Spring 2005

Long -term episodic memory in children with Attention -Deficit /Hyperactivity Disorder

Jeffrey S. Skowronek
University of New Hampshire, Durham

LONG-TERM EPISODIC MEMORY IN CHILDREN WITH ATTENTION-DEFICIT/ HYPERACTIVITY DISORDER

BY

JEFFREY S. SKOWRONEK

BA- University of Massachusetts-Lowell, 2000

MA- University of New Hampshire, 2002

DISSERTATION

Submitted to the University of New Hampshire

in Partial Fulfillment of

the Requirements for the Degree of

Doctor of Philosophy

In

Psychology

May, 2005

This dissertation has been examined and approved.

Dissertation Director, Michelle D. Leichtman, Ph.D.

Edward J. O'Brien, Ph.D.

Joseph J. Onosko, Ph.D.

David B. Pillemer, Ph.D.

Frank W. Spencer, Ph.D.

April 22, 2005
Date

ACKNOWLEDGEMENTS

I will do my best to keep this short, but there are so many people I am grateful to, and MUST thank, for their support and guidance in the completion of this dissertation. First, I need to thank a few people whose support was vital to this dissertation even being conducted and then I will thank a select few people who have provided the basis for support that got me this far.

I would like to thank the University of New Hampshire Graduate School and all those involved in awarding me the Dissertation Year Fellowship. I hope this work represents all that this award stands for. I would also like to thank Dr. Ken Fuld and the Department of Psychology and Dennis Meadows and the Institute for Policy and Social Science Research for the financial contributions. I was given a great opportunity to conduct part of this dissertation in San Diego, California at the Balboa City School. This experience was so rewarding both educationally and personally. Without this school I would not have had an ADHD group in my study. I am grateful to Dr. Stephen Parker, Michelle Parker, Rebecca Duckworth, the children, the parents, and everyone else at the Balboa School for there support and letting me take over part of their school for about a month. Balboa is an amazing school with some amazing, bright children. I look forward to returning and working closely with the school in the future. My control group was tested at various schools in the Dover School District. I am grateful that Dr. John O'Connor became the superintendent when he did or I might not have been able to complete this study. I also want to thank all of my research assistants-

Brittany Jackson, Rachel Gooze, Sarah Spates, and Erinn Walsh- for all their help with data collection.

Dr. Charlotte Mandel and Dr. Doreen Arcus provided me with the tutelage and guidance early on in my career. Both of you are undoubtedly the reasons I even made it to graduate school in the first place. Thank you so much for all your advice and support all the way through to today. Few people can look back and say they had one particular mentor or advisor that paved the way for the development of their career, I have two and for that I am grateful.

Many know that my first two years in graduate school are highlighted by struggles and negativity. However, even from afar Dr. Joe Onosko always saw my potential. I thank you for your support and belief in me. During those rough times, Dr. Frank Spencer provided the basis for helping me better understand myself. Because of you I now know so much more about the way I think, learn, and work than ever before. In my third year, at a time when faith and morale were a bit low, Dr. Pablo Chavajay came along. I thank you for being part of the "rebuilding" and helping me regain my faith.

One of the best things to happen to UNH was the creation of the Endowed Chair of Development Psychology position. Even better than that was the fact that this position was filled by Dr. David Pillemer. I am grateful for all the support and advice you have given me in the last two years. Your generosity is one of the only reasons this dissertation even got completed. I am not sure I can ever thank you enough and I look forward to working with you for many years to come.

One constant in my five years has been Ed O'Brien. Can you believe I am finally here? Which did you think would happen first, this or a Red Sox championship? Let's face it I have gotten this far mostly because of you. Not only are you a great teacher and mentor, you are a great person. I thank you for the hours of meetings and never-ending support. I am not sure where I would be without you, but it definitely wouldn't be here. I will miss all the jokes and sarçasm (at least I hope you were joking) and the responses I always got when I finally uncovered the answers to my questions (you were probably just happy I would be leaving your office though). Most of all...I think I will miss the dog! I owe you one.

Of all the great people I just mentioned, and who have influenced me in these past years, none tops my advisor Dr. Michelle Leichtman. I do not even know where to begin or the best way to put my gratefulness for all you have done for me. I am so grateful that you came along when you did. Without you as an advisor I cannot even imagine where I would be. You have made me a much better psychologist and I know my career will be successful because of it. These statements do not even do justice to what you have done for me in the past three years, but most importantly you helped me believe in me again. My only regret is that we only had three years to work together and I am eagerly looking forward to working closely with you as my career develops.

I am almost done! I am grateful for all the support from my family and friends. My parents and brother has always been a pillar of support throughout

my life. I am the luckiest man in the world to have my wifey, Andrea, with me every step of the way. Your inconvenient distractions provided me a much needed respite, relief, and a smile...even if sometimes they were at the most inopportune times! We have so much ahead of us in our lives and I can't wait to share it with you.

If there is one thing I can say to every person I mentioned, and those who I might have forgot (sorry), it would be thank you for believing in me when no one else wanted to believe and seeing what many were too blind to see. I hope that one day you can look back with great pride on my work and know you have influenced it very much.

University of Tampa here I come!

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

LONG-TERM EPISODIC MEMORY IN CHILDREN WITH ATTENTION-DEFICIT/ HYPERACTIVITY DISORDER

By

Jeffrey S. Skowronek

University of New Hampshire, May, 2005

Research on Attention-Deficit/ Hyperactivity Disorder (ADHD) has indicated that diagnosed children show considerable memory deficits. The majority of tasks that have supported such deficits have focused on working memory and school/semantic-related abilities. Although there is a small body of literature related to long-term memory in children with ADHD, no studies appear to focus on long-term episodic memory, including personal-event memory. This is the case despite clinical and anecdotal evidence suggesting that children with ADHD might show enhanced long-term episodic memory abilities in comparison to those without.

Twenty-one children with ADHD (5 females and 16 males) and 31 children without ADHD (14 females and 17 males) in the 4^{th}- 8^{th} grades (mean age 12.1 years) were administered five memory tasks assessing short-term, working memory and long-term episodic memory. Additionally, one parent for each child completed a 22-item questionnaire assessing their child's memory abilities.

The following main questions were addressed: (1) do children with ADHD exhibit superior long-term episodic memory performance when compared with controls, (2) among ADHD children, is performance on long-term episodic memory tasks superior to performance on short-term working memory tasks, and (3) how do parents perceive their child's memory abilities?

Although parents rated children with ADHD as having poor memory abilities for a number of factors, parents believed their children with ADHD had the best memories in the family for past experiences. Consistent with this profile, children with ADHD showed deficits in working memory compared to controls but showed equal or enhanced performance on long-term episodic tasks. When discussing a special-event in their life, children with ADHD provided lengthier and more descriptive narratives.

These results provide the first empirical support for anecdotal evidence suggesting children with ADHD have more elaborate episodic memory ability compared to controls. This is the first study to document strengths in children with ADHD, where weaknesses have always been the focus. Although replication is needed, these results may shed some light on the memory processes of children with ADHD and may be used to help these children succeed both in and out of the classroom. Future directions and limitations are discussed.

