the administrator how much time was left on every given task. Future studies should consider administration of all measures 24 hours after the last dose of a stimulant medication. The second explanation is that, although the within task interference control was measured by using the Stroop test, this does not explain the subject's ability to resist outside task interference. Future studies should test for both the within task and the external sources of interference. The third factor that was mentioned previously to consider is that research (Epstein, Goldberg, Conners, & March, 1997; Gordon, Mettelmman, & Irwin, 1990; Pliszka, 1989, 1992) has indicated that the presnece of a comorbid anxiety disorder improves behavior inhibition (Pliszka & Borcherding, 1995; Quay, 1988a, 1988b; Oosterlaan & Sergeant, 1996) and, therefore, it improves interference control.

The third variable that was studied was perception of time. The current results support B.'s difficulty with accurate perception of time and its reproduction. Consistent with Barkley et al.'s results (1997), B. had an increase in the absolute magnitude of reproduction error as duration increased in most cases. Also consistent with Barkley et al.'s findings, there was a general tendency toward overproduction of time rather than underproduction. Presence of distracters during visual tasks effected and increased in error at 48 and 24 seconds duration. Distracters affected auditory tasks at 48, 36, 24, and 6 seconds. Absolute discrepancy error was much higher for the auditory tasks, regardless of the presence of distracters, compared to the visual tasks.

Although the Time Perception test was administered as suggested by the manual, the auditory tasks were administered after the visual tasks, and the effect of potential fatigue and boredom must be considered. Future studies may explore the order of administration of the auditory and visual tasks as a variable to study. Barkley et al.'s results indicated that the distracter did not increase absolute discrepancies at below 36" and with little affect at 48''. Current results are not consistent with his findings. Overall the presence of distracters seemed to effect the 48" interval the most. One potential explanation for this result that is consistent with Zakay and Block's results (1995), may be that the longer the duration, the more chance that boredom and daydreaming can affect accurate perception of time. The current results were similar to Zakay's (1992), which found that distracters affected the ADHD children at longer duration of time, while affecting the normal controls at shorter intervals, e.g., below 10 seconds. Another factor that may have contributed to the current results is that on the visual and auditory tasks without distractions, B. used counting as a way to track the shorter duration produced by the computer and when he was reproducing them. This compensatory mechanism helped him produce more accurately. B. did not use counting to keep track of time on the longer duration and on the tasks that involved distractions. Although he began to count to keep track of time during the distraction tasks, he stopped counting when the distractions began. This may be due to becoming distracted and not being able to keep track of the time by counting.

The results of the current study support concurrent deficits in behavior inhibition (with the exception of interference control), non-verbal working memory, and perception of time in a subject with ADHD-C type.

The current study had several shortcomings. First, The Stroop Color-Word Test used in this study measured within task interference; outside task interference was not studied. Second, behavioral inhibition could have been studied in a more effective way. Other studies have chosen stop signal paradigms (Oosterlaan & Sergeant, 1995, 1996, 1998) or go no go tasks (Iaboni, Douglas & Baker, 1995; Militch et al., 1994; Shue & Douglas, 1989; Trommer, Hopenner, Lorber, & Armstrong, 1988; Voeller & Heilman, 1988) as more "pure" measures of behavior inhibition (Logan, Cowas & Davis, 1984), These tests differentiate the ability to interrupt an ongoing pattern, e.g., pressing the space bar at non-targeted letters in the CPT, from the ability to reengage at the original task, which is characteristic of the Stop-Go Tasks. Third, the investigator did not take into consideration the enhancing effect of comorbid anxiety on behavior inhibition. Fourth, the Stroop Color-Word Test was administered only five hours after the last dose of the subject's stimulant medication. Considering the difference in the subject's behavioral presentation between the first and the second assessment session, he may very well have had the continuous benefit of the medication, even though the active impact of Ritalin is usually estimated to be within four hours of its administration.

Fifth, the most critical shortcoming of this study is its single case design and lack of a normal control. Future studies must consider empirical investigation using a larger sample size that compares different sub-types of ADHD with and without comorbid anxiety disorders. Further, such studies should consider the administration of all measures after 24 hours from the last stimulant medication administration. Both a purer measure of behavioral inhibition, e.g., stop signal paradigm, and measures of within task and outside task interference should be considered in order to examine behavioral inhibition more carefully. This chapter has focused on the research implications of the assessment; the clinical implications of the current findings will be discussed in the Treatment chapter.

CHAPTER 3

TREATMENT

This chapter describes a five-session treatment model for a clinical case study subject, B. When providing a comprehensive treatment for ADHD, this treatment model, with all its components, can be implemented over a longer period of time than presented here. This was mainly an assessment study that also provided a treatment model rather than a comprehensive treatment program. A treatment rationale is provided using the review of literature for treatment practices of children with ADHD, and a detailed description of each treatment session with B. is also provided. The most commonly used treatment strategies for ADHD are pharmacotherapy, behavior therapy, and cognitive behavior treatment. A comprehensive treatment of ADHD involves the child, parents, and teacher. The following sections will review each of these treatment modalities in more detail. First, we discuss the pharmacotherapy of ADHD.

Medication

The predominant therapy for ADHD continues to be central nervous system (CNS) stimulant medication therapy. Some studies have found that the majority of children diagnosed with ADHD, as many as 1.5 million children or 2.8% of school-age population receive stimulants for behavioral management (Safer, Zito, & Fine, 1996; Wolraiach et al., 1990). The course of medication lasts anywhere from several months to the entire school–age years. Stimulant therapy has been known to be most effective for mid-childhood ages (Swanson, McBrunett, Christian, & Wigal, 1995); however, the usage and positive effects of this therapy have been increasing with adolescents (Klorman, Burmaghin, Fitzpatrick, & Borgstedt, 1990) and adults (Wender, Remherr, Wood, & Ward, 1985). This treatment has received the most detailed research attention and is supported by significant empirical data (see Brown & Borden, 1988; Greenhill & Osman, 1999; Klein & Wender, 1995; Rapport, 1987 for discussions; Rapport, Stoner, DuPaul, Brimingham, & Tucker, 1985; Rapport et al., 1988; Whalen, Henker, & Dotemato, 1980). Stimulant therapy is not without side effects, which vary from child to child (Rapport, DuPaul, & Kelly, 1989); some children may have no side effects, and some may have no response to medication at all (Taylor, 1986). Further, there have been public concerns about the overuse of stimulants in treating ADHD. During the 1980's there was a media campaign against stimulant therapy (Barkley, 1998); however, recent studies (e.g, Jensen et al., 1999) suggest that stimulant medication is not being over-used in treating ADHD across the United States.

The most common stimulants are methylphenidate (Ritalin), dextroamphetamine (Dexedrine), Adderall (a combination of amphetamine and dextroamphetamine), magnesium pemoline (Cylert), Concerta, and modafinil (provigil). Other medications used to treat ADHD are Clonodine, Guanfacine, Beta-Andrenergic blockers, anticonvulsant medications such as carbamazepine, and, at times, antipsychotic medications. The CNS stimulants are quickly absorbed by the gastrointestinal tract, cross the blood-brain barrier easily, and are eliminated from the body within one day (Diener, 1991). Therefore, these medications are prescribed orally. These medications are similar to such brain catecholamines as dopamine and norepinephrine, and they raise the level of activity and arousal of the central nervous system. The study of the specific mode of action of each of the stimulant medications has been difficult because, although the neurons are more localized in the brain stem, the catecholamine receptors are spread throughout the brain.

The shorter acting stimulants such as methylphenidate and Dextroamphetamine act quickly, and the impact of the medication on the recipient's behavior is noticeable anywhere from 20 to 60 minutes from its ingestion. These medications peak between 1 to 2 hours and their effect ends within 4 to 6 hours (Dulcan, 1990). They have a shorter half-life, between 2 to 4 hours, and are metabolized thoroughly within 12 to 24 hours (Diener, 1991). Their behavioral effects peak approximately 2 hours after ingestion (Solanto & Conners, 1982). They are broken down by the liver and excreted through the urine.

The longer acting stimulants such as Pemoline and Adderall have a longer half-life 7 to 8 hours in children and peak approximately 2 to 4 hours after ingestion (Sallee et al., 1985). Their behavioral effects last for about 7 hours (Pelham, Swanson, Furman, & Schwindt, 1995) similar to timed-release forms of dextroamphetamine and methylphenidate (Pelham et al., 1990). Although the maximum effect of both methylphenidate and dextroamphetamine is noted on the first day of use, pemoline requires two days of administration before it has its maximum effect (Pelham et al., 1990; Stephens, Pelham, & Skinner, 1984). A recent study (Manos, Short, & Findling, 1999) has shown that one dose of Adderall is equally as effective as two daily doses of Methyphenidate. Concerta, which was introduced to the market about 2000, is administered once per day and is convenient in terms of administration and doesn not have to involve the school nurse for a repeated daily dose.

Stimulant medications are often used in combination with other medications for the treatment of comorbid disorders in addition to ADHD. Antidepressant therapy is often combined with stimulant medications for the treatment of the comorbid mood disorders (Pataki, Carlson, Kelly, Rapport, & Biancaniello, 1993; Rapport, Carlson, Kelly, & Pataki, 1993). Similarly, a

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The general positive behavioral effects of the stimulant medications have been supported by research (Carlson, Pelham, Milich, & Dixon, 1992; DuPaul & Rapport, 1993; Pelham, 1993; Pelham et al., 1992; Pelham & Militch, 1991; Rapport, Denney, DuPaul, & Gardner, 1994; Spencer et al., 1996; Swanson et al., 1995). Despite the positive report of the effects of stimulant medications, about 30% of children do not respond to these medications, and may, in fact, develop worse behavioral symptoms (Elia & Rapport, 1991). Some children respond positively to stimulant therapy across areas of functioning; others may only respond in some areas. The effective dosage varies from child to child (Pelham & Militch, 1991; Pelham et al., 1992). Stimulant therapy is not without such unwanted side effects as stomachaches, headaches (Barkley, 1988a), appetite and sleep difficulties, growth suppression, involuntary tics, cardiovascular changes (Kelly, Rapport & DuPaul, 1988), behavior deterioration in late afternoons and early evenings (Johnson, Pelham, Hoza, & Sturges, 1988), and overfocusing or constriction of attention (Safer, 1992; Solanto, 1991). Increased risk for drug dependence as a result of long term stimulant use has been a public concern, but not supported by research (Weiss & Hechtman, 1993; Weiss & Hecktman, 1978). Although in a small percentage, the side effects persist over time, typically they are short-lived.

The physical effects of the stimulant medications include negative impact on height, weight, heart rate, and blood pressure. Although methylphenidate and dextroamphetamines are known to produce growth hormone release and alter prolactin, cortisol and betaendorphins (Reeve & Garfinkel, 1991; Arnold & Jensen, 1995; Dulcan, Bergman, Weller, & Weller 1995), their long-term impact on growth hormones and growth in general has not been found to be significant (Klein & Mannuzza, 1988). Weight loss of 1 to 2 pounds in the first year of treatment due to loss of appetite has been reported, but has not been statistically significant (Dulcan, 1990; Reeve & Garfinkel, 1991). The stimulant medications, methylphenidate in particular, are known to cause an increase in heart beat and blood pressure (Kelly, Rapport & DuPaul, 1988); however, this effect seems to be dose-dependent (Safer, 1992). Dexedrine and Pemoline seem to have a less adverse impact on heart rate in comparison to methylphenidate (Safer, 1992), but in high doses they have produced a few cases of social disengagement (Granger, Whalen, Hencker, & Cantwell, 1996).

The stimulant medication is often immediately effective with concentration and compliance issues (Gillberg et al., 1997), but its effect on academic achievement and interpersonal relationships is less substantiated (see Pelham & Bender, 1982 for a review). In the past, some studies have attempted to tease out the specific effect of stimulant therapy on domains of functioning; they have shown that stimulant therapy can improve performance on various tasks such as visual search tasks (Dykman, Ackerman & McCray, 1980) and nonsense spelling tasks (Pelham, Militch & Walker, 1986), as well as improve on academic functioning in the short term (Douglas, Barr, & O'Neil, 1986; Vyse & Rapport, 1989); however, its long-term impact on academic performance has been questioned (O'Leary, 1980; Richardson, Kupietz, Winsbery, Maitinsky, & Mendell, 1988). Studies (Aman & Werry, 1982; Ballinger, Varley, & Nolen, 1984) of the impact of methylphenidate on reading performance did not find that this medication had a significant effect on reading. Other studies (Barkley, DuPaul, & McMuray, 1991; Rapport et al., 1986; Vyse & Rapport, 1989) have shown that stimulant therapy can improve laboratory task improvement, while its effect on classroom academic performance has produced mixed results (Douglas, 1988; Douglas, Barr, & O'Neil, 1986; Pelham & Militch, 1991; Pelham et al.

1992; Rapport et al., 1985). Instead of improving specific skills, stimulant therapy seems, in general, to improve competency in self-regulation (Douglas, Barr, O'Neil, 1986; Hencker & Whalen, 1989).

A review by Hinshaw (1991) noted that methylphenidate at moderate doses decreased aggression in children with high aggression level (Murphy, Pelham & Lang, 1992) and improved prosocial behavior in group setting rather than in dyads. More recent studies have provided evidence for the benefit of stimulants with respect to improving impairments and reciprocal interactions at home and at school (Hinshaw & McHale, 1991; MTA Cooperative Group, 1999a; Swanson, et al., 1995). This treatment is known to improve sensitivity to situational cues and feedback. This sensitivity in turn improves attention to the explicit rules of the ongoing behavior as well as the social norms (Whalen & Henker, 1991). Additionally, stimulant medication seems to improve self-evaluation and persistence at tasks following failure (Carlson, Pelham, Milich, & Hoza,1993; Milich, Carlson, Pelham, & Licht, 1991; Pelham et al., 1992; Pelham et al., 1997).

Despite these benefits, a number of problems are associated with the use of stimulants. First, the effect of medication does not seem to last after it is out of the child's system (Gillberg et al., 1997; Pelham, 2000; Charles & Schain, 1981). Second, sometimes it is difficult to convince a child to take the medication. Third, the child may perceive that he or she cannot manage self-regulation without the use of the medication (T. E. Brown, 1995). A consideration of other treatment modalities is necessary, and a discussion of behavioral interventions is therefore provided.

Behavioral Interventions

As previously discussed, Barkley (1997b) hypothesized a deficiency in non-verbal working memory in those with ADHD combined and hyperactive types. Further, he (1997b;

1998; 2000) and others (T. E. Brown, 1995; Hinshaw, 1994) have hypothesized that ADHD children have a deficit in behavioral compliance, intrinsic motivation and rule-governed behavior. These children are more influenced by the immediate environmental consequences and individual instances of reward (Tripp & Alsop, 1999), rather than by internalized rules (Barkley, 1997b). Therefore, the pattern and timing of environmental contingencies are crucial in the treatment of those with ADHD. The importance of immediacy and frequency of feedback regarding the acceptability of a behavior in treating those with ADHD has been reinforced by others (Barkley, 1989; Hinshaw & Erhardt, 1990; Kinsbourne, 1984; Piazza et al., 1999; Rapport et al., 1987; Werry & Wollersheim, 1989). As a result, it is logical that treatment interventions for ADHD would include a system that involves point-of-performance treatment (Barkley, 1997b; 1998; 2000). The goal of this treatment is to manage situational factors that have an important role in the severity of the child's behavioral difficulties (DuPaul, Stoner and Tilly, 1997) through consistent external reinforcers. ADHD involves both behavioral excesses and behavioral deficiencies, and the treatment targets decreasing certain behaviors while increasing others (Hinshaw & Erhardt, 1990). The behavioral approaches have used both operant and instrumental conditioning approaches to manipulate the environmental factors of events preceding the targeted behavior and/or consequences following the desired behavior.

Interventions based on learning principles have had a long history of success in managing behavioral problems in children (Carlson & Tamm, 2000; see Hinshaw & Erhardt, 1990; Kazdin, 1984; Rapport, Murphy, & Bailey, 1982; Tripp & Alsop, 1999; Werry & Wollersheim, 1989 for reviews) including improving on-task behavior and academic achievement (Kazdin, 1977; Robinson, Newby, & Ganzall, 1981). In these situations, external/environmental reinforcers can play an important role in maintaining the ADHD child's attention and effort on task. Children with ADHD are known to respond to positive reinforcement more than to punishment (Barkley, 1989); therefore, positive reinforcement is recommended as the primary component of the behavior modification program for an ADHD child. However, exclusive reliance on the positive reinforcement may not produce the best results (Dawson, 1995), and often a mild punishment system such as response-cost is combined with positive reinforcement in managing the behavior of an ADHD child. Therefore a point system, response cost, time-out, and contracting are often combined to make a comprehensive behavior management system for the ADHD child (Dawson, 1997). A complete description of such a behavioral change system will be discussed in the second session with B.'s teacher.

Behavioral methods in treatment of ADHD have their own limitations. First, the effects of the program weaken after the environmental contingencies are removed (Hinshaw & Erhardt, 1990). Second, the improvement in the behavior does not often generalize to other situations (Barkley, 1989). Third, concerns have been raised that the reward system may become distracting to the child (Haenlein & Caul, 1987) or that it may reduce the child's intrinsic motivation (Carlson & Tamm, 2000). Fourth, behavioral interventions are time consuming, and require the cooperation of the teacher, the parents, and other individuals in the child's environment (Whalen & Henker, 1991). The last group of interventions, cognitive behavioral treatments, involves teaching the child specific skills that he or she can utilize across settings.

Cognitive-Behavioral Treatments

The third set of treatment strategies often used in treating children with ADHD is cognitive behavioral treatment (CBT). Although we have separated behavioral treatments from the cognitive behavioral treatments, most behavioral treatments do have cognitive components, e.g., relaxation training (Hinshaw, 2000). The main goals of CBT are to modify perceptions and skills of parents, teachers, and the children about ADHD from less to more accurate and adaptive ones. Considering the deficits in self-regulation in those with ADHD, CBT techniques target self-awareness and connecting with others (Pfiffner & McBurnett, 1997), and have a broad impact on enhancing motivation, improving decision making, and competency in self-regulation. These interventions include attribution retraining, self-instructional training, self-monitoring, problem-solving training, social skills training, and stress-inoculation procedures. During CBT treatment, children are directly involved in the treatment process, and they are encouraged to apply the learned skills from the treatment across problems and settings.

Self-Instruction

ADHD children are on one hand, less responsive to parental instructions (Barkley, Karlsson & Pollard, 1985), and on the other hand, have a delay in acquiring self-directed speech and behavior (Berk & Potts, 1991); therefore, there is a need for self-instruction skills to compensate for these deficits. Self-instruction methods are often used to help develop self-guiding speech to compensate for the deficit in internalization of speech that exists in those with ADHD. Self-instruction procedure involves (a) the instructor to state verbal direction for a task to be performed; (b) the child performs the task while the instructor is guiding his or her behavior; (c) the child instructs self out loud while performing the task; (d) the child whispers the instructions while performing the task; (e) the child uses private speech while performing the task (Meichenbaum & Goodman, 1971). Self-instruction is commonly used to guide problem-solving. More recent compensatory devices, such as nag tapes or screened alarm devices, have been introduced to the market to help assist children with daily self-instruction and regulation.

Self-monitoring

Several researchers (Douglas, 1980a; Barkley, 1990) have postulated that those with ADHD are not as aware of their own behavior because they do not attend to their own behavior and do not consider the consequences of their actions ahead of time. Self-monitoring involves training the child to become more aware of himself or herself, and to learn to attend to his or her own behavior. Monitoring logs, such as the "how do I affect others" worksheet (Brasswell & Bloomquist, 1991), are designed to increase the child's awareness about his or her own behavior and the impact of that behavior on others. Other options for self-monitoring are audio tones that have been used to cue children to attend to their own behaviors (e.g., Hallahan, Lloyd, Kosiewicz, Kaufman, & Graves, 1979). Random intervals of 15 to 90 seconds are used to produce a tone, then the child is to write down his or her own behavior on a log. With time, the tones and the logs are phased out, and covert self-monitoring is employed. Self-monitoring and self-awareness techniques have been used to improve academic performance classroom behavior (Hallahan et al., 1979).

Anger Management

The anger in children with ADHD may result from their tendency to misinterpret interpersonal interactions (Militch & Dodge, 1984) and poor problem-solving ability. Anger is a form of aggressive behavior that is often comorbid with ADHD (Biederman et al., 1998); therefore, anger management is a beneficial addition to ADHD treatment. Through this process, the children learn to attend to their own physiological cues and to employ effective anger management techniques prior to the anger response. First, children are encouraged to recognize body signals, such as faster breathing and sweating. Second, they are encouraged to examine the thinking signals that precede the anger response. This process helps the children not to respond impulsively to their signals of anger, but to learn to examine their interpretation of others' actions toward them. Relaxation training, role playing, and helping children generate evidence that supports their anger response can help them examine their initial anger reaction to a person or an event (Hinshaw, Hencker, & Whalen, 1984a; Robin, 1981; Lochman & Curry, 1986). Relaxation training is an important component of anger management, which helps the children cope with their increased arousal level resulting from their anger signals. Anger management techniques will be discussed and demonstrated in more detail when explaining the five-session treatment for B.

Problem-solving Skills

ADHD children tend to have poor problem-solving skills (Hinshaw, Heller, & McHale, 1992; Tant & Douglas, 1982; Weiss & Hechtman, 1993) which require organization, planning and a purposeful decision. These children are impulsive, and they do not perform cost-benefit analysis prior to making decisions; instead, they make decisions quickly and often with error (Douglas, 1983; Barkley, 1997b, 1998, 2000). Self-instruction and problem-solving techniques target deficits in sustained attention, impulse control, decision making, and promote means-end thinking (Braswell & Bloomquist, 1991; Eslinger, 1996; Sheridan, Candace, Morgan, McCormick, & Walker, 1997). Through this process children are taught to think before they act.

In the current study, the investigator used the five-step problem-solving by Braswell & Bloomquist (1991) and Kendall & Braswell (1993). The five steps are recognition of the problem, generation of alternative solutions, choosing the best alternative while anticipating obstacles, execution of the solution, and evaluating the outcome. First and most importantly, the child is encouraged to recognize when a problem exists. The second step is helping the child generate as many alternative solutions to a problem as possible. Children may often respond with anger and frustration to a problem, because they do not have the skills to generate solutions. The third step is to choose the best option by anticipating the potential obstacles. The fourth step involves the implementation of the best available solution. It is important to teach children that even the best plans often need modification; therefore, the fifth step is to teach the child to evaluate the chosen plan, decide how the plan worked, and how it can be improved for the future. This is an important step to problem-solving, which is the same as the cost-benefit analysis that is deficient in those with ADHD. During this step, the child is encouraged to evaluate the chosen response against a set of available alternatives. The goal of this step is to create an opportunity for choosing the more adaptive response in future occasions. Didactic instruction, modeling, role-playing, and coaching can be used to increase the number of best solutions and more adaptive behaviors in their repertoire. After children are trained in problem-solving skills and utilize these strategies repeatedly, there are more chances of these skills becoming internalized by the ADHD child and used across situations (Braswell & Bloomquist, 1991).

Social Skills Training

Behavioral social skills training is another CBT technique that is designed to help children with ADHD connect with others in a more effective way. Using the modual by Richardson (1996), communication skills both verbally and non-verbally are important components of social skills training. Through this process, the child is taught the difference between assertive versus aggressive and non-assertive communication, First, a description of each communication style is provided, then the child is asked to respond to a hypothetical situation in each of these styles in front of a large mirror. The mirror helps the child learn more about the non-verbal and verbal components of communication. These skills are reinforced through role playing, application practice, and incorporation of feedback (Richardson, 1996).

Empirical Support for CBT

CBT has been found to be more effective when the intervention involves multicomponents and the training includes the teacher, child, and parent (Bloomquist, August, & Ostrander (1991). Bloomquist, August, & Garfinkel (1991) examined the impact of CBT in treatment of ADHD. They found that CBT including parent training was more effective than child training alone. Also, a combination of CBT including parent training and stimulant therapy was more effective than each individual treatment at follow-up. Specificity of effect in the parent and child training was associated with improvement in behavior, while the stimulant therapy was most effective with focus and attention.

Early research (see Pelham & Murphy, 1986; for a review) showed that a combination of treatments produced better results than any single treatment with some exceptions (Hechtman & Abinkoff, 1995). Some studies (Carlson et al., 1992) have shown that by adding a behavioral intervention program, the children can be effectively maintained at lower doses of stimulant medications. Other studies have confirmed that cognitive-behavioral strategies such as social skills training have produced considerable benefit for children with ADHD (Pfiffner & McBurnett, 1997). CBT has been shown to be more effective with academic achievement and peer relationships, while stimulant therapy has not been proven as effective (Kendall , Reber, McLeer, Epps, & Ronan, 1990; Miranda & Presentacion, 2000).

Despite the above evidence, the value of CBT techniques has been questioned over time (Abikoff, 1987; Abikoff et al., 1988; Barkley, 1998; Brown, Wynne, & Medenis, 1985; Fiore, Becker, & Nero, 1993). A growing body of literature has emphasized the superiority of stimulant medication treatment over behavioral and cognitive treatments (e.g., Pelham, 1993; MTA, 1999a). Pelham (1993) compared the effect of contingency management program with stimulant medication, and concluded that the benefit of stimulant medication was greater than the contingency management. However, as Pelham et al., (1988), and Pelham (1999) have pointed out, the benefit of stimulant medication exists as long as the medication is in the child's system, while the benefits of the behavioral treatment continues when learned and practiced over time.

More recent long-term studies (14–months), such as the Multimodal Treatment Study of Children with ADHD (MTA, 1999a), have shown that behavioral treatment has impressive results. In this study, seventy-five percent of the children in behavior therapy were maintained without medication, and after 14 months, 64% did not meet diagnostic criteria for ADHD. This study also showed that medication alone produces better results with regard to ADHD symptoms associated with distruptive behavior. The parent and teacher ratings indicated the superiority of medication over the behavioral approaches; however, this effect was not found on other measures such as academic achievement and peer sociometric ratings on observed classroom behavior. The MTA studies (1999a, 1999b) have shown that adding social skills training and family training produced better results than medication alone in improving self-regulation and adaptive functioning. Furthermore, for ADHD children with comorbid anxiety disorder, the cognitive behavioral treatments were equally as effective as medication. The combination of medication and behavioral treatment was more effective with children oppositional/aggressive symptoms, social skills deficits, parent-child problems, and anxiety disorders.

Other studies have shown the effectiveness of CBT treatment. Pelham et al. (2000) compared the effect of behavioral treatment, with and without medication, and concluded that there were few differences between the combination versus behavioral treatment group.

Hinshaw (2000) found that the combination of medication and behavioral management programs produced improvement in social skills and decreased negative parenting. The reduction in negative parenting, in turn, reduced disruptive behavior at home and at school. This study has provided insight as to how initial medication and behavior therapy reduced disruptive behavior in children and facilitated better parenting.

CBT has been criticized for its limited generalizability (e.g., Dush, Hirt, & Schroeder, 1989), however, the effect of behavioral treatment strategies cannot be assessed as effectively because obtaining a baseline prior to the implementation of the behavioral approaches in studies are difficult (Pelham et al., 2000). Every parent spontaneously uses some form of reward and punishment system in daily life. Similarly, every teacher may be using a variety of behavioral approaches, such as an incentive system in his or her classroom. Therefore, it is difficult to assess the degree of improvement as a result of a specific behavioral treatment program implemented in a particular study.

Furthermore, generalization can take place in two ways-transfer and ripple effects. Transfer effect results in improvement of non-target behaviors in settings other than treatment. Both behavior therapy and CBT have been criticized for the lack of transfer generalization effects. Considering that diagnosis of ADHD includes difficulties across situations, situational specificity of treatment gains is problematic for CBT treatment. However, the second type of generalization, the ripple effect, is the increased perceived self-efficacy, willingness to try new challenges, increase in frustration tolerance level, and attitudes toward school which result in increased likability of the child with ADHD (Hinshaw, 2000)

Also, the effect of treatments has been measured as an average across the sample size versus consideration of an individual or specific group of the subjects studied in this experiment

(Hinshaw, 2000). Kazdin & Weisz (1998) have identified factors that influence the child's response to treatment. The moderator factors or pre-existing variables, such as general cognitive immaturity, high family stress level, or a comorbid anxiety disorder, and the mediators or non-treatment variables that occur during the treatment, such as a death in the family or relocation of a friend, that also can impact treatment outcome (Barkley, 1997a; Brasswell & Bloomquist, 1991; Dush, Hirt, & Scroeder, 1989). Therefore, it is important that research investigators consider such variables when studying treatment outcome for children with ADHD. As mentioned previously, the results of the MTA (1999 a; 1999b) demonstrated that children with ADHD and anxiety disorders responded equally as well to behavior therapy as those with anxiety and ADHD who received medication. On the other hand, subjects without significant anxiety disorders responded better to medication or the combination treatment versus behavior therapy alone.

Finally, most studies have considered the short-term effect of CBT. More research is needed to focus on the value of these techniques taught over longer periods of time. The CBT techniques that have been used in longer durations have produced more effective results (Deshler & Schumaker, 1988; Gaskin & Elliot, 1991; MTA 1999a; b). Another variable to consider is that parents strongly favor behavioral approaches and combination treatments to medication alone (MTA, 1999a), even though these treatments are time-consuming and require the involvement of the child's parents and teachers.

The complexitiy of ADHD and the limitations of individual treatments necessitate a combination of treatment modalities to be used in treating ADHD (Dawson, 1995; Miranda & Presentacion; 2000; Whalen & Hencker, 1991). Stimulant medication therapy is the most common treatment in the clinical management of children with ADHD, but other treatment options must be considered as well. Therefore, behavioral treatment, cognitive behavioral therapy, and pharmacotherapy are often used in combination when treating children with ADHD. Considering the limitations of medication, behavior therapy, and CBT, none of these approaches alone seems sufficient to treat children with ADHD. A combination of these interventions, specifically targeted at the problems identified through assessement, can be most efficacious (Brasswell & Bloomquist, 1991; Pelham et al., 2000; Satterfield, Satterfield, & Shell, 1987). The following section describes the treatment sessions for the current clinical case study.

The Five-Session Treatment Program for B.

Consistent with Barkley's theory of executive function (1997b), the subject in this study, B., showed a deficit in behavioral inhibition, non-verbal working memory, and accurate awareness of time. Although verbal working memory, reconstitution, and motivation were not variables that were directly studied, the results of subtests such as block design, vocabulary, and general response to tasks in the absence of external rewards showed deficits in these executive functions as well. Therefore the treatment plan chosen here provides for these specific compensatory skills:

Problem no. 1: Deficit in non-verbal working memory.

Treatment: Point-of-performance treatment including incentive systems, increasing awareness of time, self-awareness and monitoring, and environmental modification. The incentive system is also designed to help with the deficit in motivation and arousal associated with ADHD.

Problem no. 2: Deficit in behavioral inhibition, cost-benefit analysis, and reconstitution.

Treatment: Problem-solving techniques, and task and test modifications.

Problem n. 3: Impulsiveness as exhibited in expression of anger.

Treatment: Anger managment training.

Problem no. 4: Deficits in verbal working memory, particularly the inability to generate speech on demand.

Treatment: Teaching communication skills and assertiveness training. Assertiveness and relaxation training may also help reduce B.'s anxiety.

The treatment for B. included one parent training session, one teacher training session, one child treatment session, and two parent-child treatment sessions. The general emphasis of this treatment program was to help the parents and the teacher create a more "prosthetic environment (Barkley, 1997b)." This environment is set up not only to punish or reward what the child does, but to control the variables in the child's environment to help him reach maximum success. This goal is accomplished by providing a suitable and a well-structured environment that promotes on-task behavior. The first treatment session was a parent training session. Please note that the following initials are used for the transcripts: T for therapist or the investigator; F for father; M for mother, and B. for the subject.

Parent Training

Rationale

Although parent training with the ADHD population is not particularly well-researched, the data available to date (Anastopoulos, Shelton, DuPaul, & Guevremont, 1993; Erhardt & Baker, 1990; MTA Group, 1999a, b; Pisterman et al., 1989; Pisterman et al., 1992) show a positive impact of this treatment modality on children with ADHD. Parent training when combined with other treatment modalities such as medication (Abikoff & Hechtman, 1996; Pollard, Ward, & Barkley, 1983), and self-control therapy (Horn, Ialongo, Pascoe, & Greenberg 1991; Ialongo, Horn, & Pacoe, 1993), produces better results in ADHD management than any individual treatment. The rationale for including parent training as a part of our treatment program is that raising children with ADHD can compromise family functioning. Such compromise in family functioning is evident when discussing various situations about B.'s family in later sections. The parents need support and the necessary skills to feel empowered in effective parenting. Parents often view themselves as less skilled (Mash & Johnson, 1990), and they blame themselves and their poor parenting skills as the cause of their child's misbehavior. Parent training can be used to address parental attitudes and perceptions that can impact their support, understanding, and treatment of their child (Cunningham, 1990; Newby, Fischer & Roman, 1997). Also ADHD is a pervasive condition that exists across situations; therefore, should be treated as such, including at home with parents.

Further, not every child with ADHD responds to pharmachotherapy, and medication does not resolve all problems associated with poor self-regulation. Although, B. has been successfully treated with Ritalin for several years, this medication has not helped him with getting ready on time for school or remembering to take his daily medications. These issues will be discussed later. Alternative treatments are needed to help B. function more adaptably on a day-to-day basis. Parents can be educated in contingency management techniques, and the use of positive reinforcement. This increase in parental knowledge of ADHD, can, in turn, help reduce parental stress by increasing their self-efficacy (Anastopoulos et al., 1993; Erhardt & Baker, 1990; Pisterman et al., 1989).

Parents may often disagree on how to discipline their children, which then causes an inconsistency in treatment of the child and will not produce the best results. Parents in this study were asked to participate jointly in the sessions in order to create more consistency for B. They were provided with two sets of psychoeducational packets of information. The first packet described contingency management techniques, including the point system, respons-cost, time-out, and contracting. The second packet included a description of cognitive behavioral techniques, such as family anger management, guidelines for environmental modifications, problem solving, discipline practices, and communication skills. The parents were asked to study this material to utilize the techniques at home and at future parent-child sessions.

Session Goals

1. Assess parental baseline knowledge of ADHD and self-regulation.
2. Provide psychoeducation about ADHD and self-regulation.
3. Introduce point-of-performance treatment and reward system.
4. Discuss environmental modifications to help with interference control and awareness of time.
5. Discuss making check lists to help with daily self-regulation and to be used as a part of the reward system.
6. Discuss problem-solving skills.
7. Discuss anger management.
8. Discuss communication skills.
9. Discuss discipline practices.

Met with Mr. and Mrs. B. on March 10, 2001, at 10:00 a.m. They were five minutes late for this session. Prior to addressing the treatment objectives for this session, B.'s parents were eager to explain why they were late for the session:

F: It was a typical day at our house today.

M: There was an altercation between BI (B.'s brother), and B.; and BI and I. They were fooling around, punching each other. I asked them to let go. BI has not learned that yet. B. picked him up. BI said: "oh my god, my ankle." B. let him go. I get mad. I said you should not have done *that. Get out of my way. BI. said "shut up." His father told him I told you not to talk like that. BI starts to cry.*

T: It can be more helpful to take privileges away rather than acting angry with him.

F: Disrespect to his mother, I will not tolerate.

T: I know this is important.

F: I let all the stuff, some of that stuff with his brothers I let go, but disrespect to his mother, nah. (This would have been a good opportunity for the therapist to establish an alliance with B.'s parents; however, the session was about one hour, and there would not have been enough time to present the necessary educational material.) The statements made by B.'s parents at the beginning of the session indicated the ongoing stress level that exists in the family. The parents were assured that anger management and family conflict resolution would be addressed through the course of the treatment.

1. Assess parental baseline knowledge of ADHD and self-regulation

The first goal for the parent session was to assess their baseline knowledge of ADHD, particularly the areas related to the role of behavioral inhibition, non-verbal working memory, and time awareness in day-to-day self-regulation. The parents seemed concerned about how well they would perform on the pre-test. The investigator pointed out that they were not expected to know all the information and that the result of this test would be used to guide the material to be covered in the future sessions.

T: Please don't feel like you need to know all of this. Frankly I don't expect you to know a lot of this. The teacher is going to get the same test, and you may even know more about this than the teacher does. Just relax and do the best that you can. (Despite the therapist's reassurance, B.'s mother appeared concerned about providing just the right answer, and on more than one occasion, questioned the therapist, trying to narrow down her answers. It seemed important to her to appear knowledgeable about ADHD.)

Mother	pre-test=12/15	post-test=14/15
Father	pre-test=8/15	post-test=12/15

The knowledge deficit was primarily in the areas of behavior inhibition, non-verbal working memory, and their implication for behavioral management in a person with ADHD.

2. Psycho-education about ADHD

The second goal for the session was to provide some information about the causes of poor self-regulation in children with ADHD. Parents often become more tolerant and accepting of their ADHD child when they learn more about ADHD (Dawson, 1997). This tolerance, in turn can reduce the stress level within the family and promote a better relationship with the ADHD child.

T: ……There are different types of ADHD. There are those kids who are not hyperactive or fidgety, but they are more inattentive and day dreamy. Then you have the kind of kids who are real hyperactive. They talk more, climb more, hurt themselves more. Then you have the combined type, which have some fidgetiness, some hyperactivity, but they also are inattentive. This theory focuses on the hyperactive and combined type. He (Barkley) thinks the one thing that causes the problems with ADHD is what he calls behavioral inhibition. This is something that is delayed and is less efficient in these kids. What is behavioral inhibition? Behavioral inhibition is the ability to resist immediate gratification, be able to wait for a second, and do a fast cost-benefit analysis to be able to decide should you act on something as before or should you do something different. That is what is missing with these kids, and that is why they are more impulsive. They don't do the cost-benefit analysis. They don't stop for a second. He (Barkley*)* *hypothesizes that the frontal lobe, the structure in front of the brain, has some differences. It does not mean that there is brain damage. There are many ADHD children who have no brain damage at all, but there are some differences in the chemistry of it, some size differences with some of the structures. Why is behavior inhibition so important? One of its functions is to cut out interference. For example, as I'm talking to you right now, if a car goes by, I need to be able to block that out to be able to focus on you. Whereas with the ADHD kids, if they sit by a window in the classroom and a bird flies by they become distracted and forget what the teacher was saying. Or grown ups who work, and the phone rings, they are working at the computer, they handle the phone call, and they forget what they were working on. This becomes a real challenge then to stay on task and to finish things. In addition to the interference control, the cost-benefit analysis is important. What they call a non-verbal working memory needs to work well for this cost-benefit analysis to happen. You need a brief period of delay so the information can get into your brain and register. With ADHD, once the information gets in, there is often no problem, but the question is, does the information get in? You also need this memory so you can learn from experience. Let's say next time the kids get into a fight, they need to remember what happened last time they got into a fight; we ran into a problem, let's not do it this time. ADHD kids sometimes have been referred to as having no memories. Parents often say, he never learns from his mistakes. Another thing is that they say you need your short-term memory to get a good sense of time, and you need sense of time to register events in the* order in *which they happened. It is not just important what happened, but when it happened, after what event, and how long it took. We store things in our memory based on a time line. Also, often kids with ADHD don't judge duration of time accurately. They either overestimate or underestimate the duration, and that is why sometimes the impatience comes in. They may perceive a few minutes as much* *longer; you may say B. go upstairs and get dressed; you only have two minutes. Minutes later he shows up, and he may still not have his clothes on. To manage daily activities, you must have behavioral inhibition, the ability to register things and to keep things in your memory...*

(In the interest of time, the therapist presented a great deal of information to B's parents. The concern here is that they may not have been able to process the entire content of this presentation. It would have been appropriate to encourage questions from the parents and to test their knowledge by presenting a few questions to them throughout the session.)