CHAPTER I

INTRODUCTION

Overview

Attention-Deficit/ Hyperactivity Disorder (ADHD) is one of the most prevalent disorders affecting children's learning in American schools. In general, ADHD is characterized by developmentally inappropriate levels of inattention, hyperactivity, and impulse control that can severely impact cognition and behavior. Studies have documented considerable and persistent performance deficits among children with ADHD across a variety memory tasks (e.g., August, 1987; Barkley, 1997; Sergeant, Oosterlaan, & Van der Meere, 1999). For example, Barkley (1997, 1998a, 1999) reviewed available evidence from a large number of studies in which memory tasks were given to children with and without ADHD and reported that children with ADHD performed significantly worse than controls on the majority of the tasks. Most of the tasks that index memory performance deficits among children with ADHD have been semantic tasks, such as arithmetic performance, and have focused on working memory and school-related abilities (e.g., digit span and list learning). The performance of children with ADHD on primarily long-term episodic memory tasks, including personal

event memory, has been largely neglected in the literature. This is the case even though anecdotal and clinical reports suggest that children with ADHD may perform better on these tasks than they do on working memory tasks, and that they even perform better than controls. Therefore, a major goal of this dissertation is to evaluate long-term episodic and personal event memory in children with ADHD and to compare performance with that of children who have not been diagnosed with ADHD.

A number of factors may influence the memory performance of children with ADHD in real world situations. In educational contexts, such as the classroom and those environments in which children complete homework or study for examinations, the complexity and importance of memory are clearly exhibited. Most traditional educational material requires a student to encode central, factual (or semantic) information being presented and recall that information at a later date.

Attentional capacity, which is often disrupted in ADHD, has a powerful influence on what children remember. The ability to sustain attention in a classroom is necessary if a student is to focus on new educational topics, learn semantically related information, and connect new semantically rich episodes to old information. In addition to attending to the relevant information being taught, a student must effectively block out extraneous and irrelevant information that can potentially interfere with classroom learning. An inability to inhibit irrelevant information may hinder memory abilities for the material

being reviewed. The demands of attentional controls are further stressed after school, when a home or after school program is the basis for continued educational studies. The major focus in these environments is review of what was already learned throughout the day as well as acquisition of new information. When homework assignments and studying serve to reiterate what was learned in school, again the need to attend to the particular task while inhibiting irrelevant information is extremely important. With such a major focus on semantic knowledge in our education system, it is not surprising that researchers interested in ADHD have neglected episodic memory and focused on abilities related to math or vocabulary.

In contrast to the problems that attention deficits create for memory in traditional educational settings, these deficits may be less detrimental to memory for event-related educational experiences such as field trips. During these and similar episodes, the demands to focus on very specific details and stimuli are diminished. Even a child who is not attending to the "central" elements (to be discussed later) of a field trip or similar event may produce a rich account of his or her personal experience. In fact, long-term recollection of such experiences may actually be enhanced by the recall of specific information that is somewhat peripheral to the key elements of the experience.

This contrast between the demands of memory tasks in traditional educational settings and the demands of memory for real life events may

result in a memory profile among children with ADHD that appears paradoxical, such that the child with ADHD might be remembering more peripheral details and fewer central details. An example may help to clarify the point: imagine a student who has the remarkable ability to recall what a tour guide wore on his trip to a science museum in 2nd grade; he may even recall where the bus he took there parked. The memory of these peripheral event-related details may or may not help the child to recall the central elements of the museum. Similarly, imagine a child with an amazing ability to recall what his father wore on his 6th birthday, but an inability to remember the definitions from a list of 5th grade vocabulary words he studied the night before. Attending to these peripheral or seductive, but irrelevant, details (which will be discussed later) in addition to, or in place of, the central, factual, details of an event serves to enhance the autobiographical episode of that child's 6th birthday or school trip by storing more detail related to the overall event. It might even serve to enhance retention of other details of the trip or birthday itself, such as the gifts the child received, the cake he ate, or his understanding of a birthday in general. This ability to recall very specific details results in a successful and impressive account of the event, rich both in event specific details as well as semantically related knowledge. However, when this pattern of attention occurs in the classroom, the result is a decreased ability to recall meanings of vocabulary words or other semantic, general world knowledge. Remembering the details of an activity that was

intended to teach about wind but not remembering the types and direction of the winds taught (see Nuthall & Atlon-Lee, 1995) or remembering a demonstration showing that lightening kills people but not what causes lighting (see Harp & Mayer, 1998) are examples of enhanced episodic accounts with poor semantic accounts.

Levine (2002) suggested that individuals with attentional difficulties might encounter the type of situations described above. Based on clinical observations from his pediatric practice, Levine proposed that such individuals often "display an immense torrent of episodic memory amid a trickle of semantic memory" (2002, p.115). From his own observations and reports from parents made in his practice, he reported that many children with attentional difficulties appear to have "phenomenal episodic memory" (p. 115). However, on tasks such as vocabulary tests, these same children have difficulty remembering lists of words studied a night earlier. In Levine's view (2002), the parents of these children also report that their children appear to have the "best memories" in their families. Anecdotal accounts from parents also suggest that these children frequently become frustrated when no one else can remember the events as they can. One parent noted (Levine, 2002):

> I have no idea why my Vance is failing in school. He has the best memory of anyone in our family...Why he is the only person in the family who can remember what color tie Uncle Marc wore on Thanksgiving three years ago. And five years ago we travelled to

> Florida on a vacation, and to this day Vance can tell you our hotel room number. We might go to a restaurant where we haven't been for several years. He remembers where we parked and can even recall what he ate and where the men's room was. But that kid can't ever remember his vocabulary or spelling words from last night. p.115

Although difficulties with attention play a role in other disorders, these difficulties are the central aspect of ADHD. Therefore, it is most interesting to consider from an empirical perspective whether children with ADHD display superior long-term episodic memory along side impoverished short-term, working memory and long-term semantic memory. Although a number of psychiatric disorders are often comorbid with ADHD, research has ruled them out as contributing to the deficits in executive functioning that will be the focus of this paper (e.g., Nigg, Hinshaw, Carte, Treuting, 1998; Klorman, Hazel-Fernandez, Shaywitz, Fletcher, Marchione, Holahan, Stuebing, & Shaywitz, 1999; and Murphy, Barkley, & Bush, 2001).

To frame this study, in the following sections first there is a brief review of some of the literature on ADHD, a description of the defining criteria, and a review of some of the research done on memory in children with ADHD. Following this review, there is a review of relevant research on the memory system, including long-term semantic and episodic memory. Then there is a review of some of possible explanations for why children with ADHD might have outstanding long-term episodic memory ability. Included in this section is

a discussion of how memory functions both inside and outside of the educational setting.

An exploration of episodic memory in children with and without ADHD adds to a growing body of literature documenting normative differences in episodic memory. Previously, researchers have studied normative gender differences in episodic memory among adults and school-aged children (Buckner & Fivush, 2000). Therefore, a review of some relevant research on gender differences in memory is provided. In a secondary analysis, this dissertation explored whether or not gender differences existed among younger children. Furthermore, because parents are the major source of the claims regarding children's memories, this dissertation explored the relationship between parental perceptions of children memories and the actual performance of the children on memory tasks.

Attention-Deficit/Hyperactivity Disorder

Attention- Deficit/ Hyperactivity Disorder (ADHD) is the most prevalent neurobehavioral, chronic health disorder afflicting school- aged children in the U.S. (AAP, 2000; Kirby & Kirby, 1994; Scahill & Schwab-Stone, 2000). While estimates vary considerably, ADHD is diagnosed in anywhere from 3- 16% of the school- aged population, or at least one to almost two children in every classroom across America (APA, 1994; NIMH, 1996; AAP, 2000; Scahill & Schwab-Stone, 2000). The variability in estimates is a direct result of

changing diagnostic criteria and varying ways of diagnosing ADHD throughout the US (Barkley, 1998b; AAP, 2000).

The American Academy of Pediatrics reports 9.2 % of males, compared to 2.9% of females, in the general population are diagnosed with ADHD (AAP, 2000). This reported ratio is slightly different from the four to one estimate reported by the American Psychiatric Association (APA, 1994). Additionally, the APA (1994) suggests that the male to female ratio of an ADHD diagnosis increases to nine to one in a clinical setting. As with overall diagnosis, there is marked variability within these estimated ratios. Among the reasons for this variability, ADHD is often difficult to diagnose because there is no clear difference between hyperactivity, inattention, and impulsivity associated with ADHD and otherwise normal variations in temperament characteristics. The defining criteria for the disorder have been defined by the DSM- IV, but according to Carey (1998) and Barkley (1997, 1998b) these criteria have not been clearly established. Shakil (2001) noted, "In practice, it is not uncommon to see children in whom symptoms of ADHD are not clearly distinguishable from normal variations in temperament" (pg. 1964) of which high activity, distractibility, and irregularity are aspects.

ADHD is characterized by developmentally inappropriate inattention and/ or a combination of impulsivity/ hyperactivity, including motor-restlessness (APA, 1994). The DSM- IV lists four types of ADHD: ADHD, Combined Type (ADHD/C), ADHD, Predominantly Inattentive Type (ADHD/I),

ADHD, Predominantly Hyperactive, Impulsive Type (ADHD/HI) and ADHD, Not Otherwise Specified (ADHD/NOS) (APA, 1994). Children with ADHD often have a wide range of symptom profiles and the disorder is often co-morbid with other cognitive and psychological conditions, such as learning disabilities, reading disabilities, anxiety disorders, Oppositional Defiant Disorder (ODD), Conduct Disorder (CD), and depression (Barkley, 1997; AAP, 2000; Murphy, Barkley, Bush, 2001). When being diagnosed, a child must present six or more symptoms of any of the characteristically inappropriate behaviors in at least two or more social settings (APA, 1994).

The symptoms of inattention include carelessness and lack of regard for details with schoolwork, jobs, or other projects, difficulty sustaining attention, lack of listening when being spoken to, inability to follow through on tasks, organizational problems, being easily distracted by "extraneous stimuli", and apparent forgetfulness. Symptoms of hyperactivity include fidgeting and squirming with the hands and feet, inability to remain seated when in environments where remaining seated is required, inappropriate and excessive running and climbing (or restlessness in adults), excessive talking, inability to appropriately participate in quiet activities, and acting as if "driven by a motor" or consistently "on the go" (APA, 1994).

Symptoms of impulsivity include blurting out answers or other comments before required to do so, difficulties waiting for the proper time to participate in an activity, and constantly interrupting others. Although there are separate

diagnostic criteria, the symptoms of hyperactivity and impulsivity are viewed in conjunction when diagnosing hyperactivity/ impulsivity. When completing tasks, hyperactive individuals will be "less compliant with immediate commands, less able to sustain compliance, and more oppositional" (Barkley, 1989, p. 380) and children with inattention will appear to often be "daydreaming, 'spacing out', [or] being 'in a fog'" (Barkley, 1997, p.67).

Aspects of ADHD vary with age and developmental level. The characteristic behaviors of ADHD begin to appear at around the ages of 3-5 (Barkley, 1998b) and the APA (1994) suggests some relevant impairment must be present before 7 years of age. The disorder, however, is often diagnosed in the preschool years, when the individual first enters into structured and demanding environments. These age criteria are frequently difficult to follow because before the age of five children's behavior patterns are constantly changing. Many symptoms might not present themselves until the child is older than seven, a point at which the demands of school become more challenging (AAP, 2000). Often, referrals arise from parents, teachers, other professionals, or other non-parental caregivers who may have concerns about their children or students (Martin, 1994; White, 1999). The corresponding concerns stem from underachievement or failure in academics, disruptive behavior or inattention in class, poor social interactions, and low self- esteem (AAP, 2000). One interesting note is that these symptoms are often not apparent in structured clinical settings, which are often novel and

lack the demands and distractions of school or home, or other novel settings (Paule, Rowland, Ferguson, Chelonis, Tannock, Swanson, & Castellanos, 2000; AAP, 2000). As a result, it may be difficult to ascertain whether or not a child meets the established criteria for ADHD in such settings (Paule et al., 2000).

Problems of Diagnosis. In addition to difficulty applying criteria in clinical settings, treatment approaches and the methods used for diagnosis have resulted in public, media, and medical concerns over inaccurate and overdiagnosis of ADHD (AAP, 2000; Shakil, 2001). The core symptoms of ADHD are mostly treated with stimulants, either in connection with or separate from psychosocial therapies, behavior modification, and other non-pharmaceutical approaches. The potential major negative side effects of stimulants such as methylphenidate (a.k.a.- Ritalin) upon children are a major source of concern and controversy about overdiagnosing ADHD; these side effects include such problems as anorexia, growth retardation, and motor and vocal tics.

In addition to concerns over treatment methods, difficulties in inaccurate or overdiagnosing arise from uncertainty in defining criteria. Over the past 30 years, from the DSM-III to the DSM-IV (APA, 1968; APA, 1994) the criteria used for defining ADHD and the name associated with the disorder have undergone a number of changes. These changes seem to echo the concerns and uncertainty that surround issues with methodology in the diagnosis of

ADHD (Barkley, 1998b). The focus of the disorder has changed from being a brain malfunction to an attentional problem that did not require hyperactivity to a disorder in which hyperactivity/ impulsivity is a focus. The current focus of hyperactivity/ impulsivity in the DSM-IV (APA, 1994), results in the assessment of the four subtypes listed above. Even though hyperactivity is currently the primary focus of the disorder, there is still some uncertainty in diagnosing; the DSM-IV indicates that it is "often difficult to differentiate" hyperactivity from a high activity level (APA, 1994).

As a result of these concerns, in 2000 the American Academy of Pediatrics formed a committee to create new guidelines for diagnosing ADHD. The new AAP guidelines were created for children ages 6 -12. While overall the guidelines are not vastly different from those listed in the DSM-IV, the necessity for creating this committee reflects the need to not only identify a better diagnostic criteria but also suggests the need for a more encompassing and unified model of ADHD.

Barkley's Unifying Model of ADHD. Barkley (1997) suggested that the current clinical view of ADHD (from the DSM-IV) "cannot readily account for the many cognitive and behavioral deficits associated with ADHD" (p. 66). Therefore, he proposed a unifying theory of ADHD based on neuropsychological functions of the prefrontal lobe in the brain. In his model, poor behavioral inhibition and impaired self- regulation are considered the central deficiencies in ADHD rather than attention per se (Barkley, 1997, 1998a). Behavioral inhibition

refers to three interconnected processes: (a) inhibition of a response to an event for which immediate reinforcement is available or has been previously associated to that response, (b) interrupting or stopping an ongoing response, which creates the opportunity for a delay in the decision to respond; and (c) "the protection of this period of delay and the self- directed responses that occur within it from disruption by competing events and responses (interference control)" (Barkley, 1997, p. 67; Kerns, McInerney, & Wilde, 2001). Numerous research results suggest that impairments in behavioral inhibition are more characteristic of ADHD than they are of other problems, such as academic underachievement, emotional problems, conduct disorders, or autism (Barkley, 1997).

In his model, Barkley (1997) also suggested a link between behavioral inhibition and the neuropsychological performance related to the four executive functions: working memory, self- regulation of affect- motivation-arousal, internalization of speech, and reconstitution. While behavioral inhibition does not directly control the four functions, inhibition "sets the occasion for their performance" (Barkley, 1997, p. 72). ADHD characteristics diminish the efficient use of the executive functions (Barkley, 1999) because the first executive act must be that of inhibiting responses. A deficit in the cognitive and behavioral abilities involved in behavioral inhibition leads to a deficit in the performance of the four executive functions that in turn leads to poor control of motor behavior or cognitions. As a result, the cognitions and

behaviors of an individual with ADHD are controlled by the immediate environment, rather than internally represented information, such as retrospection, prospection, rules, and motivations, resulting in hyperactivity and impulsivity (Barkley, 1997).