3. Point-of-performance reward system

The third issue addressed in the session was the importance of looking for positive behaviors and occasions to reinforce B.'s behavior (Barkley, 1998), and to provide point-of-performance or immediate reward and feedback to address B.'s behavior.

T:...Now, because ADHD kids don't learn too well from experience in general, and because they are not so good with time, it is important to deliver the reinforcement and punishment right away. You don't wait an hour later or say, for example, wait till your dad comes home. Often I question children about why they are grounded, and they just don't remember. They don't remember what their action was that deserved the punishment. That is why we use behavioral charts, and we say when they do something give them a check and say good job, or when they do something wrong, charge their account and take one of the checks away...

However, praise alone does not work; therefore, there is a need for a point system as well as response-cost, which is a mild form of punishment. A description of the point-system, response-cost and time-out procedures was provided. In the interest of time, detailed information in the form of handouts was provided to them at the beginning of this session. The goal was to create more predictability for the parents with regard to B.'s behavior and to provide consistency and predictibility for B. himself through contingency management, environmental modifications, creating clear rules, and consistent routines.

4. Environmental modifications

Evidence supports that parents can help modify the child's environment to create an environment that helps him reach maximum success (Barkley & Cunningham, 1981). The third item on our agenda was to introduce environmental modifications that can help B. with his poor interference control, weak resistence to temptations, and the deficits in his working memory. Environmental modifications were addressed this session through increasing time awareness and making checklists for things to do to get ready in the morning.

The time awareness was addressed by asking B.'s parents to do the following:

a. Encourage B. to use an analog watch and refer to it before, during, and after homework and activities.

T: Does he (B.) wear a face watch or a digital?

M: Digital

T: I don't think the digital helps him as much. If you have an old-fashioned watch, he can visually see the duration; whereas, to him 46 to 57 minutes does not mean as much….

b. Make reference to time limits involved in each task presented to B.

During tasks intermittently remind B. how much time is left.

c. Use timers as reminders for B.

T:…You told me that you already are using timers since we first talked.

M: Yes, I have two timers.

T: Yes

M: The kitchen timer usually means that he should start to get ready to meet the bus. That is just a ring. The timer on the stove, has a long buzzer, and means you have to watch for the bus now.

T: That is wonderful. You have to realize that you may have to do this for a long time until it potentially becomes an over learned habit.

d. Have a message center in a central location of your house for B. Write important reminders on bright colored paper. Every few days change the color of the paper or the color of the chalk that you use to make messages more noticeable.

e. Play guessing time games, e.g., how long will it take to do two math problems. Write down B.'s guess and then time the actual event and compare.

f. Use daily checklists that include identified time periods allowed for each task.

g. Make "Nag Tapes" to periodically remind B. to stay on task, e.g., getting dressed in the morning.

(Several concepts were introduced to the parents during this session. This would have been a good time to provide specific examples and to practice some of the skills, e.g., playing time guessing games with the parents, or making a nag tape in session. However, this session was only one hour long, and there was not enough time to process these issues in detail. The parents were provided with handouts describing each concept and technique, and they were asked to review this material before the next session.)

5. Making a checklist

B.'s parents expressed frustration with his poor self-regulation that is more evident when he forgets to take his medication, a frequent occurrence. B.'s teacher had noticed a difference in his classroom behavior at these times.

M: He also has trouble taking his meds. As a matter of fact, we just got a note last week saying that he has trouble getting his work done. After we knew and he got his medicine toward the end of the week, the teacher said that things have improved greatly. Big difference between the first two and the last two days of the week.

T: Maybe you could make a checklist of what he has to do in the morning and put it somewhere where he has to pass by it often.

We broke down the morning routine into specific steps/behaviors to be used with B. during the future parent-child session:

T: Does he brush his teeth ok?

F: Put that on there.

M: No, he does all that OK? He usually does all that then he comes into the kitchen. This is when he is to take his medicine, but…

F: Put his medicine on there.

T: We will do that, don't worry.

M: He is supposed to get his book bag together.

T: Can I make a suggestion? How about getting his book bag ready the night before?

M: Normally it is ready, but I just say, do you know where your book bag is?

T: OK.

M: Then I say your hat and coat. That normally is something that he might just may figure out that he might just think, I'll just grab a hat. He should be on the bus by 20 to 8. So in that time period I have to make sure that everything is done.

T: Let's make these things in an order. We have brush teeth, eat, take medicine, book bag, coat, hat, and shoes. Let's separate hat and coat from shoes. If I put three things in one category, he may forget one.....

6. Problem-solving

As discussed above, children with ADHD do not tend to problem-solve well. They are often deficient in reconstitution or the ability to analyze or synthesize the situation at hand. Further, they typically do not stop to perform cost-benefit analyses and, therefore, tend to be more impulsive. Problem-solving skills for the child can improve self-regulation, and family problem solving can help reduce family stress level. Poor family problem-solving skills (Robin & Foster, 1989), low rate of positive reinforcement for appropriate behavior (Ramsey & Walker, 1988, as cited in Barkley, 1998), overly directive and negative parenting style (Cunningham & Barkley, 1979), and ineffective discipline practices (Ramsey et al., 1989, as cited in Barkley, 1998) are among the variables that can lead to family dysfunction. These issues can be the target of change for parent training. Through parent training, the parents can learn to implement consequences to the child's specific inappropriate behavior. Step by step family problem solving, communication skills, and anger management can be helpful tools for the family (Alexander & Parsons, 1982). The deficiency in problem-solving skills can fuel frustration and displays of anger. This can sometimes be true of the parents as well. Mr. B. reacted with anger with his sons, problem-solving and anger management skills can be helpful in lowering this family's stress level.

Problem-solving skills (Robin, 1981; Brasswell & Bloomquist, 1991):

T: Kids in general, but especially when there is ADHD, one of the reasons why they resort to physical reactions is because they don't know how to problem solve. It seems simple to us that *they can solve the problem in a different way, but a lot of them don't think about that option at the time. Don't ever hesitate to go through the problem solving steps. Say to them think about it. What was the problem? One of them may say B. did such and such, then acknowledge that it was a problem. Then ask him what were his options. You see all he sees first is to, e.g., punch him. Even though we may think, of course, he should do something different, e.g., come and get us. They don't think about that.*

F: We always say, come to us and we take care of it.

T: But you may want to say to him, you are older now, and you may not always want to run to mom and dad. What else could you have done? Give B. some feedback about what he just did.

M: B. just doesn't know when to stop. I tell him just stop and walk away.

The goal was to show the parents how to explore what the child had done wrong, what the expected behaviors are, and how the child could have behaved differently. The parents could use role-playing and teach him how he could have handled it differently.

T: That's good, but it should not end there. But to process it more and to learn what was it he did that it did not work and what better alternatives there are.

(Although we introduced problem solving techniques, these techniques could have been best taught with working through practice examples. Further, it would have been helpful to ask the parents for returned demonstration of problem-solving techniques).

7. Anger management Skills (Braswell & Bloomquist, 1991)

The concept of family anger management was introduced this session and practiced during the parent-child sessions. The family anger management skills included the following steps:

1. Recognizing anger/conflict - Each family member should learn to identify times that any one of them feels angry and to recognize verbal and non-verbal anger signals.

2. Coping with anger/conflict - Each family member will agree to take a brief time for cooling down and relaxation when anger is identified.

3. Constructive problem-solving and communication - The family then comes back together to use the problem-solving skills and effective communication to solve the problem.

T: .....Family anger management skills.

M: Oh.

T: Coping with anger and conflict. Recognizing physiological signs of anger, taking a break to cool off, and then come back together to discuss things. Don't discuss things right away.

M: Yes, even BI, I said just go to your room. After that, first I say apologize, and last time he did. I just don't want them to stay mad.

(If treatment duration had allowed, B.'s father could have benefited from the practice of anger management techniques. It is important to focus on individual needs of the family members, which may, in turn, enhance family functioning.)

8. Communication Skills

The following communication skills (Braswell & Bloomquist, 1991) were introduced this session and reinforced throughout the treatment:

- Don't be vague or critical when communicating to the child (Kendziora & O'Leary, 1992).
- Make clear and brief statements.
- Be direct and state exactly what you are asking the child to do.
- Use "I" statements, e.g., "I would like you to...."

- Make sure that your verbal and non-verbal messages to the child are the same and are congruent.

- When your child speaks to you, give him/her feedback and acknowledge that you have heard him/her.

- Let your child know how he affects you or someone else by what he says or does, e.g., "when you do …., I feel ….".

- Use active listening, e.g., nod your head, face the child, and provide eye contact.

- Learn to negotiate with your child (Robin & Foster, 1989).

- Be more interactive with your child with warmth and stimulation versus being uninvolved (Brooks, 1991; Rutter, 1980; Werner, 1993).

- Treat the child with respect.

9. Discipline Practices

Next the following discipline guidelines were provided and reinforced throughout the treatment:

- Be brief and consistent (Kendziora & O'Leary, 1992).

- Use natural and logical consequences as much as possible (Kendziora & O'Leary, 1992).

- Don't be overly harsh and controlling (Kendziora & O'Leary, 1992).

- Set reasonable expectations (Kendziora & O'Leary, 1992).

- Be consistent and capable of handling the child's difficult behavior (Kendziora & O'Leary, 1992). Don't respond too gently, inconsistently, or delayed to the child's misbehavior (Kendziora & O'Leary, 1992).

- Identify the positive behaviors and reinforce them (Barkley, 1987). Increase your child's confidence by finding his areas of strength and showing off his talents (Katz, 1994). This will help increase your child's sense of self-worth so that he can take more responsibility for his/her own behavior (Adelman & Taylor, 1983; Brendtro, Brokenleg, & Van Bockern, 1990; Curwin & Menddler, 1988; Deci & Chandler, 1986; Glasser, 1984).

- Improve quality and frequency of your attention to your child. Don't be positively attentive or ignore the undesirable behavior (Kendziora & O'Leary, 1992).

(Although the goal of introducing a treatment model was accomplished, the session was too concentrated on psychoeducation; therefore, there was not much chance for exchange. The post-test scores reflected increased knowledge of both parents, but it is not clear how this may transfer to their daily lives. Future sessions may provide some data in this area).

Teacher Session

Rationale

We included teacher training as a part of B.'s treatment because (a) ADHD exists across settings including school; therefore, it should be treated across settings; (b) consistency of treatment is important to the ADHD child. Therefore, teacher training in addition to parent training, can create more consistency for B.'s treatment because both the parents and the teacher will follow the same treatment guidelines; and (c) Increasing teachers's skills can empower her and make classroom management easier.

B.'s teacher was contacted by phone on Monday, March 12th, 2001. She was unable to commit to an appointment right away. She called the investigator within the same day and offered two different days and time. An appointment was set for Wednesday, March 14, 2001, at 2:15 p.m. when her students attended the computer lab. Ms. J. was pleasant and guided the investigator to her classroom. H. Elementary School is currently short of space, and two of the classrooms are held in two large mobile rooms that are connected to the main school building by newly built wooden railings. The desks in the classrooms were relatively close to one another. All the walls were covered with student paper work of different sizes and colors. The voices from the classroom next door could be heard but were not comprehensible.

Ms. J. declined to have the session taped. When the investigator explained that a pre-test can be helpful in determining what information to cover during the session, Ms. J.B. said “Oh no,” and was hesitant. She explained that this is her first year teaching and that she has never had an experience with a study like this. The investigator explained that not every teacher necessarily knows the answer to all the questions. This seemed to be encouraging to her, but she asked that her name not be placed on the test. She was reassured that the identifying information will be kept confidential. As the investigator proceeded with the psycho-education, Ms. J. although polite, participated passively by listening. She did not show a particular response to any of the material presented, nor did she ask any questions. However her post-test score had increased by 30%, indicating that she had attended to the material presented by the investigator. The total session time was about 50 minutes, but Ms. J. had to prepare for her students.

Session Goals

1. Assess teacher’s baseline knowledge of ADHD and self-regulation.
2. Reframe and clarify typical assumptions about the child’s poor self-regulation. Educate the teacher about the role of behavioral inhibition, non-verbal working memory, the development of sense of time in resisting immediate rewards, interference control, development and use of hindsight, forethought, and self-regulation.
3. Explain the treatment model that creates a “prosthetic environment” for B. This environment is not set up only to reward or punish what B. does, but its primary feature is to control the variables in his environment to help him reach maximum success.

a. The first goal is to provide a suitable and well-structured environment, which promotes on task behavior versus offering distractions and opportunities for the unwanted behaviors. Packet no. 1 provided information about how to increase time awareness, make environmental modifications, alter task characteristics (lesson presentation, tests and worksheets, organization), and other general helpful hints.

b. The second goal was to educate the teacher about how to design an individualized behavioral contingency program that involves token economy, response-cost, and time-out, behavioral contingency and daily report card. See packet no. 2.

4. Discuss relapse prevention.

a. Baseline Knowledge

Teacher pre-test=9/15 post-test=14/15

Similar to the results of the parents' pretest knowledge, B.'s teacher had a limited knowledge of behavior inhibition, and non-verbal working memory as well as their impact on the child's academic performance and behavioral management.

b. Clarification of assumptions and education about ADHD

First, we discussed typical assumptions about poor self-regulation associated with ADHD, for example: (a) ADHD children are lazy versus they may have a deficit in arousal and motivation; (b) ADHD children have selective listening, and act out willfully rather than they have a deficit in non-verbal working memory; (c) ADHD children are bad and they don't respond to punishment. Then, the therapist used the same script that had been used with the parents to educate the teacher about ADHD, self-regulation, deficit in non-verbal working memory and behavioral inhibition.

c. Environmental Modifications

Physical environmental modifications

As discussed in Chapter one, the deficiency in behavioral inhibition interferes with the ADHD individual's ability to resist distractions. Therefore, it would be logical to create an environment for the child with ADHD where distractions are minimal. The following material was discussed with the teacher:

1. Seating arrangements have an impact on off-task behavior (Rosenfield, Lambert, & Black, 1985). Abramowitz & O'Leary (1997) after a review of literature concluded that research suggests circle seating helps reduce off-task behavior for discussions and teacher-led activities. Seating in rows may increase productivity and reduce off-task behavior during independent work, e.g., individually working on a worksheet .
2. Seating the student near the teacher increases attention to tasks led by the teacher.
3. Arrange student's desk away from the hallway, windows, and other visual and auditory distractions (Laub & Braswell, 1991).
4. Keep a section of the room clear from distractions to help the child focus on the task (Laub & Braswell, 1991).
5. Stand near the student as much as possible, particularly when giving important instructions (Laub & Braswell, 1991).
6. Make a quiet space available for the student for independent study or reading to improve productivity (Laub & Braswell, 1991).

Lesson Presentation

While the above strategies target the reduction of environmental distractions, the following techniques can be used to reduce intra-task distractions.

1. Present the student with an outline of the lesson to be presented. Identify and highlight the important key words (Laub & Braswell, 1991).

2. Make instruction brief and to the point (Zentall & Gohs, 1984). Avoid needless repetition. The repetition of past material or material that addresses similar skills should be minimized and avoided in order to reduce boredom and tuning out from the task.

3. Lengthier tasks should initially be broken down into smaller steps, with fewer steps presented at one time. This will reduce overburdening the child's attention ability.

4. Present stories or instructions in a faster speed to improve listening comprehension and reduce non-task-related activity (Shroyer & Zentall, 1986).

5. Make tasks more structured versus open-ended (Zentall & Leib, 1985).

6. Zentall and her colleagues have used Optimal Stimulation Theory to identify task characteristics that impact on-task behavior in children with ADHD. Based on this theory ADHD children benefit from stimulation and novelty on easy and repetitive tasks. You can increase stimulation by using different colors and shapes (Zentall, 1989; Zentall & Dwyer, 1989). The increase stimulation concept applies to moderate and routine tasks; it does not apply to new and more difficult tasks (Zentall, 1985; Zentall, Falkenberg, & Smith, 1985; Zentall & Shaw, 1980; Zentall & Meyer, 1987).

7. Keep in mind that children with ADHD have a difficult time applying themselves to difficult, detailed-oriented, and uninteresting tasks (Dawson, 1997).

8. Interactive and group teaching styles are more engaging. Use role-playing to help the students act out the important parts of the lesson as much as possible (Laub & Braswell, 1991). You can also use more game-like lessons.

9. Use the student's name in your presentation, when possible, to catch his or her attention (Laub & Braswell, 1991).

10. Call on the student more often to help break potential day dreaming episodes.

11. Vary the intensity and activity levels of assignments/tasks during the day.

12. Use multi-sensory teaching devices; however, keep the distracting elements, such as pictures or specific sounds, limited to what is relevant to the task versus being irrelevant and extraneous (Laub & Braswell, 1991). Use computers as an added modality when possible.

13. Mix verbal and written instructions (Dawson, 1997).

14. As much as possible make tasks more hands-on versus using tasks that require passive participation (Zentall & Meyers, 1987).

16. You want to keep the transitional time between tasks short (Zentall, 1975); however, allow the child to respond to the task; e.g., write it down before moving to the next subject.

17. Make it clear that one task has ended and another one is about to begin;, e.g., use learning stations and clear signals to help the student transition easier from one task to another (Laub & Braswell, 1991).

18. Seat the student near another student with complementary strengths who can model appropriate on-task behavior (Dawson, 1997; Laub & Braswell, 1991).

19. Reward the child for solving the problem and not the speed at which he/she solves it. Also, the evaluation of the task performance should rely more on the completion and accuracy versus specific task-related behavior, such as remaining seated. This will allow the teacher to focus more on the behavior chain necessary for completion and accuracy of the task versus focusing on the disruptive behavior.

Tests and Tasks

1. Allow extra time for tests.

2. Keep directions simple. Underline the key words and read the directions for the student (Laub & Braswell, 1991).

3. Teach the student to attend to the problems one at a time when taking a test. He can be taught to cover the rest of the page with a clean white piece of paper, while working on a single segment or problem (Laub & Braswell, 1991).

4. Give more frequent short quizzes versus a long test (Laub & Braswell, 1991).

5. Provide practice tests (Laub & Braswell, 1991).

6. Test the student orally sometimes to find out whether he performs better (Laub & Braswell, 1991).

7. Allow the student to take the test in a less noisy and non-distracting environment.

Organization

1. Have clear-cut rules. Write down the rules on a chart in the classroom and review them every morning (Mayfield, Apperson, Austin & Oberg, 1997).

2. Use a mentor from support staff/services where the child can check in with someone twice a day at the beginning and at the end of each day (Dawson, 1997; Barkley, 1998).

3. The student can be involved in finding ways to organize self, e.g., different color folders, and highlighters. Use color highlighters to bring more salient information to the child's attention and to increase accuracy (Zentall, 1985; Zetall & Zantall, 1986).

4. Repeat and highlight directions.

5. Decrease the workload appropriately for the child when possible.

6. Help the student plan for completion of long-term assignments.

7. Teach the student adaptive skills, such as note-taking and test-taking.

8. Teach the child to make checklists. Use daily routine checklists including identified time periods and check off completed tasks.

Increasing time awareness

1. Sit student across from a clock placed on the classroom wall.
2. Encourage the student to use an analog watch and refer to it before, during, and after tasks.
3. Make reference to time limits involved in each task presented to the student.
4. During tests remind the student intermittently how much time is left.
5. Use timers as reminders for the student; e.g., when the timer goes off, it is time to go to math class.

5. Incentive or Behavior Change System:

Behavior change system should include a point system, contracting, response cost, and time-out from privileges.

Point-system

The point-system is where the child earns a point or a check mark every time he or she exhibits a desirable behavior previously identified as the targeted behavior by the teacher and the child. The advantage of this program is that it provides an immediate, specific, and potent reward that an ADHD child often needs. Providing feedback without having to deliver the reinforcement immediately is a major advantage of this program. Check marks can be used for older children. Also the student will have a choice as to for what he or she may want to trade in the tokens. Response cost (defined in the next section) can be used in conjunction with the token economy system. Using this system, the teacher withdraws an earned token for undesirable behavior. Such behavioral management system has been known to increase attention to tasks and completion of schoolwork (Fiore, Becker, & Nero, 1993), academic productivity, and appropriate behavior in children (e.g., Allyon, Layman, & Kandel, 1975; Robinson, Newby, & Ganzall, 1981).

When using an incentive system keep in mind to first ask the student to become involved to collaboratively design the incentive program. The teacher and the student can jointly decide the number of points necessary to attain a specific privilege. Directly negotiate with the student about the reinforcers/privileges. It is important to design the program with the student rather than for the student The students often have good ideas and this will help encourage them to be responsible for their own behavior (Sheehan, 1997).

First, specific behaviors, e.g., number of problems to be solved on a particular academic subject or specific actions such as interaction with peers that are incompatible with inattentive and disruptive behavior, can be targeted for change (Robinson, Newby, & Ganzall, 1981). The targeted behavior must be specifically spelled out, e.g., specific number of problems, specific time period, certain percentage of accuracy. Second, to identify the value of each secondary reinforcer, divide the total number of chips or marks available by the number of privileges available. The administration of the reinforcements (check marks) must be immediate and every time (as much as possible) after the child displays the targeted behavior. The tokens should be exchanges for the primary reinforcers at least daily; otherwise, they will be less effective. Keep in mind that continuous reinforcement is more effective than partial reinforcement (Fiore, Becker, & Nero, 1993).

ADHD children like novelty, and they satiate quickly; therefore, there is a need for variety among the reinforcements. Make a reward menu. (Preferred activities, e.g., off-task behaviors can be used as reinforcers and be put on the reward menu.) The menu choices should be altered often to avoid boredom and habituation. Third, "Priming" or listing of all the privileges by the student and the teacher can be used prior to the academic assignment (Rapport, 1987b) to intensify the value of the classroom privileges. Frequently evaluate reinforcements and make adjustments in the design of the program. Ask the student to keep a monitoring log to set his or her own personal goals, and to evaluate his or her own progress daily and weekly. This way the student is automatically sold on the idea, and it would be more likely that he/she will follow through with the program. Fourth, the repeatedly obtained behaviors can be marked off, and new ones can be added. Remember that with ADHD such behavioral change does not automatically generalize to other situations (DuPaul, 1997).

Response cost

Response cost is a mild punishment system where an earned check mark is deducted for an undesirable behavior. Unfortunately the studies show that relying exclusively on the positive reinforcement is seldom effective in modifying the undesirable behavior and maintaining the desired academic and social behaviors in children with ADHD. Several studies have established the need for a concurrent mild punishment system (Pfiffner & O'Leary, 1987; Pfiffner, O'Leary, Rosen, & Sanderson, 1984; Rosen, O'Leary, Joyce, Conway, & pfiffner, 1984). The use of response cost system, in addition to a point-system has shown to increase seat work, on-task behavior, and the accuracy of academic work in children with ADHD (Rapport, Murphy, & Bailey, 1980, 1982).

Prior to using response cost the following points should be considered. First, the use of response cost may influence the child's perception; he/she may view the whole token system as negative. It is important to emphasize the positive and the reinforcing components of the program. Second, children with ADHD may initially test the teacher and try to see how many points they can get deducted (DuPaul, Stoner & Tilly, 1997). The adults must make sure not to participate in such a game. Points should not be reduced more than one per minute regardless of the off-task behavior. After reducing the point/s the teacher must look away (Rapport, 1987b) to avoid observing an opportunity to reduce more points. The child's total points earned should never fall below zero, and when it is close to that point, ignore the child's off-task behavior. As the child experiences success, he/she will buy into the system, then the standards for the system can be increased.

Time-out

Time-out is withdrawing the child from a reinforcing environment. These are suggested guidelines (DuPaul, Stoner & Tilly, 1997) which are based on modifications of Barkley's (1987) time-out procedures for home: (a) remove the child from the reinforcing environment; (b) do this immediately following the undesirable behavior, e.g., talking out of turn; (c) be consistent. Address the behavior every time that you witness it. Deliver the appropriately agreed upon reward or punishment; (d) use small amounts of time, e.g., 1-5 minutes for the duration of time out; (e) use a distraction free corner of the classroom, e.g., no pictures, no other kids, (f) model the desirable behavior for the child, e.g., rather than hitting your friend, you could have told him how you felt; (g) terminate time-out when there has been a period of calm and after the child has expressed a desire to correct his behavior; (h) if the child continues to misbehave, lengthen the time-out by a fixed amount, e.g., 1 minute after each violation or lose a point from the token economy; and (I) if all fails, use at-school or in-home suspension. Keep in mind that a shorter time-out is less effective when it comes after a lengthier one (Kendall, Nay & Jeffers, 1975).

Contracting

This is a contract between the teacher and student; it is used as a fading out procedure for the point-system. In this contract the desired behaviors and the consequences contingent upon the performance of these behaviors are listed. This is similar to the point-system, but there are no check marks used. Therefore the child may have to wait longer to receive the primary reinforcement. The student must be older than 6, and have the verbal ability to understand what is in the contract. Furthermore, considering that children with ADHD do not respond as well to delay reinforcement, it would be better if the primary reinforcement were delivered at the end of each school day.

Home-school report cards

Communication with home helps to create more consistency for the child (Thompson & Parkinson, 1997). This system creates an opportunity for the teacher and the parents to collaborate on an ongoing basis. Steps are: (a) identify four targeted behaviors; (b) use a scale of 0-10 to evaluate each behavior; (c) list all the choices of reinforcements, including the number of points to be earned to receive each reinforcer. Keep in mind that children prefer smaller, daily rewards; and (d) at the end of each day, the student and the teacher together will review the day and complete the report card (some teachers like to rate the child and then have the child rate himself/herself and then they will compare the ratings; this helps the child build a sense of self-evaluation). The parents then can provide a reward for the child's success at school. The teacher is to remind the child to put the report card in the backpack; response cost can be used for forgetting to do so.

6. General helpful hints

a. Praise the student for every acceptable behavior. If the student is apathetic, use personalized high praise consistently.

b. Child's behavioral improvement at home does not automatically generalize to the school setting (Breinier & Forehand, 1981); therefore, you need to address these behaviors separately at school .

c. Immediate feedback and consequences (compliment, reward, and affection) are important.

d. Use positive feedback before you use a negative one. Find areas to reinforce with ADHD versus reducing their self-esteem by repetitive and more frequent negative feedback (Brooks, 1991; Rutter, 1980; Werner, 1993). This will help the child feel more invested in the school and like it more.

e. Be very consistent, particularly in the first week or two. All progresses plateau, but you want it to plateau at a good time (Barkley, 1998).

f. If the student has a short frustration tolerance level, use frequent reinforcement and provide individual help (Dawson & Guare, 1997).

g. Should other children become envious of any reward system used with the ADHD student and view the ADHD child negatively, keep in mind that these are usually temporary situations. Furthermore, the rewards can be shared with the classmates (if previously agreed upon by the student).

h. Use redirection immediately following the undesirable behavior; avoid threats or repeated reprimands (Fiore & Becker, 1997).

. Be consistent and patient; explain to the student what he/she has done wrong (Chrystal, 1988).

i. Teach the child to problem-solve, to choose alternative solutions and to plan ahead (Verble, 1985). Define targeted behavior, brainstorm about possible solutions, choose the most appropriate solution, implement the intervention, and evaluate the results of the intervention (Dawson, 1997).

j. Children with ADHD need more frequent, consistent and specific feedback for optimal performance. Provide feedback about the child's behavior, correct, and practice again. Teach the student to evaluate his/her own performance.

k. Model the appropriate behavior for the child.

l. Instructions and reminders are more effective than motivational statements when addressing the student's off-task behavior, e.g., "please raise your hand prior to answering a question" versus "I know you can do better" (Abramowitz, O'Leary & Rosen, 1987).

m. Reminders accompanied by eye contact and closer proximity are more effective (Van Houten, Nau, Mackenzie-Keating, Sameoto, & Colavecchia, 1982).

n. Shorter reminders are more beneficial than longer reminders (Abramowitz, O'Leary & Futtersak, 1988). Calm, firm, consistent and immediate statements are more effective than emotionally charged and delayed ones (Rosen, O'Leary, Joyce, Conway, & Pfiffner, 1984).

o. Delayed reminders for about 2 minutes are less effective (Abramowitz & O'Leary, 1991).

p. Modify difficult situations such as waiting in line by choosing the student to be a teacher's helper.

q. Use natural and logical consequences that will help the child assume more responsibility (Curwin, & Mendier, 1988; Mendier, 1992). Should the child repeatedly challenge the rules and push limits, there is a need to re-evaluate the rules.

r. Address motivational issues. Internal sources of motivation are often limited for those with ADHD, and the use of an incentive system is imperative. If a task is boring, an external source of reward is important (Barkley, 1998)

s. Use warmth, acceptance, and nurturance.

t. Make the rules fair to avoid resentment and a reduced sense of autonomy (Adelman & Taylor, 1990).

u. There is a need for structure, but also for flexibility. Be creative in finding a variety of strategies that will help the student learn without getting bored.

v. There is a need for a logical and reasonable negative consequence to maintain the desirable on-task behavior (Rosen et al., 1984), e.g., consistent, specific, brief, and immediate verbal reprimands.

w. Allow for choices in what task to do first (Dawson, 1997).

7. Relapse Prevention (Barkley, 1992)

The therapist let the teacher know to anticipate problems ahead of time and how to use the five step problem-solving skills (Barkley, 1992; Brasswell & Bloomquist, 1991). This method is discussed in detail in the parent-child sessions.

8: Post-Session Assessment

(As mentioned before, Ms. J. did not particpate actively during this session. There may be several explanations for the appeared lack of participation. Ms. J. had a limited time frame, 45 minutes, before her students were to return to her classroom. She may have kept quiet in the interest of time. Second, this was Ms. J.'s first teaching experience, and it is not clear how confident she feels about her position. Her reaction to having to take tests seemed to create some anxiety, that there may be a judgment made about her knowledge level. Third, this was the first time Ms. J. had ever participated in a study, and was uncertain about the process, despite the initial explanation provided by the therapist. Again, had there been more time, the therapist could have worked on the alliance with the teacher, prior to, and during attending to tasks. This may have helped make the teacher more at ease, and less pressured by time constraints.)

Child Training Session

Rationale

Children with ADHD have a neurological deficit in behavior inhibition (Barkley, 1997b; Quay, 1997; Schachar, Tannock, & Logan, 1993) which interferes with thinking through the consequences of their actions; therefore, helping an ADHD child to become more aware of his or her own behavior, their impact on others, and their consequences are important (Barkley, 1998).

Met with B. on 3/24/01 at 10:00 a.m.

Session Goals

1. Assess B.'s baseline knowledge about ADHD.
2. Acknowledge communication with B.'s teacher.
3. Psycho-education about ADHD.
4. Increase awareness of time.
5. Discuss problem-solving skills.
6. Introduce anger management.
7. Teach relaxation techniques.
8. Increase self-awareness.

9. Improve communication skills.

10. Assess post session knowledge.

1. Assess B.'s Baseline Knowledge

The first item on the agenda was to assess B.'s baseline knowledge of ADHD. He was asked to take the pre-test. The pre-test for B. was in the form of short answers. On his pre-test, his limited knowledge of ADHD and self-regulation was exhibited by his brief and sometimes incorrect responses.

2. Acknowledge Communication with B's Teacher

The second item on the agenda was to acknowledge to B. that there had been communication with his teacher as discussed during the debriefing of the assessment results:

B: I saw you at my school

T: I came to meet with your teacher. She was nice.

B: She is.

T: Do you have enough room in that classroom? (The classroom, placed in a trailor, due to shortage of space, did seem small. Desks were placed close together. This potentially could be distracting to some of the students.)

B: Yes.

T: Was your classroom in the trailor last year also?

B: I was in a different school last year.

T: Well I enjoyed meeting your teacher. She was very nice.

3. Psycho-education about ADHD

T: First of all, tell me what you know about Attention Deficit Hyperactivity Disorder which is also called ADHD?

B: It is hard to concentrate.

T: Yes, what else do you know about it?

B: Not much.

T: Would you like to learn more about it?

B: Yes.

T:.. Basically what happens is sometimes it is hard to keep your concentration. It is not that you cannot concentrate in general. I bet when you like something a lot, you can spend a lot of time on that. Can't you? Like if you liked a movie or if you play game boy. Do you lose your concentration there?

B: I do.

T: After how long?

B: Two hours.

T: Two hours? No wonder. Two hours is pretty good to keep your concentration. Another thing is that you may not think about the consequences of your behavior before you do something. Or, sometimes you may feel restless for example, you may have a hard time to keep sitting in your seat. Do you ever get like that?

B: Yeah, I go like this sometimes (squirming in his seat) *or tap my feet.*

T: Another thing with ADHD is that the kids like to do what feels good at that moment. That is not always possible; for example, if you are in the classroom, you can't be playing your game- boy right? Or you may want to give an answer to a question, but there are all these other kids raising their hands. You should do what?

B: Keep raising my hand.

T: Yes, rather than what?

B: Saying it.

The investigator did not give an extended lecture on ADHD because B. may have lost interest. Instead the psychoeducation occurred throughout the treatment as we discussed concepts of time awareness, problem solving, communication skills, and anger management.

4. Increasing Time Awareness

We discussed using a timer, an analog watch, and made references to time and during various events and tasks, to help improve awareness of time.

T: Also what may happen is that sometimes you can't keep track of time as well. Your mom may say B. go get ready and come down in ten minutes. What happens then?

B: I come down in 11 minutes, and she yells at me.

T: Do you have a watch?

B: My mom switched the watch that I had. I used to have a regular one, but now I have one with a face.

T: That is wonderful because now you can see the whole thing.

B: The other one, she would say 10 minutes, but it didn't have a face, and I couldn't tell how long 10 minutes was.

T: I didn't notice a clock in your classroom. Do you have a clock there?

B: Yeh, right above the bell.

T: Where you sit, do you face that?

B: Yeah.

T: Oh, good. Do you look at it often?

B; Yeh, when I don't have my watch, it is good.

T: Good.

B: When I'm about to eat lunch I do.

T: You want to know how much longer.

B: Yeah, because I'm starving.

T: Sometimes there are a lot of people that are not good with time. What you need to do is to wear a watch and, for example, before a task starts, like if you are taking a test, look at your watch and say ok now how much time do I have to do this test. Then every so often you need to look at your watch to see how much time is left. Like if I was your teacher, and I said you have twenty minutes to do this test, what time is it now.

B: 10 of 3.

T: Then what time will it be when it is time to be finished?

B: 3-10.

T: Good, that is exactly right. Now if you were half way through your test, it would be really good to look at your watch or the clock to see how much time has passed. So, what time would it be about, when you are half way throught the test?

B: 10 minutes after 3.

T: No, it would be 3 O'clock.

T: That kind of a thing can help you to keep track. All right keeping track of time is really *important. Is mom using the timer in the morning for getting ready for school?*

B: The ding.

T: Yes.

B: The ding, and the BUZZZ.

T: So she uses two of them?

B: Yeah, one is to warn me that in 10 minutes I should be ready. That is the ding one. I look at the TV and get ready, but that is until the other one goes BUZZZ. Then I turn that off and go to the bus stop.

T: That is wonderful, so have you been on time more?

B: Yes.

T: B., I am so proud of you. I have to find out more about the kind of timers that your mom uses.

B: It is like a buzzer that you use for the stove, but you set it on time clock, and then it goes buzz, and someone has to go and turn it off.

5. Problem-Solving Skills

Parents had mentioned that the family stress was high because B. and his brothers often became angry with one another, and rather than resolving their conflict, they would fight. One explanation for the expressed anger may be that they lack problem-solving skills. This is how we addressed problem-solving skills:

T: Ok, now one of the things that I wanted to talk to you about is that, sounds like you and your brother get into a lot of arguments?

B: Just my brothers.

T: With each other or with you?

B: With me, and I don't do anything, and they always think I did it, and I'm the youngest.

T: Oh,

B: Well that is what they think.

T: Can you give me an example? When is the last time this happened?

B: The other day.

T: What happened?

B: My mom is sick right now, and my dad had put a soda in the refrigirator. My brother opened the door, the soda fell out, and my brother got mad at me. Then my dad came out and said (yelling,) "don't yell at him, it was me, and if you have a problem with that go to your room."

T: So everybody starts to yell, and how do you feel about this?

B: I don't know. I didn't do it.

T: *Let's look at this problem-solving sheet* ("Five-step Problem-solving " Worksheet, (a) Define the problem; (b) find alternative solutions; (c) choose the best solution; (d) implement the plan; and (e) evaluate the solution before responding to help correct errors).

1.) What was the problem?

T: OK. let's go back to the soda problem. In that situation what was the problem B.?

B: It spilled everywhere and made a mess, and he said it was my fault.

2.) What were the possible solutions? Generate as many possible solutions as you can:

T: OK. now, if you were in BI' s situation, what were some options or plans to take care of that? What would you have seen as some options?

B: Clean it up.

T: Ok. What else?

B: Ask other people what to do with that.

T: OK. What else?

B: Ask nicely.

T: OK. or do it the way he did it? and just go UH.... That is an option right?

B: Um.

3.) What was the best option?

T: Then you have to ask yourself, what was the best option?

B: Ask them nicely, did you do this? If they say no, then say ok., and go clean it up. Then ask other people if they did that, and if they said yes, then ask them not to do it again.

4.) Implement the plan:

T: So first you do the plan.

5.) Evaluate the plan used:

T: Wonderful. That sounds like a perfect plan. Then you should ask yourself, was that a good plan? So first you do the plan and then ask yourself did it work well?

B: Uhm.

T: What did you do when your brother started to yell at you?

B: I said calm down. I didn't do it. It wasn't me.

T: What a good choice. I'm proud of you. This is something that you can use. Maybe you can also show it to your brothers.

B: My mom can make copies for them and hang it on their wall.

T: That would be good.

B: My dad can make copies at work and get it laminated. We can make five copies. One in my room, one in Br.'s room and one in BI's room, one for downstairs. Well on on Br.'s side.

T: No one got mad at anyone. The situation got taken care of. Take this with you, and if dad wants to make copies that is fine.

As the session progressed, B. talked more about the dynamics between him and his brothers. It became clear that B. did not know how to assert himself and clearly state his needs. Instead he would either keep quiet or respond with anger. Therefore, self-awareness techniques, anger management, relaxation training, and communication skills were the issues addressed during this session.

6. Anger Management (Hinshaw, Hencker, & Whalen, 1984a)

T: ....Now, do you ever get angry?

B: At my dog, but not anyone else.

T: Really, you never get angry with your brothers?

B: If I do, then they yell at me for no good reason. They can smack me. They go like this (hitting his other arm) and say hey B. Then I start crying, and they call me a baby.

T: Well, I have just the right thing to teach you today to take care of some of this. We are going to do some exercises that will help you deal with some of these things. OK?

B: Good.

T: OK., let's see. This is something good for everybody to learn about. Sometimes I can get angry. The good thing to ask yourself, what was the even? What was it that made me feel so angry? How did I know that I was getting angry? What did my body do? What did your body do?

B: It hurts.

T: How does it hurt? How does your body change?

B: Right here (pointing to his heart).

T: Yeah, what happens by your heart?

B: When I get real mad, it gets really pumped up.

T: That's right. It beats faster. What else happens when you get angry?

B: You can't control your temper.

T: But what happens before that? Before you start to act out on your anger, when you know you are angry, your heart beats faster, what else happens to your body?

B: Your head feels heavy.

T: What else? Do you ever clench your jaw?

B: Yeah, Just like this (pushing his teeth together, and clenching his fists).

T: You clench your fists, clench your jaw.

B: Sometimes my brothers crack their knuckles.

T: That is good, you know when they are getting angry.

B: When my mom is angry, she goes (making a tense face).

T: She changes her face uh?

B: She goes likes this, her one eyebrow goes up like this, and the other one curls up. It goes squiggly, and then she goes Oh. I jump behind the couch then, and there is only this much space.