In Barkley's unifying model, from Bronowski's model (Bronowski, 1967, 1976, 1977: cited in Barkley, 1997), it is not just the response that needs to be delayed but also the decision to respond. The ability to delay and inhibit responses results in the ability to maintain focus on a particular ongoing task and use internally represented information rather than information of the immediate environment. Barkley (1998b) noted it is not an inability to filter out extraneous sensory inputs that children with ADHD suffer from, but rather the inability to inhibit the impulsive motor behavior to the input. If a child cannot inhibit the prepotent response to turn to or attend to extraneous stimuli, exhibiting poor interference control, then the child will not remain focused on the central sensory input.

Therefore, the attentional filter, which serves to focus on some information in light of other stimuli, will take in irrelevant information to the exclusion of central information. Additionally, in Barkley's unifying model, it is reasoned, from Fuster's model (Fuster, 1989, 1995: cited in Barkley, 1997), that poor inhibition, which would prevent delays of responses and protection of delays from interference, would manifest into distractibility, hyperactivity, and impulsivity, all characteristics of ADHD. The distractibility and inattention

associated with ADHD should also arise because poor interference control allows external and internal events to disturb the executive functions for self-control and task persistence (Barkley, 1997). Because individuals with ADHD are especially vulnerable to being controlled by influences from the external environment, impulsive/hyperactive behaviors should result in appropriate responses to stimuli in inappropriate contexts (Barkley, 1997); an example is a child who upon seeing a bike in a living room rides it immediately rather than taking the bike outside to ride. The response elicited is correct, one rides a bike, but the response is elicited in the wrong context, immediately riding the bike in the living room.

Consistent with Barkley's model and predictions, numerous deficits have been found in children with ADHD that are related to executive functioning and the prefrontal cortex. Deficits in working memory and its subfunctions have been documented in both children and adults with ADHD (see e.g. Murphy, et al., 2001; Vassileva, Vongher, Fisher, Conant, Risinger, Salmeron, Stein, Barkley, and Rao, 2001). One such deficit in working memory is difficulty with imitating long sequences of goal-oriented behavior. In children with ADHD the to-be-imitated sequence cannot be held in mind along with how to execute the behavior, such as the patterns exhibited in the game Simon (Murphy, Barkley, and Bush, 2001). Barkley (1997) has reported that children with ADHD have difficulty with interference control, as measured by the Stroop Color-Word interference test. Researchers have also noted

impairments in time-perception, such as time duration estimation, perception of time duration, and timing behavior (e.g., calling out in class) (Paule, et al., 2000). These difficulties with time perception have been noted to result in disorganized motor planning and execution, and deficiencies in keeping temporal order (Paule et al., 2000, Barkley, 1997). Children with ADHD have also been shown to use poor problem solving skills (Barkley, 1997) and have difficulty with creating impromptu strategies for organizing to- be remembered material (August, 1987),

Children with ADHD should also be more affected by immediate events rather than those distant in time, lack proper anticipatory behavior and thought, and be unable to recall and hold information in mind to prepare future plans (Barkley, 1997). Because of poor behavioral inhibition which affects the executive function of working memory, children with ADHD should be less able to sustain a particular goal-directed behavior due to greater interference from disruptive sources, both from the internal and external environment, resulting in an inability to complete the initial goal (Barkley, 1997). Children with ADHD are believed to have central and autonomic nervous system regulation problems resulting in an inability to meeting task demands (Barkley, 1997). Many of these deficiencies, such as being controlled by external stimuli and difficulties organizing to-be remembered material, are also found in individuals with prefrontal lobe injuries (Barkley, 1997).

The Memory System

Contemporary research suggests the memory system consists of three main areas, the sensory store, short- term/ working memory, and long-term memory (Rayner & Pollatsek, 1989). Within these areas there are subdivisions consisting of multiple types of memory. A general review of these systems will serve to establish, at least at a basic level, how information reaches long-term memory, which is the main focus of this study.

At any given moment, vast amounts of stimuli or information are bombarding an individual as sensory inputs from the outside environment. For information to be stored and later recalled, this information must be encoded and retained for some period of time, either brief for short-term recall or extended for long-term recall. Initially, all of this information is processed by the sensory store. The sensory store is the most basic level of the memory system and contains echoic memory for auditory information and iconic memory for visual information (Rayner & Pollatsek, 1989). The sensory store can take in this vast amount of information at a fast rate but the memory system needs to filter information in order to focus on relevant inputs and block out others. Although the relationship between memory and attention is complex, this is the first area in which attention plays a crucial role because as the sensory store takes information in, attention serves as the filter to focus on some stimuli to the exclusion of others.

Attention has a limited capacity. In the process of concentrating effort on a stimulus or an event, a stimulus can be attended to as long as there is not an overload in the capacity to attend such that there is competing irrelevant information (Ashcraft, 2002). An overload in capacity might occur when too much irrelevant information is focused on (Marzocchi, Lucangeli, De Meo, Fini, & Cornoldi, 2002). If a child is unable to maintain attention, selectively attending to certain incoming stimuli to the exclusion of other stimuli, this may place excessive demands on attention. A deficit in attention, after stimuli have entered the sensory store, means that a child may not be processing the subset of information from the environment that is central to the experience. When this deficit is present a vast amount of attention is given to irrelevant information and information that gets filtered out is the same information that should have been the very focus in the environment. Therefore, the irrelevant stimuli are not filtered out of short-term memory.

Once a stimulus has been recognized, the information for this input must be passed on to the short-term memory store to have a chance to last a long time in memory and become meaningful. Much information is lost during this process because the transfer from the sensory store to short-term memory is slow (Rayner & Pollatsek, 1989). Short-term memory and working memory are often used interchangeably to refer to the active part of memory for the storage of new information. It is made up of information from the outside environment and from internal memory. Short-term memory has a

limited capacity and the information only stays in the short-term store for a limited amount of time (Miller, 1956).

Information can remain in short-term memory for as long as it is being worked on, but once it is gone, it is gone for good (Rayner & Pollatsek, 1989). This has led some researchers, including Goldman- Rakic (1985), Kerns, McInerney, and Wilde, (2001) and Klingber, Forssberg, & Westerberg (2002), to distinguish working memory from short-term memory. The distinction created suggests working memory is the area in which we hold events or stimuli in mind, manipulate the information to control a response, and organize the information for future retrieval, while short-term memory is merely a component of this more elaborate system. Working memory is susceptible to distractions and therefore must be protected from interference by the "behavioral inhibition system" (Kerns, McInerney, & Wilde, 2001; Barkley, 1997). According to Baddeley (2001), working memory consists of three buffers for storing information: one for verbal information, one for spatial information, and one for episodes. Working memory also includes retrospective and prospective functioning, anticipatory sets, and the sense of time (Barkley, 1997).

Through processes such as rehearsal and elaboration, information is passed from the short-term/ working memory to long-term memory. Long-term memory is limitless but much information is lost in the transfer from short-term memory because, when compared to the transfer from the sensory

store to short-term memory, information passes even more slowly through short- to long-term memory (Rayner & Pollatsek, 1989). Based on a review of empirical studies, Squire (1993) suggested that long-term memory can be broken down into nondeclarative, implicit, memory and declarative, explicit, memory. Nondeclarative memory is thought to be made up of information that can unconsciously influence behaviors and thoughts without any necessary overt awareness. Declarative memory, on the other hand, is thought to be made up of information that can consciously be retrieved and reflected upon. Two distinct types of declarative memory, which will be discussed next, are semantic and episodic memory.

Semantic Memory and Episodic Memory. A central distinction in this study is the difference between semantic and episodic memory. Tulving (1972) viewed the episodic and semantic memory systems as two neurocognitive information-processing systems that hold onto information. According to Tulving (1972), when required to do so, these systems pass on this information to other systems, such as those responsible for behavior and conscious awareness. Tulving (1993) suggested the relationship between the episodic and semantic systems was "hierarchical: episodic memory has evolved out of, but many of its operations have remained dependent on, semantic memory" (p.67). However, these systems differ in many ways with respect to functions (e.g., remembering experiences versus facts), temporal

orientation, and conscious awareness at retrieval (Tulving & Markowitsch, 1998).

Semantic memory contains all general world knowledge, which has been learned or even over-learned. According to Tulving (1972), this knowledge is highly organized knowledge and includes all verbally related information; it includes knowledge of referents to the symbols, relations between symbols, rules related to symbols, and ways to manipulate these symbols and relations (Tulving, 1972). McKoon, Ratcliff, and Dell (1986) suggest that all questions and orientations of semantic memory are in terms of finding a reference and there is no temporal organization of this information. These interrelated concepts or references are typically retrieved through a spreading activation process (Neely, 1977). Often an individual has no specific recollection, or thoughts of reexperiencing, the event in which the semantic information was acquired; therefore, semantic memories are thought to be "known" rather than "remembered" (McKoon, Ratcliff, & Dell, 1986).

Episodic memory, the main focus of this study, is made up of events that happened to an individual at a specific moment in time and in a specific place. The focus of these memories is the individual and their experience and these memories usually have some temporal sequence (McKoon, Ratcliff, & Dell, 1986). Episodic memory is different from the memory for general events, which are made up of the general outline of an event, or extended

occurrences, rather than any specific moment in time (Nelson, 1993; Pillemer, 1998). Episodic memory is believed to be quite susceptible to the loss or changing of information. These episodic events may range from seeing lists of words during an experiment to flashbulb memories for important historical events and recollections of personal life events, i.e., eating a sandwich or the birth of a child. According to Tulving (1998), "episodic remembering always implies semantic knowing, whereas knowing does not imply remembering" (p. 202).

Autobiographical memories, or more specifically "personal event memories" (Pillemer, 1998, p. 50), are memories of personally experienced events throughout the lifespan. Additionally, while these events are being recounted the person telling the story may feel a sense of returning to a particular moment in time (Pillemer, 1998). Unlike semantic memory, these events are thought to be "remembered" rather than "known" (McKoon, Ratcliff, & Dell, 1986) because the individual usually remembers the specific event, or feels as if they are reliving the experience of one moment in time, when the event is recalled (Pillemer, 1998).

Not all episodic memories are autobiographical and not all personally experienced events become part of autobiographical memory. Recalling what one ate for dinner last night is an episodic memory that will bear no significance in one's life, however, getting a first big win at blackjack will surely remain part of one's autobiographical experience. A person may

remember the time, place, and even little details associated with the event. Additionally, recalling what happened on one's last birthday will probably not be recalled 35 years from now, but one will surely never forget what he did on his 21st birthday.

For the most part, educational situations are a prime example of how semantic and episodic memories are connected (Martin, 1993; Pillemer, 1998). Martin (1993) noted that "it is extremely common to converse with individuals who, quite unprompted, appear to recall very specific events from their educational and school experiences in vivid and compelling detail many years after such events are reported to have occurred" (p. 172). In many situations, the specific event or episode is the clearest referent for semantically related general world knowledge. In these instances semantic and episodic, or even autobiographical, information are inevitably intertwined in such a way that the individual will clearly recall learning knowledge through the episodes that occurred simultaneously. However, the school system is typically not geared towards creating distinct learning episodes; the primary emphasis is on acquiring technical, general world knowledge. In early, and even later, education the approach to teaching is usually similar; the teacher lectures to a class who diligently listens and records what is said. The teacher then questions the students for semantic recall; in fact, probing for any episodic memory or detail is usually secondary (Martin, 1993).

The major focus in education is attending to new to-be-learned semantic knowledge. This creates a problem for a child with ADHD who struggles to maintain focus and is captivated by the surrounding irrelevant stimuli. With the inability to maintain focus on a very specific topic, the ADHD child might be "seduced" by irrelevant, peripheral details. This situation might be remedied by the use of peripheral stimuli which are related to the to-be-learned material. As shown by Nuthall and Alton- Lee's (1995) excerpts of students' recall, when the peripheral information is related to the learning experience the student can recall both the specific episode as well as the details related directly to the answer itself.

Memory for Details. There are both central and peripheral details that can be attended to in the memory of any particular episode. The literature reflects that there has been some difficulty in categorizing central and peripheral details. For example, there has been a division between whether or not the central and peripheral details are best defined by a perceptual versus spatial distinction, as employed by Christianson and Loftus (1991: cited in Burke, Heuer, & Reisberg, 1992), or a plot- relevant versus plot- irrelevant distinction, as employed by Heuer and Reisberg (Burke, Heuer, & Reisberg, 1992). For purposes of this study, the definition of central details will be similar to that employed by Burke, Heuer, and Reisberg (1992). This definition suggests that a central detail is "any fact or element pertaining to the basic story that could not be 'changed or excluded without changing the basic story

line'" (p. 278). For example, knowing the color of a car that hit a pedestrian is peripheral to the main event, that of an individual being hit by a car. The car color could be red, white, or green and the event will still be unchanged, but if what the car struck was an animal and not a person then the main event of the story would be altered. Therefore, central details are considered to be the main gist or important details of an event while peripheral details are considered to pertain to irrelevant or less important information (Rizzella & O'Brien, 2002; Wessel, van der Kooy, & Merckelbach, 2000).

The term "seductive detail" has been used to refer to irrelevant details that are also highly interesting (Harp & Mayer, 1998; Schraw, 1998). When seductive details are present, research suggests that individuals typically remember the interesting irrelevant information in lieu of central details (Harp & Mayer, 1998). The recall of interesting but irrelevant details instead of central themes has been referred to as the "seductive detail effect" (Harp & Mayer, 1998; Schraw, 1998). Myers, O'Brien, Balota, and Toyofuku (1984) discovered a conceptually similar effect, in a reading paradigm. In their study low integration, which included sentences unrelated to a target sentence, resulted in a fan effect (Myers et al., 1984). In a fan effect more time is needed to retrieve information in a memory search. However, with a high integrated sentence, which was related to the target, the fan effects were reduced and even reversed (Myers et al., 1984). Low integrated sentences appear to be related to seductive details, as they result in fewer connections

in memory for recall of central details. Rizzella & O'Brien (2002) also found that when the central and peripheral details are held constant it is more difficult to recall central than peripheral details. This might suggest that under such conditions the irrelevant information is more interesting and the result is the seductive detail effect.

Harp and Mayer (1998) suggested two hypotheses that help make sense of why children with ADHD might be affected by seductive details. The distraction hypothesis states that seductive details entice the individual to divert their selective attention away from the important information. The diversion hypothesis suggests that individuals develop a representation based on seductive details rather than main details (Harp & Mayer, 1998). To examine which hypothesis is the cause for the "seductive detail effect", Harp and Mayer (1998) gave college students problems to solve that were based on a passage called "The Process of Lightening." To test each hypothesis the main passage was altered in each of three experiments, i.e., main ideas were highlighted or the seductive details were placed at the beginning or end of the passage, and the answers to the problems were analyzed. Harp and Mayer concluded that the way seductive details do their damage is through diversion; however, both hypotheses described above might apply to the case of children with ADHD. The results from Harp and Mayer (1998) also showed that seductive details have a major influence only before the central details are attended to. However, as discussed later, children with ADHD are

influenced by irrelevant details both before and after attending to central details of to-be-learned material, and the effect is somewhat greater when the irrelevant material is at the end (Marzocchi, et al., 2002). This suggests that the distraction hypothesis may exert a greater influence on why children with ADHD are affected by seductive details.