T: OK, so you know what the physical signs of anger are. You know what your body does when you get angry, and then after that comes a thought. Do you know what that thought is?

B: I'm going to kill him (laughing).

T: Hopefully you won't kill him (Joking).

B: I would never do it. The worst thing is that I may punch my pillow.

T: OK. Hopefuly some of the exercises that we are going to do will help you.....

B: Sometimes it may also bring tears to your eyes.

T: Well, you know what I like you to do when you get those physical signs of anger? I would love for you to learn to relax yourself. How do you usually relax yourself?

B: Go to sleep.

T: Well that is one way, but maybe not the best way. What else?

B: How I could relax myself?

T: Um.

B: Take deep breaths (breathing through his chest?)

7. Relaxation Training

This session B. was instructed in diaphramatic breathing. He was provided with a relaxation tape later in the treatment. The relaxation tape included diaphragmatic breathing, progressive muscle relaxation, and imagery.

T: May I teach you a real cool way to breathe?

B: Yes. I just hit my knee, ouch.

T: Are you OK?

B: Yes. I just pulled like this.

T: Yeah, that hurts sometimes. What I would like you to do is to find your ribcage. Where is your ribcage?

B: (pointing to his ribcage).

T: There you go. Where is your belly button?

B: (pointing over his shirt to his belly button).

T: There you go. Can you find the space between the two? Ok. just lay your hand there flat. You know what that area is called?

B: No.

T: That is called your diaphragm.

B: I was going to say your stomach.

T: Your stomach is some where in there also, but there is a part called a diaphragm, and that diaphram, do you know what that is like? It is just like a balloon.

B: Yeah, you breath in like this.

T: Well, but you are sucking in the diaphram when you are breathing in, but I want you to do the opposite of that because when you put air in the balloon, what happens?

B: (puffing up his diaphragm).

T: It blows up, correct. Put one hand on your chest, and one on your diaphragm. Try not to move this hand (on the chest). It will be good if you could put air in it and then (demonstrating the breathing in and out of the diaphram). In slowly and then exhale.

B: (doing the breathing along with the therapist).

T: Do it slowly. Let's try it together again. Ready? Breathe in.

B: (making a face).

T: Are you getting light headed?

B: (nodding his head yes).

T: Are you OK?

B: (nodding his head yes).

T: Let's try it again. This time breathe in, and this (pointing to the diaphragm) should come out as you breathe in. This should puff out.

B: (expanding his diaphragm)

T: There you go. Very good. It is really hard to learn at first.

B: Shaking his head yes.

T: But you got it. This is the opposite of how we usually breathe, but what I love for you to do is to learn to breathe like this everyday. Set aside 10 minutes and see if you can do this kind of breathing. Soon I will make a tape for you with a relaxation exercise, and this will help you relax. What I like you to do, is whenever you get the signals that you are about to get angry, I want you to do the tape or just breathe this way.

B: I can also give this to my brothers.

T: I would love you to do that.

B: And also my dad when he is mad.

T: Maybe I should make two tapes.

B: One for kids and one for parents.

8. Increase Self-Awareness

We used the "Connecting with Others" social skills training curriculum (Richardson, 1996) to help B. realize what his various behaviors are, and how he affects others as a result of his behavior. The first part of the curriculum explained how each individual has the potential to behave differently in different situations; the difference between enthusiastic, impulsive, caring, bossy, and logical behaviors was also explained. Then B. was asked to identify several hypothetical behaviors.

T: Did you know that each of us has different ME's inside of us?

B: Like different personalities.

T: No it is not that we have different personalities. We are all the same person, but just act in different ways. There is the enthusiastic ME. Do you know what that would be like?

B: Like when I shout .

T: Yes, when you shout yeah. That is the side of us that says: "let's go play, let's go do this, let's go do that." That is when you are excited about something. That is kind of like a kid in all of us that gets really excited and energetic.

B: That is like when we were going to Disney World. I got like that. It was in October. I said "Let's get in the car; let's get in the car."

T: That was the enthusiastic you . That kind of me, helps you laugh at yourself, be creative, enjoy life. Guess what? We can't use that kind of me all the time because then we would get nothing done except play.

B: That would not be good. You would get a detention in school.

T: Too much of a good thing is sometimes not good. Then there is the impulsive me. That is the me that does not think about the consequences, and just does.

B: It does things, it doesn't stop, and it doesn't think.

T: That is right. That is exactly correct. So if we were impulsive all the time, we can lose our friends, get into trouble, get punished a lot, and as a result we would not feel so good about ourselves. Then there is the bossy me. That is a part of our parents that stays in us, and we say to our brother "put your shoes away" or "give me that." Kind of bossing people around. Do you ever do that? Do you ever shake your finger at anybody and say do this or do that?

B: It is hard to remember.

T: Hard to remember? OK, and then there is the caring me that is also a part of our parents that stays inside us. What would you do if you saw your friend at school get hurt?

B: I would be sad.

T: You would be concerned. Would you get some help maybe? Would you take him to the nurse, or call the nurse?

B: Get the teacher.

T: Good. The caring me is really nice because it helps you connect with other people.

B: Or I would use the phone to call anywhere for 10 minutes.

T: What? (Puzzled by the response)

B: Yes, you get 10 free minutes with the phone, so I would call his mom.

T: I got it. Do you have a calling card?

B: yes. (making a hole in his pants with his fingers).

T: ...Now, there is a part of us that is called the thinking me. That is the part of us that decides which me should come out and when. That is a really good part to have. That is your brain, and your intelligence. Now I will give you some sentences, to see if you can tell me which me that is. Hey, when I was your age, I walked to school.

B: I can't remember the me's.

T: OK., choose one. Is this the bossy me or the caring me?

B: Bossy.

T: Stop that noise right now.

B: Bossy.

T: Here, let me put some ointment on your sore.

B: Caring.

T: Don't you dare talk back to me.

B: Bossy.

T: I can help by sharing the work.

B: Caring.

T: Which ME is this? It can be any of them, the enthusiastic, the impulsive, bossy or caring. Get out of my way dummy.

B: bossy.

T: What else can it be?

B: Enthusiastic.

T: Umm

B: I can't remember, the I one.

T: Impulsive, because this guy is not thinking about the consequences of what he is saying. The enthusiastic me is not necessarily mean, but it has a lot of energy.

B: Hyper.

T: I've got to get through; I've got to get through; I'm late for the game.

B: Enthusiastic me.

T: That is good.

B: I like this game.

Assertiveness Training

B. seemed shy and had made several comments indicating that he did not know how to assert himself with his brothers; e.g., they fight with me, and I don't do anything. We addressed improving his communication skills by explaining the difference between assertive, aggressive, and non-assertive behavior. Then we placed a large mirror in front of B. and asked him to communicate different hypothetical situations in all three communication styles while obsering himself in the mirror. The use of the mirror was helpful with increasing B.'s awareness of the non-verbal components of communication.

T: You like this? Ok. This is the part that may really help you with your brothers. I will make you some handouts like this so you can reread them. You know B., there are three different behaviors. There is aggressive behavior. There is one we call non-assertive behavior, and one called assertive behavior. I will explain all of them to you. Aggressive behavior is when somebody is kind of impulsive, and pretty much they show their anger in a way that they have not thought it through.

B: Kind of like dogs.

T: Well, in a way. They throw temper tantrums, shout, hurt someone, destroy property, throw things...

B: Do doo doo on the carpet.

T: What happens when someone gets aggressive like that.

B: Someone will end up getting hurt.

T: You bet. That is the correct answer, and guess what, sometimes that person may be the aggressive one. They may put the fist through the wall, and break their wrist. Right?

B: Yeah, my brother put his foot through the wall once.

T: Did he break it?

B: No, he was just so mad. He tried to deny it, but I wasn't that dumb. He was so mad, because we could not go fishing because it was raining. He could not understand that. He took his foot and put it through the wall.

T: I bet he ended up with a sore foot; he probably ended up with a headache; his blood started to rush; his heart started to race. Right?

B: Right.

T: Those things are not good for you.

B: And your dad may get real mad and yell at you.

T: OK. When you are non-assertive, then people don't pay attention to you, ignore you; you won't get what you want. Also sometimes what happens is that you may lose your cool. You can't always keep these feelings inside, and sometimes you have a temper tantrum or go the other way, and try to get what you want in a sneaky way. Now we need to talk about assertive behavior. Assertive is when you talk to people real directly, put your shoulders back, you look at them in the eye, and tell them exactly what is on your mind in a nice way. That is very cool *because you feel good about yourself when you do this and people listen to you. OK. Now I'm going to give examples then I'll put a mirror in front of you and ask you to show me the certain situations in all three ways. Watch yourself act out the three different ways. I showed this to a different kid an hour ago, and he really got into it. Here is the example: "Get out of my room or I'm going to throw you out. Which one of the behaviors is that?"*

B: Agre...

T: Aggressive. Lets see, what would be an easier word for aggressive that you can remember easier? Out of control?

B: Yeah.

T: Another way to say the last sentence is to say: "You're always in my room, what am I going to do with you?" Which one is that?

B: Non-Assertive.

T: Good. What if I looked at you straight in the eye, and said, "Please leave my room."

B: Assertive.

T: Yes, awesome. Now look in the mirror and... I almost tripped over the mirror.

B: Are you OK?

T: Thanks, I'm OK. I needed a large mirror, so you can really look at yourself. All right.

B: You could put that right here.

T: Oh, what a smart idea. You are full of good ideas. OK. Ready?

B: Yep.

T: I want you to tell somebody who usually uses your clothes, that he can't wear your jacket, in an aggressive or "out of control" way.

B: I don't want you to wear my clothes. How many times do I have to tell you that? (Yelling).

T: OK. Good. Now I want you to do it in a non-assertive, shy way.

B: I, I, I don't like other people wearing my clothes. Please take that off.

T: People who are shy and non-assertive may not even be that direct. They may say"You know I kind of like that jacket; you are wearing that now." Because you are not even telling that person that you want him to take the jacket off. Now do this in an assertive way or the best way.

B: Hi, can you please take that off because that is one of my favorite jackets, and I was going to wear it today.

T: Wonderful, that's great. Now let's say you were in the lunch line; your were first, and you are in a hurry. This kid just cuts in front of you. Be aggressive about it.

B: (yelling) What do you think you are doing? Get in the back of the line.

T: Good. Now I want you to say it in a non-assertive shy way.

B: Um. Excuse me, weren't you somewhere else?

T: Wonderful. That's great. Now can you be assertive and do it in the best way?

B: Excuse me, I think you were in a different place in line, and it is not polite to butt in.

T: OK. you know what, let's not use the word butt in, because that is along the lines of cursing. Maybe a better way to say it is this. "Excuse me, I was first in line. I am in a hurry. Will you please get back in line." OK.? Now let's say you are good at tying your own shoelaces, and you do that all the time, but your mom starts to hover over you and says let me tie that for you. Be aggressive and tell her that you don't want her to tie your shoelaces for you, you are old enough.

B: Mom, I'm old enough. I'm not a little child anymore. I can tie my own shoes (yelling).

T: Awesome, now do it in a shy way.

B: Mom, I think that I don't really need your help right now.

T: Good. Do it in an assertive way.

B: Mom, I am old enough now, I'm not a little child anymore. I can tie my own shoes. I'm not trying to be mean. I don't need help right now (firm voice).

T: Now somebody is cheating off your test in class. Be aggressive and tell him to stop cheating off you.

B: Stop cheating moron.

T: You seem to do that too well (Laughing). I like you to try the non-assertive, shy way.

B: Don't you have your own test?

T: Excellent, now be assertive.

B: Excuse me, but can you not cheat because if you cheat, the only person that you are hurting is yourself.

T: That is good. The only other thing that I may say is that I don't appreciate you looking over my test, please stop it. You can't just say that you don't appreciate it because someone may say, big deal, you don't appreciate it, but I can still look at it. Right?

B: (nodding yes.)

T: Super. Actually we can stop that. But first, think of a couple of times that your brothers were aggressive with you, and you said nothing. Not saying anything may encourage them to do more of that behavior. Can you think of any of those situations. By the way, the situation with the soda, you handled that very well. Can you give a different example?

B: Well, one time BR. was mad because his friend could not play, and I said, "BR. don't be mad; it is not the end of the world," and he said: "B. be quiet and get away."

T: You were trying to comfort him. How else could you do that? What else can you say to him, because when you say it is not the end of the world, you are acknowledging that he is disappointed. What can you say to him?

B: Um, "BR. your friend just can't play right now, and there are a lot of other days."

T: That would be good, or you could say: "I'm really sorry that your friend can't play right now, but try to make the best of it." If he continues to go on, then say, " BR. I know that you are frustrated, but I don't appreciate you taking that out on me." Right?

B: (nodding, yes).

T: What if they just come over and hit you?

B: Stop, I didn't do anything.

T: Stop is good, but that does not address their behavior. You can say to them I'm not your punching bag. Don't do this again. You do this again, I will go to mom and dad, and you will have to face the consequences. Look them in the eye, shoulders back. Do it in an assertive way, look in the mirror, and now shoulders down, see the difference? Which way would they take you more seriously?

B: (showing the shoulders back in the mirror)

T: Exactly. You are getting very good at this, aren't you?

9. Post Session Assessment

On the post-test, B. was able to provide more correct and comprehensive answers to the questions asked about ADHD and self-regulation.

(B. seemed quite engaged througout the session. The structure of the session and the specific excercises seemed to prevent boredom, and to give him several opportunities for direct participation and practice. It was clear that the repeated opportunities for practice helped B. master the skills better. Future sessions will provide some data as to whether he transfered and used these techniques outside the session; e.g., at home. Handouts could have been used to help reinforce the skills outside the session. The use of visual aids; e.g., a board, during the session could have helped B. better remember the names for different MEs and styles of communication. The visual aids may also provide more stimulation and make learning more interesting for a child like B.)

Parrent-Child Session no.1

Rationale

The reasons for having joint sessions between B. and his parents were that it was important to see how B. and his parents interacted and problem solved together. Additionally, the joint sessions can give the parents an opportunity to design behavior modification programs along with their child rather than for their child. This process helps with modification of the treatment program based on the feedback from B. Also, this joint decision- making process can help B. feel more invested in the treatment program.

Met with B. and his parents on 3/31/01 at 1:00 p.m.

Session Goals

1. Follow-up on point-of-performance treatment.
2. Reinforce previously learned skills.
3. Use CBT to reframe parental misconceptions, incorrect attributions and assumptions about ADHD and B.
4. Homework.

1. Point-of-Performance Treatment

A. First, we had to identify two to three behaviors as targets for change:

T: I think we should find two or three behaviors that we would like to change. Again B. has great behavior, but everybody can improve some things, and no one is perfect. So, can we think of two or three things?

The following behaviors were identifed as the targets for change: first, as Barkley (1998) has pointed out, increasing the child's compliance with parents is often an issue raised by parents as a goal for treatment. In B.'s case, the compliance issue particularly pertained to getting ready in the morning, which involved self-care; e.g., brushing teeth, getting clothes on, taking medication, and being ready for the bus.

M: When we ask him to do something, he has this idea in his head that he does not want to do it. (She attributes this more as a willfulness act than forgetfulness).

T: OK. So one, follow through with requests. Is that OK. B.?

B: (laughs)

M: Am I right?

B: Yeah.

The second behavior was, not initiating negative interactions with his brothers; e.g., impulsive hitting. As mentioned before, high level of conflict in the family increases the family stress level, and B.'s father was eager to use decreasing conflict between B. and his brothers as a treatment item:

T: What other behavior dad do you have any suggestions?

F: Minimize conflict between he and his brothers.

T: Good. What do you mean by conflict?

F: B. has a tendency to be an agitator. (Father uses labling versus describing the behavior).

B: Dad has a tendency to be the dominator.

T: OH. (looking at the father), can you give me an example?

F: This morning they are playing a computer game, a baseball game or something. Instead of B. going over to BR. and saying good job BR., what he did was he started to hit him on the head.

B: I hit him on the head and said good job.

F: It was a little bit more than that.

M: BR. would say stop it, and B. just keeps it up.

B: He didn't say stop I; he just smacks me.

F: He is retaliating.

B: I just said good job.

M: Then there is yelling and screaming around the house.

The third behavior, was not "whining" as labled by parents. Parents often attribute the ADHD child's behavior to a purposeful action rather than a problem with anxiety or a deficit in memory and self-regulations.

M: and the whining and the baby voice.

F: Right, B.

B: (using a shallow voice) I was just saying good job...

M: Wait a minute, what is that voice? What is that voice?

B: He does not say stop though; he just smacks me.

F: If you had not hit him to begin with.

B: I just tried to tell him good job.

Timing of Reward Delivery

The second variable related to point-of-performance treatment addressed here was the importance of timing of the reward and feedback to B. about his behavior. As mentioned above, the timing of the delivery of reward and punishment is important to help compansate for the deficits in non-verbal working memory and the poor ability to hold feedback on-line to be used in future performances. Therefore every behavior must be addressed every time and immediately as much as possible.

T:.... when B. does something either good or bad, you need to give him feedback right away. You can't wait till the end of the day, and the most effective thing would be that as he starts his behavior, to say to him, now B., stop right here.

B: (nodding his head yes).

T: All right, at that time (looking at the parents) give him feedback, or you can take a chart and put a minus for the behavior, but don't stop there. Go through it, and problem solve with him. Same thing for when he makes a real good choice. Be able to right away give him feedback, and tell him that this was the situation; this is what you did; as a result of that these consequences are going to happen. We want to reinforce good things as well, and not just to catch him when he does something negative.

M: Right.

T: Obviously, positive and negative points cancel each other out, so you want to get a lot more positive than negative checks. Then what you can do is, at the end of each day you can trade so many points or checks that you have earned for something good. What are some of the things that you would like as a reward?

As Barkley has pointed out, it is important to catch kids being good, versus just to look for the negative:

T:...We want to reinforce good things as well, and not just to catch him when he does something negative.

Reward Menu

Establishing a reward menu and a point system is not an easy task, and there are many variables to consider. The point system was discussed, and B. was asked to be directly involved in generating a reward menu. His ideas for rewards were not always realistic, but the therapist and parents tried to work with the ideas as much as possible. Establishing a reward menu requires compromise and a balance between the child's wishes and the parents'. We had to include items that B. found rewarding, and to check with his parents to make sure the suggested menu items were acceptable to them.

T: What are some of the things that you would like as a reward?

B: A dirt Bike.

T: Can we go a lot smaller? Aren't you kind of young for a dirt bike.?

M: (shakes her head no).

T: Really, he is not?

B: Oh, come on mom.

M: That is not even for discussion right now.

T; Well, what else?

M: I know, how about different color markers and pens?

T: B. is that good? Would you like that? Is that worth working for?

B: Yes.

T: What else?

B: It is hard to think.

M: Ice cream?

B: I like ice cream.

T: Would you work for it? Is it worth behaving for it?

B: I don't know.

T: So you are not so sure about that one. OK. What else do you like?

M: Spending time with dog?

B: I can spend time with the dog anyway.

M: We can put Rocky in your room. He can sleep in your room.

T: Is Rocky the dog?

B: I don't know.

T: What else would be good?

B: Toys

T: What kind of toys?

B: Play station games.

T: The CD's you mean?

B: Hum

T: How much are they?

F: $30 to $60 (laughing).

B: Sometimes they are $15.

T: But, you know what we could do? We could (pause, thinking). (looking at the parents) Are you against him earning money?

M: (nodding her head, yes)

T: Ok. That is not something you want to start.

M: I don't want him to think that he has to get money to behave.

T: OK.

F: Well, it is not that he gets money. He'll spend it on something that he wants.

T: You know what else we could do is that you could draw a picture of a play station CD, and then you could divide it into six pieces. You could cut it and make it like a puzzle. Then every time, he could earn a piece of that, for so many points. When he has the whole picture, which may take him a long time to earn, then he can get the actual thing.

B: Or the dirt bicke.

T: (laughing) That would be...

F: That would be into a thousand pieces.

T: That would be too delayed.

M: How about fishing? Daddy could take you fishing.

2. Reinforcement of Previously Learned Material

Review of previously discussed and practiced skills are important when treating a child and a family with ADHD. It is through practice and overlearning that the use of the new skills can become more spontaneous and automatic.

Problem-solving

In this session, as opportunities presented themselves, we revisited problem-solving.

T: OK. For the second one it would be initiating bothering his brothers, and then the next one is stopping a negative behavior like hitting his brother on the head, when asked by his brother.

M: Or sometimes I ask him to stop it, and he just doesn't listen.

T: Does he not do it at all, or is he late in doing it? Do you know what I mean?

M: No, it is just like there is a block. He just has the blinders on, and it's like he is saying I'm not going to pay attention to that.

F: I think he (pause), specially B. just keeps at it, keeps at it until BR. explodes. Then BR. wants to hurt him, and he starts to cry. Then we talk to BR because he made him cry He initiates a lot.

T: Do you remember what the first step was?

B: What is the hyper stuff?

T: What is the problem? I'm talking about the paper that I gave you last week when you and I met.

M: The paper that you wanted to laminate. Remember the two sheets?

B: (shaking his head, no)

T: I'll refresh your memory. Remember the first step was, think what is the problem? That is, what are some of the ways that I can act in this situation, what can I do about it? Right? Then the third one is which one of my choices would be the best choice? And then try it out, and decide how well did the best choice work? When he is hitting BR. Or bugging his brother, when you come over, rather than reacting to him immediately, I would love for you to say:"OK. B. what is going on right now? What are you doing?" Have him generate several solutions. To you and me it is obvious, but I want him to identify that he is hitting his brother on the head repeatedly.

B: Laughing. (When criticized or embarrassed, B. often laughed).

T: Right? You have to generate several possible alternative behaviors. I can stop. I can stop and apologize. Then think, which one of these possibilities would have the best results?

B: Stop and apologize.

Increasing Self-Awareness

B.'s mother talked about how sometimes B. makes unkind statements to his brothers and then seems puzzled when a fight starts with his brothers. This was a good opportunity to help B. become more aware of his own behavior and how his behavior may affect others.

M: Yeah, what he does, when they are punching the right buttons, he tells BI to go see his therapist; tells BR., calls him fatty.

T: OK. That is good.

M: That is his basic tactic.

T: He gets back at them.

M: He has not figured it out yet that basically that puts him behind the bullseye, and at war with them.

T: How do you think that when (pausing, thinking). What I would like you to do is to be able to learn how your behavior affects other people. OK.? So one of the things that I like you to say to yourself is that when I do blank, so and so feels blank. When I call BR. fat, he feels.. Fill in the blank.

B: Sad.

T: Sad. Is that what you want? Do you want him to feel sad?

B: No.

T: Well, that is how he is going to feel, if you say that. You say to BI, BI., it is now time to go see the psychiatrist, or why don't you go see your psychiatrist. How do you think that BI. Feels?

B: Bad.

M: What do you think happens then, and why are you hiding behind the couch?

T: See if they do something nasty to you that upsets you, then by you acting in a way that makes them feel bad, that still does not take care of what they did to you. Do you know what I mean?

B: (nodding, yes).

T: So, you need to be assertive, and communicate in the good way that we communicated in the mirror. You should give them feedback directly about what they are doing. Because for you just *to go back, and just get back at them, is not related to what they did. That does not take care of their bad behavior. It is just going to complicate things more and more, and also make more work and hassle for mom and dad to deal with. One of the things that you can do for me is to start a log. Keep a log. Put the date, the situation, and then you say, what was it that I did; this is how the other person felt. This will help you keep track. Mom and dad, will you help B. become more assertive with his brothers, and what to say to them directly? Directly talk about it. No hitting, no acting. That should not even be a choice. That is why God gave us a nice ability to talk.*

M: Like with BI., rather than hitting, say to him why are you yelling at me like that? Why are you mad?

B: That is because....

M: You got hurt, so what you do, you turn around and hurt him. That is not going to solve anything.

T: That is right.

M: Correct? (looking at B.)

T: Does that make sense? (looking at B.).

B: Um.

T: That is good. The other thing that, mom and dad, if you think or you get a chance, do this with the whole family. One of the handouts that I gave you before has a section for family anger management. This actually gives you tips like learning to walk away for a few minutes, think the problem through, try to relax, and then come together, and make sure that you talk about what was the problem. Then you can use the five-step problem-solving skills to solve the problem. You *got to think about it. What just happened? What were the options? How would it have turned out differently, had you done something differently?*

Another issue that was addressed through increasing self-awareness was what B.'s mother had raised (him using a "baby voice.")

M: Don't use that baby voice.

T: Well, B. here is the thing (pausing to think). Are you aware that sometimes you change voice? Are you aware that you do that?

B: Sometimes I do that for fun.

T: For fun, OK. You know what would be real cool, mom and dad? Sometime just tape him and then let him listen to it. There was someone that I worked with, who was about B.'s age, maybe a year older, and she used to do that non-stop. Not occasionally. So, one time, I taped her in session, and then I said to he, "let's listen to this" I played it back for her, and she said, "Who is that?" And I said, "that's you," and she said that she could not believe it. She could not believe that she sounded like that. So, we did it again, and sure enough, that changed that behavior totally. He (B.) needs some feedback.

M: Well that is what we did basically. I mean, the way that I've done it, is that I say I don't speak with 3- year-olds, so if you want to be the 10-year-old, I'll listen to what you have to say. That changes it right away because someone (meaning B.) *wants to be known as the baby.* (The pattern noticed by the therapist was that when she gave suggestions to the parents, B.'s mother often stated "we do that." This may be due to a weak alliance between the parents and the therapist. Another possible explanation is that B.'s mother expects to have done everything right with B., and the therapist's suggestions may indicate to her that she needs improvement in her parenting. As the therapist reflects on this session, this issue should have been addressed with

B.'s mother. This would have provided an opportunity to reframe B.'s mother's thoughts around this issue.)

B: Smiles.

T: Well, you will always be the baby of the house, and you don't have to.

M: You don't have to talk like one.

T: But he knows how important voice is when you communicate. Last week he and I did a great exercise that...

B: The mirror thing?

T: The mirror thing, remember that? What we did was that we practiced saying several things in an aggressive way, in a very non-assertive/shy way, and in a very assertive/direct way. And he saw how his voice was different, his words were different. That was good. He needs that because with his brothers, when he does not communicate assertively, then he gets frustrated and gets angry.

3. Use CBT to Correct Parental Assumptions

There were many occasions when B.'s parents criticized his behavior:

B: (Twisting the button on his jacket)

F: (Looking at B. with frustration)

B: What I'm just twisting that.

F: Stop it. Now you are giving your mother more work, right?

B: (looks at father).

or

B: (Cracking his knukcles).

M: (pointing to B. to stop it).

T: He is OK.

M: He constantly is doing that. Actually now, he has been pulling on it, and is disjointing his fingers.

T: Well, that is not good, if you are playing baseball.

M: That is what I told him.

F: Uh, I told him that. He won't be able to play.

B: Sometimes I can crack my back.

F: Sit up.

B: When I sit for a while, then I move my back, and it cracks. I go like this.

T: Stretching it is not bad.

B: But sometimes it cracks, but I don't mean to.

CBT can also help clarify parental assumptions about the nature of ADHD and trait versus state attributions toward their child (Epstein, Schlesinger, & Dryden, 1988; Sobol, Ashbourne, Earn, & Cunningham, 1989). They may make global and stable causal attributions about their child's misbehavior. Further, they may have unrealistic expectations for their child (Sobol et al., 1989). Parental perceptions of the child may directly impact the parental treatment of the child, which often includes inappropriate expression of anger (Di Giuseppe, 1988). The therapist took the initiative to reframe negative comments and labels on several occasions.

An example of how B.'s parents address his poor self-regulation was later in the session when B.'s mother addressed his lack of attention to the session in this way:

M: (interrupts) B. I'm watching you. Because Roya is talking to you, and you are looking this way and looking that way. (she is attributing his behavior to a purposeful action rather than restlessness related to ADHD).

T: That is ok.

M: But I can see that…

T: (interrupts) Is he due for another dose of his medication?

M: This morning he forgot his medication. He usually takes it with his meal, and we were out.

M: I'm really tired of having to tell him to take his medication. BI. has never done this before, but B. I know says to himself that I wonder if she is going to say anything. It's like I'm constantly saying "Go take your medicine."

T: Let me make a suggestion. First, does his watch have an alarm?

M: No, the other one did, but I went back to …

T: Yes, the face one. Do any of the ones with the face have an alarm? Probably not.

M: No, but maybe like the face ones with a little square box that have the digital here.

T: But does it have the face around it?

M: Yes.

T: Fine. Let's see if we can find one of those for him, because, then he can set his alarm for 12 o'clock, and when his alarm goes off …

M: That will be good because I feel like I'm constantly saying go take (pausing) and then I'm yelling. What happens is that you don't realize it until they start to go off the wall again. Then I say, you should know better. You know you need your medicine.

T: Um…

F: (interrupts) Even when you lay down the medicine on the counter for him…

M: (interrupts) which I do.

F: He'll walk off and go to school without it.

M: It is very dangerous for him to do that. It is not just the Ritalin. It is also the Propolset . He is on a program right now. They took it off the market. They very closely monitor it. You have to bring your medication with you, and they measure how much is in there. They know automatically how much you're taking. You are supposed to take it three times a day.

T: ....Remember how we talked about the fact that short-term memory is not the best in some people, and that they may not remember that this morning I initiated bugging BR.; I kept hitting him on the head and when they asked me to stop, I didn't, and that got me in trouble with dad. We think that the next time something like this happens, he should remember what happened, and not to do it again, right? Sometimes what happens is that if we don't store that information too well, we may not remember to reuse that information again.

Taking medication was an item that was added to the daily checklist. The checklist is used to compensate for the deficit in the non-verbal working memory, and to promote self-regulation.

OR

Sometimes parents attribute the child's misbehavior to stable and unchangeable factors and are more pessimisstic about change. As we were discussing the point system:

M: Just in one word I'll put it up there. By the end of the day, you add up the negatives and positives then.

T: Good.

B.'s father made a comment that he expected B. to continue to misbehave most of the time:

F: He would be in the negative most of the time.

T: I hope not.

Also B.'s parents labled and interpreted some of his behaviors rather negatively:

F: B. has a tendency to be an agitator.

Later, B. was asking for water to take his Ritalin in the session:

M: Yes, but you take your pills in an unusual way anyway.

B: When I take my medicine, I take some water first.

Therapist used this opportunity to normalize the comment made by mother:

T: I have seen that before. As long as you get it down. Why don't I get some water.

Point of performance feedback

B. had to leave the room to use the bathroom, and the therapist used this time to give the parents feedback about how they address B.'s behavior at times.

(B. leaves the room).

T: Be careful about the words that you use with him. I can see from his expressions that he takes it to heart. I see his facial expression change with that.

M: Smiles. It is so frustrating.

4. Homework

a. The parents were asked to use bright-colored paper for the week, and to write down the identified targeted behaviors for change on a behavioral chart. The first column had a list of behaviors. The next seven small columns listed the days of the week. This paper was to be displayed on the refrigerator. Everytime B. exhibited the desired behavior, the parents would put a check under the correct day of the week. On the other hand, everytime the undesired behavior occurred, the parents were to charge B.'s chart, and cross off a check from the previously earned checks.

b. The parents were also asked to complete the reward menu for the next session.

c. The parents were to complete a checklist of things that B. needed to do in order to get ready on time for school.

(The therapist noticed that B.'s parents were quite critical toward him. Several sessions could have been used to address and practice this specific issue. Similarly, several sessions could have been used to address the parental perceptions and beliefs about B. and his behavior, as well as their expectaions of B. Another issue affected by time constraints was the amount of homework assigned this session. Ordinarily, the above homework assignment would be assigned over the course of several sessions, however that did not fit in with the time constraints of this study.)

Parent-child session no. 2

Session Goals

1. Address any concerns presented by parents or B.
2. Discuss feedback from school.
3. Follow-up on environmental modifications.
4. Follow-up on point-of-performance incentive system.
5. Discuss importance of a daily routine.
6. Closure and follow-up.

Prior to addressing the first session goal, B. and his parents presented his difficulty with comorbid anxiety. They discussed how fear of the dark interfered with his self-regulation:

B: I was the first one up.

M: Yes you were.

T: Were you? Great. What did you do when you got up by yourself?

B: Waiting for my mom to come up.

M: Chicken liver.

B: No, I laid down.

T: You lied down?

M: You were scared, right?

B: Nah, I sometimes go out.

F: Right!

T: You know what would be good? To ask yourself what am I thinking? You get up, you stay in your room, you don't go down; well it is only one level, right?

B: Two levels, if you include the attic.

T: Oh, OK. Never mind the attic. Do you have to go through your room to the kitchen? Would you go to the kitchen by yourself?

B: Yeah, I would. I do that sometimes in the middle of the night to get a drink.

T: So, what wouldn't you do this morning when you first got up?

B: I just wouldn't get up. I was so tired when I woke up. I just waited for my mom to get up.

T: (looking at the mother's facial expressions of disbelief) Well, what do you think mom?

M: He is full of it.

T: Why is that?

M: What scared you that you didn't want to get out of the bed?

B: Nothing, I was just tired.

It was clear that B. was not comfortable with admitting to being scared. The therapist attempted to normalize this issue enough for B. to be open to discussing it.

T: B., can I make a confession? When I was your age, and even older, I used to be afraid of the dark...

B: Same here.

T: I used to sometimes not go to another part of the house by myself. Thank God, we had a small house. So what I'm telling…

B: (Twisting the button on his jacket)

F: (Looking at B. with frustration because he is twisting his jacket button.)

T: So, B. what I'm saying is that you don't have to feel ashamed. It is just good to know what these issues are, so we can help you through them. Don't feel like you have to hide them. They are a lot more common than you think they are. Ask mom and dad. If they want to be really truthful, I bet they can come up with a couple of things that they were afraid of. So why wouldn't you go out again?

B: Well, I wouldn't go out because I had to go out to the basement, and it was dark down there.

T: Ha.

B: I just wanted mommy and daddy to be awake.

T: So, you would not go down to the basement and your thought was?

B: That it is too dark.

T: And what would happen? What does the darkness down there mean?

B: It is weird.

T: What do you think is going to be there?

B: (looking embarrassed).

T: That is OK. That is a common thing.

B: It is weird.

T: As Angelica would say, Do you think that the bugerman is going to get you?

B: (Laughing), no the boogyman.

T: Sometimes, we just get scared of a concept other than really looking at what about that...

B: (Cracking his knuckles).

B: I know shadows.

T: Sometimes what happens in general is that we get scared of something because of darkness or all the movies, but we don't stop to think what about it really bothers us. It is a good thing for you before you say it is dark, and just back out to think to yourself, what about it. I'm sure there is a light switch somewhere. Right?

B: (Laughing).

T: And then what? If you turn the light switch on?

B: It's cheating.

T: So will it still be scary if the light was on?

B: No

T: So why don't you turn the light on and go down there?

B: I don't know.

The therapist attempted to use B.'s previous strengths to deal with the current issue:

T: Here is what I suggest, for you to try some of these things. You know how you said before that you were often uncomfortable in meeting new people or to go to someone's house for the first time? You would go ahead anyway. That is what is working out for you. That did not stop you from being with your friends. With the darkness same thing.

Relaxation technique was suggested as another coping tool to deal with the fear of the dark.

T: Oh I made you a relaxation tape. Remember what you called the balloon breathing?

B: Nodding his head yes.

T: Here is a 10 to 15 minutes of the exercise. Try to practice it everyday for a week or two. After that you'll memorize it naturally, and you may get tired of it, and you will be able to do it on your own.

2. Discussed Feedback From School

As mentioned above, communication between home and school is important, because parents and teachers can support one another in their efforts of creating more consistency for the ADHD child and managing his behavior. Feedback from B.'s teacher to home was discussed:

M: Did you tell Roya about your conference?

B: Oh, yes, she said it was very good.

T: Wonderful, so you got good grades?

B: (Nodding his head yes).

T: What did she say about your behavior?

F: Good.

B: (just about to speak)

M: (interrupts). He is still a little fidgety, now, he is better which is really interesting. He is better writing on the floor than doing something at his desk.

B.'s teacher had begun environmental modification in the classroom since our last meeting.

T: Great, let's look at that. Why is that?

B: Because I go to my cozy spot (spot designated by the teacher away from the rest of the children)

T: And I bet you that is less distracting probably for you and away from the other kids.

M: He does not like to sit still for very long.

T: That is great idea to let him do that.

M: She said, she has a lot of kids like B., and she realized it is a lot better, and it is not that important that they sit at their desks, and if they had another area and not keep them at their desks, it is better.

T: That is fantastic, and that is one of the things in that packet that I gave her. Look what he even calls it. His cozy spot. That is wonderful.

2. Environmental Modifications at Home

Checklists

Often B. forgot his daily medication or would forget certain items for school. A checklist was used to help B. with these issues.

M: Get your shoes on.

T: OK. (writing it down)

B: Get coat on, get hat on…

M: (interrupts) Wait a minute.

B: (interrupts) Put the dishes in the dishwasher. Turn TV off.

M: (interrupts) wait a minute.

B: Make bed, put shoes on.

To make the checklist more noticeable to B., bright-colored papers were used for the checklist. The color of the paper was to be changed weekly to make it stand out more.

M: .We went to the bright colored paper. UM (thinking)…

B: (interrupts) I do everything OK on the list, but I forget to put a check on it.

T: (laughing) Now you are doing the opposite of what you used to do. You know what?…

F: Last minute, he wants to watch TV., but I say come on you've got to go.

However, as mentioned above, it is important to do the compensatory plans along with the child rather than for the child. B. gave us feedback about how he found the checklist.

B: You put too much stuff on the check list. That is why?

T: How many do you have?

B: There are like 12 things.

M: It is broken down.

F: Wait a minute. Wait a minute (Mother and B. chiming in as well)

M: Wait a minute now. We broke it down: brush your teeth, wash your face, get dressed...

T: OK. (writing it down*)*

M: Get your shoes on.

T: OK. (writing it down)

B: Get coat on, get hat on....

M: (interrupts) *Wait a minute.*

B: (interrupts) *Put the dishes in the dishwasher. Turn TV off.*

M: (interrupts) *wait a minute.*

B: Make bed, put shoes on.

M: You asked me to put that in there. Make the bed.

B: You said how about...

M: You don't really have to make your bed. Just pull it up.

B: (interupts) you said how about.

M: (interrupts) Just pull it up, and the reason is that a lot of times, he won't be able to find the socks on his bed because he does this with the sheets (making a motion with her hand so just pull it up with the sheets. If I get your clothes out, unless you want to do it yourself. They are at the *bottom of your bed, so I said look, what do you want on here, because you want it all broken down. So we did: brush your teeth, wash your face go together. Get yourself dressed, get your shoes and socks on, that goes together, but then he said, how about if you say put the dishes in the dishwasher. I said OK. we put it in, but I said remember what you have to do when you leave. Then we said get your coat and your book bag ready.*

T: Um (thinking)

M: Those are two different things. So he can make it sound like a lot.

T: So does this overwhelm you? Does it sound like a lot? What do you suggest B.? How can we help you? If we don't put all of them there you may forget. Would you rather we chunk it together? Like put these four together, for example getting ready is get clothes, brush teeth...

B: Wash my face.

T: That is all one category. Like it is one kind right?

M: That is what I said.

B: (trying to interject something, but mother kept on going).

M: You go in the bathroom; you are dressed. Your shoes and socks are on. OK. That is something that you can check off as soon as you get to the kitchen.

B: Trying a board may work. That is one thing that may work. An erase board.

T: That is a good idea. You know what I was thinking...

M: (interrupts) I just don't know where we are putting in.

B: In my room.

M: Well, if we put it in your room, it is not all finished or maybe we can do that.

B: Well just the ones that need to be done in the room.

M: (rolling her eyes).