The seductive detail effect would seem to contradict the idea that peripheral information would serve to aid in the recall of both episodic and semantic memory. However, there might be a need to further define peripheral details, as related and unrelated to central information, to understand how peripheral information can enhance recall. It is possible that when peripheral information is unrelated to the central information, the peripheral information interferes with the central information. The result would be a seductive detail effect. However, if the peripheral information is related to the central information, the peripheral information might support the ideas of the central information and therefore aid in elaboration of the central details. This would be the goal behind using specific events in the classroom where the peripheral episode would be related to the semantic material. The result would be a better recall of the central information as a result of related peripheral information.

Normative Differences in Memory. In general, there have been normative differences found in episodic memory ability. For example, there is a growing literature indicating cultural differences in autobiographical narratives,

especially between Eastern and Western cultural groups (Leichtman, Wang, & Pillemer, 2003). As a case in point, Han, Leichtman, and Wang (1998) found normative cultural differences in memory narratives of American, Chinese, and Korean children. Americans provided more information related to description, internal states, and specific past references. Additionally, the American children spoke more than the Korean children, while the Chinese children narratives resembled the American children in length but the American narratives were much more detailed. Han et al. (1998) also found developmental trends in the amount of words used, the amount of specific details, and the number of descriptives provided in autobiographical narratives. In addition to differences among cultures and age, there is some research on gender differences in episodic memory, most of which has focused on adults.

Females and males appear to recall and use episodic, personal event, memories differently. Males are more likely use personal memory for things like trivia, jokes, and names to establish a hierarchy in social settings, while females establish community through emotional experiences from the past (Tannen, 1990). Sehulster (1995) found that females tended to suggest that statements of autobiographical memory described them well while statements concerning verbal memory, or memory for names, trivia facts, news events, or jokes, did not. The reverse pattern was found for males. Sehulster speculated that "females more frequently access emotional material in conversation and

therefore have it better rehearsed, organized, and accessible. Males, on the other hand, more frequently access factual material in conversation and therefore have verbal, factual material more at hand" (Sehulster, 1995, p. 84). Not only do females tend to remember specific episodes, as in a marriage, but they appear to also be influenced by the recollection (Pillemer, 1998). Herlitz, Nilsson, and Backman (1997) found that females consistently outperformed males on episodic memory tasks, such as recall of newly acquired facts, face recognition, and free recall of past actions performed. Additionally, males and females appear to differ in the reporting of memories. In describing experiences, females' memories appear more "revealing and detailed" while males' appear more "guarded and general" (Pillemer, 1998, p. 180). Females also tend to report "longer, more detailed, and more vivid accounts of the past than do adult males" (Buckner & Fivush, 2000, p. 401). Buckner & Fivush (2000) noted that 8-year-old girls are "more vivid, more coherent, and more elaborated in their narratives than their male peers" (p. 401).

Neuroanatomy in ADHD and Memory. ADHD symptoms appear to arise from dysfunctions of the prefrontal cortex (PFC) and its cortical and subcortical connections (Haines, 2002). Many of the criteria for diagnosis of inattention or hyperactivity/ impulsivity (see above) are related to abilities of the PFC (Haines, 2002). In addition to the PFC, other brain regions appear to malfunction in individuals with ADHD (Barkley, 1997, 1998; Paule, et al.,

2000). Barkley (1998b) reviewed neuroimaging studies that suggested ADHD is the result of under active genes, which have been polygenically mutated. These mutations cause shrinkage in areas of the brain that are thought to regulate attentional abilities, such as two basal ganglia (caudate nucleus and globus pallidus), right PFC, and the vermis region of the cerebellum. PET studies have revealed decreased blood flood in the striatum and prefrontal regions of the cerebrum (Paule, et al., 2000). Studies reviewed by Paule et al. (2000) also report smaller anterior regions of the corpus callosum, which is consistent with involvement of prefrontal cortical regions. Hyperactive subjects appear to have less brain activity, as measured with fMRI, in the right mesial frontal cortex, in the right inferior PFC, and in the left caudate nucleus during tasks that require combining a motor response with a visual stimulus (Paule, et al., 2000).

In addition to prefrontal cortex associations in ADHD, the same regions of the anterior, dorsolateral, and ventrolateral PFC appear to be activated during both working and episodic memory (Ranganath, Johnson, & D'Esposito, 2003). Nyberg, Marklund, Persson, Cabeza, Forkstam, Peterson, and Ingvar (2003) also found similarities in PFC activity for working, semantic, and episodic memory. The common areas of activation were the left mid-ventrolateral PFC, left mid- dorsolateral PFC, left frontopolar cortex, and dorsal anterior cingulate cortex (Nyberg et al., 2003). These areas are related to updating and maintaining information and mediation in active encoding and

retrieval of information (mid- ventrolateral PFC), active selection (mid-dorsolateral PFC), "evaluating externally attended- to information" (dorsolateral PFC), and "cognitive control and effortful task completion" (anterior cingulate) (Nyberg et al., 2003, p. 376). Jonides, Lacey, and Nee (2005) suggest that the posterior cortex may be more important for storage in working memory than the frontal cortex, except when interference from other stimuli is present. The results of these brain studies support the idea that the deficits associated with ADHD and working memory share commonalities. However, because of the common activation areas of the PFC, these results also suggest that there should be similar impairments in long-term semantic and episodic memory.

Although there are commonalities in activity of the PFC, different types of memory tasks also show specific activation patterns in the PFC for working, long-term semantic, and long-term episodic memory. Additionally, the degree of activation within the described regions of the PFC can be affected by task difficulty and novelty, and performance errors (Nyberg et al., 2003). Individuals with prefrontal lesions can perform well on simple working memory span tasks but not on working memory tasks that "tax attentional inhibition or selection processes" (Ranganath, et al., 2003, p. 378). Additionally, these same individuals can perform well on simple long-term memory tasks of recognition or cued recall but not on more complex free recall or source memory tasks (Ranganath, et al., 2003). Tulving (1998)

pointed out that in his "Serial Parallel Independent model" an individual's "episodic memory may be more impaired and semantic memory not impaired or less impaired, or semantic memory may be more impaired and episodic memory not impaired or less impaired" (p.200). These distinctions are important in understanding how there might be deficits in working memory but not long-term episodic memory. So, even though there might be common activations of the PFC that result in deficits of working memory, there appear to be specific activations for certain memory tasks that might allow for normal or enhanced performance of some memory systems while there are deficits in others.