T: This does sound like a lot of work for you (looking at the parents). If you can get it down to a science, it may make things easy. I was thinking it would be nice to have one list in his room that he gets to finish and check off before he leaves his room. Then he can have another list when he gets to the kitchen. Because, then brushing teeth, getting clothes and all can be done and checked off in his room, and then the book bag, coat, TV and the dishes are four items. OK?

Increasing time awareness

The family has been increasing B.'s awareness of time by emphasizing the external sources of time such as timers:

M: (B. has not been late for school this week). Be honest, why has that been? Why?

T: I'm sorry? (puzzled)

M: (looking at B.) Why haven't you been late?

B: Because of the buzzer.

M: What else?

T: The buzzer has helped, what else?

M: Dad.

T: (looking at B.) your dad?

F: But he does. A lot of the time I'm there, but I don't get up with him. I stay in bed for the most part. It is not that he missed the bus, but he may not have everything done by time that the bus gets there.

T: OK.

F: Whatever is not done, just doesn't get done, and he has to rush out the door slamming the door.

T: OK.

F: That is not a problem. The problem is getting everything done before the bus gets there.

T: OK The last timer goes off at what time? How long before the bus comes?

F: Five minutes.

T: Five minutes (thinking).

M: What about the first one?

F: The first one at 20 of, and the bus comes at ten of by seven fifty.

M: The first one goes off at 20 of, and the second one goes off at quarter of, because you really don't know when they are going to come (the bus). That way….

Physical Environmental Modifications

To be consistent with the teacher's efforts in the classroom, it was important to create an environment at home away from distractions where he could study after school.

T: I wonder where would be a good place for him (to study or do homework away from distractions)?

M: I know we have not found it yet. We are in the process of (pausing), they don't have a desk in their room. Br. Had to be out…

B: (interrupts) I would be comfortable with a desk. We don't have a desk except in BR.'s room.

T: It would be good for you to have your own spot. And you know what else would be good? Put it in the corner of the room where you would not have much on the wall and don't keep much of anything on the desk. Try it that way first. Sort of…

M: (interrupts) Yes, I think what we are in the process of doing is that he had a double single bunk bed, now he had two single beds, but I don't like it. It does not seem to work for them. It just causes more disarray in their room. So I think we are going back to the double single bunk bed that we had there. And it is a big window there. It stands up. The end is like a solid wall.

We thought if we put the desk right next to that like the wall is there (pointing), the closet in there (pointing), and the regular wall is there (pointing). There really is not much there.

T: Good.

M: He can't look out the window because the window is not there.

T: Good, that would be excellent.

B: Can I get BI's desk?

T: You can negotiate that later with mom and dad.

M: Yes we are. The desk that BI has is too small.

3. Utilization of Previously Learned Coping Skills

B. had begun to use relaxation techniques and anger management techniques to help reduce impulsive responding and decrease family conflict:

B: My mom is saying that I'm doing real good because my brothers are fighting with me. I used to yell, but now I do deep breathing and just walk away and tell my mom what I did.

T: That is wonderful. You have done this all week!

M: Yes.

T: Wonderful.

M: Now if we can get the other two to do that.

B: (interrupts) Now they are the ones that get it started.

4. Point-of- Performance Incentive Program

We followed up on how B. was doing with getting ready in the morning. His father mentioned that B. likes to watch T.V. in the morning, and this was a good opportunity to demonstrate how off-task behaviors can be used as a reward for the targeted behavior:

T: Well you know what? If in fact he has enough time that he could empty the dishwasher and watch a bit of TV, that can be his treat for getting everything done. He should get everything done, check them one by one as he gets it done. Remember B. before you used to check everything without doing them?

B: Hum.

T: Now you are doing them but not checking them. So let's do them and then check them.

B: Well (thinking).

Although including the child's input for reward menu is important, as mentioned before, sometimes the options offered are not the best and need modification:

B: (interrupts) Um, I just came up with an idea. Get a bottle of M&M's or skillets and then I can eat them after I check them.

T: (laughing).

M: No

F: It is 7:30 in the morning B.

B: Well, I mean, still like candy time or something. I can put it there after I check it and then eat it later.

T: You know what? Is there anything else that doesn't involve candy, and it's good for a treat that you can eat in the morning. Is there any kind of cereal that you like?

B: Or marshmallows.

M: B. you know what? I know you like rewards and everything, but isn't it much better to be able to be all ready and walk out the door and feel like you are getting a good start to the day?

T: You know what?

M: You don't have to rush. You know how the morning is.

B: But I sometimes like the cool ones.

T: Also how about using the jell pens?

B: (thinking).

T: Experiment with different colors, or...?

B: (interrupts) I have gold jell pens.

T: I like gold jell pens.

M: You have silver jell pens.

B: No, gold.

M: It's gold? I thought it was silver. What do I know.

T: (laughing).

B: I bought my gold ones at the school store.

T: All right. That is a good idea, or if your mom does not mind, she can get some stickers. Do you get this magazine (pointing to teachers supply magazine)?

M: Yes, I know someone who does. I can get that.

T: All right, that would be great.

During the course of this session, it was important to check with B. to make sure that he was paying attention and that he understood the assignment:

T: Do you know what I'm asking you to do?

B: Well, the thing is that if you could make the checks fun or something. Like a game and I'll be able to do it.

T: Do you have a good idea for that?

B: Like something fun, like a game piece.

T: Um, I see what you mean. Rather than a check, something more fun. Do you like stickers?

B: (Nodding his head yes).

M: He gets stickers at school.

T: Have you been on time for school everyday in the last week? Tell me about it.

B: I haven't missed the bus or anything.

Addressing Parental Assumptions/Expectaions

F: I don't mean to sound like an idiot, but…

T: No, go ahead.

F: Shouldn't this stuff become routine after a period of 10 years?

T: You know what…

F: (interrupts) Getting dressed brushing your teeth, you should not even have to think about that.

Father's comments about B.'s self-regulation showed that he continues to expect B. to function more spontaneously and without difficulty.

F: The 15-year-old does the same things you know. (He also has ADHD).

T: I know, and that is so frustrating. That is what I'm trying to help by doing some of the charting because I don't want you to be frustrated in the morning. Then all they have to do in the morning is touch each other once, and then you will react to that situation. See what we think is that everything should be routine, but I see a 30 -year-old right now that she cannot even get to school on time. I don't even know how she has made it to graduate school. You would think that it is not a lot to get up on time, get to the doctor's appointments. All she has to do is write it on the calendar. The routine of making it to school on time. Give yourself time to park the car. The thing with ADHD is that you notice a lot of things that are distractions. You and I can block that out, but they will notice it. In the morning, you and I get up, and we just think about shower, brush teeth, and that is it. He is going to notice the bird outside, his brother's *voice down stairs, the TV. A lot of things have the potential of becoming a distraction where he can spend time with that. All you need is 5 minutes spent here and 5 minutes spent there, and you have not gotten to do what you needed to get done. So hopefully as he gets older some of the ability to fight the distractions can become easier and more of a routine, but there definitely is a delay in what we call interference control. It is going to take him longer to develop that, and even after he develops it, he may still not be as good as other people. He may always have to work on this to some degree. That is why we try to do relapse prevention. Don't assume because we do the checklist and such, that it is all done. In a few days or weeks, you may need to evaluate and see where he is with it. Eventually you will have to teach him how to use his own methods in high school or college to do his own regulation.*

5. Daily Routine

B.'s parents had begun to reinforce a checklist and a daily schedule for weekdays; however, they did not have a routine for the weekends. The importance of structure and routine throughout the week, including the weekends, was discussed:

F: That is like the morning. He is up in plenty of time. He always has got plenty of time to get ready. That is not what bothers me. He always has time to get ready, but we are getting ready to go out the door, and I said B. did you brush your teeth this morning. He says, " I forgot."

T: Does that mean that you forgot to look at your list this morning. Right?

B: I looked at it, remembered it, but then it pops out of my head, and I just go blank.

T: I understand.

M: B. I know what you are talking about. I do the same thing.

F: She is a lot more understanding of it than I am.

M: I know, I know, I know. How many times have I made it to church on time on Sunday. I know I have 2 hours to get ready for church. I know what she is saying, you have to get yourself into a routine. I know that I have to do the same things, in the exact same thing everyday. I take my shower. I get out of the shower, put lotion on. I mousse my hair, then I come back and put my make-up on first. I do my hair. Then I move to the other sink and I brush my teeth. I do it that way, exactly that way so I'll remember.

T: You know this supports the fact that you may not forget it as much on the weekdays, because you do the same routine, but on the weekend that pattern is broken and the techniques and the checks are not used, and he will forget. Mom and dad, please use understanding and patience.

B: I know, on the weekend, I just want to play, but on the week days, I know, I have to get everything done.

M: Well, you still have to do it on the weekend.

T: Maybe, you need a routine for the weekend, or have a couple of things that you check off, like brushing teeth, getting dressed.

M: The same checklist.

6. Closure and Follow-Up

Despite the high level of parental frustration, the father was able to interject some humor while we were discussing the making of a nag tape as another way to guide B. through the morning routine.

T: What you need to do is to look at the duration from the time that he gets up and when it he is ready to walk out the door. It would be good to pace it, and then say something and then stop.

F: Like in a witchy voice?

T: Actually no.

F: (imitating a witch's voice) Did you brush your teeth B.?

T: (Laughing) No, mom can use her wonderful regular voice. (therapist joking) or whatever that you think he will respond to.

Due to lack of follow through with homework, not setting a reward menu, had to continue negotiating the rewards.

T: Did you make a reward menu? A list of all the things that he may like to do or get?

M: No, not yet.

T: OK. So you will get to that.

M: I was amazed that using the timer was helpful.

The therapist presented B. and his parents with educational material; a relaxation tape, a list of support groups, and a list of psychologists in the area that work with children with ADHD.

T: ....OK. I guess, I went through all this looking at the goals for the session. Here is what I want to give you. A list of books and videotapes all about ADHD that are good for parents, teachers and kids. . A list of these in case you decided you have nothing to do (joking). This is a booklet or a guide for families. You are beyond all this, but also a child's guide to concentration. B. you probably can write your own. This is what is available and I thought you might like these. Here is relaxation tape on side A that you get to keep, and mom is going to make a nag tape and all that. The other is a guide that someone may be able to work with B. to address things like fear of the dark, how the point system works, the reward menu and things like that. I have a list of professionals who work with children and know about ADHD.

The investigator elicited B.'s feedback about the helpfulness of the treatment program.

T: Any questions? Anything? So how was this experience for you B.?

B: I don't know?

M: Did you like it?

B: Yeah.

T: What did you like the best?

B:: The mirror one.

T: The mirror one. The mirror one is a good one for you to continue to use. Anything else?

B: I just liked everything.

Follow-up and the availability of the community professionals were discussed; however, B.'s parents decided not to consider follow-up at this time.

T: ....I have a list of professionals who work with children and know about ADHD. What do you think about that?

M: Not right now, maybe later.

T: Well I really liked working with you and appreciate you giving up your time on Saturdays and everything to come here. I really thank mom and dad because they invested a lot in this. Thank you.

Discussion

It is important to keep in mind that this research study was primarily an assessment study that introduced a treatment model, rather than a comprehensive treatment study. This section discusses the limitations and the strenghts of the proposed treatment model as well as several ethical and cultural issues related to the treatment of B. and his family. The first limitation of this treatment model was the limited number of sessions used to implement the model. This treatment model needs to be implemented as a more comprehensive treatment program over time and in multiple sessions with the parents, child, teacher, and the child and parents together. There are several reasons why we need multiple sessions for each component of this treatment. First, the establishment of therapeutic alliance with the patient(s) takes time, and especially during the first session. It would have been a good oppportunity to hear B.'s parents and to work on the therapeutic alliance with them when they explained their reason for being late for the first session. Second, offering advice early on in the session in the interest of time was not a good idea and most likely impacted the alliance between the parents and the therapist. This was evident in the pattern noted throughout the sessions when B.'s mother often replied "we do that" when the therapist offered suggestions on how to manage B.'s behavior. This type of response may have been due to the poor alliance established with the therapist.

Third, a great deal of information was presented to the parents in the first session. There was not enough time to test their understanding of the psychoeducation material until the very end of the session when the post-test was administered. It would have been more helpful if the therapist had more time to intermittently check with the parents and to test their understanding of the material throughout the session. Fourth, several techniques and strategies were introduced to the parents, e.g., problem solving and anger management, without the opportunity to provide specific examples and time to practice these skills during the session. The benefits of using specific examples and repetition of the newly introduced skills were noted in the child's session, where B. became fully engaged in the session and was able to demonstrate proficiency in the skills introduced to him. However, in addition to the first session, the parents were expected to self-educate using the detailed handouts provided to them by the therapist.

As clinicians, we may often overestimate the adults' ability and motivation to learn and utilize new information. Depending on the adult client's education, intellectual and motivation levels, such assumptions may be incorrect. We need to simplify the material to the client's level of understanding as we often do for children. We cannot assume that the adult clients know better, learn faster, or will ask for clarification when they do not undesrtand the presented material. In fact, children may be more likely to admit when they do not understand or remember, presented material; whereas the adults may fear judgment and be more hesistant to admit lack of understanding of the material.

Fifth, although homework is an important part of treatment, the amount of homework introduced to B.'s parents may have overwhelmed them. Fortunately, they were motivated enough to carry through many of the suggested homeworks, but in some instances, e.g., writing a complete reward menu, they did not complete the assignment. This may have been due to the number of homework assignments given to them all at once.

Sixth, not enough time was spent addressing parental assumptions and underlying beliefs that guided their expectations and treatment of B. A future comprehensive treatment program for an ADHD child should address modification of parental assumptions and expectations of their ADHD child in more detail. An increased number of sessions will allow for the parents to be targeted together, and individually to address each of their specific perceptions. For example, B.'s mother, appeared concerned about her level of ADHD knowledge. On several occasions she made it known that she was familiar with some of the techniques mentioned by the therapist. A logical question to address would be: What does it mean to B.'s mother to not know certain skills? Another question to have asked her after she stated that she did not want to use money as a reward for B. would be: What does using money as a reward means to her?

Generalizability of CBT techniques in treatment of ADHD has been criticized (e.g., Dush et al., 1989). While some of the techniques used in the current treatment model, e.g., problem-solving and assertiveness training, can be generalized to various settings, other techniques such as externalization of time and point-of-performance incentive program, have either not been investigated before, e.g., time awareness, or have shown not to generalize well when implemented in short-term, incentive programs. However Barkley (1998) has pointed out that these types of treatments with age appropriate modifications may be required to continue throughout childhood, adolescence, and, potentially, in adulthood in those with ADHD.

In addition to the above shortcomings, several ethical and cultural issues are related to B.'s treatment. First, there was a conflict between the role of the investigator as an investigator of the study and as a clinician treating B. B.'s family presented a number of complicated and extensive needs. The treatment provided here only addressed the tip of the iceberg. Although B. and his parents were offered follow-up options, the parents declined to pursue further treatment at the end of the study. As a clinician, the investigator could clearly see the needs of this family and the potential consequences of not pursuing follow-up treatment. However, as an investigator, she may have acted beyond the boundaries of her role had she encouraged B. and his parents to seek further professional assistance.

Second, although every clinician may selectively attend to certain information presented by the client, this tendency is greater when the clinician is also the investigator. It was interesting that the investigator did not pursue the reason why B.'s parents were late for the first session; however, she spent a considerable amount of time in another session discussing why B. was scared to go to the family room by himself. Although, the investigator did not consciously be selective, comorbid anxiety in ADHD has been of an interest to study, and this may have influenced her attending to this information. B. and his family could have clearly benefited from the exploration of both issues.

Another ethical and cultural issue involved in B.'s treatment is understanding the parents' family background and how their upbringings have influenced them as parents. As clinicians we must understand the context of our clients' lives and make treatment suggestions that are best for them with these issues in mind. In the case of B.'s father, it was clear that in his family, children were expected to obey parents. This, in turn, has influenced his expectations of his children including B. His assumptions about children and parenting should have been addressed more comprehensively. Another issue related to B.'s father is his education level and how this factored into the parent training. The educational material presented to him should have been simplified more to make sure that he understood the content. On several occasions, he mentioned "I don't mean to sound ignorant, but…" This may have been an indication that he was aware that his knowledge and beliefs were not typical of those being discussed. The current treatment did not address these issues well.

On a more positive note, several strengths in the proposed treatment model worked well. First, the treatment session with B. seemed successful as measured by his level of motivation and engagement in the session and by his correct demonstration of techniques that were taught to him. In the final session, when asked what he liked best about his treatment experience, he named the individual session and the techniques that he had learned. Second, B.'s parents seemed interested in specific and simple suggestions that they could implement at home. The therapist was able to provide several suggestions; e.g., making a morning checklist and the use of timers to prevent B. from being late for the bus in the morning. The parents cooperated with these homework assignments with positive outcomes. Perhaps this issue was reinforcing and helped compensate for the potential weak alliance with the therapist. Third, this treatment model addressed ways to externalize the concept of time; e.g., use of timers to minimize interference control, quiet and plain study room, and to compensate for the non-verbal working memory deficit, morning checklist. These elements are often overlooked in treatment of children with ADHD.

In light of the above discussion, a major shortcoming of the current treatment program was its duration and pace. Future treatment programs need to address length, therapeutic alliance, the capability and motivation of the clients, including the parents, the simplification of the education material to suit the children and their parents, opportunity for practice of skills, and more emphasis on the parental assumptions related to their ADHD child and his or her management.

CHAPTER 4

PROPOSED STUDY

The essence of Barkley's theory of executive function is that the delay in behavior inhibition causes secondary deficits in the other four executive functions; non-verbal working memory, verbal working memory, reconstitution, and regulation of affect/motivation/arousal, in those with ADHD, hyperactive and combined types. In the presented clinical case study concurrent deficits in behavior inhibition, non-verbal working memory, and awareness of time were confirmed in a subject with ADHD, combined type. One factor that attenuates behavior inhibition is the existence of comorbid anxiety disorders (Oosterlaan & Sergeant, 1998; Pliszka, 1991; Pliszka & Borcherding, 1995; Schachar & Tannock, 1995). In this proposed study the goals are to confirm deficits in behavior inhibition, non-verbal working memory, and awareness of time in a group of subjects with pervasive ADHD, hyperactive or combined types; and to investigate the impact of anxiety on behavior inhibition, non-verbal working memory, and accurate reproduction of time in the same subjects with pervasive ADHD with and without comorbid anxiety disorders.

This section provides a review of literature on comorbid anxiety disorders and ADHD, the relationship between behavior inhibition and comorbid anxiety disorders in ADHD, and a newly proposed hypothesis and study to assist us in gaining a better understanding of ADHD.

ADHD and Comorbid Disorders

Comorbidity refers to the simultaneous occurrence of two or more unrelated disorders (Pliszka, Carlson & Swanson, 1999). Epidemiological studies have shown that comorbidity is quite common (Anderson, Williams, & McGee, 1987; Jensen et al., 2001; Kashani, Beck, & Hoeper, 1987; Szatmari, Offord, & Boyle, 1989; Weissman et al., 1987) in child and adolescent psychiatry. Individuals with ADHD are known to have more symptoms of anxiety, depression, dysthymia, and low self-esteem as compared to normal children (Biederman, Faraone, Mick, Moore, & Leleon, 1996; Breen & Barkley, 1983; Jensen, Burke, & Garfinkel, 1988; Jensen, Shervette, Xenakis & Richters, 1993; Margalit & Arieli, 1984; Weiss, Hechman, & Perlman, 1978). This high level of comorbidity has been found in both diverse epidemiological samples (Bird, Canino, & Rubio-Supec, 1988; McGee, Williams & Silva, 1985) and in clinical samples (Biederman, Keenan, & Faraone, 1990). The rate of comorbidity in boys and girls with ADHD suggests that there is no significant difference in comorbidity occurrences; however, boys tend to have a higher rate of comorbid conduct and oppositional disorders, while girls show a higher prevalence for comorbid anxiety disorders (Bird, Gould, & Staghezza, 1993).

A high rate of comorbidity is associated with ADHD. About 44% of children diagnosed with ADHD have two other psychiatric diagnoses, and 11% have at least three (August, Realmuto, McDonald, Nugent, & Crosby, 1996; Szatmari, Offord, & Boyle, 1989). Of those with ADHD, 25% also meet criteria for at least one anxiety disorder. Psychiatric comorbidities most often associated with ADHD are internalizing and externalizing disorders, and learning disabilities (Pliszka, Carlson, & Swanson, 1999). More specifically, ADHD is known to be comorbid with such disorders as anxiety (Tannock, 2000), mood (Spencer, Wilens, Biederman, Wozniak, & Harding-Crawford, 2000), oppositional defiant (Newcorn & Halperin, 2000), obsessive-compulsive (Brown, 2000), learning disabilities (Tannock & Brown, 2000; Denckla, 2000), substance abuse (Wilens, Spencer, & Biederman, 2000), sleep/arousal (Brown & Modestino, 2000), tourette syndrome (Comings, 2000) and developmental coordination problems

(Gilberg & Kadesjo, 2000). This proposed study is limited to comorbidity of anxiety disorders and ADHD. The following section reviews the literature on ADHD and comorbid anxiety disorders.

ADHD with Comorbid Anxiety Disorders

Anxiety disorders are among the most common childhood disorders (Bernstein & Borchardt, 1991), and have symptom severity and level of impairment similar to adult anxiety disorders (Last, 1993). Internalizing problems are persistent with the stability of the symptoms stronger for girls as compared to boys (Verhulst & Van Der Ende, 1992). Recovery from childhood anxiety disorders is challenging; often at follow-up, close to one third of the children often meet diagnostic criteria for a new anxiety disorder (Last et al., 1996). Extensive epidemiological studies (Szatmari, Offord, & Boyle, 1989) have found that 17% of females and 21% of males with ADHD, ages 4 to 11, and 24% of males and 50% of female adolescents suffer from anxiety disorders.

A review of literature suggests an overlap between ADHD and anxiety disorders in 10% to 40% of cases, with a suggested average range of 25% (Biederman, Newcorn, & Sprich, 1991; Livingston, Dykman, & Ackerman, 1990; Jensen et al., 1993). Biederman et al., (1991a) examined the prevalence of ADHD and anxiety disorders among the first-degree relatives of clinic referred children with ADHD with and without anxiety disorders. Relatives of ADHD children had an increased risk of ADHD themselves regardless of whether the child had an anxiety disorder or not. Relatives of ADHD children without anxiety had a higher risk of anxiety disorders as compared to controls, and the relatives of children with anxiety disorder had the highest risk for anxiety as compared to the other two groups. These results further suggested that the anxiety disorders are transmitted independent of ADHD in families.

While the presence of comorbid anxiety in children with ADHD presents complications for treatment, on the other hand, seems to attenuate impulsivity by improving behavioral inhibition (Pliszka, 1991; Pliszka & Borcherding, 1995; Oosterlaan & Sergeant, 1998; Schachar & Tannock, 1995). The following section provides a review of literature on the relationship between ADHD, comorbid disorders and behavior inhibition.

Behavioral Inhibition and Comorbidity in ADHD

Behavioral inhibition has been studied in several ways. Direct behavioral observation, CPT, go-no-go tasks, stop-signal paradigm, delayed tasks such as Kagan's Matching Familiar Figures Test (Kagan, 1964), and WCST have been used to study behavioral inhibition. Studies using behavioral observation of children with ADHD found that these children have a difficult time inhibiting their behavior. They have a higher rate of activity (Gomez & Sanson, 1994b; Teicher et al., 1996), and a difficult time restricting their behavior when asked (Militch & Loney, 1979; Ullman, Barkley, & Brown, 1978). Difficulty in delaying gratification (Campbell et al., 1994; Schweitzer & Sulzer-Azaroff, 1995), and resisting temptations (Hinshaw, Simmel, & Heller, 1995) provide further evidence for poor inhibitory control in children with ADHD.

Several studies (Barkley et al., 1990; Grodzinsky & Diamond, 1992; Reader et al., 1994; Pliszka, 1991; Pliszka et al., 1997) have used Continuous Performance Tasks (CPT), and have found that subjects with ADHD make a greater number of commission errors than the controls. Commission errors indicate the subject's inability to inhibit an ongoing behavior on time. Similarly the go-no-go-tasks require the subject to inhibit a motor response, e.g., finger tapping upon cue. The ADHD subjects have found it difficult to withhold their response on the no-go signal (Trommer et al., 1988; Shue & Douglas, 1989; Iaboni, Douglas, & Baker, 1995; Militch et al., 1994; Yong-Liang et al., 2000). Similarly, on delayed tasks, studies (Sonuga-Barke, Houlberg, & Hall, 1994; Weyandt & Willis, 1994) have found that ADHD subjects respond more impulsively, rather than use a delay period to reflect upon the task.

While most of the above tasks and methods of studying behavioral inhibition measure the subject's ability to stop an ongoing behavior, one of the three components of behavioral inhibition, the stop-signal paradigm (Logan, Cowan, & Davies, 1984) studies both the ability to inhibit a response and response re-engagement. This paradigm measures the efficiency of the subject's ability to inhibit his or her ongoing response and also to become re-engaged and respond when given the signal to go. The ability to inhibit the ongoing response depends on the speed and variability of the primary task that initially requires the subject to respond, as well as the speed and efficiency of the inhibition process. The longer the time period between the presentation of the primary task and the presentation of the stop signal, the more chances that the subject will inhibit the response more successfully (Schachar, Tannock, & Logan, 1993). However when the interval between the presentation of the primary task and the request for inhibition of response is short, ADHD subjects find it difficult to respond successfully to inhibit an ongoing response.

A growing number of studies using The Stop-Signal Task, have provided evidence that ADHD involves inhibitory deficit (e.g., Pliszka et al., 1997; Nigg, 1999; Schachar & Logan, 1990; Schachar et al., 1995; Oosterlaan & Sergeant, 1998; Pliszka, Liotti & Woldorff, 2000; see Oosterlaan, Logan, & Sergeant, 1998 for a meta analysis). Pliszka et al. (1997) studied inhibitory control using the Stop-Signal Task in a group of children with ADHD compared to controls. The results showed that the ADHD group had a significantly slower inhibitory control. This is consistent with other findings of Nigg (1999) that further showed that the ADHD children have a response inhibition deficit regardless of IQ, reading difficulties, and disruptive behavior. Such inhibitory deficits have been confirmed by other studies and have been linked to frontal lobe activity level (e.g., Pliszka, Liotti & Woldorff, 2000; Yong-Liang et al., 2000).

A number of studies have investigated different groups of ADHD and response inhibition. Schachar and Logan (1990) studied the development of inhibitory control in children Grades 2, 4, and 6. Their sample included ADHD (both pervasive and situational), conduct disorder (CD), learning disorder, emotional disorder, and "normal" children. The results of the Stop-Signal Task showed that the ADHD group showed the greatest number of errors and amount of variability in mean reaction time, while the emotional disordered group showed the least amount of variability. On the stopping processes, the ADHD group inhibited fewer responses in comparison to the control group; however, their number was not significantly different from the CD or the ADHD plus CD group. Further analysis, after excluding the ADHD situational (school only) from the ADHD pervasive sample (home and school), showed that the ADHD pervasive group (at home and at school) had significantly slower inhibitory processing. They were most affected by the stop-signal delays, and the shorter the delay between the start and stop process, the poorer performance in inhibition by the ADHD (pervasive) group. Based on this evidence, Schachar and Logan (1990) concluded that the ADHD, pervasive group was the only group that showed a deficit in the underlying inhibitory control. Schachar et al., (1995) have confirmed these findings by studying inhibitory control in children with situational ADHD, pervasive ADHD, and controls. Their results supported a deficit in inhibition and response re-engagement in those with pervasive ADHD and, to a lesser degree, in children with ADHD (situational). Later studies have confirmed these results (Kuntsi, Oosterlaan, & Stevenson, 2001).

Inhibitory control and cognitive functioning have been studied across

ADHD and its comorbid groups, but these studies have produced mixed results (Nigg, 1999; Manassis, Tannock, Barbosa, 2000; Oosterlaan & Sergeant, 1996, 1998; Pliszka, 1991; Pliszka et al., 1997; Pliszka, Liotti, & Woldorff, 2000; Schachar et al., 2000; Schachar & Tannock, 1995; Slusarek, Velling, Bunk, & Christian., 2001; Yong-Liang et al., 2000). Oosterlaan and Sergeant (1998) studied behavioral inhibition in a group of children with ADHD, aggression, anxiety, and controls. Similar to Pliszka & Borcherding, (1995), they found inhibitory deficit in both aggressive and ADHD groups; therefore, they did not conclude that inhibitory deficit was limited to ADHD only. On the other hand, Schachar & Tannock (1995) studied inhibitory control in children with ADHD only, CD only, and ADHD + CD. They found a deficiency in response inhibition in both the ADHD only and the ADHD + CD groups, but not in CD only group. Therefore, they concluded that the inhibitory deficit in the ADHD + CD group can be attributed to the ADHD symptoms rather than to the CD. Recent studies (Schachar et al., 2000) have confirmed that children with ADHD have a significantly impaired inhibitory control in comparison to ADHD+CD, CD, and controls.

Another comorbid group studied is anxious children with ADHD (Pliszka, 1991; Manassis, Tannock, & Barbosa, 2000; Pliszka & Borcherding, 1995; Schachar and Tannock, 1995). The study by Schachar and Tannock (1995) included a group of children with anxiety disorders. While the ADHD group showed a slow inhibitory process, the anxious group did not show any inhibitory deficit compared to the normal control. This is similar to Pliszka (1991), Pliszka & Borcherding, (1995), and Oosterlaan and Sergeant (1998) who have suggested that children with ADHD + anxiety are less impulsive and less impaired in their inhibitory control than the ADHD only group but more impaired than the control group. There was no evidence of over-inhibition compared to the normal controls, contrary to what had been previously suggested

(Quay, 1988a, 1988b; Oosterlaan & Sergeant, 1998). However, a study by Oosterlaan and Sergeant (1998) investigated response inhibition and response re-engagement in children with ADHD, disruptive behavior, anxiety and normal control, and found evidence for enhancement of response inhibition in those with anxiety. It is important to keep in mind that their anxious group did not have ADHD; therefore, while anxiety alone may enhance inhibition, the impact of anxiety and ADHD on inhibition needs further investigation. Other studies (Manassis, Tannock, & Barbosa, 2000) that included ADHD comorbid with anxiety have found that the ADHD group exhibited slower inhibitory control on the Stop-Signal Task compared to ADHD + anxiety, anxiety and normal control groups, but these results did not reach a significant level. This study did not separate ADHD, pervasive from ADHD, and situational. Such separation may have strengthened their results to support significant inhibitory deficit in those with ADHD.

As indicated above, the results of the studies investigating behavior inhibition and anxiety in ADHD have produced mixed results. Further investigation is needed to address several shortcomings. First, not all the studies differentiated between ADHD, pervasive and ADHD situational types. Second, some of the studies that investigated anxiety and behavior inhibition did not include ADHD comorbid with anxiety, but just sampled an anxious group without ADHD. Third, several of the above studies did not reach statistical significance; however, none of them discussed what their results meant in terms of clinical significance. Fourth, and most importantly, only two out of three components of behavioral inhibition have been studied using the Stop-Signal Task. None of the studies investigated the interference control aspect of behavior inhibition. The following proposed study will investigate all three components of behavior inhibition in addition to the non-verbal working memory and reproduction of time intervals in a pervasive ADHD sample with and without comorbid anxiety disorders.

Hypothesis

The hypotheses are (a) there will be a deficit in all three components of behavior inhibition (response inhibition, response re-engagement, and interference control) non-verbal working memory, and sense of time in ADHD subjects, both pure and with comorbid anxiety disorders compared to controls; (b) the deficit in response inhibition will be significantly different as follows, pure ADHD >ADHD + anxiety >controls; (c) the deficit in response re-engagement will be significantly different as follow; pure ADHD >ADHD + anxiety > normal controls, (d) the deficit in interference control will be significantly different as follow; pure ADHD >ADHD + anxiety> controls; (e) The deficit in non-verbal working memory will be significantly different as follows, pure ADHD > ADHD + anxiety > controls; (f) the inaccuracy in reproduction of time will be significantly different as follows, pure ADHD > ADHD + anxiety > controls. Unlike previous studies, the proposed study will address all three components of behavior inhibition including interference control. Previous studies have used the Stop-Signal Task to measure inhibition of prepotent response and response re-engagement. The current study proposes the use of the Stroop Color-Word test to measure the interference control part of behavior inhibition in addition to the inhibition of response and response re-engagement.

Method

Subjects

Three groups will be involved in this study: (a) ADHD (pervasive) hyperactive or combined type group without comorbid internalizing or externalizing disorders; (b) ADHD (pervasive) group with comorbid anxiety disorders; and (c) normal controls. The first two groups will consist of 45 children in each group with ADHD (pervasive), ages 7 to 13 years, referred from Concord Behavioral Health, an out-patient practice. The third group will be recruited by using the snowball technique described in the procedure section.

The inclusion criteria are:

1. Meeting full DSM-IV diagnostic criteria for either ADHD with hyperactivity or combined type.
2. Rating Scale-IV hyperactivity scores within the 93rd percentile.
3. Rating Scale-IV inattentive scores within the 93rd percentile.

The exclusion criteria are:

1. Any children with IQ scores of less than 70.
2. Any children with present or past episodes of psychosis.
3. Any child with the diagnosis of ADHD, inattentive type.
4. Any child with diagnosis of conduct disorder.

Setting

The subjects will be interviewed, and the experiment will be conducted at the Concord Behavioral Health Office, in Wilmington, Delaware.

Design

The design of this study will be between group quasi-experimental.

Independent variable - The independent variable of interest in this study is diagnosis (ADHD pervasive - hyperactive or combined types, anxiety, and controls).

Dependent Variables - The dependent variables of interest are: (a) the three components of behavior inhibition; response inhibition, response re-engagement, and interference control; (b) non-verbal working memory (immediate recall, delayed recall, and recognition trial); and (c) accuracy in time reproduction (absolute discrepancy error in auditory + distraction task, auditory – distraction, visual + distraction, and visual – distraction).

Measurements

Interview Instruments

Clinical Interview (Barkley & Murphy, 1998) - This interview is based on the DSM-IV diagnostic criteria specific for ADHD. This interview provides a structured way to gather biographical information, developmental and medical history, school history, psychological and social strengths, and family history of mental illness; it also provides a screening for the DSM-IV childhood disorders and parental management of the child's behavior. This information is necessary prior to generating a treatment plan because comorbid disorders and more effective parental management methods are to be included in the treatment plan.

Rating Scales

ADHD Rating Scale-IV (DuPaul, Power, Anastopoulos, & Reid, 1998) – This is an 18-item parent and teacher-rating scale designed to assess nine symptoms of hyperactivity-impulsivity as described in the DSM-IV. Items on this scale were taken from DSM-IV; however, in many cases they were reworded to increase their clarity. Each item is rated on a 4-point scale (0=not at all, rarely; 1=sometimes; 2=often; 3=very often). Factor analyses of both the home and school versions of the ADHD Rating Scale-IV have shown that the factor structure of this scale is similar to the theoretical structure described in the DSM-IV

(DuPaul et al., 1998; DuPaul et al., 1997). Parent and teacher ratings on this measure were found to be internally consistent and stable over a four-week period. They also correlate significantly with observations of classroom behavior, task accuracy, and corresponding subscales of the Conners' Parent and Teacher Rating Scales (DuPaul, 1998). Both the parent and teacher versions include the normative data collected in a large national sample stratified according to geographic region and ethnic group (DuPaul et al., 1998; DuPaul et al., 1997).

Test of Time Reproduction

Time Perception Test (TPT; University of Massachusetts Medical Center, 1996) - TPT is a research tool with standardized administration, and norms in development. This is a computerized test that measures the person's psychological sense of time and ability to estimate and to reproduce time intervals set by the experimenter. The test is divided into visual and auditory trials. The visual trials test the subject's time perception via visual cue, which is a lit light bulb. The auditory tests provide a tone for the subject, who is to listen or to watch the cues carefully. The subject is then asked to repeat the tone or the lit bulb by pressing and holding down the space bar on the computer for the same duration as the visual or the auditory cue. (a) Visual Test Without Distraction - During this test a light bulb is presented on the left side of the window. Before the light bulb is lit, the word "WATCH" appears. The subject is to watch the light bulb very carefully. When the lit interval is ended, the light bulb on the left side of the computer will be in the UNLIT state. At the same time, another unlit light bulb will be displayed on the right side of the display. This light bulb is for the subject, and the words "YOUR TURN" will appear under this light bulb. The subject is then to press and hold the space bar to light the second bulb for the same interval as the first light bulb was lit. The time intervals chosen by the examiner will be presented to the subject randomly on all four tasks. Each test has ten trials; (b)

Visual Test With Distraction - This test is exactly the same as the test above, but a random visual distraction such as a butterfly is displayed across the main window during the computer's interval. This distraction does not appear while the subject is reproducing the task; (c) Auditory Test Without Distraction - The auditory tasks are similar to the visual tasks, but a tone is used rather than introducing a light bulb. Just prior to the computer tone, the word "LISTEN" appears on the left side of the blank screen. Two seconds later the tone is introduced for the duration set by the examiner, then the words "YOUR TURN" appear on the screen. The subject is to press and hold the space bar to reproduce the tone for the same duration; (d) Auditory Test with Distraction - This test is exactly the same as the auditory test without distraction except as the computer produces the tone, random auditory distractions occur in addition to the main tone. The distractions include noises such as clapping or a train whistle. Despite the distractions, the main tone is audible at all times. These distractions do not occur when the subject is reproducing the tone. Temporal organization and the perception of time are the functions of the dorsolateral loci (Fuster, 1995).

Psychometric Testing/ Screening for Cognitive Abilities

Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) – This is a screening measure to rule out subjects with below average cognitive ability, rather than an extensive measure of the subject's cognitive abilities. This test is an individually administered short, reliable, and valid estimation of fluid and crystallized intelligence (Horn, 1995; Kaufman, 1994). The WASI is often used for such screening purposes as attention-deficit/hyperactivity disorder, learning disabilities, mental retardation, or giftedness. This test can be administered to individuals ages 6 to 89; the administration time is about 30 minutes. The WASI is nationally standardized and provides three scores for Verbal, Performance, and Full Scale IQ. The subtests of WASI are Vocabulary, Block Design, Similarities, and Matrix Reasoning. These subtests are similar to their counter subtests in WISC-III, and their correlation coefficient ranges from .69 to .74. The coefficient for the IQ scales, as compared to the WISC-III, range from .76 to .87. The WASI subtests have the highest loadings on general intellectual functioning (g factor) (Brody, 1992; Kamphaus, 1993; Kaufman, 1990; Sattler, 1988; Wechsler, 1991; 1997). In addition to the g factor loadings, these subtests were chosen for their ability to tap into cognitive functioning such as verbal versus nonverbal and fluid versus crystallized abilities.

Neuropsychological Measures

The Rey Complex Figure Test and Recognition Trial (Meyers & Meyers, 1995)- This is a test of perceptual organization, which relies on the non-verbal working memory. Patients with frontal lobe lesions have been shown to perform poorly on this task (Lezak, 1995). Furthermore, this test has effectively differentiated ADHD subjects from controls (Douglas & Benezra, 1990; McGee et al., 1989; Grodzinsky & Diamond, 1990; Grodzinsky & Diamond, 1992). This test requires the subject to copy a complex abstract design accurately. This is followed by a recall after three-minute and 30-minute delays. In addition to the recall components, this test involves a recognition trial immediately followed by the 30-minute recall. The recognition trial involves the introduction of 24 geometric figures, 12 of which are components of the initial complex figure previously presented to the subject. The subject then identifies only the figures that he or she has seen before in the original complex figure. The scoring criterion used here is based on the criteria developed by Rey (1941). Rey's scoring system divides the complex figure into 18 components; each component receives an individual score of 0, 0.5, 1 or 2. These values are assigned to each component based on accuracy and placement criteria. The obtained values are then compared to the norms indicated for the subject's age group.