Memory Deficits in Children with ADHD

The results of the neuroimaging studies appear to be consistent with the deficits in working memory found in children with ADHD. Vassileva, et al. (2001) found that individuals with ADHD performed worse on 2-back and 3 back tasks. In these tasks a child was shown a series of letters and was required to respond to a target letter if a presented letter was the same as a letter presented either two letters earlier, 2- back (e.g., a,b,a), or three letters earlier, 3-back (e.g., A,B,C,A). These children also made more errors of commission, and more errors of omission when compared to controls. On tests of free recall, August (1987) found that children with ADHD recalled fewer words when compared to learning disabled and normal controls. Children with ADHD also had lower clustering scores for recall organization

and showed an inability to "maintain recall equality over multiple sort-recall trials" (August, 1987, p. 438). The results were attributed to deficiencies in organizational ability and in the ability to sustain effort and control required to meet the demands of repetitive, boring, tasks. Voelker, Carter, Sprague, Gdowski, & Lachar (1989) noted that ADD-H boys (ADD-H was a term used to refer to individuals with Attention Deficit Disorder with Hyperactivity; this would now be considered ADHD/HI or C) show deficits in cognitive processing on tasks that are effortful and complex but not on memory capacity of recognition and cued recall or conceptual thinking, when compared to IQ matched samples. On a semantically related but unclustered list of words, ADD-H boys performed significantly worse than the group of age, IQ, and achievement matched controls (Voelker, et al., 1989). Voelker, et al. (1989) also found that ADD-H children appear to have a firm understanding of metamemory processes, such as spontaneous clustering, but only appear to be able to use them under clearly obvious, highly salient, and minimally effortful conditions.

Also in the domain of metamemory, O'Neill and Douglas (1996) found that children with ADHD used less effective rehearsal strategies even though they were aware of more effective strategies. Additionally, children with ADHD did not differ in their ability to create adequate study plans; rather when confronted with the memory tasks they used less effective strategies than ones they claimed to know. Using rote repetition of items when they

could have used more elaborate multi- item rehearsal, ADHD boys recalled fewer words on a self- paced free-recall task and spent less time rehearsing and attempting to retrieve words (O'Neill & Douglas, 1996). The use of single-item strategies was attributed to self- regulatory failures; multi-item rehearsal required considerably more mental effort.

Kerns, McInerney, and Wilde (2001) did not find differences in working memory between children with ADHD and controls, but did find differences in inhibition and attentional ability, and time reproduction. The conflicting results on working memory are attributed to the type of working memory tasks used in the study. Maintenance tasks, ones that require maintaining information across a short delay (i.e. holding previously given responses in mind so as to not make the same response again), were used in the Kerns, McInerney, and Wilde study. These tasks are believed to be easier to perform than manipulation tasks, which require reordering and reorganization of information; there is less demand in working memory on maintenance tasks. Another problem creating conflicting results is small sample sizes. A study with a small sample might result in a null finding that might be significant in a larger sample. Results obtained in small sample sizes are not completely representative because of the adherence to significance levels obscuring otherwise significant results if they were found in a larger sample (Murphy, Barkley, & Bush, 2001).

In one of the more interesting results, Marzocchi, et al. (2002) found that when irrelevant information was included in self- paced arithmetic word problem solving tasks, children with ADHD/ I (predominantly inattentive subtype) performed significantly worse than the IQ and age matched controls. When there was no irrelevant information available the children with ADHD/I performed similarly to the controls. However, when irrelevant information was present children with ADHD had difficulty selecting the proper procedure for the tasks. It appeared as if for the children with ADHD/I the irrelevant information remained highly activated in working memory and it was then used during the problem solving (Marzocchi et al., 2002). A working memory overload was further confirmed by the fact that the children with ADHD/I were able to correctly calculate the problem but used the irrelevant information to do so. Although these results were obtained independent of the position of the irrelevant information, the use of the irrelevant information was slightly more apparent when the irrelevant information was placed at the end of the word problem-solving task than when placed at the beginning.

In the second part of this study, Marzocchi et al. (2002) used irrelevant arithmetic information on some problem solving tasks and irrelevant verbal information on others. In the irrelevant verbal and arithmetic conditions, children with ADHD/I made significantly more procedural errors than controls. However, they also made more calculation errors than controls when using the irrelevant verbal information. This was not the case with the irrelevant

arithmetic information. As with the results described above, these results must be considered with caution because the classification of ADHD/I was a result of teacher suggestions and there was considerable variability within groups across tasks.

Rationale for Study

While there is a vast body of literature on working memory deficits in children with ADHD, there appear to be only a few studies related to long-term memory functioning in these children (e.g., Kaplan, Dewey, Crawford, & Fisher, 1998; Lorch, Sanchez, van den Broek, Milich, Murphy, Lorch, & Welsh, 1999; Mealer, Morgan, & Luscomb, 1996; Webster, Hall, Brown, & Bolen, 1996). Additionally, there appear to be only a few studies that examine long-term episodic memory, in the form of story recall, and no studies that focus on personal event memory in children with ADHD. In the current study, I compared long-term episodic memory ability and a number of other measures among children with ADHD and age matched children without ADHD. The design allowed me to evaluate the clinical insight that children with ADHD perform as well as or better than children without ADHD on long-term episodic tasks, including personal event memory, while they perform significantly worse on working memory tasks.

As a subsidiary to the main focus of this study, the design allowed for the evaluation of gender differences in episodic memory in a gender matched sample of children. In view of the literature showing gender differences in

episodic memory of adults, there has been little done to examine if these differences exist in children. Additionally, as stated earlier, anecdotal parental reports and claims from clinicians (e.g., Levine, 2002) suggest that children with ADHD appear to have the "best memory" in their families. Therefore, I also questioned parents to see if in fact they believed this to be true of their children with ADHD.

In this study, I hypothesized that children with ADHD would exhibit better memories than controls on long-term episodic memory tasks, including a personal event memory task. In their narratives, children with ADHD were expected to provide more words, sentences, and descriptives. In line with issues related to temporal sequencing, children with ADHD were expected to provide fewer time statements. I also predicted that children with ADHD should provide more peripheral details when recalling stories and remember more peripheral pictures, from a story recall task. Not only should children with ADHD provide more peripheral details, they should also show no difference compared to controls when recalling central details of the stories. The expected results for the story recall task are based on the assumption that seductive details have the effect because of the distraction hypothesis described earlier (Harp & Mayer, 1998). Because there is unrelated peripheral information, children with ADHD will become seduced by this information, recalling more of the peripheral details. However, because there is also

related peripheral information, this should help children get back to the central details.

The rationale behind why a child with ADHD should have better long-term episodic memory appears to lie in their deficit with behavioral inhibition. Because of the inability to block out external stimuli and ultimately be controlled by it (Barkley, 1997, 1998a), a majority of irrelevant, peripheral information in the environment is not properly filtered. Upon recall in long-term episodic memory, the more information the child can recall the better the personal, autobiographical, account will be. This would all point to the child with ADHD having rich personal event memory reports and to recalling the seductive details that are not necessary for main ideas. In a semantic recall situation, such as those of a test, it is not adaptive to be able to recall a lot of information but rather the need is for specific information to answer the questions accurately. In these situations, attention at encoding might disrupt stimulus identification. When it is time to retrieve the information the child with ADHD cannot remember the semantic material because the irrelevant information that has been encoded interfered with the to-be-remembered information. While the child may appear to understand the question or material procedurally, they cannot give a correct response because the irrelevant information is interfering with retrieval or they never completely encoded the central, semantic information in the first place because of the focus on the irrelevant information.

Although exploratory, it is expected that parents may perceive and rate their child with ADHD as having poorer memories for school-related abilities and telling jokes, according to documented problems with school-related abilities and temporal sequencing, but more elaborate episodic memory compared to controls. Additionally, gender differences similar to those described earlier were expected to be found. Females were expected to show better narratives for episodic memories, such that they will recall more details than males. Finally, an exploration of parental perceptions will reveal if there are any relationships between parent perceptions of children's memories and the child's actual performance.

CHAPTER II

METHOD

Overview

Researchers administered five memory tasks to children with and without ADHD, in a cross-sectional design. Additionally, one parent of each child who participated completed a 22-item questionnaire. Half of the children were tested in a school in San Diego, CA and half were tested in schools in Dover, NH. The procedures were designed to assess both working and long-term memory ability in these children. Each child participated in two 30-minute test sessions spaced approximately 2-3 hours apart during the regular school day.