The Stroop Color-Word Test (Golden, 1987) - This test is based on the concept that it takes longer to call out the color name of colored patches than to read the words. It takes even longer to name the color when the printed word is in a different color than the word suggests. This task measures the subject's ability to inhibit one set of responses and to be able to use selective attention. The patient is first asked to read the name of colors on the first trial and then to name the color of four continuous X's. The last trial requires the subject to name the color of the word when the words spell a different color. Most subjects show the tendency to read the word, but this tendency is even stronger in those with ADHD. Several studies (Grodzinsky, 1990; Hopkins et al., 1979; Gorenstein, Mammato, & Sandy, 1989; Boucugnani & Jones, 1989; Pennington, Grossier, & Welsh, 1993; Weyandt & Willis, 1994) have shown that the Stroop Color-Word Test is particularly sensitive to differentiating ADHD subjects from normal controls.

The Stop-Signal Task (Logan, Cowan & Davis, 1984) – This is a laboratory analogue of everyday situations that require fast and accurate inhibition or execution of a response. This is a measure of an internal ability to control one's behavior (Schachar, Tannock, & Logan, 1993). This task is computerized, and the subjects are first asked to respond as quickly and as accurately as they can to a primary task. The primary task is the initial presented stimulus that requires the subject to respond. The subjects are unpredictably presented with a tone generated by the computer; e.g., a car horn which is the stop-signal requiring them to withhold their motor response; clicking on the computer mouse. This paradigm measures the efficiency of the subject's ability to inhibit his or her ongoing response and to become re-engaged and respond when given the signal to go. The original Stop- Signal Task was created based on a model presented by Logan, Cowan, & Davis (1984). According to this model the ability to inhibit an ongoing response depends on a race between two sets of responses. First, there is the go or the primary task requiring the subject to respond and second, there is the inhibition process. The finishing times of the two processes determine the outcome as to which process takes place. The ability to inhibit the ongoing response depends on the speed and variability of the primary task, and the speed and efficiency of the inhibition process. The longer the time period between the presentation of the primary task and the presentation of the stop signal, the more chances that the subject will inhibit the response more successfully (Schachar, Tannock, & Logan, 1993). However, when the interval between the presentation of the primary task and the request for inhibition of the response is short, ADHD subjects find it difficult to respond successfully to inhibit an ongoing response. The reliability and validity of this instrument as a research tool to measure response inhibition and response re-engagement have been established (Denckla, 1994; Tannock, Schachar, Carr, Chajczky, & Logan, 1989).

Procedure

Clinical Groups: Children, ages 7-13 diagnosed with ADHD only, ADHD and comorbid anxiety and anxiety only, will be referred by the Concord Behavioral Health psychiatrist. He will offer the children and their parents a pamphlet describing the study, explain the need for the ADHD children to stop their stimulant medication 24 hours prior to the study, and the time involved. The parents will have a chance to take this information home and decide whether or not their child would like to participate in this study. Parents of children who are willing to participate in this study will then contact the principal investigator to schedule an appointment.

The investigator will confirm diagnosis based on the DSM-IV criteria, using a structured clinical interview (Barkley & Murphy, 1998), parent and teacher reports (the ADHD Rating Scale-IV, both home and school versions, will be administered to assess the level of hyperactivity and inattention). Next, the WASI will be administered. Only subjects with Full

Scale IQ of above 70, and those who meet criteria for ADHD (hyperactive or combined type), both anxiety and ADHD (hyperactive or combined type), and anxiety only will be included in this study. Subjects will be divided into the pure ADHD group, and the ADHD + comorbid anxiety group.

Control Group: The third group, the control subjects, will be recruited using the "snowball" technique. The ADHD subjects will be given the option to ask their friends and associates of the same age range who have not been identified as having ADHD, anxiety, or CD to participate in this study. In turn, those families will be asked to recruit their friends of appropriate age for the study until there are 45 participating control subjects. After all three groups are established, a multiple-sample Chi-Square Test will be used to investigate possible group differences in sex, age and IQ. It is important that the groups be comparable in these areas, because behavior inhibition may improve with age. Further, anxiety disorders may be more common and commonly diagnosed in females of the same age groups as compared to males.

All Groups: Once the comparable samples are identified, an appointment will be made to meet for assessment. During the initial session, the consent form is reviewed with each subject and parent(s) to make sure that they understand the nature of the study and the informed consent. Both parent(s) and the child will need to consent and sign the form prior to the experiment. The parents will then be asked to wait in the waiting room for approximately two hours or to return for their child at a specific time. The investigator will explain to each subject that she is about to play several games with him or her. Some games will involve using a computer, and some will not. The subject is simply asked to do the best that he or she can, and to ask for breaks as needed. The measures will be administered in the following order: the Rey-Complex Figure Test and

Recognition Trial, the Stroop Color-Word Tests, the Time Perception Task (TPT), both visual and auditory, with and without distractions, and the Stop-Signal task. After the completion of the session, the experimenter will be available to the subjects and their parents to answer questions.

Results

1. Response inhibition is being measured by The Stop-Signal task by plotting the probability of inhibition against stop-signal interval. The slope of inhibition (IF-slope) is taken as a measure of subject's capability for response inhibition. This slope is calculated by a regression line. The flatter the slope, the poorer the response inhibition. According to the race model (Logan, Cowan, & Davis, 1984), the inhibition function is assessed by (a) the speed of response execution; (b) the speed of inhibition and variability in the speed of inhibition; and (c) the probability of triggering the inhibitory response. Therefore, a flat inhibition function can be either due to a deficiency to response execution or a deficiency in the inhibitory process. According to the race model, two measures are obtained. First, Stop-Signal Reaction Time (SSRT), and second, the slope of inhibition as a function of ZRFT (ZRFT slope). ZRFT equals the difference between primary-task reaction time and delay in stop-signal reaction time. The faster the SSRT, the more likely that a response will be inhibited. In addition to the slow SSRT, the low probability of triggering the inhibitory processing, and the high variability in the latency of the inhibitory process may contribute to poor response inhibition. To establish the group differences in response inhibition, the ZRFT transformation is needed to correct for differences in mean reaction or MRT and for variability in reaction times or SSRT. If group differences disappear after the ZRFT correction, then the difference in the inhibitory response was either due to MRT or SSRT. However, if differences continue to exist after the ZRFT correction, this

indicates a difference in triggering the inhibitory process, and a flat ZRFT indicates deficiency in inhibition.

2. Response re-engagement will be measured by the change response. The mean latency of responding (change MRT) and the variability in reaction times (as the standard deviation of latencies or change SD) will be measured across stop trials to inhibit the primary task. The total number of commission and omission errors provide accuracy of change responses.

Table 1.

Response Inhibition and Response re-engagement

Measure	ADHD only		ADHD + Anxiety		Controls	
	Mean	SD	Mean	SD	Mean	SD
Response Inhibition						
IF-slope						
SSRT (ms)						
ZRFT-slope						
Change response						
Change MRT (ms)						
Change SD						
Number of errors						

Repeated measure ANOVA will be used to determine the significance for response inhibition and response re-engagement. If the results are significant at 0.05 level, then post hoc pairwise comparison, using Tukey's Honesty Significance Difference will be used to investigate the source(s) of these differences.

3. The interference control component of behavior inhibition will be measured by the interference score on the Stroop Color-Word Test (Golden, 1978).

Table 2.

Stroop Color-Word Test Results

	ADHD Only	ADHD + Anxiety	Controls
Interference score			

One-way ANOVA will be used to determine differences between the group means.

The second dependent variable, non-verbal working memory, will be measured by Rey-Complex Figure and Recognition Trial Test (Meyers & Meyers, 1995).

Table 3.

Rey-Complex Figure Test and Recognition Trial Results

	ADHD Only		ADHD + Anxiety		Controls	
	Mean	SD	Mean	SD	Mean	SD
Immediate Recall T-score						
Delayed-Recall T-score						
Recognition Trial T-score						

One-way ANOVA will be used to determine differences between the group means.

The third dependent variable is the accuracy of time reproduction as measured by the Time Perception Task (both auditory and visual tasks, with and without distractions). Absolute Discrepancy Error Scores will be obtained on auditory tasks with distraction, auditory task without distraction, visual tasks with distraction, and visual tasks without distraction.

Table 4. The Time Reproduction Test Results

Absolute Discrepancy Error (ms)	ADHD Only		ADHD + Anxiety		Controls	
	Mean	SD	Mean	SD	Mean	SD
Auditory + Distraction						
Auditory – Distraction						
Visual + Distraction						
Visual – Distraction						

One-way ANOVA will be used to determine differences between the group means.

The expectations are that the ADHD only group will show significantly slower inhibitory processes (including inhibiting a response, response re-engagement, and interference control), a deficit in non-verbal working memory, and less accurate reproduction of time intervals. This would be consistent with Barkley's model for ADHD. The ADHD + anxiety group will also show a deficiency in behavior inhibition, non-verbal working memory, and less accurate reproduction of time intervals; however, this deficit will be significantly less than what is found in the pure ADHD group, but significantly more deficient than those in the control group.

Discussion

Prior to discussing the specific findings of this study, several factors with regard to generalization are noteworthy. There are several threats to the internal and external validity of this study that may make generalization to the respective populations, difficult. History is a threat to internal validity of this study that was difficult to control. There was no control for any external events that may have systematically affected the status of the subjects in this study. Therefore, it is difficult to establish a causal relationship between the dependent and the independent variables with complete certainty. The interaction between selection and the independent variables may be a factor that impacts this study. The two experimental groups were already patients at Concord Behavioral Health, and despite the choice that they were given, may have found it difficult to refuse to participate in the study. The control group on the other hand, had no previous encounter with this organization, and may have been more motivated to participate in the study. The motivation level of the subjects often can impact their performance level, therefore altering the results.

The results will show that the subjects with ADHD only are significantly more deficient in all three components of behavior inhibition in comparison to the ADHD + anxiety, and the controls. The ADHD=anxiety group will have a significantly better behavior inhibition than the ADHD only group, and significantly more deficient than the controls. While, the ADHD + Anxiety group, have a significantly better behavior inhibition when compared to the ADHD only group, they have significantly lower level of behavior inhibition than the controls. Unlike previously suggested (Gray, 1987), while anxiety alone may increase behavior inhibition, anxiety comorbid with ADHD can at best attenuate behavior inhibition.

While our understanding of ADHD, behavior inhibition, and the impact of anxiety on this function have been expanding, the understanding of underlying mechanism of action in anxiety needs further investigation. Researchers have attempted to explain the underlying mechanisms of anxiety from the information processing and neurobiological points of view. Tannock (2000) explains that anxiety may facilitate task performance and behavioral inhibition by preempting the processing and storage of the working memory system on simple reaction time tasks and by providing a motivational function that facilitates processing and storage of the working memory. Others have attempted to explain the mechanism of action in anxiety on ADHD through the neurobiological mechanisms (Gray, 1982). Behavior inhibition is controlled by the noradrenergic and serotonergic systems (Gray, 1982). Children with anxiety have higher noradrenergic functions and a higher level of behavioral inhibition; however, children with ADHD only have a decrease in noradrenergic function and a lower level of behavioral inhibition.

In addition to anxiety, recent research has identified other variables that impact the study and understanding of behavior inhibition that have not been considered in previous research. Slusarek et al. (2001) have explored the effect of motivational aspects and the delayed aversion variables associated with ADHD on inhibitory control. They studied the impact of reward on response inhibition of children with ADHD compared to psychiatric and normal groups. The ADHD children showed slower inhibitory processing in low incentive conditions, but when the incentives were high, the ADHD children performed equally as well on response inhibition. These results suggest the differentiation of performance versus ability. This is not inconsistent with Barkley's Theory of Executive function (1997b). He proposed that motivational deficit is a significant component of executive function involved in ADHD. Future studies should investigate motivational variables further.

Recently, Yong-Liang et al. (2000) proposed the impact of task order on behavior inhibition using EEG measures in ADHD and normal children on a go-no-go task. Their results showed that the deficit in EEG functions and behavior inhibition were only present when the go-no-go response was performed after a non-related task, such as drawing an animal. They concluded that perhaps ADHD involves an inhibitory regulation problem rather than an inhibition deficit. This variable was not previously considered in research and warrants future investigation.

Other variables to consider when studying behavior inhibition are factors that affect its measurement. Considering that ADHD children do not exhibit consistent effort, and perform variably, there is a need to measure sustained inhibition versus momentary inhibition. The Stop-Signal Task measures momentary inhibitory processing versus ongoing inhibition (Kuntsi, Oosterlaan, & Stevenson, 2001; Oosterlaan & Sergeant, 1996); therefore, there is a need for a research tool that measures sustained inhibition over a period of time.

In light of the above findings, the newly proposed study has several limitations. This study did not consider the impact of motivational variables on inhibitory processing, nor was the impact of task order on inhibition included. Most significantly, this study only measured moments of inhibition versus sustained inhibition. Although, there has been an increase in the understanding of behavior inhibition and its function in ADHD, more recent research has raised questions about how behavior inhibition has been conceptualized in ADHD thus far. Future research should address these questions, and work toward the development of effective measures to study sustained behavior inhibition.

References

Abikoff, H. (1987). An evaluation of cognitive behavior therapy for hyperactive children. In B. B. Lahey & A. E., Kazdin (Eds.), *Advances in clinical child psychology, 10,* 171-216.

Abikoff, H., Ganeles, D., Reiter, G., Blim, C., Foley, C., & Klein R. G. (1988). Cognitive training in academically deficient ADHD boys receiving stimulant medication. *Journal of Abnormal Child Psychology, 16,* 411-432.

Abikoff, H. B., & Hechtman, L. (1996). Multimodal Therapy and stimulants in the treatment of children with attention-deficit hyperactivity disorder. In E. D. Hibbs & P. S., Jensen (Eds.), *Psychosocial treatments for child and adolescent disorders: Empirically based strategies for clinical practice(pp. 341-369).* Washington, DC: American Psychological Association.

Abramowitz, A. J., & O'Leary, S. G. (1997). Behavioral interventions for the classroom: implications for students with ADHD. In. D. L. Smallwood. (Ed.), *Attention disorders in children: Resource for school psychologists (169-180).* Bethesda, MD: The National Association of School Psychologists.

Abramowitz, A. J., & O'Leary, S. G., Rosen, L. A. (1987). Reducing off-task behavior in the classroom: A comparison of encouragement and reprimands. *Journal of Abnormal Child Psychology, 15,* 153-163.

Achenbach, T. M. (1991). *Integrative Guide for the 1991 CBCL 14-18, YSR, and TRF Profiles.* Burlington, VT: University of Vermont, Department of Psychiatry.

Achenbach,T. M., & Edelbrock, C. (1983). *Manual for the Child Behavior Checklist and Revised*

Child Behavior Profile. Burlington, VT: Author.

Achenbach,T. M., & Edelbrock, C. (1986). *Manual for the Teacher Report Form and the Child Behavior Profile.* Burlington, VT: Author.

Achenbach,T. M., Howell, C. T., McConaughy, S. H. (1995). Six-year predictors of problems in a national sample. III: Transitions of young adult syndromes. *Journal of American Academy of Child and Adolescent Psychiatry, 34*, 658-669.

Ackerly, S. S., & Benton, A.L. (1947). Report of a case of bilateral frontal lobe defect. *Research Nervous Mental Disorders, 27,* 479-504.

Ackerman, P. T. Ahant, J. M., & Dykman, R. A. (1986). Arithmetic automazation failure in children with attention deficit and reading disorders: Associations and sequela. *Journal of Learning Disabilities, 19,* 222-232.

Adelman, H., & Taylor, L. (1983). Enhancing motivation for overcoming learning and behavior problems. *Journal of Learning Disabilities, 16,* 384-392.

Adelman, H., & Taylor, L. (1990). Intrinsic motivation and school misbehavior: Some intervention implications. *Journal of Learning Disabilities, 16*, 384-392.

Alexander, G. E., Curtcher, M. D., & Delong, M. R. (1991). Basal Ganglia-thalamocortical circuits: Parallel subtrates for motor, oculomotor, "prefrontal" and "limbic" functions. *Brain Research, 85,* 119-145.

Alexander, G. E., Delong, M. R., & Strick, P. L. (1986). Parallel organization of functionally segregated circuits linking basal ganglia and cortex. *Annual Review Neuroscience, 9,* 357-381.

Alexander, G.E., Newman, J.D., & Symmes, D. (1976). Convergence of prefrontal and acoustic inputs upon neurons in the superior temporal gyrus of the awake squirrel monkey. *Brain research, 97,* 17-31.

Alexander, J. F., & Parsons, B. (1982). *Functional family therapy.* Monterey, CA: Brooks/Cole.

Aman, M. G., & Werry, J. S. (1982). Methylphenidate and diazepam in severe reading retardation. *Journal of American Academy of Child and Adolescent Psychiatry, 21,* 31-37.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders (4th ed.).* Washington, DC: Author.

Anastopolous, A. D., Shelton, T. L., DuPaul, G. J., & Guevremont, D. C. (1993). Parent, training for attention deficit hyperactivity disorders: Its impact on parent functioning. *Journal of Abnormal Child Psychology, 21,* 581-596.

Anderson, S. W., Damasio, H., Jones, R. D., & Tranel, D. (1991). Wisconsin Card Sorting Test performance as a measure of frontal lobe damage. *Journal of Clinical and Experimental Neuropsychology, 13*, 909-922.

Anderson, J.C., Williams, S., & McGee, R. (1987). DSM-III disorders in preadolescent children: Prevalence in a large sample from the general population. *Archives of General Psychiatry, 44,* 69-76.

Arnold, L. E. (1996). Sex differences in ADHD: Conference summary. *Journal of Abnormal Child Psychology, 24,* 555-569.

Arnold, E., & Jensen, P. S. (1995). Attention-deficit disorders. In H. I. Kaplan & B. Sadrock (Eds.), *Comprehensive Textbook of Psychiatry (6th ed., pp. 2295-2310).* Baltimore: Williams & Wilkins.

Arnsten, A. (2000). Genetics of childhood disorders: XCIII, ADHD, part 2: Norepinephrine has a critical modulary influence on prefrontal cortical function. *American Academy of Child and Adolescent Psychiatry, 39(9),* 1201-1203.

Arnsten, A. F. T., Steere, J. C., & Hunt, R. D. (1996). The contribution of alpha 2 noradrenergic mechanism to prefrontal cortical cognitive function. *Archives of General Psychiatry, 53,* 448-455.

August, G. J., Realmuto, G. M., McDonald, A. W., Nugent, S. M., & Crosby, R. (1996). Prevalence of ADHD and comorbid disorders among elementary school children screened for disruptive behavior. *Journal of Abnormal Child Psychology, 24,* 571-595.

Aylward, E. H., Reiss, A. L., Reader, M. J., Singer, H. S., Brown, J. E., & Denckla, M. B. (1996). Basal ganglia volumes in children with attention-deficit hyperactivity disorder. *Journal of Child Neurology, 11,* 112-115.

Bahati, M.S., Nigam, V.R., & Bohra, N. (1991). Attention deficit disorder with hyperactivity among pediatric outpatients. *Journal of Child Psychology and Psychiatry, 32,* 297-306.

Ballinger, C., Varley, C., & Nolen, P. (1984). Effects of methylphenidate on reading in children with attention deficit disorder. *American Journal of Psychiatry, 141,* 1590-1593.

Barkley, R. A. (1985). The social interactions of hyperactive children: Developmental changes, drug effects, and situational variation. In R. McMahon & R. Peters (Eds.), *Childhood disorders: Behavioral-developmental approaches* (pp. 218-243). New York: Brunner/Mazel.

Barkley, R. A. (1987). *Defiant Children: A clinician's manual for parent training.* New York: Guilford.

Barkley, R. A. (1988). Tic disorders and Gilles de la Torette syndrome. In E. J. Mash, & L. A.

Terdal (Eds.), *Behavioral assessment of childhood disorders (2^{nd} ed., pp.69-104).* New York: Guilford Press.

Barkley, R. A. (1989a). The Problem of stimulus control and rule-governed behavior in Children with attention deficit disorder with hyperactivity. In J. Swanson & L. Bloomingdale (Eds.), *Attention deficit disorders (pp.203-234).* New York: Pergamon Press.

Barkley, R. A. (1990). Attention-deficit hyperactivity disorder: *A handbook for diagnosis and treatment.* New York: Guilford Press.

Barkley, R. A. (1991). The echological validity of laboratory and analogue assessment of ADHD symptoms. *Journal of Abnormal Child Psychology, 19,* 149-178.

Barkley, R. A. (1992). *ADHD: What do we know?* New York: Guilford Press.

Barkley, R. A. (1994). Impaired delayed responding: A unified theory of attention deficit hyperactivity disorder. In D. K. Routh (Ed.), *Disruptive behavior disorders: Essays in honor of Herbert Quay (pp. 11-57).* New York: Plenum Press.

Barkley, R. A. (1995). Linkages between attention and executive functions. In G. R. Lyon & N. A. Krasnegor (Eds.), *Attention, memory, and executive function (pp. 307-326).* Baltimore: Paul H. Brookes.

Barkley, R. A. (1996). Attention-deficit/hyperactivity disorder. In E. J. Mash & R. A. Barkley (Eds.), *Child psychopathology (pp. 63-112).* New York: Guilford Press.

Barkley, R. A. (1997a). Behavioral Inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin, 121,* 65-94.

Barkley, R. A. (1997b). *ADHD and the nature of self-control.* New York: Guilford Press.

Barkley, R. A. (1998). Attention-deficit hyperactivity disorder: *A handbook for diagnosis and treatment.* New York: Guilford Press.

Barkley, R. A. (2000). Genetics of childhood disorders: XVII. ADHD, part 1: The executive functions and ADHD. *Journal of The American Academy of Child and Adolescent Psychiatry, 39(8),* 1064-1068.

Barkley, R. A., & Cunningham, C. E. (1979). The effects of methylphenidate on the mother-child interactions of hyperactive children. *Archives of General Psychiatry, 36,* 201-208.

Barkley, R. A., & Cunningham, C. E. (1980). The parent-chld interactions of hyperactive children and their modification by stimulant drungs. In R. Knights & D. Bakker (Eds.), *Treatment of hyepractive and learning disordered children (pp. 219-236).* Baltimore, MD: University Park Press.

Barkley, R. A., Cunningham, C., E., & Karlsson, J. (1983). The speech of hyperactive children and their mothers: Comparisons with normal children and stimulant drug effects. *Journal of Learning Disabilities, 16,* 105-110.

Barkley, R. A., DuPaul, G. J., & McMurray, M. B. (1990). A comprehensive evaluation of attention deficit disorder with and without hyperactivity. *Journal of Consulting and Clinical Psychology, 58,* 775-789.

Barkley R. A., Fischer, M., Edelbrock, C. S., & Smallish, L. (1990). The adolescent outcome of hyperactive children diagnosed by research criteria: I. An 8-year prospective follow-up study. *Journal of the American Academy of Child and Adolescent Psychiatry, 29*, 546-557.

Barkley, R. A., Grodzinsky, G., & DuPaul, G. (1992). Frontal lobe functions in attention deficit disorder with and without hyperactivity: A review and research report. *Journal of Abnormal Child Psychology, 20,* 163-188.

Barkley, R. A., Karlsson, J., Pollard., S., & Murphy, J. U. (1985). Developmental changes in the mother-child interactions of hyperactive boys: Effects of two dose levels of Ritalin. *Journal of Child Psychology and Psychiatry, 26,* 705-715.

Barkley, R. A., Koplowicz, S., Anderson, T., & McMurray, M. B. (1997). Sense of time in children with ADHD: Effects of duration, distraction, and stimulant medication. *Journal of International Neuropsycholgical Society, 3, 359-369.*

Barkley, R. A., Murphy, K. R. (1998). *Attention deficit hyperactivity disorder.* New York: Guilford Press.

Barkley, R. A., Murphy, K. R., Kwasnik, D. (1996). Psychological adjustment and adaptive impairements in yong adults with ADHD. *Journal of Attention Disorders, 1,* 41-54.

Barkley, R. A., & McMurray, K. R. (1998). *Attention-Deficit Hyperactivity Disorder: A clinical work-book.* New York: Guilford Press. Barr, R. G., Douglas, V. I., & Sananes, R. (1990). Copying the Rey-Ostrrieth Complex Design: ADHD-normal differences and stimulant effects. *Journal of Developmental and Behavioral Pediatrics, 11,* 215.

Barkley, R. A., & Ullman, D. G. (1975). A Comparison of objective measures of activity level and distractibility in hyperactive and nonhyperactive children. *Journal of Abnormal Psychology, 3,* 213-244.

Baumgardner, T. L., Singer, H. S., Denckla, M. B., Rubin, M. A., Abrams, M. T., Coli, M. J., & Reiss, A. L. (1996). Corpus Callosum morphology in children with tourette syndrom and attention deficit hyperactivity disorder. *Neurology, 47,* 477-482.

Baummgaertel, A., Wolraich, M. I., & Dietrich, M. (1995). Comparison of diagnostic criteria for the attention deficit disorders in a German elementary school sample. *American Journal of Child and Adolescent Psychiatry, 34,* 629-638.

Bench, C. J., Fritch, C. D., Grasby, P. M., Friston, K. J., & Paulesu, E., Frackowiak, R. S. et al. (1993). Investigations of the functional anatomy of attention using the Stroop test. *Neuropsychologia, 31,* 907-922.

Benninger, R. J. (1989). Dopamine and learning: Implications for attention deficit disorder and hyperkinetic syndrome. In T. Sagvolden & T. Archer (Eds.), *Attention deficit disorder : Clinical and basic research (pp. 323-338).* Hillsdale, NJ: Erlbaum.

Benton, A. (1991). Prefrontal injury and behavior in children. *Developmental Neuropsychology, 7,* 275-282.

Berk, L. E. (1992). Children's private speech: An overview of theory and the status of research. In R. M. Diaz & L. E. Berk (Eds.), *Private Speech: From social interaction to self-regulation (pp.17-54).* Mathwah, NJ: Erlbaum.

Berk, L. E. (1994). Why Children talk to themselves. *Scientific American, 271,* 78-83.

Berk, L. E., & Potts, m. K. (1991). Development and functional significance of private speech among attention-deficit hyperactivity disorder and normal boys. *Journal of Abnormal Child Psychology, 19,* 357-377.

Berkowitz, M. W. (1982). Self-control development and relation to prosocial behavior: A response to Peterson. *Merrill-Palmer Quarterly, 28,* 223-236.

Berman, K. F., Ostrem, J. L., Randolph, C., Gold, J., Goldberg, T. E., & Coppola, R. et al. (1995). Physiological activation of cortical network during performance of the Wisconsin Card Sorting Test: A positron emission tomography study. *Neuropsychologia, 33,* 1027-1046.

Bernstein, G. A., & Borchardt, C. M. (1991). Anxiety disorders of childhood and adolescence: A critical review. *Journal of American Child and Adolescent Psychiatry, 30,* 519-532.

Biederman, J., Faraone, S. V., Keenan, K., Benjamin, J., Krifcher, B., Moore, C., Sprich-Buckminster, S., et al. (1992). Evidence for family-genetic risk factors in attention deficit hyperactivity disorder. *Archives of General Psychiatry, 49,* 728-738.

Biederman, J., Faraone, S. V., Keenan, K., Steingard, R., & Tsuang, M. T. (1991a). Familial association between attention deficit disorder and anxiety disorders. *American Journal of Psychiatry, 148,* 251-256.

Biederman, J., Faraone, S.V., Mick, E., Moore, P., & Leon, E. (1996). Clinical correlates of ADHD in females: Findings from a large group of girls ascertained from pediatric and psychiatric referral sources. *Journal of American Academy of Child and Adolescent Psychiatry, 38,* 966-975.

Biederman, J., Faraone, S., Mick, E., Spencer, T., Wilens, T., Kiely, K. et al., (1995). High risk for attention deficit hyperactivity disorder among children of parents with childhood onset of the disorder: A pilot study. *American Journal of Psychiatry, 152,* 431-435.

Biederman, J., Faraone, S., Milberger, S., Curtis, S., Chen, L., Mars, A., Ouellette, C., Moore, P., & Spencer, T. (1996). Predictors of persistence and remission of ADHD into adolescence: Results from a four-year prospective follow-up study. *Journal of the American Academy of Child and Adolescent Psychiatry, 35,* 343-351.

Biederman, J., Faraone, S.V., & Mick, E. (1999). Clinical correlates of ADHD in females. *Journal of American Academy of Child and Adolescents, 38,* 966-975.

Biederman, J., Faraone, S.V., Spencer, T., Wilens, T. E., Norman, D., Lapey, K. A.. et al. (1993). Patterns of psychiatric comorbidity, cognition, and psychosocial functioning in adults with attention deficit disorder. *American Journal of Psychiatry, 150,* 1792-1798.

Biederman, J., Faraone, S. V., Taylor, A., Sienna, M., Williamson, S., & Fine, C. (1998).

Diagnostic Continuity between child and adolescent ADHD: Findings from a longitudinal clinical sample. *Journal of American Academy of Child and Adolescent Psychiatry, 37(3),* 305-314.

Biederman, J., Keenan, K., & Faraone, S. V. (1990). Parent-based diagnosis of attention deficit disorder predicts a diagnosis based on teacher report. *American Journal of Child and Adolescent Psychiatry, 29,* 698-701.

Biederman, J., Newcorn, J., & Sprich, S. (1991). Comorbidity of attention deficit hyperactivity disorder with conduct, depressive, anxiety and other disorders. *American Journal of Psychiatry, 148,* 564-577.

Birch, H. G. (1964). *Brain damage in children: The biological and social aspects.* Baltimore: Williams & Wilkins.

Bird H. R., Canino, G., Rubio-Supec, M. (1988). Estimates of the prevalence of childhood maladjustment in a community survey in Puerto Rico. *Archives of General Psychiatry, 45,* 1120-1126.

Bird, H. R., Gould, M. S., & Staghezza, B. M. (1993). Patterns of diagnostic comorbidity in a community sample of children aged 9 through 16 years. *Journal of the American Academy of Child and Adolescent Psychiatry, 32,* 361-368.

Blau, A. (1936). Mental changes following head trauma in children. *Archives of Neurology and Psychiatry, 35,* 722-769.

Bloomquist, M. L., August, G. L., & Garfinkel, B. D. (1991). Cognitive-behavioral therapy for children with attention deficits and hyperactivity: Effects of parent involvement and methylphenidate. In: M. L. Bloomquist, G. J. August, & R. Ostrander (eds.), Effects of a school based cognitive-behavioral intervention for ADHD children.

Journal of Abnormal ChildPsychology, 19(5), 591-605.

Bloomquist, M. L., August, G. J., & Ostrander, R. (1991). Effects of a school-based cognitive-behavioral intervention for ADHD children. *Journal of Abnormal Child Psychology,19(5),* 591-605.

Boucugnani, L. L., & Jones, R. W. (1989). Behaviors analogous to frontal lobe dysfunction in children with attention deficit hyperactivity disorder. *Archives of Clinical Neuropsychology, 4,* 161-173.

Braaten, E. B. & Rosen, L. A. (2000). Self-regulation of affect in attention deficit-hyperactivity disorder (ADHD) and non-ADHD boys: Differences in empathic responding. *Journal of Consulting and Clinical Psychology, 68(2),* 313-321.

Brand, E., & Van der Vlugt, H. (1989). Activation: Base-level and responsivity- A search for subtypes of ADHD children by means of electrocardiac, dermal, and respiratory measures. In T. Savolden & T. Archer (Eds.), *Attention deficit disorder: Clinical and basic research (pp.137-150).* Hillsdale, NJ: Erlbaum.

Braswell, L., & Bloomquist, M. L. (1991). *Cognitive-Behavioral Therapy with ADHD Children.* New York: Guilford Press.

Breen, M., & Barkley, R. A. (1983). The personality Inventory for Children (PIC): Its clinical utility with hyperactive children. *Journal of Pediatric Psychology, 13,* 356-366

Brendtro, L. K., Brokenleg, M., & Van Bockern, S. (1990). *Reclaiming youth at risk: Our hope for the future.* Bloomington, IN: National Educational Services.

Brenier, J. L., & Forehand, R. (1981). An assessment of the effects of parent training on clinic-referred children's school behavior. *Behavioral Assessment, 3,* 31-42.

Brody, N. (1992). *Intelligence (end ed.).* San Diego, CA: Academic Press.

Brokowski, J. G., Milsted, M., & Hale, C. (1988). Components of children's metamemeory: Implications for strategy generalization. In F. Weinert & M. Perlmutter (Eds.), *Memory Development: Individual differences and universal changes (pp. 73-100).* Hillsdale, NJ: Lawrence Erlbaum Associates.

Bronowski, J. (1977). Human and animal languages. *In a sense of the future (pp.104-131).* Cambridge, MA: MIT Press.

Brooks, R. B. (1991). *The self-esteem teacher.* Circle Pines, MN: American Guidance Service.

Brown, J. W. (1990). Psychology of time awareness. *Brain and Cognition, 14,* 144-164.

Brown, T. W. (1985). Time perception and attention: The effect of prospective versus retrospective paradigms and task demands on perceived duration. *Perception and Psychophysics, 38,* 115-124.

Brown, R. T. (1995). Diagnosis of attention deficit hyperactivity disorder (ADHD) and treatment assessment: A look at old practices and a need for reformation. *Progress Notes, 19(3),* 4-5.

Brown, R. T., & Borden, K. A. (1986). Hyperactivity in adolescence: Some misconceptions and new directions. *Journal of Clinical Child Psychology, 15,* 194-209.

Brown, R. T., & Borden, K. A. (1988). Neuropsychological effects of stimulant medication on children's learning and behavior. In C. R. Reynolds & E. Fletcher-Janzen (Eds.), *Handbook of clinical neuropsychology (pp. 443-472).* New York: Plenum Press.

Brown, R. T., & Quay, H. C. (1977). Reflection-impulsivity of normal and behavior-disordered children. *Journal of Abnormal Child Psychology, 5,* 457-462.

Brown, R. T., Wynne, M. E., & Medenis, R. (1985). Methylphenidate and cognitive therapy: A comparison of treatment approaches with hyperactive boys. *Journal of Abnormal Child Psychology, 13,* 69-87.

Brown, T. E. (1995). Differential diagnosis of ADD Vs. ADHD in adults. In K. G. Nadeau (Ed.), *A comprehensive guide to attention deficit disorder in adults (pp. 93-108).* New York: Brunner/Mazel.

Brown, T. E. (1996). *Brown Attention-Deficit Disorder Scales.* San Antonio, TX: The Psychological Corporation.

Brown, T. E. (2000). Emerging understandings of attention-deficit disorders and comorbidities. In: T. E. Brown (ed.), *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults (pp. 3-57).* Washington, DC: American Psychiatric Press.

Cadoret, R. J., & Stewart, M. A. (1991). An adoption study of attention deficit hyperactivity/aggression and their relationship to adult antisocial personality. *Comprehensive Psychiatry, 32,* 73-82.

Cammann, R., & Miehlke, A. (1989). Differentiation of motor activity of normally active and hyperactive boys in schools: Some preliminary results. *Journal of Child Psychology and Psychiatry, 30,* 899-906.

Campbell, S. B. (1987). Parent-referred problem three-year-olds: Developmental changes in symptoms. *Journal of Child Psychology and Psychiatry, 28,* 835-846.

Campbell, S. B., Breaux, A. M., Ewing, L. J., & Szumowski, E. K. (1984). A one-year follow-up of parent-identified "hyperactive:" preschoolers. *Journal of the American Academy of Child Psychiatry, 23,* 243-249.

Campbell, S. B., Douglas, V. I., & Morganstern, G., (1971). Cognitive styles in hyperactive children and the effect of methylphenidate. *Journal of Child Psychology and Psychiatry, 12,* 55-67.

Campbell, S. B., Pierce, E. W., March, c. L., Ewing, L. J., & Szumowski, E. K. (1994). Hard-to-manage pre-eschoolers: Symptomatic behavior across contexts and time. *Child Development, 65,* 836-851.

Cantwell, D. (1975). *The hyperactive child.* New York: Spectrum.

Cantwell, D., & Hanna, G. (1989). Attention deficit hyperactivity disorder. In A. Tasman, R. Hales, & A. Frances (Eds.), *Review of Psychiatry (pp. 134-161).* Washington DC: American Psychiatric Association.

Cappella, B., Gentile, J. R., & Juliano, D. B., (1977). Time estimation by hyperactive and normal children. *Perceptual and Motor Skills, 44,* 787-790.

Carlson, C. L., Pelham, W. E., Milich, R., & Dixon, M. J. (1992). Single and combined effects of methyphenidate and behavior therapy on the classroom behavior, academic performance and self-evaluations of children with attention deficit/hyperactivity disorder. *Journal of Abnormal Child Psychology, 20,* 213-232.

Carlson, C. L., Pelham, W. E., & Milich, R., & Hoza, B. (1993). ADHD boys' performance and attributions following success and failure: Drug effects and individual differences. *Cognitive Therapy and Research, 17(3),* 269-287.

Carlson, C. L., & Tamm, L. (2000). Responsiveness of children with attention deficit-hyperactivity disorder to reward and response cost: Differential impact on performance and motivation. *Journal of Consulting and Clinical Psychology, 68(1),* 73-83.

Carte, E. T., Nigg, J. T., & Hinshaw, S. P. (1996). Neuropsychophysiological functioning, motor speed, and language processing in boys with and without ADHD. *Journal of Abnormal Child Psychology, 24,* 481-498.

Casey B. J., Castellano, F. X. Giedd, J. N., Marsh, W. l., Hamburger, S. D., Schubert, A. et al. (1997a). Implication of right frontostriatal circuitry in response inhibition and attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 36,* 347-383.

Casey, B. J., Trainor, R. J., Orendi, J. L., Schubert, A. B., Nystrom, L. E., & Giedd, J. N., et al. (1997b). A developmental functional MRI study of prefrontal activation during performance of a go-no-go task. *Journal of Cognitive Neuroscience, 9,* 835-847.

Castellanos, F. X., Giedd, J. N., Echburg, P., Marsh, W. L., Vaituzis, C., Kaysen, D., et al. (1994). Quantitative morphology of the caudate nucleus in attention deficit hyperactivity disorder. *American Journal of Psychiatry, 151,* 1791-1796.

Castellanos, F. X., Giedd, J. N., Marsh, W. l., Hamberger, S. D., Vaituzis, A. C., Dickenstein, D. P., et al. (1996). Quantitative brain magnetic resonance imaging in attention-deficit hyperactivity disorder. *Archives of General Psychiatry, 53,* 607-616.

Castellanos, F. X., Marvasti, f. F., Ducharme, J. L., Walter, J. M., Israel, M. E., Krain, A., et al. (2000). Executive function oculomotor tasks in girls with ADHD. *Journal of the American Academy of Child and Adolescent Psychiatry, 39 (5),* 644-650.

Certutti, D. T. (1989). Discrimination theory of rule-governed behavior. *Journal of the Experimental Analysis of Behavior, 51,* 259-276.

Charles, L., & Schain, R. (1981). A four-year follow-up study of the effects of methylphenidate on the behavior and academic achievement of hyperactive children. *Journal of Abnormal Child Psychology, 9,* 495-505.

Chee, P., Logan, G., Schachar, R., Lindsay, P., & Wachsmuth, R., (1989). Effects of event rate and display time on sustained attention in hyperactive, normal, and control children. *Journal of Abnormal Child Psychology, 17*, 317-391.

Chelune, G. J., Fergusen, W., Koon, R., & Dickey, T. O. (1986). Frontal lobe disinhibition in attention deficit disorder. *Child Psychiatry and Human Development, 16,* 221-234.

Clore, G. L. (1994). Why emotions are felt. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions (pp. 103-111).* New York: Oxford University Press.

Cohen, N. J., Weiss, G., & Minde K. (1972). Cognitive styles in adolescents previously diagnosed as hyperactive. *Journal of Child Psychology and Psychiatry, 13,* 203-209.

Comings, D. E. (2000). Attention-deficit hyperactivity disorder with tourette syndrome. In: T. E. Brown (Ed.), *Attention-Deficit Disorders and Comorbidities in Children, Adolescents and Adults, (pp. 363-393).* Washington, DC: American Psychiatric Press.

Conners, C. K. (1994a). *Conners' continuous performance tets computer program 3.0 users' manual.* Toronto, ON: Multi-Health Systems Inc.

Conners, C. K. (1994b). *The continuous performance test(CPT): Use a disgnostic tool and measure of treatment outcome.* Paper presented at the annual meeting of the American psychological Association, Los Angeles, CA.

Conners, C. K. (2000). *Continuous Performance Test - II Manual.* North Tonawanda, NY, Multi-Health Systems.

Conners, C. K. (1997). *Conners rating scales-Revised.* North Tonawanda, NY, Multi-Health Systems.

Conners, C. K., & Wells, K. (1986). *Hyperactive children: A neuropsychological approach.* Beverly Hills, CA: Sage.

Connor, D. F. (1998). Other medications in the treatment of child and adolescent ADHD. In R. A. Barkley. *Attention-Deficit Hyperactivity Disorder (pp. 564-592).* New York, NY: Guilford Press.

Copeland, A. P. (1979). Types of private speech produced by hyperactive and nonhyperactive boys. *Journal of Abnormal Child Psychology, 7,* 169-177.

Corkum, P. V., & Siegel, L. S. (1993). Is the continuous performance task a valuable research tool for use with children with attention-deficit-hyperactivity disorder? *Journal of Child Psychology and Psychiatry, 34,* 1217-1239.

Cruickshank, B. M., Eliason, M., & Merrifield, B. (1988). Long-term sequelae of water near-drowning. *Journal of Pediatric Psychology, 13,* 379-388.

Crystal, C. A. (1988). Teacher management and helping style: How can we develop student self-control? *Focu on exceptional children, 21*, 9-14.

Cunningham, C. E. (1990). A family systems approach to PT. In R. A. Barkley, *Attention Deficit-Hyperactivity Disorder: A handbook for diagnosis and treatment(pp.432-461).* New York: Guilford Press.

Cunningham, C. E., Barkley, R. A. (1979). The interactions of hyperactive and normal children with their mothers during free play and structured tasks. *Child Development, 50,* 217-224.

Cunningham, C. E., & Seigel, L. S (1987). Peer interaction of normal and attention-deficit disordered boys during free-play, cooperative task, and simulated classroom situations. *Journal of Abnormal Child Psychology, 15,* 247-268.

Curwin, R. L., & Medier, A. N. (1988). *Discipline with dignity.* Reston, VA: Association for Supervision and Curriculum Development.

Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain.* New York: Putnam.

Damasio, A. R. (1995). On some functions of the human prefrontal cortex. In J, Grafma, K. J. Holyoak, & F. Boller (Eds.), Structure and functions of the human prefrontal cortex: Vol. 769. *Annals of the New York Academy of Sciences (pp.241-251).* New York: New York Academy of Sciences.

Davies, P. (1995). *About time: Einstein's unfinished revolution.* New York: Simon & Schuster.

Dawson, M. M. (1995). Best practices in planning interventions for students with attention disorders. *Best Practices in School Psychology, 3,* 987-998.

Dawson, M. M. (1997). Best practices in planning interventions for students with attention disorders. In: D. L. Smallwood. *Attention Disorders in Children: Resources for school psychologists (123-135).* Bethesda, MD: The National Association for School Psychologists.

Dawson, P., & Guare, R. (1997). Interventions for Adolescents with Attention Disorders. In: D. L. Smallwood. *Attention Disorders in Children: Resources for school psychologists (261-264).* Bethesda, MD: The National Association for School Psychologists.

Deci, E. L., & Chandler, C. (1988). The importance of motivation for the future of the LD field. *Journal of the Learning Disabilities, 19,* 587-594.

Dehaene, S., & Changeux, J. P. (1995). Neuronal models of prefrontal cortical functions. In J. Grafman, K. J. Holyoak, & F. Boller (Eds.), structure and functions of the human prefrontal cortex: Vol.769. *Annals of the New York Academy of Sciences (pp. 305-319).* New York: New York Academy of Sciences.

Dellis, D. C., Squire, L. R., Bihrle, A., & Massman, P. (1992). Componential analysis of problem-solving ability: Performance of patients with frontal lobe damage and amnesic patients on a new sorting test. *Neuropsychologia, 30,* 683-697.

Denckla, M. B. (1994). Measurement of executive function. In: G. R. Lyon (ed.), *Frames of Reference for the Assessment of Learning Disabilities: New Views on Measurement Issues (pp. 117-142).* Baltimore: Brooks.

Denckla, M. B. (1996). A theory and model of executive function: A neuropsychological perspective. In G. R. Lyons & N. A. Krasnegor (Eds.), *Attention, Memory, and Executive Function (pp. 263-277).* Baltimore: Paul H. Brookes.

Denckla, M. B. (2000). Learning disabilities and attention-deficit/hyperactivity disorder in adults: Overlap with executive dysfunction. In: T. E. Brown (Ed.), *Attention-Deficit Disorders and Comorbidities in Children, Adolescents and Adults, (pp. 297-319).* Washington, DC: American Psychiatric Press.

Dennett, D. C. (1995). *Darwin's dangerous idea: Evolution and the meaning of life.* New York: Simon & Schuster.

Deshler, D. D., & Schumaker, J. B. (1988). An instructional model for teaching students how to learn. In J. L. Graden, J. E., Zins, & M. E. Curtis (Eds.), *Alternative educational delivery systems: Enhancing instructional options for all students.* Washington, DC: National Association for School Psychologists.

D'Esposito, M., Detre, J. A., Alsop, D. C., Shin, R. K., Atlas, S., & Grossman, M. (1995). The neural basis of the central executive system of working memory. *Nature, 378,* 279-281.

Diener, R. M. (1991). Toxicology of Ritalin. In L. L., Greenhill & B. B. Osmon (Eds.), *Ritalin: Theory and patient management (pp.34-43).* New York: Mary Ann Liebert.

Di Guseppe, R. (1988). A cognitive behavioral approach to the treatment of conduct disorder children and adolescents. In N. Epstein, S. Scheslinger, & W. Dryden (Eds.), *Cognitive-behavior therapy with families. (pp.183-214).* New York: Brunner/Mazel.

Douglas, V. I. (1972). Stop, look, and listen: The problem of sustained attention and impulse control in hyperactive and normal children. *Canadian Journal of Behavioral Science, 4,* 259-282.

Douglas, V. I. (1980a). Higher mental processes in hyperactive children: Implications for training. In R. Knights & D. Baker (Eds.), *Treatment of hyperactive and learning disordered children (pp. 65-92).* Baltimore: University Park Press.

Douglas, V. I. (1980b). Treatment and training approaches to hyperactivity: Establishing internal or external control. In C. Whalen & B. Hencker (Eds.), *Hyperactive children: The social ecology of identification and treatment (pp. 283-318).* New York: Academic Press.

Douglas, V. I. (1983). Attention and cognitive problems. In M. Rutter (Ed.), *Developmental Neuropsychiatry (pp.280-329).* New York: Guilford Press.

Douglas, V. I. (1988). Cognitive deficits in children with attention deficit disorder with hyperactivity. In L. M. Bloomingdale & J. A. Sergeant (Eds.), *Attention Deficit Disorder: Criteria, cognition, intervention (pp.65-82).* London: Pargamon Press.

Douglas, V. I. (1989). Can Skinnerian psychology account for the deficits in attention deficit disorder? A reply to Barkley. In L. Bloomingdale & J. Sergeant (Eds.), *Attention deficit disorder (Vol. 6, pp. 235-253).* New York: Pergamon Press.

Douglas, V. I., Barr, R. G., Desilets, J., & Sherman, E. (1995). Do high does of stimulants impair flexible thinking in attention-deficit hyperactivity disorder? *Journal of the American Academy of Child and Adolescent Psychiatry, 34,* 877-885.

Douglas, V. I., Barr, R. G., & O'Neill, M. E., B. G. (1986). Short-term effects of methylphenidate on the cognitive, learning and academic performance of children with attention deficit isorder in the laboratory and the classroom. *Journal of Child Psychology and Psychiatry, 29,* 191-211.

Douglas, V. I., & Benezra, E. (1990). Supraspan verbal memory in attention deficit disorder with hyperactivity, normal, and reading disabled boys. *Journal of Abnormal Child Psychology, 18,* 617-638.

Douglas, V. I., & Parry, P. A. (1983). Effects of reward on delayed reaction time task performance of hyperactive children. *Journal of Abnormal Child Psychology, 11,* 313-326.

Douglas, V. I., & Parry, P. A. (1994). Effects of reward and non-reward on attention and frustration in attention deficit disorder. *Journal of Abnormal Child Psychology, 22,* 281-302.

Douglas, V. I., & Peters, K. G. (1978). Toward a clearer definition of the attention deficit of hyperactive children. In G. A. Hale & M. Lewis (Eds.), *Attention and the development of cognitive skills (pp 173-248).* New York: Plenum Press.

Doyle, A. E., Biederman, J., Seidman, L. J., Weber, W., & Faraone, S., V. (2000). Diagnostic efficacy of neuropsychological test scores for discriminating boys with and without attention deficit-hyperactivity disorder. *Journal of Consulting and Clinical Psychology, 68(3),* 477-488.

Draeger, S., Prior, M., & Sanson, A. (1986). Visual and auditory attention performance in hyperactive children: Competence or compliance. *Journal of Abnormal Child Psychology, 14,* 411-424.

Drew, E. A. (1974). The effect of type and area of brain lesion on Wisconsin Card Sorting Test performance. *Cortex, 10,* 159-170.

Dulcan, M. K. (1990). Using Psychostimulants to treat behavioral disorders of children and adolescents. *Journal of Child and Adolescent Psychopharmacology, 1,* 7-20.

Dulcan, M. K., Bergman, J. D., Weller, E. B., & Weller, R. A. (1995). Treatment of childhood and adolescent disorders. In A. F. Chatzberg & C. B. Nemeoff (Eds.), *Textbook of psychopharmacology (pp. 69-706).* Washington, DC: American Psychiatric Press.

DuPaul, G. R. (1991). Parent and teacher ratings of ADHD symptoms: Psychometric properties in a community-based sample. *Journal of Clinical Child Psychology, 20,* 242-253.

DuPaul, G. J., Power, T. J., Anastopoulos, A. D., & Reid, R. (1998). *ADHD Rating Scale IV.* New York: Guilford Press.

DuPaul, G. J., Power, T. J., Anastopoulos, A. D., Reid, R., McGoey, K., & Ikeda, M. (1997). Teacher ratings of attention-deficit/hyperactivity disorder: Factor structure and normative data. *Psychological Assessment, 9,* 436-444.

DuPaul, G. J., Anastopoulos, A. D., Power, T. J., Reid, R., Ikeda, M. J., & McGoey, K. E. (1996). Parent ratings of attention-deficit/hyperactivity disorder symptoms: Factor structure, normative data, and psychometric properties. *Journal of Psychopathology & Behavior Assessment, 20,* 83-102.

DuPaul, G. L., & Rapport, M. D. (1993). Does methylphenidate normalize the classroom performance of children with attention deficit disorder? *Journal of American Academy of Child and Adolescent Psychiatry, 32,* 190-198.

DuPaul, G.L., Stoner, G., & Tilly, D. (1997). Interventions for attention problems. In. D. L. Smallwood. (Ed.), *Attention disorders in children: Resources for school psychologists.* Bethesda, MD: The National Association for School Psychologists.

Dush, D. M., Hirt, M. L., & Schroeder, H. E. (1989). Self-statement modification in the treatment of child behavior disorders: A meta-analysis. *Psychological Bulletin, 106,* 97-106.

Dykman, R. A., Ackerman, P. T., & McCray, D. S. (1980). Effects of methylphenidate on selective and sustained attention in hyperactive, reading-disabled and presumable attention-disordered boys. *Journal of Nervous and Mental Disease, 168,* 745-752.

Edelbrock, C., Costello, A., Dulcan, M. K., Conover, N. C., & Kalas, R. (1986). Parent-child agreement on child psychiatric symptoms assessed via structured interview. *Journal of Child Psychology and Psychiatry, 27, 181*-190.

Edelbrock, C. S., Rende, R., Plomin, R., & Thompson, L. (1995). A twin study of competence and problem behavior in childhood and early adolescence. *Journal of Child Psychology and Psychiatry, 36,* 775-786.

Edinger, H. M., Seigel, A., Troiano, R. (1975). Effect of stimulation of prefrontal cortex and amygdala on diencephalic neurons. *Brain Research, 97*, 17-31.

Elia, J., & Rapport, J. L. (1991). Ritalin versus dextroamphetamine in ADHD: Both should be tried. In L. L. Greenhill, & B. B. Osmon (Eds.), *Ritalin: Theory and patient management (pp. 69-74).* New York: Mary Ann Liebert.

Engle, R. W., Conway, A. R. A., Tuholski, S. W., & Shisler, R. J. (1995). A resource account of inhibition. *Psychological Science, 6,* 122-125.

Epstein, J. N., Conners, C. K., Erhardt, D., March, J. S., & Swanson, J. M. (1997).

Asymmetrical hemispheric control of visual-spatial attention in adults with attention deficit hyperactivity disorder. *Neuropsychology, 11,* 467-473.

Epstein, J. N., Goldberg, N. A., Conners, C. K., & March, J. (1997). The effects of anxiety on continuous performance test functioning in an ADHD clinical sample. *Journal of Attention Disorders, 2,* 45-52.

Epstein, N. E., Schlesinger, S. E., & Dryden, W. (1988). Concepts and methods of cognitive-behavior family treatment. In N. Epstein, S. Schlesinger, & W. Dryden (Eds.), *Cognitive-behavioral therapy with families (pp. 5-48).* New York: Brunner/Mazel.

Erhardt, D., & Baker, B. L. (1990). The effects of behavioral parent training on families with young hyperactive children. *Journal of Behavior Therapy and Experimental Psychiatry, 21,* 121-132.

Eslinger, P. J. (1996). Conceptualizing, describing, and measuring components of executive function. In C. R. Lyons & N. A. Krasnegor (Eds.), *Attention, memory and executive function (pp. 367-395).* Baltimore: Brooks.

Faraone, S. V., Biederman, J., Lehman, B., Keenan, K., Norman, D., Seidman, I. J., Kilodny, P., Kraus, I., Perrin, J., & Chen, W. (1993). Evidence for the independent familial transmission of attention deficit hyperactivity disorder and learning disabilities: Results from a family genetic study. *American Journal of Psychiatry, 150,* 891-895.

Faraone, S. V., Biederman, J., Mennin, D., Gershon, J., & Tsuang, M. T. (1996). A Prospective four-year follow-up study of children at risk for ADHD: Psychiatric, neuropsychological, and psychosocial outcome. *Journal of the American Academy of Child and Adolescent Psychiatry, 35(11),* 1449-1459.

Fergusson, D. M., & Horwood, L.J. (1995). Predictive validity of categorically and dimentionally scored measures of disruptive childhood behaviors. *Journal of Academy of Child and Adolescent Psychiatry, 34,* 477-485.

Fergusson, D. M., Horwood, L.J., & Lynskey, M. T. (1993a). Prevalence and comorbidity of DSM-III diagnoses in a birth cohort of 15 year olds. *Journal of American Academy of Child and Adolescent Psychiatry, 32,* 1127-1134.

Fergusson, D. M., Horwood, L.J., & Lynskey, M. T. (1993). The effects of conduct disorder and attention deficit in middle childhood on offending and scholastic ability at age 13. *Journal of Child Psychology and Psychiatry, 34,* 899-916.

Fergusson, H. B., & Pappas, B. A. (1979). Evaluation of psychophysiological neurochemical, and animal models of hyperactivity. In R. L. Trites (Ed.), *Hyperactivity in children.* Baltimore, MD: University Park Press.

Filipek, P. A., Semrud-Clikeman, M., Steingard, R. J., Renshaw, P. F., Kennedy, D. N., & Biederman, J. (1997). Volumetric MRI analysis comparing subjects having attention-deficit hyperactivty disorder with normal controls. *Neurology, 48,* 589-601.

Fiore, T. A., Becker, E. A., Nero, R. C. (1993). *Research synthesis on educational interventions for students with ADD.* Research Triangle Park, NC: Research Triangle Institute.

Fiore, T. A., Becker, E. A. (1997). Classroom Interventions for students with ADD. In: D. L. Smallwood. *Attention Disorders in Children: Resources for school psychologists (249-253).* Bethesda, MD: The National Association for School Psychologists.

Firestone, P., & Martin, J. E. (1979). An analysis of the hyperactive syndrome: A comparison of hyperactive, behavior problem, asthmatic, and normal children. Journal of Abnormal Child Psychology, 7, 261-273.

Fischer, M., Barkley, R. A., Edelbrock, C. S., & Smallish, L. (1990). The adolescent outcome of hyperactive children diagnosed by research criteria: II. Academic, attentional, and neourpsychological status. *Journal of Consulting and Clinical Psychology, 58,* 580-588.

Fischer, M., Barkley, R. A., Fletcher, K., & Smallish, L. (1993). The adolescent outcome of hyperactive children diagnosed by research criteria II. Academic, attentional, and neuropsychological status. *Journal of Consulting and Clinical Psychology, 58 (5),* 580-588.

Flavell, J. H., Miller, P. H., & Miller, S. A. (1993). *Cognitive development.* Englewood Cliffs, NJ: Prentice Hall.

Frank, Y., Lazar, J. W., & Seiden, J. A. (1992). Cognitive event-related potentials in learning-disabled children with or without attention-deficit hyperactivity disorder. *Annals of Neurology, 32,* 478.

Frick, P. J., Lahey, B. B., Applegate, B., Kerdyck, L., Ollendick, T., Hynd, G. W., et al. (1994). DSM-IV field trials for the disruptive behavior disorders: Symptom utility estimates. *Journal of the American Academy of Child and Adolescent Psychiatry, 33,* 529-539.

Friebergs, V., & Douglas, V. I. (1969). Concept learning in hyperactive and normal children. *Journal of Abnormal Child Psychology, 74,* 388-395.

Frijda, N. H. (1994). Emotions are functional, most of the time. In P. Elkman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions (pp. 112-122).* New York: Oxford University Press.

Frost, L. A., Moffitt, T. E., & McGee, R. (1989). Neuropsychological correlates of psychopathology in an unselected cohort of young adolescents. Journal of Abnormal Psychology, 98 (3), 307-313.

Funahashi, S., Bruce, C. J., & Goldman-Rakic, P. S. (1989). Mnemonic coding of visual space in the monkey's dorsolateral prefrontal cortex. *Journal of prefrontal Cortex. Journal of Neurophysiology, 61,* 331-349.

Fuster, J. M. (1980). *The prefrontal cortex.* New York: Raven Press.

Fuster, J. M. (1989). *The Prefrontal Cortex.* New York: Raven Press.

Fuster, J. M. (1995). Memory and planning: Two temporal perspectives of frontal lobe function. In H. H. Jasper, S. Riggio, & P. S. Goldman-Rakic (Eds.), *Epilepsy and the functional anatomy of the frontal lobe (pp.9-18).* New York: Raven Press.

Fuster, J. M., & Alexander, G. E. (1971). Neuron activity related to short-term memory. *Science, 173,* 652-654.

Gadow, K. D., & Sprafkin, J. (1994). *Child Symptom Inventories Manual.* Stony Brook: New York. Checkmate Plus.

Gallucci, F., Bird, H.R., & Berarni, C. (1993). Symptoms of attention-deficit hyperactivity disorder in an Italian school sample: Findings of a pilot study.*Journal of American Academy of Child and Adolescent Psychiatry, 32,* 1051-1058.

Garber, J., & Dodge, K. K. (1991). (Eds.), *The development of emotional regulation and dysregulation.* Cambridge, England: Cambridge University Press.

Gaskin, I., & Elliot, T. (1991). *Implementing cognitive strategy instructions across the school.* Cambrige, MA: Brookline Books.

Gaub, M., & Carlson, C.L. (1997). Gender differences in ADHD: a metal-analysis and critical review. *Journal of American Academy of Child and Adolescent Psychiatry, 26,* 1036-1045.

Gerbing, D. W., Ahadi, A. A., & Patton, J. H. (1987). Toward a conceptualization of impulsivity:

Components across the behavioral and self-report domains. *Multivariate behavioral Research, 22,* 357-379.

Gilberg, C., Kadesjo, B. (2000). Attention-deficit hyperactivity disorder and developmental coordination disorder. In: T. E. Brown (Ed.), *Attention-Deficit Disorders and Comorbidities in Children, Adolescents and Adults, (pp. 393-407).* Washington, DC: American Psychiatric Press.

Gillberg, C., Melander, H., Von Knorring, A. L., Janols, L. O., Thernlund, G., Hagglof, B. et al. (1997). Long-term stimulant treatment of children with attention-deficit hyperactivity disorder symptoms: A randomized, double-blind, placebo-controlled trial. *Archives of General Psychiatry, 54,* 857-864.

Gillis, J. J., Gilger, J. W., Pennington, B. F. & DeFries, J. C. (1992). Attention deficit hyperactivity disorder in reading-disabled twins: Evidence for a genetic etiology. *Journal of Abnormal Child Psychology, 20,* 303-315.

Gittelman, R., Mannuzza, S., Shenker, R., & Bonaguara, N. (1985). Hyperactive boys almost grown up: I. Psychiatric status. *Archives of general Psychiatry, 42,* 937-947.

Glasser, W. 91984). *Control theory; A new combination of how we control our lives.* New york: Harper & Row.

Glow, P.H., & Glow, R. A. (1979). Hyperkinetic impulse disorder: A developmental defect of motivation. *Genetic Psychology Monographs, 100,* 159-231.

Godbout, L., & Doyon, J. (1995), Mental representation of knowledge following frontal-lobe or post-rolandic lesions. *Neuropsychologia, 33,* 1671-1696.

Gold, J. M., Berman, K. F., Randolph, C., Goldberg, T. E., & Weinberger, D. R. (1996). PET validation of novel prefrontal task: Delayed response alternation. *Neuropsychology, 10,* 3-10.

Goldberg, E., & Podell, K. (1995). Lateralization in the frontal lobes. In H. H. Jasper, S. Riggio, & P. S. Goldman-Rakic (Eds.), *Epilepsy and the functional anatomy of the frontal lobe (pp. 85-96).* New York: Raven Press.

Golden. C. J. (1987). *Manual for the Stroop Color and Word Test.* Chicago, IL. Stroelting Co.

Goldman-Rakic, P. S. (1987a). Circuitry of primate prefrontal cortex and the regulation of behavior by representational memory, In Plum, F. (Ed.), *Handbook of Physiology, The Nervous System, Higher Functions of the Brain (pp. 373-417).*

Goldman-Rakic, P. S. (1987b). Development of cortical circuitry and cognitive function. *Child Development, 58,* 601-622.

Goldman-Rakic, P. S. (1995a). Anatomical and functional circuits in prefrontal cortex of nonhuman primates: Prevalence to epilepsy. In H. H. Jasper. S. Riggio, & P. S. Goldman-Rakic (Eds.), *Epilepsy and the functional anatomy of the frontal lobe (pp. 51-62).* New York: Raven Press.

Goldman-Rakic, P. S. (1995b). Architecture of the prefrontal cortex and the central executive. In J. Grafman, K. J. Holyoak, & F. Boller (Eds.), Structure and functions of the human prefrontal cortex: Vol.769. *Annals of the New York Academy of Sciences (pp. 71-83).* New York: New York Academy of Sciences.

Goltz, F. (1888). Uber die Verrichtungen des Grossshirns. Pfuger's archiv fur die gesamte physiologie, 42, 419-467. Translation by Von Bonin G. On the functions of the hemispheres (1960). In Von Bonin (Ed.), *Some papers on the cerebral cortex (pp.118-158).* Springfield, IL: CC Thomas.

Gomez, R., & Sanson, A. V. (1994). Mother-child interactions and noncompliance in hyperactive boys with and without conduct problems. *Journal of Child Psychology and Psychiatry, 35,* 477-490.

Goodman, J. R., & Stevenson, J. (1989). A twin study of hyperactivity: II. The etiological role of genes, family relationships, and prenatal adversity. *Journal of child Psychology and Psychiatry, 30,* 691-709.

Goodyear, P., & Hynd, G. (1992). Attention deficit disorder with (ADD/H) and without (ADD/WO) hyperactivity: Behavioral and neuropsychological differentiation. *Journal of Clinical Child Psychiatry, 21,* 273-304.

Gordon, M. (1979). The assessment of impulsivity and mediating behaviors in hyperactive and nonhyperactive children. *Journal of Abnormal Child Psychology, 7,* 317-326.

Gordon, M., Mattelmman, B. B., & Irwin, M. (1990). *The impact of comorbidity on ADHD laboratory measures.* Paper presented at the annual meeting of the American Psychological Asspcoation, Boston.

Gordon, K., Statman, D., Johnson, M. V., Robinson, T. E., Becker, J. B., Silverstein, F. S. (1990). Transient hypoxia alters striatal catecholamine metabolism in immature brain: An in vivo microdialysis study. *Journal of Neurochemistry, 54,* 605-611.

Gorenstein, E. E., Mammato, C. A., & Sandy, J. M. (1989). Performance of inactive-overactive children on selected measures of prefrontal-type function. *Journal of Clinical Psychology, 45,* 619-834.

Goyette, C. H., Conners, C. K., & Ulrich, R. F. (1978). Normative data on revised Conners Parent and Teacher Rating Scales. *Journal of Abnormal Child Psychology, 6,* 221-236.

Grafman, J., Jones, B., & Salazar, A. (1990). Wisconsin Card Sorting Test performance based on location and size of neuroanatomical lesion in Vietnam veterans with penetrating head injuries. *Perceptual and Motor Skills, 71,* 1120-1122.

Granger, D. A., Whalen, C. K., Hencker, B., & Cantwell, C. (1996). ADHD boys' behavior during structured classroom social activities: Effects of social demands, teacher proximity, and methylphenidate. *Journal of attention disorders, 1,* 16-30.

Grant, M.L.; Ilai, D.; Nussbaum, N.L.; Bigler, E.D. (1990). The relationship between continuous-performance tasks and neuropsychological tests in children with attention-deficit hyperactivity disorder. *Perceptual and Motor Skills, 1990, 70,* 435-445.

Grattan, L. M., & Eslinger, P. J. (1991). Frontal lobe damage in children and adults: A comprehensive review. *Developmental Neuropsychology, 7,* 283-326.

Gray, J. A. (1982). *The neuropsychology of anxiety.* New York: Oxford Press.

Gray, J. A. (1987). *The psychology of fear and stress (*2nd ed.). Cambridge: Cambridge University Press.

Gray, J. A. (1994). Three fundamental emotional systems. In P. Ekman & R. Davidson (Eds.), *The nature of emotion: Fundamental questions (pp. 243-247).* New York: Oxford University Press.

Green, L., Fry, A. F., & Myerson, J. (1994). Discounting of delayed rewards: A life-span comparison. *Psychological Science, 5,* 33-36.

Green, l., Merson, J., Lichtman, D., Rosen, S., & Fry, A. (1996). Temporal discounting in choice between delayed rewards; The role of age and income. *Psychology and Aging, 11,* 79-84.

Greenhill, L. L., & Osman, B. O. (1999). *Ritalin: Theory and patient management (end ed.).* Larchmont, NY: Mary Ann Liebert.

Grodzinsky, G. (1990). Assessing frontal lobe functioning in boys with attention deficit hyperactivity disorder. *ADHD Hyperactivity Newsletter, 15,* 4-6.

Grodzinsky, G. M., & Diamond, R. (1992). Frontal lobe functioning in boys with attention-deficit hyperactivity disorder. *Developmental Neuropsychology, 8*, 427-445,

Grskovic, J. A., Zentall, S. S., & Stormont-Spurgin, M. (1995). Time estimation and planning abilities: Students with and without mild disabilities, *Behavioral Disorders, 20,* 197-203.

Gualtieri, C. T., Hicks, R. E. (1985). Neuropharmacology of methylphenidate and a neural subtrate for childhood hyperactivity. *Psychiatric Clinics of North America, 8,* 875-892.

Haenlein, M., & Caul, W. F. (1987). Attention deficit disorder with hyperactivity: A specific hypothesis of reward dysfunction. *Journal of the American Academy of Child and Adolescent Psychiatry, 26,* 356-362.

Hall, S. J., Halperin, J. M., Schwartz, S. T., & Newcorn, J. H. (1997). *Journal of Attention Disorders, 1(4),* 235-247.

Hallahan, D. P., Lloyd, J., Kosiewicz, M. M., Kaufman, J. M., & Graves, A. W. (1979). Self-monitoring of attention as a treatment for learning disabled boys' off-task behavior. *Learning Disability Quarterly, 2,* 24-32.

Hallowell, E. M., & Ratey, J. J. (1994). *Driven to Distraction: Attention Deficit Disorder in Children and Adults.* New York: Pantheon.

Halperin, J. M., Matier, K., Bedi, G., Sharma, V., & Newcorn, J. H. (1992). Specificity of inattention, impulsivity, and hyperactivity to the diagnosis of attention-deficit hyperactivity disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 31,* 190-196.

Hamlett, K. W., Pellegrini, D. S., & Conners, C. K. (1987). An investigation of executive processes in the problem-solving of attention deficit disorder-hyperactive children. *Journal of Pediatric Psychology, 12,* 227-240.

Hart, E. L., Lahey, B. B., Loeber, R., Applegate, B., & Frick, P. J. (1995). Developmental changes in attention deficit hyperactivity disorder in boys: A four-year longitudinal study. *Journal of Abnormal Child Psychology, 23,* 729-750.

Hartsough, C. S., & Lambert, N. M. (1985). Medical factors in hyperactive and normal children: Parental, developmental, and health history findings. *American Journal of Orthopsychiatry, 55,* 190-210.

Hastings, J., & Barkley, R. A. (1978). A Review of psychophysiological research with hyperactive children. *Journal of Abnormal Child Psychology, 7,* 337-413.

Hauser, M. D. (1993). Right hemisphere dominance for the production of facial expressions in monkeys. *Science, 261,* 475-477.

Hayes, S. (1989). *Rule-governed behavior.* New York: Plenum Press.

Hayes, S., Gifford, E. V., & Ruckstuhl, L. E. J. (1996). Relational frame theory and executive function: A behavioral analysis. In G. R. Lyons & N. A. Krasnegor (Eds.), *Attention, Memory, and Executive Function (pp. 279-306).* Baltimore: Paul H. Brookes.

Heaton, R. K. (1981). *A manual for the Wisconsin Card Sort Test.* Odessa, FL: Psychological Assessment Resources.

Heaton, R. K., Chelune, G. J., Talley, J. L., Kay, G. G., & Curtiss, G. (1993). *Wisconsin Card Sorting Test Manual: Revised and expanded.* Odessa, FL: Psychological Assessment Resources.

Hechtman, L. T., & Abokoff, H. (1995). Multimodal treatment plus stimulants VS. stimulant treatment in ADHD children: Results from a 2-year comparative treatment study. P. C.

Kendall (ed.), (2000). *Child & adolescent therapy: Cognitive-behavior procedures (2nd ed.).* New York, NY: Guilford Press.

Hencker, B., & Whalen, C. K. (1989). Hyperactivity and attention deficits. *American Psychologist, 44,* 216-223.

Heilman, K. A., Voeller, K. K. S., & Nadeau, S. E. (1991). A possible pathophysiological subtrate of attention deficit hyperactivity disorder. *Journal of Child Neurology, 6,* 74-79.

Herbert, M. (1964). The concept and testing of brain damage in children: A review. *Journal of Child Psychology and Psychiatry, 5,* 197-217.

Hillyard, S. A., & Picton, T. W. (1987). Electrophysiology of cognition. In: F. Plum (Ed.), *Handbook of physiology: The nervous system (pp. 519-584).* Baltimore, MD: American Physiological Society.

Hinshaw, S. P. (1987). On the distinction between attentional deficits/hyperactivity and conduct problems/aggression in child psychopathology. *Psychological Bulletin, 101,* 443-447.

Hinshaw, S. P. (1991). Stimulant medication and the treatment of aggression in children with attentional deficits. *Journal of Clinical Child Psychology, 20,* 301-312.

Hinshaw, S. P. (1994). *Attention deficit and hyperactivity in children.* Thousand Oaks. CA: Sage.

Hinshaw, S. P. (2000). Attention-deficit/hyperactivity disorder: The search for viable treatments. In: P. C. Kendall (Ed.), *Child and adolescent therapy: Cognitive-behavioral procedures (2nd ed.).(pp. 88-128).* New York: Guilford Press.

Hinshaw, S. P., & Erhardt, D. (1990). Behavioral treatment of attention deficit-hyperactivity disorder. In V. B. Van Hasselt & M. Hersen (Eds.), *Handbook of behavior therapy and pharmacotherapy for children: An integrative approach.* New York: Plenum.

Hinshaw, S. P., Heller, T., & McHale, J. P. (1992). Covert antisocial behavior in boys with attention-deficit hyperactivity disorder: External validation and effects of methylphenidate. *Journal of Consulting and Clinical Psychology, 60,* 274-281.

Hinshaw, S. P., Hencker, B., & Whalen, C. K. (1984a). Cognitive-behavioral and pharmacologic interventions for hyperactive boys: Comparative and combined effects. *Journal of Consulting and Clinical Psychology, 52,* 739-749.

Hinshaw, S. P., Hencker, B., & Whalen, C. K. (1984b). Self-control in hyperactive boys in anger inducing situations: Effects of cognitive-behavioral training and methylphenidate. *Journal of Abnormal Child Psychology, 12,* 55-77.

Hinshaw, S. P., Melnick, S. M. (1995). Peer relationships in boys with attention-deficit hyperactivity disorder with and without comorbid aggression. *Development and Psychopathology, 7*, 627-647.

Hinshaw, S. P., & McHale, J. P. (1991). Stimulant medication and social interactions of hyperactive children: Effects of implications. In D. G. Gilbert & J. J. Connally (Eds.), *Personality, Social Skills, and Psychopathology: An individual differences approach (pp.229-253).* New York: Plenum Press.

Hinshaw, S. P., Simmel, C., & Heller, T. L. (1995). Multimethod assessment of covert antisocial behavior in children: Laboratory observations, adult ratings, and child self-report. *Psychological Assessment, 7,* 209-219.

Hoffman, M. L. (1970). Moral development. In P. H. Mussen (Ed.), *Handbook of child psychology (vol2, pp. 261-293).* New York: Wiley.

Holdsworth, L., & Whitmore, K. (1974). A study of children with epilepsy attending ordinary schools: I. Their seizure patterns, progress, and behavior in school. *Developmental Medicine and Child Neurology, 16,* 746-758.

Hopkins, J., Perlman, T., Hechtman, L., & Weiss, G. (1979). Cognitive style in adults originally diagnosed as hyperactive. *Journal of Child Psychology and Psychiatry, 20,* 209-216.

Horn, J. L. (1995). Theory of fluid and crytallized intelligence. In R. J. Sternberg (Ed.), *Encyclopedia of Human Intelligence (pp.443-451).* New York: Simon & Schuster/Macmillan.

Horn, W. F., Ialongo, N., Pascoe, J. M., & Greenberg, G. (1991). Addictive effects of psychostimulants, parent-training, and self-control therapy with ADHD children. *Journal of the American Academy of Child and Adolescent Psychiatry, 30,* 233-240.

Houghton, S., Douglas, G., West, J., Whiting, K., Wall, M., & Langsford, S. (1999). Differential patterns of executive function in children with attention-deficit hyperactivity disorder according to gender and subtype. *Journal of Child Neurology, 14(12),* 801-805.

Humphrey, N. (1984). *Consciousness regained.* Oxford, England: Oxford University Press.

Hynd, G. W., Semrud-Clikerman, M., Lorys, A. R., Novey, E. S., & Eliopulos, D. (1990). Brain morphology in developmental dyslexia and attention deficit-hyperactivity. *Archives of Neurology, 47,* 919-926.

Hynd, G. W., Semrud-Clikeman, M., Lorys, A. R., Novey, E. S., Eliopulos, D., & Lyytinen, H. (1991). Corpus callosum morphology in attention deficit-hyperactivity disorder: Morphometric analysis of MRI. *Journal of Learning Disabilities, 24,* 141-146.

Iaboni, F., Douglas, V. I., & Baker, A. G. (1995). Effects of reward and response costs on inhibition in ADHD children. *Journal of Abnormal Psychology, 104,* 232-240.

Iaboni, F., Douglas, V.I., & Ditto, B. (1997). Psychophysiological response of ADHD children to reward and extinction. *Psychophysiology, 34(1),* 116-123.

Ialongo, N. S., Horn, W. F., & Pascoe, J. M. et al. (1993). The effects of a multimodal intervention with attention-deficit hyperactivity disorder children : A 9-month follow-up. *Journal of American Academy of Child and Adolescent Psychiatry, 32,* 182-189.

Jacobsen, C.F. & Nissen, H.W. (1937). Studies of cerebral function in primates. IV. The effects of frontal lobe lesions on the delayed alternation habit in primates. *Journal of Comprehensive Physiological psychology, 23,* 101-112.

Jacobsen, C.F., Wolfe, J.B., & Jackson, T.A. (1935). An experimental analysis of the frontal association areas in primates. *Journal of Nervous Mental Disease, 82,* 1-14.

Jennings, J. R., Van der Molen, M. W., Pelham, W., Debski, K. B., & Hoza, B. (1997). Inhibition in boys with attention deficit hyperactivity disorder as indexed by heart rate change. *Developmental Psychology, 33(2),* 308-318.

Jensen, P. S., Bhatara, V. S., Vitiello, B., Hoagwood, K., Feil, M., & Burke, L. B. (1999). Psychoactive medication prescribing practices for US children: Gaps between research and clinical practice. *Journal of American Academy of Child and Adolescent Psychiatry, 38,* 557-565.

Jensen, J. B., Burke, N., & Garfinkel, B. D. (1988). Depression and symptoms of attention deficit disorder with hyperactivity. *Journal of American Academy of Child and Adolescent Psychiatry, 27,* 742-747.

Jensen, P. S., Hinshaw, S. P., Kraemer, H. C., Leonora, N., Newcorn, J. H., & Abikoff,

H. B., et al., (2001). ADHD comorbidity findingd from MTA study: Coparing comorbid subgroups. *Journal of the American academy of Child and Adolescent Psychiatry, 40(2),* 147-158.

Jensen, P. S., Shervette, R. S., Xenakis, S. N., & Richters, J. (1993). Anxiety and depressive disorders in attention-deficit disorder: New findings. *American Journal of Psychiatry, 150,* 1203-1209.

Johnson, C., Pelham, W., Hoza, J., Sturges, J. (1988). Psychostimulant rebound in attention deficit disordered boys. *Journal of the American Academy of Child and Adolescent Psychiatry, 27,* 806-810.

Jonkman, L. M., Kemner, C., Verbaten, M. N., Van Engeland, H., Camfferman, G., & Buitelaar, J. K., (2000). Attentional capacity, a probe ERP study: differences between children with attention-deficit hyperactivity disorder and normal control children and effects of methylphenidate. *Psychophysiology, 37(3),* 334-346.

Joseph, J. P., & Barone, P. (1987). Prefrontal unit activity during a delayed oculmotor task in the monkey. *Experimental Brain Research, 67,* 460-468.

Kagan, J. (1964). *Matching Familiar Figures Test.* Cambridge, MA: Harvard University.

Kamphaus, R. W. (1993). *Clinical assessment of children's intelligence.* Boston, MA: Allyon & Bacon.

Kanbayashi, Y., Nakata, Y., & Fujii, K. (1994). ADHD-related behavior among non-referred children: Parents' ratings of DSM-III-R symptoms. *Child Psychiatry and Human Development, 25,* 13-29.

Kanfer, F. H., & Karoly, P. (1972). Self-control: A behavioristic excursion into the lion's den. *Behavior Therapy, 3,* 398-416.

Karatekin, C., & Asarnow, R. F. (1998). Working memory in childhood –onset schizophrenia and attention-deficit hyperactivity rong>disorder. *Psychiatry Research, 80(2),* 165-176.

Kashani, J. H., Beck, N., & Hoeper, E. (1987). Psychiatric disorders in a community sample of adolescents. *American Journal of Psychiatry, 144,* 584-589.

Katz, M. (1994). From Challneged childhood to achieving adult: Studies in resilience. *Chadder, 1,* 8-11.

Katz, L. J., Wood, D. S., Goldstein, G., Auchenbach, R. C., & Geckle, M. (1998). The utility of neuropsychological tests in evaluation of attention-deficit/hyperactivity disorder (ADHD) versus depression in adults. *Assessment, 5(1),* 45-51.

Kaufman, A. S. (1990). *Assessing adolescent and adult intelligence.* Boston, MA: Allyon & Bacon.

Kaufman, A. S. (1994). *Intelligence testing with WISC-III.* New York: Wiley.

Kazdin, A. E. (1977). Assessing the clinical or applied significance of behavior change through social validation. *Behavior Modification, 1,* 427-452.

Kazdin, A. E. (1984). *Behavior modification in applied settings (3rd ed.).* Homewood, Ill: Dorsey.

Kazdin, A., E., & Weiss, J. R. (1998). Identifying and developing empirically supported child and adolescent treatments. *Journal of Consulting and Clinical Psychology, 66,* 19-36.

Kelly, K. L., Rapport, M. D., & DuPaul, G. J. (1988). Attention deficit disorder and methylphenidate: A multi-step analysis of dose response effects on children's cardiovascular functioning. *International Clinical Psychopharmacology, 3,* 167-181.

Kendall, P. C. & Brasswell, L. (1993). *Cognitive-behavior therapy for impulsive children (2nd ed.).* New York: Guilford.

Kendall, P. C., Nay, W. R., & Jeffers, J. (1975). Time out duration contrast effect: A systematic evaluation of a successive design. *Behavior Therapy, 6,* 609-615.

Kendall, P. C., Reber, M., McLeer, S., Epps, J., & Ronan, K. R. (1990). Cognitive behavioral treatment of conduct-disordered children. *Journal of Cognitive Therapy and Research, 14,* 279-297.

Kendall, P. C., & Wilcox, L. E. (1979). Self-control in children: Development of a rating scale. *Journal of Consulting and Clinical Psychology, 47,* 1020-1029.

Kendziora, K. T., & O'Leary, S. G. (1992). Dysfunctional parenting as a focus for prevention and treatment of child behavior problems. In T. H. Ollendick & R. J. Prinz (Eds.), *Advances in child clinical psychology (vol 15; pp. 175-296).* New York: Plenum.

Keplan, B. J., Dewey, D., Crawford, S. G., & Fisher, G. C. (1998). Deficits in long-term memory are not characteristics of ADHD. *Journal of Clinical and Experimental Neuropsychology, 20(4),* 518-528.

Kesner, R. P., Hopkins, R. O., & Fineman, B. (1994). Item and order dissociation in humans with prefrontal cortex damage. *Neuropsychologia, 32,* 881-889.

Kindlon, D., Mezzacappa, E., & Earls, F. (1995). Psychometric properties of impulsivity measures: Temporal stability, validity, and factor structure. *Journal of Child Psychology and Psychiatry, 36,* 645-661.

Kinsbourne, M. (1984). Beyond attention deficit: Search for the disorder in ADD. In L. M. Bloomingdale (Ed.), *Attention deficit disorder: Diagnostic, cognitive and therapeutic understanding (pp. 133-145).* New York: Spectrum.

Klein, R. G., & Mannuzza, S. (1988). Hyperactive Boys almost grown Up: III. Methylphenidate effects on ultimate height. *Archives of General Psychiatry, 45,* 1131-1134.

Klein, R. G., & Wender, P. (1995). The role of methylphenidate in psychiatry. *Archives of general Psychiatry, 52,* 429-433.

Klorman, R. (1992). Cognitive event-related potentials in attention deficit disorder. In S. E. Shaywitz & B. A. Shaywitz. (1992), *Attention deficit disorder comes of age: Toward the twenty-first century (pp. 221-244).* Austin, TX: Pro-ed.

Klorman, R., Brumaghin, J. T., Fitzpatrick, M. A., & Borgstedt, A. D., (1990). *Journal of the American Academy of Child and Adolescent Psychiatry, 26,* 702-709.

Klorman, R., Brumaghin, J. T., & Salzman, L. F. (1988). Effects of methylphenidate on attention-deficit hyperactivity disorder with and without aggressive/noncompliant features. *Journal of Abnormal Psychology, 97,* 413-422.

Klorman, R., Hazel-Fernandez, L. A., Shaywitz, S. E., Fletcher, J. M., Marchion, K. E., & Holahan, J. M., (1999). Executive functioning deficits in attention-deficit/hyperactivity disorder are independent of oppositional defiant or reading disorder. *Journal of the American Child and Adolescent Psychiatry, 38(9),* 1148-1155.

Klorman, R., Salzman, L. F., & Borgstedt, A. D. (1988). Brain even-related potentials in evaluation of cognitive deficits in attention deficit disorder and outcome of stimulant therapy. In L. Bloomingdale (Ed.), Attention deficit disorder, Vol. 3. *New research in attention, treatment, and psychopharmacology (pp. 49-80).* New York: Pergamon.

Knight, R. T., Grabowecky, & Sabini, D. (1995). Role of human prefrontal cortex in attention control. In H. H. Jasper, S. Riggio, & P. S. Goldman-Rakic (Eds.), *Epilepsy and the functional anatomy of the frontal lobe (pp. 21-34).* New York: Raven Press.

Kolb, B., & Wishaw, I. Q. (1990). *Fundamentals of human neuropsychology.* New York: WH Freemont and Company.

Konard, K., Gauggel, S., Manz, A., & Scholl, M. (2000). Inhibitory control in children with traumatic brain injury (TBI) and children with attention deficit/hyperactivity disorder (ADHD). *Brain Injury, 14(10),* 859-875.

Kopp, C. B. (1982). Antecedents of self-regulation: A developmental perspective. *Developmental Psychology,18,* 199-214.

Kopp, C. B. (1989). Regulation of distress and negative emotions: A developmental view. *Developmental Psychology, 25,* 343-354.

Koziol, L. F., & Stout, C. E. (1992). Use of a verbal fluency measure in understanding and evaluating ADHD as an executive function disorder. *Perceptual Motor Skills, 75,* 1187-1192.

Krener, P., Carter, C., Chaderjian, M., Wolf, V., & Northcutt, C. (1993). Executive function in children with ADHD and controls. In: R. A. Barkley. *ADHD and the nature of self-control.* New York, NY: Guilford Press.

Kuntsi, J., Oosterlaan, J., & Stevenson, J. (2001). Psychological mechanisms in hyperactivity: I response inhibition deficit, working memory impairment, delay aversion, or something else? *Journal of Child Psychology and Psychiatry, 42 (2),* 199-210.

Kuperman, S., Johnson, B., Arndt, S., Lindgren, S., & Wolraich, M. (1996). Quantitative EEG differences in a nonclinical sample of children with ADHD and undifferentiated ADD. *Journal of American Academy of Child and Adolescent Psychiatry, 35,* 1009-1017.

Lahey, B.B., Applegate, B., & McBurnett, K. (1994). DSM-IV field trials for attention deficit hyperactivity disorder in children and adolescents. *American journal of Psychiatry, 151,* 1673-1685.

Lahey, B. B., Pelham, W. E., Schughency, E. A., Atkins, M. S., Murphy, H. A., and Hynd, G. W.

et al. (1988). Dimensions and types of attention deficit disorder with hyperactivity in children: A factor and cluster-analytic approach. *Journal of the American Academy of Child and Adolescent Psychiatry, 27,* 330-335.

Last, C. G. (1993). Introduction. In: Last C. G. (Ed.), *Anxiety across the life span: A developmental perspective (pp.1-7).* New York, NY: Springer.

Laub, L. & Braswell, L. (1991). Suggestions for Classroom Teachers of ADHD Elementary School Students. In Braswell, L., & Bloomquist, M. L. *Cognitive-Behavioral Therapy with ADHD children (Appendix C).* New York, NY: Guilford Press.

Laufer, M., Denhoff, E., & Solomons, G. (1957). Hyperkinetic impulse disorder in children's behavior problems. Psychosomatic Medicine, 19, 38-49.Lazarus, R. (1994). Appraisal: The long and the short of it. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions (pp.208-215).* New York: Oxford University Press.

Lauria, A. R. (1966). *Higher cortical functions in man.* New York: Basic Books.

Lazarus, R. (1994). Appraisal: The long and the short of it. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions (pp.208-215).* New York: Oxford University Press.

Leth-Steensen, C., Elbaz, Z. K., & Douglas, V. I. (2000). Mean response times, variability, and skew in the responding of ADHD children: A response time distributional approach. *Acta Psychologia,104,* 167-190.

Leung, P. W. L., & Connally, K. J. (1996). Distractibility in hyperactive and conduct-disordered children. *Journal of Child Psychology and Psychiatry, 37,* 305-312.

Leung, P.W.L., Luk, S.L., Ho, T.P. (1996). The diagnosis and prevalence of hyperactivity in Chinese schoolboys. *British Journal of Psychiatry, 168,* 486-496.

Levenson, R. W. (1994). Human emotions: A functional view. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions (pp. 123-126).* New York: Oxford University Press.

Levin, P. M. (1938). Restlessness in children. *Archives of Neurology and Psychiatry, 39,* 764-770.

Levy, F., Hay, D.H., & McStephen, M. (1997). Attention-deficit hyperactivity disorder: a category of a continuum? Genetic analysis of a large-scale twin study. *Journal of American Academy of Child and Adolescent Psychiatry, 36,* 734-744.

Lezak, M. D. (1995). *Neuropsychological assessment, 3rd Edition.* New York: Oxford University Press.

Livingston, R. L., Dykman, R. A., & Ackerman, P. T. (1990). The frequency and significance of additional self-reported psychiatric diagnoses in children with attention deficit hyperactivity disorder. *Journal of Abnormal Child Psychology, 18*, 465-478.

Lochman, J. E., & Curry, J. F. (1986). Effects of social problem-solving training and self-instruction training with aggressive boys. *Journal of Clinical Child Psychology, 15,* 159-164.

Loeber, R., Green, S. M., Lahey, B. B., & Stouthamer-Loeber, M. (1989). Optimal informants on childhood disruptive behaviors. *Development and Psychopathology, 1,* 317-337.

Logan, G. (1985). Executive control of thought and action. *Acta Psychologia, 60,* 193-210.

Logan, G. D., Cowan, W. B., & Davies, K. A. (1984). On the ability to inhibit simple and choice reaction time responses: A model and a method. *Journal of Experimental Psychology, 10, (2),* 276-291.

Loge, D. V., Staton, D., & Beatty, W. W. (1990). Performance of children with ADHD on tests sensitive to frontal lobe dysfunction. *Journal of the American Academy of Child and Adolescent Psychiatry, 29,* 540-545.

Loney, J. (1983). Research Diagnostic Criteria for childhood hyperactivity. In S. B. Guze, F. J. Earls., & J. E. Barrett (Eds.), *Childhood psychopathology and development (pp.109-137).* New York: Raven.

Losier, B. J., McGrath, P. J., & Klein, R. M. (1996). Error patterns on the continuous performance test in non-medication and medicated samples of children with and without ADHD: A meta analysis. *Journal of Child Psychology and Psychiatry, 37,* 971-987.

Lou, H. C., Henriksen, L., & Brauhn, P. (1984). Focal cerebral hypoperfusion in children with dysphasia and /or attention deficit disorder. *Archives of Neurology, 41,* 825-829.

Lou, H. C., Henriksen, L., Brauhn, P., Borner, H., & Neilsen, J. B. (1989). Striatal dysfunction in attention deficit and hyperkinetic disorder. *Archives of Neurology, 46,* 48-52.

Ludlow, C., Rapoport, J., Brown, G., & Mikkelson, E. (1979). The differential effects of dextroamphetamine on the language and communication skills of hyperactive and normal children. In R. Knight & D. Baker (Eds.), *Rehabilitation, treatment, and management of learning disorders.* Baltimore: University Park Press.

Lufi, D., & Parish-Plass, J. (1995). Personality assessment of children with attention deficit hyperactivity disorder. *Journal of Clinical psychology, 51,* 94-99.

Luk, S. (1985). Direct observations studies of hyperactive behaviors. *Journal of the Academy of Child and Adolescent Psychiatry, 24,* 338-344.

Manassis, K., Tannock, R., & Barbosa, J. (2000). Dichotic listening and response inhibition in children with comorbid anxiety disorders and ADHD. *American Academy of Child and Adolescent Psychiatry, 39(9),* 1152-1159.

Mannuzza, S., Klein, R. G., Konig, P. H., & Giampino, T. L. (1989). Hyperactive boys almost grown up: IV. Criminality and its relationship to psychiatric status. *Archives of General psychiatry, 46,* 1073-1079.

Manos, M., Short, E., & Findling, R. (1999). Differential effectiveness of methylphenidate and Adderall in school-age youths with attention deficit hyperactivity disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 38(7),* 813-819.

Marenco, S., Coppola, R., Daniel, D. G., Zigun, J. R., & Weinberger, D. R. (1993). Regional cerebral blood flow during the Wisconsin Card Sorting Test in normal subjects studied by Xenon-133 dynamic SPT: Comparison of absolute values, percent distribution values, and covariance analysis. *Psychiatry Research: Neuroimaging, 50,* 177-192.

Margalit, M., & Arieli, N. (1984). Emotional and behavioral aspects of hyperactivity. *Journal of Learning Disabilities, 17,* 374-376.

Mariani, M., & Barkley, R. A. (1997). Neuropsychological and academic functioning in preschool children with attention deficit hyperactivity disorder. *Developmental Neuropsychology, 13,* 111-129.

Mash, E. J., & Johnson, C. (1990). Determinants of parenting stress: Illustrations from families of hyperactive children and families of physically abused children. *Journal of Child Clinical Psychology, 19,* 313-328.

Mataro, M., Garcia-Sanchez, C., Junque, C., Estevez-Gonzalez, A, & Pujol, J. (1997). Magnetic resonance imaging measurement of the caudate nucleus in adolescents with attention-deficit hyperactivity disorder and its relationship with neuropsychological and behavioral measures. *Archives of Neurology, 54(8),* 963-968.

Mattes, J. A. (1980). The role of frontal lobe dysfunction in childhood hyperkinesis.

Comprehensive Psychiatry, 21, 358-369.

Mayfield, J. M., Apperson, J., Austin, L., & Oberg, K. (1997). The super card system: A classroom behavior management system for classes effected by ADHD/impulsive behavior. In: D. L. Smallwood. *Attention disorders in children: Resources for school psychologists (255-259).* Bethesda, MD: The National Association for School psychologists.

Mazure, J. E. (1993). Predicting the strength of a conditioned reinforcer: Effects of delay and uncertainty. *Current Directions in Psychological science, 2,* 70-74.

Mealer, C., Morgan, S., & Luscomb, R. (1996). Cognitive functioning of ADHD and non-ADHD boys on the WISC-III and WRAML: An analysis within a memory model. *Journal of Attention Disorders, 1(3),* 133-147.

Meichenbaum, D. H., & Goodman, J. (1971). Training impulsive children to talk to themselves: A means of developing self-control. *Journal of Abnormal Psychology, 77,* 115-126.

Mendelson, W., Johnson, N., & Stewart, M. A. (1971). Hyperactive children as teenagers: A follow-up study. *Journal of Nervous and Mental Disease, 153*, 273-279.

Mendier, A. N. (1992). *What do I do when...? How to achieve discipline with dignity in the classroom.* Bloomington, IN: National Educational Service.

Mercugliano, M. (1995). Neurotransmitter relations in attention-deficit/hyperactivity disorder. *Mental Retardation and Developmental Disabilities Research Reviews, 1*, 220-226.

Meyers, J. E., & Meyers, K. R. (1995). *Rey Complex Figure Test and Recognition Trial: Professional Manual.* Psychological Assessment Resources Inc.

Michon, J. A. (1985). Introduction. In J. Michon, & T. Jackson (Eds.), *Time, mind, and behavior.* Berlin: Springer-Verlag.

Michon, J. A., & Jackson, J. L. (1984). Attentional effort and cognitive strategies in the processing of temporal information. In J. Gibbon & L. Allan (Eds.), time, and time perception: Vol. 423. *Annals of the New York Academy of Sciences (pp. 298-321).* New York: New York Academy of Sciences.

Michon, J. A., Jackson, J. L., & Vermeeren, A. (1984). The processing of temporal information. In J. Gibbon & L. Allan (Eds.), Timing and time perception: Vol. 423, *Annals of the New York Academy of Sciences (pp. 603-604).* New York: New York Academy of Sciences.

Milich, R., Carlson, C. L., Pelham, W. E., & Licht, B. G. (1991). Effects of methylphenidate on the persistence of ADHD boys following failure experiences. *Journal of Abnormal Child Psychology, 19,* 519-536.

Milich, R., & Dodge, K. A. (1984). Social information processing in child psychiatric populations. *Journal of Abnormal Child Psychology, 12,* 471-490.

Milich, R., & Kramer, J. (1985). Reflections on impulsivity: An empirical investigation of impulsivity as a construct. In K. Gadow & I. Bialer (Eds.), *Advances in learning and behavioral disabilities (Vol. 3, pp. 57-94).* Greenwich, CT: JAI Press.

Milich, R., Hartung, C. M., Martin, C. A.M & Haigler, E. D. (1994). Behavioral disinhibition and underlying processes in adolescents with disruptive disorders. In D. K. Routh (Ed.), *Distruptive behavior disorders in childhood (pp.109-138).* New York:Plenum Press.

Milich, R., & Loney, J. (1979). The factor composition of the WISC for hyperkinetic/MBD males. *Journal of Learning Disabilities, 12,* 67-70.

Millstein, R. B., Wilens, T. E., & Biederman J., et al. (1997). Presenting ADHD symptoms and subtypes of clinically referred adults with ADHD. *Journal of Attention Disorders, 2,* 159-166.

Milner, B. (1963). Effects of different brain lesions on card sorting. *Archives of Neurology, 9,* 90-100.

Milner, B. (1964). Some effect of frontal lobectomy in man. In: Warren, J.M., Akert, K. (Eds). *The frontal granular cortex and behavior (P.313-314).* New York: McGraw-Hill.

Milner, B. (1995). Aspects of human frontal lobe function. In H. H. Jasper, S. Riggio, & P. S. Goldman-Rakic (Eds.), *Epilepsy and the functional anatomy of the frontal lobe (pp. 67-81).* New York: Raven Press.

Miranda, A., & Presentacion, M. J. (2000). Efficacy of cognitive-behavior therapy in the treatment of children with ADHD, with and without aggressiveness. *Psychology in the Schools, 37(2),* 169-182.

Mischel, W., Shoda, Y., & Rodriguez, M. I. (1989). Delay of gratification in children. *Science, 244,* 933-938.

Mirsky, A. F. (1996). Disorders of attention: A neuropsyhological perspective. In R. G. Lyon & N. A. Krasnegor (Eds.), *Attention, memory and executive function (pp. 71-96).* Baltimore: Paul H. Brookes.

Moffitt, T. E. (1990). Juvenile delinquency and attention deficit disorder: Boys' developmental trajectories from age 3 to 15. *Child Development, 61,* 893-910.

Moffitt, T. E., & Silva, P. A. (1988). Self-reported delinquency, neuropsychological deficit, and history of attention deficit disorder. *Journal of Abnormal Psychology, 16,* 553-569.

MTA Cooperative Group. (1999a). A 14-month randomized clinical trial of treatment strategies of attention-deficit/hyperactivity disorder. *Archives of General Psychiatry, 56,* 1073-1086.

MTA Cooperative Group. (1999b). Moderators and mediators of treatment response for children with attention-deficit hyperactivity disorder. *Archives of General Psychiatry, 56,* 1088-1096.

Munk, H. (1890). Uber die functionen der grossshirnrinde. In. B. F. Pennington, & S. Ozzonoff (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry, 37(1),* 51-87.

Murphy, D. A., Pelham, W. E., & Lang, A. R. (1992). Aggression in boys with attention deficit disorder: Methylphenidate effects on naturalistic observations of aggression, response to provocation in the laboratory, and social information processing. *Journal of Abnormal Child Psychology, 20,* 451-466.

McAndrews, M. P., & Milner, B. (1991). The frontal cortex and memory for temporal order. Neuropsychologia, 29, 849-859.

McBurnett, K., Harris, S. M., Swanson, J. M., Pfiffner, L. J., Tamm, l., & Freeland, D. (1993). Neurological and psychophysiological differentiation of inattention/hyperactivity and aggression/defiance symptom groups. *Journal of Clinical Child Psychology, 22,* 165-171.

McCullum, W. C., Curry, S. H., Cooper, R., Pocock, P. V., & Papakostopoulos, D. (1983). Brain event-related potentials as indicators of early selective processes in auditory target localization. *Psychophysiology, 20,* 1-17.

McDonald, S., Bennett, K. M., & Castiello, U. (1999). Covert orienting and focusing of attention in children with attention deficit hyperactivity disorder. *Neuropsyhologia, 37(3),* 345-356.

McGee, S. E., Clark, S. E., & Symons, D. K. (2000). Does the Conner's continuous test aid in ADHD diagnosis? *Journal of Abnormal Child Psychology, 28(5),* 415-424.

McGee, R., & Feehan, M. (1991). Are girls with problems of attention underrecognized? *Journal of Psychopathology and Behavioral Assessment, 13,* 187-198.

McGee, R., Williams, S., Moffitt, T., & Anderson, J. (1989). A comparison of 13-year old boys with attention deficit and/or reading disorder on neuropsychological measures. *Journal of Abnormal Child Psychology, 17,* 37-53.

McGee, R., Williams, S., & Silva, P. A. (1987). A comparison of girls and boys with teacher-identified problems of attention. *American Academy of Child and Adolescent Psychiatry, 26,* 711-717.

Nahri, V., & Ahonen, T. (1995). Reading disability with or without attention deficit disorder: Do attentional problems make a difference? *Developmental Neuropsychology, 11,* 337-349.

Needleman, H. L., Shell, A., Bellinger, D. C., Leviton, L., & Alfred, E. D. (1990). The long-term effects of exposure to low doses of lead in childhood: An 11-year follow-up report. *New England Journal of Medicine, 322,* 83-88.

Nelson, H. E. (1976). A modified card-sorting test sensitive to frontal-lobe effects. *Neuropsychologia, 12,* 313-324.

Newby, R. F., Fischer, M., & Roman, M. A (1997). Parent training for families of children with

ADHD. In. D. L. Smallwood (Ed.), *Attention disorders in children: Resources for school psychologists (141-153).* Bethesda, MD: The National Association of School Psychologists.

Newcorn, J. H., & Halperin, J. M. (2000). Attention-deficit disorders with oppositionality and aggression. In: T. E. Brown. *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults (pp. 171-209).* Washington, DC: American Psychiatric Press. Newcorn, J. H., & Halperin, J. M. (2001).

Newman, J. P., & Wallace, J. F. (1993). Diverse pathways to deficient self-regulation: implications for disinhibitory psychopathology in children. *Clinical psychology review, 13,* 699-720.

Niki, H. (1874). Prefrontal unit activity during delayed alteration in the monkey. I. Relation to direction of response. *Brain research, 68*, 185-196.

Nicholas, P. L., & Chen, T. C. (1981). *Minimal Brain Dysfunction: A prospective study.* Hillsdale, NJ: Erlbaum.

Nigg, J. T. (1999). The ADHD response-inhibition deficit as measured by the stop task: replication with DSM-IV combined type, extension, and qualification. *Journal of Abnormal Child Psychology, 27(5),* 393-402.

Nigg, J. T., Hinshaw, S. P., Carte, E. T., & Treuting, J. J. (1998). Neuropsychological correlates of childhood attention-deficit/hyperactivity disorder explainable by comorbid disruptive behavior or reading problems? *Journal of Abnormal Psychology, 107(3),* 468-480.

Norrelgen, F., Lacerda, F., & Forssberg, H. (1999). Speech discrimination and phonological working memory in children with ADHD. *Developmental Medicine and Child Neurology, 41(5),* 335-339.

Oads, R. D. (1987). Attention deficit disorder with hyperactivity: The contribution of catecholaminergic activity. *Progress in Neurobiology, 29,* 365-391.

O'Dougherty, M., Nucchterlein, K. H., & Drew, B. (1984). Hyperactive and hypoxic children: Signal detection, sustained attention, and behavior. *Journal of Abnormal Psychology, 93,* 178-191.

Oei, M., & Rund, B. R. (1999). Neuropsychological deficits in adolescent-onset schizophrenia compared with attention deficit hyperactivity disorder. *American Journal of Psychiatry, 156(8),* 1216-1222.

Oosterlaan, J., Logan, G. D., & Sergeant, J. A. (1998). Response inhibition in AD/HD, CD, comorbid AD/HD = CD, anxious, and control children: A meta-analysis of studies with the Stop Task. *Journal of Child Psychology and Psychiatry, 39, (3),* 411-425.

Oosterlaan, J., & Sergeant, J. A. (1995). Response choice and inhibition in ADHD, anxious, and aggressive children: The relationship between S-R compatibility and stop signal task. In J. A. Sergeant (Ed.), *European approaches to hyperkinetic disorder (pp. 225-240).* Amsterdam: J. A. Sergeant.

Oosterlaan, J., & Sergeant, J. A. (1996a). Inhibition in ADHD, aggressive and anxious children: A biologically based model of child psychopathology. *Journal of Abnormal Psychology, 24,* 19-36.

Oosterlaan, J., & Sergeant, J. A. (1996b). Inhibition in ADHD, aggressive, and anxious children. *Journal of Abnormal Child Psychology, 24(1),* 19-36.

Oosterlaan J., & Sergeant, J. A., (1998a). Effects of reward and response cost on response inhibition in AD/HD, disruptive, anxious, and normal children. *Journal of Abnormal Child Psychology, 26(3),* 161-174.

Oosterlaan J., & Sergeant, J. A., (1998b). Response inhibition and response re-engagement in attention-deficit/hyperactivity disorder, disruptive, anxious and normal children. *Behavioral Brain Research, 94,* 33-43.

Osmon, D. C., Zigun, J. R., Suchy, Y., & Blint, A. (1996). *Whole brain MRI activation on Wisconsin-like card sorting measures: Clues to test specificity.* In. R. A. Barkley. *ADHD and the nature of self-control.* New York: Guilford Press.

Ott, D. A., & Lyman, R. D. (1993). Automatic and effortful memory in children exhibiting attention deficit hyperactivity disorder. *Journal of Clinical Child Psychology, 22,* 420-427.

O'Leary, K. D. (1980). Pills or skills for hyperactive children. *Journal of Applied Behavior Analysis, 13,* 191-204.

Parasurament R. (ed). (1998). *The Attentive Brain*. Cambridge, MA: MIT Press.

Pardo, J. V., Fox, P. T., Raiche, M. E. (1991). Localization of a human system for sustained attention by position emission tomography. *Nature, 349*, 61-64.

Parry, P. A., & Douglas, V. I. (1976). The effects of reward on the performance of hyperactive children. *Unpublished doctoral dissertaion,* McGill University, montreal.

Parry, P. A., & Douglas, V. I. (1983). Effects of reinforcement on concept identification in hyperactive children. *Journal of Abnormal Child Psychology, 11,* 327-340.

Pasamanick, B., Rogers, M., & Lilienfield, A. M. (1956). Pregnancy experience and the development of behavior disorder in children. *American Journal of Psychiatry, 112,* 613-617.

Pataki, C., Carlson, G., Kelly, K., Rapport, M. D., & Biancaniello, T. (1993). Side effects of methylphenidate and desipramine alone and in combination in children. *American*

Journal of Psychiatry, 32, 1065-1072.

Pauls, D. L. (1991). Genetic factors in the expression of attention-deficit hyperactivity disorder. *Journal of Child and Adolescent Psychopharmachology, 1,* 353-360.

Pelham, W. E. (1993). Pharmachotherapy for children with attention-deficit hyperactivity disorder, *School Psychology Review, 22,* 199-227.

Pelham, W. E. (1999). The NIMH multimodal treatment study for attention-deficit hyperactivity disorder: Just say yes to drugs alone? *Canadian Journal of Psychiatry, 44,* 981-990.

Pelham, W. E. (2000). Implications of the MTA study for behavioral and combined treatments. In: R.A Barkley (Ed.). *The ADHD Report (pp. 9-13, 16).* New York, NY: Guilford Press.

Pelham, W. E., & Bender, M. E. (1982). Peer relationships in hyperactive children: Description and treatment. In K. Gadow & I. Bialer (Eds.), *Advances in learning and behavioral disabilities (vol 1, pp. 365-436).* Greenwich, CT: JAI.

Pelham, W. E., Gnagy, E. M., Greiner, A. R., Hoza, B., Hinshaw, S. P., & Swanson, J. M. et al (2000). Behavioral versus behavioral and pharmacological treatment in ADHD children attending a summer treatment program. *Journal of Abnormal Psychology.*

Pelham, W. E., Greenslade, K. E., Vodde-Hamilton, M., Murphy, D. A., Greenstein, J. J., and Gnagy, E. M. et al (1990). Relative efficacy of Long-acting stimulants on children with attention deficit-hyperactivity disorder: A comparison of standard methylphenidate, sustained-release methylphenidate, sustained-release dextroamphetamine, and pamoline. *Pediatrics, 86,* 226-237.

Pelham, W. E., Hoza, B., Kipp, H. L., Gnagy, E. M., & Trane, S. T. (1997). Effects of methylphenidate and expectancy on ADHD children's performance, self-evaluations, persistence, and attributions on a cognitive task. *Experimental and Clinical Psychopharmacology, 5 (1),* 3-13.

Pelham, W. E., & Milich, R. (1991). Individual differences in response to Ritalin in classroom and social behavior. In L. L. Greenhill, B. B. Osman (Eds.), *Ritalin: Theory and patient management (pp. 203-221).* New York: Mary Ann Libert.

Pelham, W. E., Milich, R., & Walker, J. L. (1986). Effects of continuous and partial reinforcement and methylphenidate on learning in children with attention deficit disorder. *Journal of Abnormal Psychology, 95,* 319-325.

Pelham, W. E., & Murphy, H. A. (1986). Attention deficit and conduct disorders. In M. Hersen (Ed.), *Pharmacological and behavioral treatments: An integrative approach (pp. 108-148).* New York: Wiley.

Pelham, W. E., Murphy, D. A., Vannatta, K., Milich, R., Licht, B. G., & Gnagy, E. M. et al. (1992). Methylphenidate and attributions in boys with attention-deficit hyperactivity disorder. *Journal of Consulting and Clinical Psychology, 60,* 282-292.

Pelham, W. E., Schnedler, R. W., Bender, M. E., Nilsson, D. E., Miller, J., Budrow, M. S. et al. (1988). The combination of behavior therapy and methylphenidate in the treatment of attention deficit disorders: A therapy outcome study. In: L. L. Bloomingdale (Ed.), Attention Deficit-Disorder (vol 3, pp. 29-47). London: Pergamon.

Pelham, W. E., Swanson, J. M., Furman, M. B., & Schwindt, H. (1995). Pemoline effects on children with ADHD: A time-response by dose-response analysis on classroom measures. *Journal of the American Academy of Child and Adolescent Psychiatry, 34,* 1504-1513.

Pennington, B. F., Grossier, D., & Welsh, M. C. (1993). Contrasting cognitive deficit disorder versus reading disability. *Developmental Psychology, 29,* 511-523.

Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry, 37,* 51-87.

Pfiffner, L., & McBurnett, K. (1997). Social skills training with parent generalization: Treatment effects for children with attention deficit disorder. *Journal of Consulting and Clinical Psychology, 65,* 749-757.

Pfiffner, L. J., & O'Leary, S. G. (1987).The efficacy of all-positive management as a function of the prior use of negative consequences. *Journal of Applied Behavior Analysis, 20,* 265-271.

Pfiffner, L. J., & O'Leary, S. G., Rosen, L. A., & Sanderson, W. C. (1984). A comparison of the effects of continuous and intermittent response cost and reprimand in the classroom. *Journal of Clinical Child Psychology, 14,* 348-352.

Piazza, C. C., Bowman, L. G., Contrucci, S. A., Delia, M. D., Adelinis, J. D., & Goh, H. L. (1999). An evaluation of the properties of attention as reinforcement of destructive and appropriate behavior. *Journal of Applied Behavior Analysis, 32(4),* 437-449.

Pineda, D., Ardila, A., & Rosselli, M. (1999). Neuropsychological and behavioral assessment of ADHD in seven-to twelve-year-old children: A discriminant analysis. *Journal of Learning Disabilities, 32(2),* 159-173.

Pisterman, S., Firestone, P., Mcgrath, P., Goodman, J. T., Webster, I., & Mallory, R. (1992). The role of parent training in treatment of preschoolers with ADD-H. *American Journal of Orthopsychiatry, 62,* 397-408.

Pisterman, S., McGrath, p., Firestone, P., Goodman, J. T., Webster, I., Mallory, R. (1989).

Outcome of parent-mediated treatment of preschoolers with attention deficit disorder with hyperactivity. *Journal of Consulting and Clinical Psychology, 57,* 628-635.

Pliszka, S. P. (1989). Effect of anxiety on cognition, behavior, and stimulant response in ADHD. *American Academy of Child and Adolescent Psychiatry,* 882-887.

Pliszka, S. P. (1991). Comorbidity of attention-deficit hyperactivity disorder and overanxious disorder. *Journal of American Academy of Child and Adolescent Psychiatry, 31, (2),* 197-203.

Pliszka, S. P. (1992). Comorbidity of attention deficit-hyperactivity disorder and overanxious disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 31,* 197-203.

Pliszka, S. P., & Borcherding, S. H. (1995). The Stop-Signal Task in children with ADHD and anxiety. In: H. C. Quay. Inhibition and ADHD. *Journal of Abnormal Child Psychology, 25(1),* 7-13.

Pliszka, S. P., Borcherding, S. H., Spratley, K., Leon, S., & Irick, S. (1997). Measuring inhibitory control in children. *Developmental and behavioral Pediatrics, 18, (4),* 254-259.

Pliszka, S. P., Carlson, C.L, & Swanson, J. M. (1999). *ADHD with comorbid disorders.* New York, NY: Guilford Press.

Pliszka, S. P., Liotti, M., & Woldorff, M. G. (2000). Inhibitory control in children with attention-deficit/hyperactivity disorder: Event-related potentials identify the processing component and timing of an impaired right-frontal response-inhibition mechanism. *Society of Biological psychiatry, 3,* 238-246.

Pollard, S., Ward, E. M., & Barkley, R. A. (1983). The effects of parent training and Ritalin on the parent-child interactions of hyperactive boys. *Child and Family Therapy, 5,* 51-69.

Pontius, A. A. (1973). Dysfunction patterns analogous to frontal lobe system and caudate nucleus syndromes in some groups of minimal brain dysfunction. *Journal of the American Medical Women's Association, 26, 285-292.*

Porrino, l. J., Rapoport, J. l., Bahar, D., Sceery, W., Ismond, D. R., & Bunney, W. E., jr. (1983). A naturalistic assessment of the motor activity of hyperactive boys. *Archives of General Psychiatry, 40,* 681-687.

Posner, M.I., & Raichle, M.E. (1994). *Images of mind.* New York: Scientific American library.

Pribram, K.H. & Tubbs, W.E. (1967). Short-term memory, phrasing and the frontal cortex. *Science, 156,* 1765-1767.

Purvis, K. L., & Tannock, R. (2000). Phonological processing, not inhibitory control, differentiates ADHD and reading disability. *Journal of the American Academy of Child and Adolescent Psychiatry, 39(4),* 485-494.

Quay, H. C. (1987). The behavioral reward and inhibition systems in childhood behavior disorder. In L. M. Bloomingdale (Ed.), *Attention Deficit Disorder: III. New research in treatment, pschopharmacology, and attention (pp. 176-186).* New York: Pergamon Press.

Quay, H. C. (1988a). Attention deficit disorder and the behavioral inhibition system: The relevance of the neuropsychological theory of Jeffrey A. Gray. In L. M. Bloomingdale & J. Sergeant (Eds.), *Attention deficit disorder: Criteria, cognition, intervention) pp. 117-126).* New York: Pergamon Press.

Quay, H. C. (1988b). The behavioral reward and inhibition systems in childhood behavior disorder. In L. M. Bloomingdale (Ed.), *Attention deficit disorder: III. New research in treatment, psychopharmacology, and attention (pp. 176-186).* New York: Pergamon Press.

Quay, H. C. (1997). Inhibition and attention deficit hyperactivity disorder. *Journal of Abnormal Child Psychology, 25(1),* 7-13.

Quinlann, D. M. (2000). Assessment of attention-deficit/hyperactivity disorder and comorbidities. In. Brown, T. E. *Attention-deficit Disorders and Comorbidities in Children, Adolescents and Adults (pp. 455-508).* Washington, DC: American psychiatric Press.

Quintana, J., & Fuster, J. M. (1992). Mnemonic and predictive functions of cortical neurons in a memory task. *Neurology Report, 3,* 721-724.

Quintana, J., Yajeya, J., & Fuster, J. M. (1988). Prefrontal representation of stimulus attributes during delay tasks. *Brain Research, 474(2),* 211-221.

Raggio, D.J., Rhodes, R.L., & Whitten, J.D. (1999). Factor analysis of the continuous performance test and parent-teacher reports of attention deficit disorder. *Psychological Reports, 85 (1),* 935-941.

Ramirez, C. A., Rosen, L. A., Deffenbacher, J., Hurst, H., Nicoletta, C., and Rosencranz, T.. et al. (1997). Anger and expression in adults with high ADHD symptoms. *Journal of Attention Disorders, 2,* 115-128.

Rapkin, I. (1964). Brain Damage in children. In J. Brennemann (Ed.), *Practice of pediatrics, 4,* Hagerstown, MD: Prior.

Rapport, M. D. (1987b). *The attention training System: User's mannual.* DeWitt, NY: Gordon Systems.

Rapport, M. D., Carlson, G. A., Kelly, K. L., & Pataki, C. (1993). Methylphenidate and desipramine in hospitalized children: I. Separate and combined effects on cognitive function. *Journal of the American Academy of Child and Adolescent Psychiatry, 32,* 333-342.

Rapport, M. D., Denney, C., DuPaul, G. J., & Gardner, M. J. (1994). Attention deficit disorder and methylphenidate: Normalization rates, clinical effectiveness, and response prediction in 76 children. *Journal of American Academy of Child and Adolescent Psychiatry, 33,* 882-893.

Rappport, J. L., Donnelly, M., Zametkin, A., & Carrougher, J. (1986). "Situational hyperactivity" in U.S. clinical setting. *Journal of Child Psychology and Psychiatry, 27,* 639-646.

Rapport, M. D., DuPaul, G. J., & Kelly, K. L. (1989). Attention-deficit hyperactivity disorder and methylphenidate: The relationship between gross body weight and drug response in children. *Psychopharmacology Bulletin, 25,* 285-290.

Rapport, M. D., Jones, J. T., DuPaul, G. J., Kelly, K. L., Gardner, M. J., & Tucker, S. B. et al. (1987). Attention deficit disorder and methylphenidate: Group and single-subject analysis of dose effects on attention in clinic and classroom settings. *Journal of Consulting and Clinical Psychology, 16*, 329-338.

Rapport, M. D., Murphy, A., & Bailey, J. S. (1980). The effect of response cost treatment tactic on hyperactive children. *Journal of School Psychology, 18,* 98-111.

Rapport, M. D., Murphy, A., & Bailey, J. S. (1982). Ritalin versus response cost in the control of hyperactive children. *Journal of School Psychology, 15,*_ 205-216.

Rapport, M. D., Stoner, G., DuPaul, G. J., Brimingham, B. K., & Tucker, S. (1985).

Methylphenidate in hyperactive children: Differential effects of dose on academic, learning, and social behavior. *Journal of Abnormal Child Psychology, 13,* 227-244.

Rapport, M. D., Tucker, S. B., DuPaul, G. J., Merlo, M., & Stoner, G. (1986). Hyperactivity and frustration: The influence of control over and size of rewards in delaying gratification. *Journal of Abnormal Child Psychology, 14,* 181-204.

Raskin, L. A., Shaywitz, S. E., Shaywitz, B. A., Anderson, G. M., & Cohen, D. J. (1984). Neurochemical correlates of attention deficit disorder. *Pediatric Clinics of North America, 31,* 387-396.

Reader, M. J., Harris, E. l., Schuerholz, L. J., & Denckla, M. B. (1994). Attention deficit hyperactivty disorder, and executive dysfunction. *Developmental Neuropsychology, 10,* 493-512.

Reeve, E., & Garfinkel, B. (1991). Neuroendocrine and growth regulation: The role of sympathomimetic medication. In L. L. Greenhill, & B. B. Osman (Eds.), *Ritalin: Theory and patient management (pp. 289-300).* New York: Mary Ann Liebert.

Reich, W., & Earls, F. (1987). Rules for making psychiatric diagnosis in children on the basis of multiple sources of information: Preliminary strategies. *Journal of Abnormal Child Psychology, 15,* 601-616.

Rey, A. (1941). L'examen psychologique dans les cas d'encephalopathie traumatique. *Archives de Psychologie, 28,* 286-340.

Reynolds, C. R., & Kamphaus, R. W. (1992). *Behavior Assessment System for Children.* _Circle Pines: MN. American Guidance Services.

Richardson, R. C. (1996). *Connecting with Others.* Champaign, IL: Research Press.

Richardson, E., Kupietz, S. S., Winsberg, B. G., Maitinsky, S., & Mendell, N. 91988). Effects of methylphenidate dosage in hyperactive reading-disabled children: II. reading achievement. *Journal of the American Academy of Child and Adolescent Psychiatry, 27*, 78-87.

Roberts, R. J., & Pennington, B. F. (1996). An integrative framework for examining prefrontal cognitive processes. *Developmental Neuropsychology, 12,* 105-126.

Robertson, H. A., Datta, N. K., Bird, D. C., & Kutcher, S. P. (1999). *Absence of attentional deficits in stablized bipolar youth.* Paper presented at the annual meting of the American Academy of Child and Adolescent Psychiatry. Chicago, IL.

Robin, A. L. (1981). A controlled evaluation of problem-solving communication training with parent-adolescent conflict. *Behavior Therapy, 12,* 593-609.

Robin, A. L., & Foster, S. L. (1989). *Negotiating parent-adolescent conflict: A behavioral-family systems approach.* New York: Guilford.

Robinson, P. W., Newby, T. J., & Ganzall, S. L. (1981). A token system for a class of underachieving hyperactive children. *Journal of Applied Behavior Analysis, 14,* 307-315.

Rolls., E. T. (1999a). *The brain and emotion.* Oxford: Oxford University Press.

Rolls., E. T. (1999b). The functions of the orbitofrontal cortex. *Neurocase, 5,* 301-312.

Rolls., E. T. (2000). The orbitofrontal cortex and reward. *Cerebral Cortex, 10,* 284-294.

Rolls, E. T., Hornak, J., Wade, D., & McGrath, J. (1994). Emotion-related learning in patients with social and emotional changes associated with frontal lobe damage. *Journal of Neurology, Neurosurgery, and psychiatry, 57,* 1518-1524.

Rosen, L. A., O'Leary, S. G., Joyce, S. A., Conway, G., & Pffiffner, L. J. (1984). The importance of prudent negative consequences for maintaining the appropriate behavior of hyperactive children. *Journal of Abnormal Child Psychology, 12,* 581-604.

Rosenfield, P., Lambert, N. M., & Black, A. (1985). Desk arrangement effects on pupil classroom behavior. *Journal of Educational Psychology, 77,* 101-108.

Rosenthal, R. H., & Allen, T. W. (1978). An examination of attention, arousal, and learning dysfunctions of hyperkinetic children. *Psychological Bulletin, 85,* 689-715.

Rosenthal, R. H., & Allen, T. W. (1980). Intratask distractibility in hyperkinetic and nonhyperkinetic children. *Journal of Abnormal Child Psychology, 8,* 175-187.

Routh, D. K., & Schroeder, C. S. (1976). Standardized playroom measures as indices of hyperactivity. *Journal of Abnormal Child Psychology, 4,* 199-207.

Rubin, P., Holm, S., Friberg, L., Videbech, P., Anderson, H. S., Bjerg-Bendsen, B, et al. (1991). Altered modulation of prefrontal and subcortical brain activity in newly diagnosed schizophrenia and schizophreniform disorder: A regional cerebral blood flow study. *Archives of General Psychiatry, 48,* 987-995.

Rutter, M. (1977). Brain damage syndromes in childhood: Concepts and findings. *Journal of Child Psychology and Psychiatry, 18,* 1-21.

Rutter, M. (1980). School influences on children's behavior and development. *Pediatrics, 65,* 208-220.

Rutter, M. (1989). Attention deficit disorder/hyperkinetic syndrome: Conceptual and research issues regarding diagnosis and classification. In T. Sagvolden& T. Archer (Eds.), *Attention deficit Disorder: Clinical and basic research (pp. 1-24).* Hillsdale, NJ: Erlbaum.

Sadeh, M., Ariel, R., & Inbar, D. (1996). Rey-Osterrieth and Taylor Complex Figures: Equivalent measures of visual organization and visual memory in ADHD and normal children. *Child Neuropsychology, 2,* 63-71.

Safer, D. J. (1992). Relative cardiovascular safety of psychostimulants used to treat attention-deficit hyperactivity disorder. *Journal of Child and Adolescent Psychopharmacology, 2,* 279-290.

Safer, D. J., & Allen, R. (1976). *Hyperactive children.* Baltimore, MD: University Park Press.

Safer, D. J., Zito, J. M., & Fine, E. M. (1996). Increased methylphenidate usage for attention deficit disorder in the 1990s. *Pediatrics, 98,* 1-5.

Sallee, F., Stiller, R., & Perel, J. (1985). Oral pamoline kinetics in hyperactive children. *Clinical Pharmacological Therapeutics, 37,* 606-609.

Sandberg, S. T., Rutter, M., & Taylor, E. (1978). Hyperkinetic disorder in psychiatric clinic attenders. *Developmental Medicine and Child Neurology, 20,* 279-299.

Satterfield, J. H., Satterfield, B. T., & Shell, A. M. (1987). Therapeutic interventions to prevent delinquency of hyperactive boys. *Journal of the American Academy of Child and Adolescent Psychiatry, 26,* 56-64.

Sattler, J. M. (1988). *Assessment of children (3rd ed.).* San Diego, CA: Sattler Publishing Inc.

Schachar, R. J., & Logan, G. D. (1990). Impulsivity and inhibitory control in normal development and childhood psychopathology. *Developmental Psychology, 26,* 710-720.

Schachar, R. J., Logan, G. , Wachsmuth, R., & Chajczyk, D. (1988). Attending and maintaining preparation: A comparison of attention in hyperactive, normal, and disturbed control children. *Journal of Abnormal Child Psychology, 16(4),* 361-378.

Schachar, R., J., Mota, V. L., Logan, G. D., Tannock, R., & Klim, P. (2000). Confirmation of an inhibitory control deficit in attention-deficit/hyperactivity disorder. *Journal of Abnormal Child Psychology, 28, (3),* 227-235.

Schachar, R. J., & Tannock, R. (1995). Test of four hypotheses for the comorbidity of attention-deficit hyperactivity disorder and conduct disorder. *Journal of Academy of Child and Adolescent Psychiatry, 34, (5),* 639-648.

Schachar, R. J., Tannock, R., & Logan, G. (1993). Inhibitory control, impulsiveness, and attention deficit hyperactivity disorder. *Clinical Psychology review, 13,* 721-739.

Schachar, R. J., Tannock, R., Marriott, M., & Logan, G. (1995). Deficient inhibitory control in attention deficit hyperactivity disorder. *Journal of Abnormal Child Psychology, 23,* 411-438.

Scheehan, C. M. (1997). Teacher consultation for success oriented education of students with ADHD. In: D. L. Smallwood. *Attention Disorders in Children: Resources for school psychologists (pp. 7-19).* Bathesda, MD: The National Association for School Psychologists.

Scherer, K. R. (1994). Emotion serves to decouple stimulus and response. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions (pp. 127*-130). New York: Oxford University Press.

Schnolnick, E. K., & Friedman, S. L. (1993). Planning in context: Developmental and situational considerations. *International Journal of Behavioral Development, 16,* 145-167.

Schonfeld, I. S., Shaffer, D., & Barmack, J. E. (1989). Neurological soft signs and school achievement: The mediating effects of sustained attention. *Journal of Abnormal Child Psychology, 17,* 575-596.

Schughency, E., McGee, R., Raja, S. N., Feehan, M., & Silva, P. A. (1994). Self-reported inattention, impulsivity, and hyperactivity at ages 15 and 18 years in the general population. *Journal of the American Academy of Child and Adolescent Psychiatry, 33,* 173-184.

Schwartz, M. L., Rakic, P., & Goldman-Rakic, P. S. (1991). Early phenotype expression of cortical neurons: Evidence that a subclass of migrating neurons have callosal axons. *National Academy of Science USA, 88,* 1354-1358.

Schweitzer, J. B., & Sulzer-Azaroff, B. (1995). Self-control in boys with attention-deficit hyperactivity disorder: effects of added stimulation and time. *Journal of Child Psychology and Psychiatry, 36,* 671-686.

Seidman, L. J., Benedict, K. B., Biederman, J., Bernstein, J. H., Seiverd, K., Milberger, S. (1995a). Performance of children with ADHD on the Rey-Osterreith Complex Figure: A pilot neuropsychological study. *Journal of Child Psychology and Psychiatry, 36, 1459-*1473.

Seidman, L. J., Biederman, J., Faraone, S. V., Milberger, S., Norman, D., & Seiverd, K. (1995b). Effects of family history and comorbidity on the neurological performance of children with ADHD: Preliminary findings. Journal of the American academy of Child and Adolescent Psychiatry, 34, 1015-1024.

Seidman, L. J., Biederman, J., Faraone, S. V., Weber, W., Mennin, D., Jones, J. (1997a). A pilot study of Neuropsychological function in girls with ADHD. *Journal of the American Academy of Child and Adolescent Psychiatry, 36(3),* 366-373.

Seidman, L. J., Biederman, J., Faraone, S. V., Weber, W., & Ouellette, C. (1997b). Toward defining a neuropsychology of attention-deficit-hyperactivity disorder performance of children and adolescents from a large clinically referred sample. *Journal of Consulting and Clinical Psychology, 65(1),* 150-160.

Seidman, L. J., Biederman, J., Monuteaux, M. C., & Weber, W. (2000). Neuropsychological functioning in nonreferred siblings of children with attention deficit/hyperactivity disorder. *Journal of Abnormal Psychology, 109(2),* 252-265.

Seidman, L. J., Biederman, J. H., Weber, W., & Quellette, C. (1996). Toward defining the neuropsychology of ADHD: performance of children and adolescents from a large clinically referred sample. *Journal of Consulting and Clinical Psychology, 65,* 150-160.

Semrud-Clikeman, M., Steingard, R. J., Filipek, P., Biederman, J., Bekken, K., & Renshaw, P. F. (2000). Using MRI to explain brain-behavior relationships in male with attention deficit disorder with hyperactivity. *Journal of American Academy of Child and Adolescent Psychiatry, 39(4),* 477-484.

Senior, N., Towne, D., & Huessy, D. (1979). Time estimations and hyperactivity, a replication. *Perceptual and Motor Skills, 49,* 289-290.

Sergeant, J. A., & Van der Meere, J. J. (1988). What happens when the hyperactive child commits an error? *Psychiatry Research, 24,* 157-164.

Sergeant, J., & Van der Meere, J. J. (1989).The diagnostic significance of attention processing: Its significance for ADHD classification-A future DSM. In T. Sagvolden & T. Archer (Eds.), *Attention Deficit Disorder: Clinical and bias research (pp. 151-166).* Hillsdale, NJ: Erlbaum.

Sergeant, J., & Van der meere, J. J. (1990). Convergence of approaches in localizing the hyperactivity deficit. In B. B. Lahey & A, E. Kazdin (Eds.), *Advances in Child Clinical Psychology (Vol. 13, pp.207-245).* New York: Plenum Press.

Shallice. T. (1988). *From neuropsychology to mental structure.* Cambridge: University Press.

Shapiro, S., & Herod, L. (1994). Combining visual and auditory tasks in the assessment of attention-deficit hyperactivity disorder. In D. Routh (Ed.), *Disruptive behavior disorder in childhood (pp. 87-107).* New York: Plenum Press.

Shaw, G., & Brown, G. (1999). Arousal, time estimation, and time use in attention-disordered children. *Developmental Neuropsychology, 16(2),* 227-242.

Shaywitz, B. A., Cohen, D. J., & Bowers, M. B. (1977). CSF monoamine metabolites in children with minimal brain dysfunction: Evidence for alteration of brain dopamine. *Journal of pediatrics, 90,* 67-71.

Shaywitz, S. E., & Shaywitz, B. A. (1984). Diagnosis and management of attention deficit disorder: A pediatric perspective. *Pediatric Clinics of North America, 31, 429*-457.

Shaywitz, S. E., Shaywitz, B. A., Jatlow, P. R., Cebrechts, M., Anderson, G. M., & Cohen, D. J. (1986). Biological differentiation of attention deficit disorder with and without hyperactivity. A preliminary report. *Annals of Neurology, 21,* 363.

Shea, T., & Fisher, B. E. (1996). Self ratings of mood levels and mood variability as predictors of junior 1-6 impulsivity and ADHD classroom behaviors. *Personality and Individual Differences, 20,* 209-214.

Shelton, T. L., Barkley, R. A., Crosswait, C., Moorhouse, M., Fletcher, K., Barrett, S., et al. (1997). Early psychiatric and psychological morbidity in preschool children with high levels of aggression and hyperactive-impulsive behavior. In R. A. Barkley. Attention-Deficit Hyperactivity Disorder: A handbook for diagnosis and treatment. New York: Guilford Press.

Sheridan, S. M., Candace, C. D., Morgan, J. C., McCormick, M. E., & Walker, D. (1997). A multimethod intervention for social skills deficits in children with ADHD and their parents. In . D. L. Smallwood (Ed.). *Attention disorders in children (pp. 211-226)..*

Bethesda, MD: The National Association of School Psychologists.

Sherman, D. K., McGue, M. K., & Iacono, W. G. (1997). Twin concordance for attention deficit hyperactivity disorder: A comparison of teachers' and mothers' reports. *American Journal of Psychiatry, 154(4),* 532-535.

Shimamura, A. P., Janowsky, J. S., & Squire, L. R. (1990). Memory for the temporal order of events in patients with frontal lobe lesions and amnestic patients. *Neuropsychologia, 28,* 803-813.

Shirley, M. (1939). A behavior syndrome characterizing prematurely born children. *Child Development, 10,* 115-128.

Shroyer, C., & Zentall, S. S. (1986). Effects of rate, nonrelevant information, and repetition on the listening comprehension of hyperactive children. *Journal of Special Education, 20,* 231-239.

Shue, K., & Douglas, V. I. (1989). Attention deficit hyperactivity disorder, normal development, and frontal lobe syndrome. *Canadian Psychology, 30,* 498.

Silverman, W. K., & Albano, A. M. (1996). *Anxiety Disorders Interview Schedule for DSM-IV: Clinician Manual.* Graywind Publications Incorporated.

Silverman, I. W., & Ragusa, D. M. (1992). A short-term longitudinal study of the early development of self-regulation. *Journal of Abnormal Child Psychology, 20,* 415-425.

Sirigu, A., Zalla, T., Pillon, B., Grafman, J., Bubois., & Agid, Y. (1995). Planning and script analysis following prefrontal lobe lesions. In J. Grafman, K. J. Holyoak, & F. Boller (Eds.), Structure and functions of the human prefrontal cortex: Vol. 769. *Annal of the New York Academy of sciences (pp.277-288).* New York: New York Academy of Sciences.

Sitarenios, G. 91998). *Split-half reliability for Conners' CPT (technical report no. 0009).* Toronto, ON: Multi-Health Systems Inc.

Skinner, B. F. (1953). *Science and Human Behavior.* New York: Macmillan.

Skinner, J.E., & Yingling, C.D. (1977). Central gating mechanisms that regulate events-related potentials and behavior. In: J. E. Desmedt, (Ed.), *Attention, voluntary contraction and event-related cerebral potentials (P30-69).* Basel: S. Karger.

Sleator, E. K., & Ullmann, R. K. (1981). Can the physician diagnose hyperactivity in the office? *Pediatrics, 67,* 13-17.

Slusarek, M., Velling, S. D., Bunk, D., & Christian, E. (2001). *American Journal of Child and Adolescent Psychiatry, 40 (3),* 355-363.

Sobol, M. P., Ashbourne, D. R., Earn, B. M., & Cunningham, C. E. (1989). Parents' attributions for achieving compliance from attention-deficit disordered children. *Journal of Abnormal Child Psychology, 17,* 359-369.

Solanto, M. V. (1991). Dosage effects of Ritalin on cognition. In L.L. Greenhill, & B. B. Osman (Eds.), *Ritalin: Theory and patient management (pp. 233-246).* New York: Mary Ann Liebert.

Solanto, M. V., & Conners, C. K. (1982). A dose-response and time-action analysis of autonomic and behavioral effects of methylphenidate in attention deficit disorder with hyperactivity. *Psychophysiology, 19,* 658-667.

Songua-Barke, E. J. S., Houlberg, K., & Hall, M. (1994). When is "impulsiveness" not impulsive? The case of hyperactive children's cognitive style. *Journal of Child Psychology and Psychiatry, 35,* 1247-1255.

Songua-Barke, E. J. S., Taylor, E., & Hepinstall, E. (1992). Hyperactivity and delay aversion: II.

The effect of self versus externally imposed stimulus presentation periods on memory. *Journal of Child Psychology and Psychiatry, 33,* 399-409.

Songua-Barke, E. J. S., Taylor, E., Sembi, S., & Smith, J. (1992). Hyperactivity and delay aversion: I. The effect of delay on choice. *Journal of Child Psychology and Psychiatry, 33,* 387-398.

Speltz, M. L., DeKlyen, M., Calderon, R., Greenberg, M. T., & Fisher, P. A. (1999). Neuropsychological characteristics and test behaviors of boys with early onset conduct problems. *Journal of Abnormal Psychology, 108(2),* 315-325.

Spencer, T. J., Biederman, J., Harding, M., O'Donnell, D., Faraone, S. V., & Wilens, T. W. (1996). Growth deficits in ADHD children revisited: Evidence of disorder-associated with growth delay? *Journal of the American Academy of Child and Adolescent Psychiatry, 35,* 1460-1469.

Spencer, T., Biederman, J., & Wilens, Faraone S. V., & Li T. (1994). Is attention-deficit hyperactivity disorder in adults a valid disorder? *Harvard Psychiatry Review, 1,* 326-335.

Spencer, T., Wilens, T., Biedreman, J., Wozniak, J., & Harding-Crawford, M. (2000). Attention-deficit hyperactivity disorder with mood disorders. In: T. E. Brown (Ed.), *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults (pp. 79-125).* Washington, DC: American Psychiatric Press.

Spitzer, R. L., Davies M., & Barkley, R. A. (1990). The DSM-III-R field trial for the disruptive behavior disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 29,* 690-697.

Stein, M. A., Weiss, R. E., & Refetoff, S. (1995). Neurocognitive characteristics of individuals with resistance to thyroid hormone: Comparisons with individuals with attention-deficit hyperactivity disorder. *Journal of Developmental and Behavioral Pediatrics, 16,* 406-411.

Steinkamp, M. W. (1980). Relationship between environmental distractions and task performance of hyperactive and normal children. *Journal of Learning Disabilities, 13,* 40-45.

Stephens, R. S., Pelham, W. E., & Skinner, R. (1984). Stage-dependent and main effects of methylphenidate and pamoline on paired-associate learning and spelling in hyperactive children. *Journal of Consulting and Clinical Psychology, 52,* 104-113.

Stewart, M. A., Pitts, F. N., Craig, A. G., & Dieruf, W. (1966). The hyperactive child syndrome. *American Journal of Orthopsychiatry, 36,* 861-867.

Still, G. F. (1902). Some abnormal physical conditions in children. *Lancet, (1),* 1008-1012.

Streissguth, A. P., Bookstein, F. L., Sampson, P. D., & Barr, H. M (1995). Attention: Prenatal alcohol and continuities of vigilance and attentional problems from 4 through 14 years. *Development and Psychopathology, 7*, 419-446.

Stroop, J. P (1935). Study of interference in serial verbal reactions. *Journal of Experimental Psychology, 18,* 643-662.

Stuss, D. T., & Benson, D. F. (1986). *The frontal lobes.* New York: Raven.

Swanson, J., Castellanos, F. X., Murias, M., LaHoste, G., Kennedy, J. (1998). Cognitive neuroscience of attention deficit hyperactivity disorder and hyperkinetic disorder. *Current Opinions in Neurobiology, 8(2),* 263-271.

Swanson, H.L., Mink, J., Bocian, K. M. (1999). Cognitive processing deficits in poor readers with symptoms of reading disabilities and ADHD more alike than different? *Journal of Educational Psychology, 9(2),* 321-333.

Swanson, J. M., McBurnett, K., Christian, D. L., & Wigal, T. (1995). Stimulant medications and the treatment of children with ADHD. In T. H. Ollendick & R. J. Prinz (Eds.), *Advances in clinical child psychology (vol. 17, pp. 265-322).* New York: Plenum.

Swanson, J., Oosterlaan, J., Murias, M., Schuck, S., Flodman, P., Spence, M. A., et al. (2000). Attention deficit/hyperactivity disorder children with a 7-repeat allele of the dopamine receptor D4 gene have extreme behavior and normal performance on critical neuropsychological tests of attention. *Proceedings of the National Academy of Sciences of the United States of America, 97(9),* 4754-4759.

Szatmari, P., Offord, D. R., & Boyle, M. H. (1989). Correlates, associated impairments, and patterns of service utilization of children with attention deficit disorders: Findings from Onterio Child Health Study. *Journal of Child Psychology and psychiatry, 30,* 205-217.

Tannock, R. (1996). *Discourse deficits in ADHD: Executive dysfunction as an underlying mechanism?* Paper presented at the annual meeting of the International Society for Research in Child and Adolescent Psychology, Santa Monica, CA.

Tannock, R. (2000). Attention-deficit disorder with anxiety disorders. In: T. E. Brown. (Ed.), *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults (pp. 125-171).* Washington, DC: American Psychiatric Press.

Tannock, R., & T. E. Brown. (2000). Attention-deficit disorders with learning disorders in children and adolescents. In: T. E. Brown (Ed.), *.Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults (pp. 231-297).* Washington, DC: American Psychiatric Press.

Tannock, R., Purvis, K. l., & Schachar, R. J. (1992). Narrative abilities in children with attention deficit hyperactivity disorder and normal peers. *Journal of Abnormal Child Psychology, 21,* 103-117.

Tannock, R., Schachar R.J., Carr, R. P., Chajczky, D., & Logan, G. D. (1989). Effects of methylphenidate on inhibitory control in hyperactive children. *Journal of Abnormal Child Psychology, 17,* 473-491.

Tant, J. L., & Douglas, V. I. (1982). Problem-solving in hyperactive, normal, and reading-disabled boys. *Journal of Abnormal Child Psychology, 10,* 285-306.

Tao, K.T. (1992). Hyperactivity and attention deficit disorder syndromes in China. *Journal of American Academy of Child and Adolescent Psychiatry, 31,* 1165-1165.

Taylor, E. (1986). Childhood hyperactivity. *British Journal of Psychiatry, 149,* 562-573.

Teicher, M. H., Ito, Y., Gold, C. A., & Barber, N. I. (1996). Objective measurement of hyperactivity and attentional problems in ADHD. *Journal of the American Academy of Child and Adolescent Psychiatry,* 35, 334-342.

Thompson, L. E., & Parkinson, M. A. (1997). In D, Smallwood (Ed.), *Attention disorders in children: Resources for school psychologists (pp.259-266).* Bethesda, MD: The National Association of School Psychologists.

Torgesen, J. K. (1994). Issues in the assessment of the executive function: An information-processing perspective. In G. R. Lyon (Ed.), *Frames of reference for the assessment of learning disabilities: New views on measurement issues (pp.143-162).* Baltimore: Paul H. Brookes.

Tripp, G., & Alsop, B. (1999). Sensitivity to reward frequency in boys with attention deficit hyperactivity disorder. *Journal of Clinical Child Psychology, 28(3),* 366-375.

Trites, R. L. (1979). *Hyperactivity in children: Etiology, measurement, and treatment implications.* Baltimore: University Park Press.

Trommer, B. L., Hopenner, J., Lorber, R., & Armstrong, K. (1988). Pitfalls in the use of Continuous Performance Test as a diagnostic tool in attention deficit disorder. *Developmental and Behavioral Pediatrics, 9,* 339-346.

Trommer, B. L., Hopenner, J., & Zecker, S. G. (1991). The Go-No Go Test in attention deficit hyperactivity disorder is sensitive to methylphenidate. *Journal of Child Neurology, 6,* 126-129.

Ullman, D. G., Barkley, R. A., & Brown, H. W. (1978). The behavioral symptoms of hyperkinetic children who successfully responded to stimulant drug treatment. *American Journal of Orthopsychiatry, 48,* 425-437.

University of Massachusetts Medical Center. (1996). *Time perception Test.* MD: Chesapeake Technology.

Van Den Oard, E. J. C. G., Boomsma, D. I., & Verhulst, F. C. (1994). A study of problem behaviors in 10- to 15-year-old biologically related and unrelated international adoptees. *Behavior Genetics, 24,* 193-205.

Van der Meere, J., Gunning, W. B., & Stemerdink, N. (1996). Changing response set in normal development and in ADHD children with and without tics. *Journal of Abnormal Child Psychology, 24,* 767-786.

Van der Meere, J., & Sergeant, J. (1988). Focused attention in pervasively hyperactive children. *Journal of Abnormal Child Psychology, 16,* 627-640.

Van der Meere, J., Vreeling, H. J., & Sergeant, J. (1992). A motor presetting study in hyperactive, learning disabled and control children. *Journal of Child Psychology and Psychiatry,_33,* 1347-1354.

Vandrell., P., Junque, C., Pujol, J., Jurado, M. A., Molet, J., & Grafman, J. (1995). The role of prefrontal regions in the Stroop task. *Neuropsychologia, 33,* 341-352.

Van Houten, R., Nau, P. A., MacKenzie-Keating, S. E., Sameoto, D., & Colavecchia, B. (1982). An analysis of some variables influencing the effectiveness of reprimands. *Journal of Applied Behavior Analysis, 15,* 65-83.

Verble, M. 91985). How to encourage self-discipline. *Learning, 14,* 40-42.

Verhulst, F. C., & Van der Ende, J. (1992). Six-year developmental course of internalizing and externalizing problem behaviors. *Journal of American Academy of Child and Adolescent Psychiatry, 31,* 924-931.

Voeller, K. K. S., & Heilman, K. M. (1988). Motor impersistence in children with attention deficit hyperactivity disorder: Evidence for right hemisphere dysfunction. *Annals of Neurology, 24,* 323-334.

Vygotsky, L. S. (1987). Thinking and speech. In the collected works of L. S. Vygotsky: Vol. 1. *Problems in general psychology IN. Minick, (Trans., pp. 37-285).* New York: Plenum Press.

Vyse, S. A., & Rapport, M. D. (1989). The effects of methylphenidate on learning in children with ADHD: The stimulus-equivalence paradigm. *Journal of Consulting and Clinical Psychology, 57,* 425-435.

Walker, N. W. (1982). Comparison of cognitive tempo and time estimation by young boys. *Perceptual and Motor Skills, 54,* 715-722.

Ward, M. F., Wender, P. H., & Reimherr, F. W. (1993). The Wender Utah Rating Scale: an aid in the retrospective diagnosis of childhood attention deficit hyperactivity disorder. American *Journal of Psychiatry, 150,* 885-890.

Wechsler, D. (1991). *Manual for the Wechsler Intelligence Scale for Children (3rd ed.).* New York: Psychological Corporation/Harcourt Brace.

Wechsler, D. (1997). *Wechsler Adult Intelligence Scale (3rd ed.).* San Antonio, TX: The Psychological Corporation.

Wechsler, D. (1999). Manual for the Wechsler Abbreviated Scale of Intelligence. San Antonio, TX: The Psychological Corp.

Weiss, G., & Hechtman, L. (1979). The hyperactive child syndrome. *Science 205,* 1348-1354.

Weiss, G., & Hechtman, L. (1993). *Hyperactive children grown up: ADHD in children, adolescents, and adults (2nd ed.).* New York: Guilford Press.

Weiss, G., Hechtman, l., & Pearlman, T. (1978). Psychiatric status of hyperactives as adults: School, employer, and self-rating scales obtained during ten-year follow-up evaluation. *American Journal of Orthopsychiatry, 48,* 438-445.

Weissman, M. M., Gammon, G. D., Merikangas, K. R., Warner, V., Prusoff, B. A., & Sholomskas, D. (1987). Children of depressed parents. *Archives of General Psychiatry, 44,* 847-853.

Welner, Z., Reich, W., Herjanic, B., Jung, K. G., & Amado, H. (1987). Reliability, validity, and parent-child agreement studies of the Diagnostic Interview for Children and Adolescents (DICA). *Journal of the American Academy of Child and Adolescent Psychiatry, 26,* 649-653. Welsh, M. C., Pennington, B. F., & Grossier, D. B. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology, 7, 131*-149.

in the retrospective diagnosis of childhood attention deficit hyperactivity disorder. American *Journal of Psychiatry, 150,* 885-890.

Wechsler, D. (1991). *Manual for the Wechsler Intelligence Scale for Children (3rd ed.).* New York: Psychological Corporation/Harcourt Brace.

Wechsler, D. (1997). *Wechsler Adult Intelligence Scale (3rd ed.).* San Antonio, TX: The Psychological Corporation.

Wechsler, D. (1999). Manual for the Wechsler Abbreviated Scale of Intelligence. San Antonio, TX: The Psychological Corp.

Weiss, G., & Hechtman, L. (1979). The hyperactive child syndrome. *Science 205,* 1348-1354.

Weiss, G., & Hechtman, L. (1993). *Hyperactive children grown up: ADHD in children, adolescents, and adults (2nd ed.).* New York: Guilford Press.

Weiss, G., Hechtman, l., & Pearlman, T. (1978). Psychiatric status of hyperactives as adults: School, employer, and self-rating scales obtained during ten-year follow-up evaluation. *American Journal of Orthopsychiatry, 48,* 438-445.

Weissman, M. M., Gammon, G. D., Merikangas, K. R., Warner, V., Prusoff, B. A., & Sholomskas, D. (1987). Children of depressed parents. *Archives of General Psychiatry, 44,* 847-853.

Welner, Z., Reich, W., Herjanic, B., Jung, K. G., & Amado, H. (1987). Reliability, validity, and parent-child agreement studies of the Diagnostic Interview for Children and Adolescents (DICA). *Journal of the American Academy of Child and Adolescent Psychiatry, 26,* 649-653. Welsh, M. C., Pennington, B. F., & Grossier, D. B. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology, 7, 131*-149.

Wender, p. (1971). *Minimal brain dysfunction.* New York: Wiley.

Wender, P. H., Remherr, F. W., Wood, D., & Ward, M. (1985). A controlled study of methylphenidate in the treatment of attention deficit disorder, residual type, in adults. *American Journal of Psychiatry, 142,* 547-552.

Werner, E. E. (1993). Risk, resilience, and recovery: Perspectives from the Kauai longitudinal study. *Development and Psychopathology, 5,* 503-515.

Werry, J. S., Elkind, G. S., & Reeves, J. S. (1987). Attention deficit, conduct, oppositional, and anxiety disorders in children: III. Laboratory difference. *Journal of Abnormal Child Psychology, 15,* 409-428.

Werry, J. S., & Wollersheim, J. P. (1989). Behavior therapy with children and adolescents: A 20-year overview. *Journal of the American Academy of Child and Adolescent Psychiatry, 28,* 1-18.

Weyandt, L. L., & Willis, W. G. (1994). Executive functions in school-aged children: Potential efficacy of tasks in discriminating clinical groups. *Developmental Neuropsychology, 19,* 27-38.

Whalen, C. K., & Henker, B. (1991). Therapies for hyperactive children: Comparisons, combinations, and compromises. *Journal of Consulting and Clinical Psychology, 59(1),* 126-137.

Whalen, C. K., Henker, B., & Dotemoto, S. (1980). Methylphenidate and hyperactivity: Effects on teacher behaviors. *Science, 208,* 1280-1282.

White, J., Barratt, E., & Adams, P. (1979). The hyperactive child in adolescence: A comparative study of physiological and behavioral patterns. *Journal of the American Academy of Child psychiatry, 18,* 154-169.

White, J. L., Moffitt, T. E., Caspi, A., Bartusch, D. J., Needles, D. J., & Stouthamer-Loeber, M. (1994). Measuring impulsivity and examining its relationship to delinquency. *Journal of Abnormal Psychology, 103,* 192-205.

Wiers, R. W., Gunning, W. B., & Sergeant, J. A. (1998). Is a mild deficit in executive functions in boys related to childhood ADHD or to parental multigenerational alcoholism? *Journal of Abnormal Child Psychology, 26(6),* 415-430.

Wilens, T. E., Spencer, T. J., & Biederman, J. (2000). Pharmacotherapy of attention-deficit/hyperactivity disorder. In: T. E. Brown (Ed.), *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and adults (pp.509-537).* Washington, DC: American Psychiatric Press.

Wilkison, P. C., Kircher, J. C., McMahon, W. M., & Sloane, H. N. (1995). Effects of methylphenidate on reward strength in boys with attention-deficit hyperactivity disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 34,* 877-885.

Williams, D., Stott, C. M., Goodyer, I. M., & Sahakian, B. J. (2000). *Developmental Medicine and Child Neurology, 42,* 368-375.

Williams, G. V., & Goldman-Rakic, P. S. (1995). Modulation of memory fields by dopamine D1 receptors in prefrontal cortex. *Nature, 376,* 572-575.

Wilson, J. M., & Marcotte, A. C. (1996). Psychological adjustment and educational outcome in adolescents with a childhood diagnosis of attention deficit disorder. *Journal of American Academy of Child and Adolescent Psychiatry, 35,* 579-587.

Woldorff, M. G., & Hillyard, S. A. (1991). Modulation of early auditory processing during selective listening to rapidly presented tones. *Electroencephalography Clinical Neurophysiology, 79,* 170-191.

Wolraich, M.L., Hannah, J. N., Pinnock, T. Y. (1996). Comparison of diagnostic criteria for attention-deficit hyperactivity disorder in a county-wide sample. *Journal of American Academy of Child and Adolescent Psychiatry, 35,* 319-324.

Wolraich, M. L., Lindgren, S., Stromquist, A., Milich, R., Davis, C., & Watson, D. (1990). Stimulant medication use by primary care physicians in the treatment of attention-deficit hyperactivity disorder. *Pediatrics, 86,* 95-101.

Wood, D. L. (1990). The physiological basis of selective attention: Implications of event-potentiated studies. In: J. Rothbough, R. J. Johnson., & R. Parasurman (Eds.), *Event – related brain potentials (178-210).* New York: Oxford University Press.

Yong-Liang, G., Robaey, P., Karayanidis, F., Bourassa, M., Pelletier, G., & Geoffroy, G. (2000). ERPs and behavioral inhibition in a Go/No-go task in children with attention-deficit hyperactivity disorder. *Brain & Cognition, 43(1-3),* 215-220.

Zahn, T. P., Krusei, M. J. P., & Rapoport, J. L. (1991). Reaction time indices of attention deficits in boys with disruptive behavior disorders. *Journal of Abnormal Child Psychology, 19,* 233-252.

Zakay, D. (1990). The evasive art of subjective time measurement: Some methodological dilemmas. In R. A. Block (Ed.), *Cognitive models of psychological time (pp. 59-84).* Hillsdale, NJ: Erlbaum.

Zakay, D. (1992). The role of attention in children's time perception. *Journal of Experimental Child Psychology, 54,* 355-371.

Zakay, D., & Block, R. (1995). An attentional gate-model of prospective time estimation. In M. Richelle., V. De Keyser, G. , d'Ydewalle, & A. Vandierendonck (Eds.). *Time and the dynamic control of behavior (pp.167-178).* Liege: Presses de I'Universite.

Zametkin, A. J., Nardahl, T. E., Gross, M., King, A. C., Semple, W. E., & Eumsey, J. (1990). Cerebral glucose metabolism in adults with hyperactivity of childhood onset. *New England Journal of Medicine, 323,* 1361-1366.

Zametkin, A. J., & Rapport, J. L. (1986). The pathophysiology of attention deficit disorder with hyperactivity: A review. In B. B. Lahey & A. E. Kazdin (Eds.), *Advances in clinical child psychology (Vol. 9, pp. 177-216).* New York: Plenum.

Zentall, S. S. (1985). A context for hyperactivity. In K. D. Gadow & I. Bialer (Eds.), *Advances in learning and behavioral disabilities (Vol. 4, pp. 273-343).* Greenwich, CT: JAI Press.

Zentall, S. S. (1988). Production deficiencies in elicited language but not in the spontaneous verbalizations of hyperactive children. *Journal of Abnormal Child Psychology, 16,* 657-673.

Zentall, S. S. (1989). Attentional cueing in spelling tasks for hyperactive and comparison regular classroom children. *Journal of Special Education, 23,* 83-93.

Zentall, S. S., & Dwyer, A. M. (1989). Color effects on the impulsivity and activity of hyperactive children. *Journal of School Psychology, 27,* 165-173.

Zentall, S. S., Falkenberg, S. D., & Smith, L. B. (1985). Effects of color stimulation and information on the copying performance of attention-problem adolescents. *Journal of Abnormal Child Psychology, 13,* 501-511.

Zentall, S. S., & Gohs, D. E. (1984). Hyperactive and comparison children's response to detailed VS. global cues in communication tasks. *Learning Disabilities Quarterly, 7,* 77-87.

Zentall, S. S., & Myers, M. J. (1987). Self-regulation of stimulation for ADD-H children during reading of a vigilance task performance. *Journal of Abnormal Child Psychology, 15,* 519-536.

Zentall, S. S., & Shaw, J. H. (1980). Effects of classroom noise on the performance and activity of second-grade hyperactive and control children. Journal of Educational Psychology, 72, 830-840.