Participants

Fifty-two 4^{th}- 8^{th} grade children participated. Of the 52 children, 31 children, the "control group" (14 females, 17 males), were tested in Dover, NH and were not diagnosed with any kind of cognitive or psychological disorder. The mean age of the control group was 11.6 (*SD* = .17) and mean grade level was 6.6 (*SD* = 1.56). The 21 children (5 females, 16 males; *mean age* = 12.6, *SD* = 1.43; *mean grade level* = 6.4, *SD* = 1.4) in the "experimental group" were tested in San Diego, CA and were diagnosed with some kind of cognitive or psychological disorder, mainly ADHD. Ten additional children

tested were excluded from the experimental group because they were not diagnosed with ADHD. 62% of the children (1 female, 12 males) were diagnosed with ADHD with no comorbid disorder, while 28% of the children (4 females, 4 males) were diagnosed with ADHD with some type of comorbid disorder (e.g., ADHD and Asperger's Syndrome, a learning disability, etc.). Because of the issues with comorbidity, the results of this study will be presented in two forms: (1) comparisons of the control group (n = 31) and all children with ADHD, regardless of comorbidity, (n = 21) and (2) comparisons of the control group and children with ADHD and no comorbidity. The second comparison only includes males because only 1 female had no comorbid diagnosis (n = 17 for control group and n = 12 for ADHD group). This latter comparison represents the purest form of the sample for data analysis.

After approval from the appropriate heads of each participating school and the UNH Institutional Review Board, parents of all potential child participants were asked to complete a 22-item questionnaire and consent to their child's participation in the study. In total, this questionnaire was sent to 1348 parents (48 in CA and 1300 in NH). The overall return rate for the questionnaires was 15.4%; of these returns 174 agreed to participation and 33 refused participation. Children in the control group (i.e., those without ADHD) were selected, based on parental responses, and were matched by grade and gender with the children with ADHD. The parental responses were also used to assess parental perceptions of children's memory abilities.

Materials and Procedure

There were two parts to the study. First, a questionnaire was sent home to the parents, along with the informed consent forms and a letter describing the study. Each parent was asked to fill out the questionnaire and sign the consent form and return the completed forms to their child's teacher. The parent had to sign the consent form in order for a child to be considered for inclusion in this study. Second, the other half of the study took place in the individual schools in California and New Hampshire. With parent and teacher permission, students were removed from their classroom for the testing. Each student met individually with a hypothesis- and condition-blind researcher in a separate room for two sessions. The first session included the personal event memory task and the initial showing and narration of the story task. The second session, which was held approximately two to three hours later, included the working memory tasks and both a recall and recognition task based on the stories shown during the first session. Each session was tape recorded and later transcribed and then coded for analysis. Each session lasted approximately 30 minutes for a total of an hour of testing. For each task, a description of the material and testing procedure are given followed by coding information.

Parental Questionnaire. The parental questionnaire, created specifically for this study, assessed how parents viewed their children's memory capabilities *(see Appendix A).* Quantitative questions were answered on a five-point

Likert-type scale. The questions assessed whether or not the parents believed the child had difficulties in school, whether they believed the child was the best at remembering events in the family, how well the child appeared to be able to recall details of events in their past, and how well they recalled information for schoolwork. Some additional questions assessed the child's perceived ability to tell jokes. The questionnaire also had questions related to ADHD, such as whether or not the child was diagnosed with ADHD, if the child was receiving any treatments for ADHD (i.e., medications or behavior therapy), if the child was in any special education classes or received any special assistance in school, and if the child had a comorbid learning disability or other disorder. These qualitative questions were answered with a forced-choice binomial (i.e., yes or no, with or without). Most were in a skip-pattern format, in which answers for certain follow-up questions were given based on the answers to preceding questions (i.e., if the child did not have ADHD then the parent did not need to provide information about whether or not the child was receiving medication for ADHD). A final question asked if the parent could be contacted in the future for more information. The questionnaire took approximately 15 minutes to complete.

Working Memory Task. Two working memory tasks were given to all the children. The Simon game and the digit span- forward and backward- task are both measures of working memory in which children with ADHD have been found to consistently perform significantly worse than children without ADHD

(Barkley, 1997; Murphy, Barkley, & Bush, 2001). Giving working memory tasks allowed for a replication of past findings and also further confirmed the diagnosis of children with ADHD in this study.

The Simon game is a widely recognized test of working memory, in which considerable performance deficits have been documented for children with ADHD (Murphy, Barkley, & Bush, 2001). The Simon game is made by Hasbro™ for 7-year-olds through adults and is available commercially. The game is made up of four large plastic colored keys in a yellow plastic base. The colors of the four keys are blue, green, red, and yellow. Each key emits a sound when pressed. This game requires the player to repeat increasingly longer color/ sound patterns that the game provides. When the game is started, a pattern of different tones and lights connected to each tone are displayed. When the pattern is complete the individual must then press the appropriate colored keys, reproducing the sound and light pattern displayed by the game. The game typically begins by displaying a pattern of just one tone and lit key. With each successful repetition, the game then displays a longer and more complex pattern for the individual to repeat.

Before playing the game, the child was asked if he/she was familiar with the game and, regardless of familiarity, was read a standard set of directions. After listening to the directions, each child completed one practice/trial game. The game was scored by recording the longest correctly reproduced pattern and, therefore, the length of this task was dependent

upon how long the child could successfully repeat the game's patterns. Each child was given three trials and the longest sequence completed was used as the child's score for data analysis.

Digit span, which is made up of two parts, is a subset of the Wechsler Intelligence Scale for Children- Third Edition (WISC-III; Wechsler, 1991). In the first part, the researcher said a series of number strings to the child at a rate of one number per second. The child then repeated the numbers back in the same numerical sequence as they were heard. The first level began with two trials of two number sequences (e.g., 2-9 and 4-6). The child was given longer strings of numbers after successfully repeating at least one sequence in a level. The testing ended when the child was unable to successfully repeat back both sequences in a level. The only change in the second part was that the child repeated the numbers they heard in reverse, or backwards, order. For every successful repetition of a sequence the child received a score of one, for a total score per level of two. If a child did not successfully repeat a sequence they received a score of zero. The sum of all completed sequences within each part made up the score for that part; the sum of the scores for each part made up the total digit span score.

The Simon game is believed to assess nonverbal working memory while the digit span task is believed to assess verbal working memory. For the purposes of this study, both working memory tasks are thought to be assessing episodic working memory. In both tasks, the child is presented with

a series of patterns (either lights and sounds or numbers) that they have never seen before and have not have an opportunity to learn. Even though the digit span task uses common numbers, the task is assessing whether or not the child recalls a specific number sequence, presented at a specific time, in a specific pattern. The task in not assessing any semantic knowledge related to the numbers per se.

Long-term Memory Tasks. A personal event memory task, story recall task, and picture recognition task were used to assess long-term episodic memory.

Personal Event Memory Task. The personal event memory task consisted of two questions asking each child about past events that they experienced *(see Appendix B).* Based on the responses, two separate narrative reports were obtained about personally experienced events from some specific moment in life. The questions were modeled after questions from Han, et al. (1998). Each question was asked in an open-ended format and then the child was given standard prompts to provide more information (See Appendix B). Each answer was recorded, transcribed, and analyzed for multiple components. The coding was similar to the coding scheme used in Han et al. (1998) and Leichtman, Pillemer, Wang, Koreishi, and Han (2000). Each narrative report was coded for the following:

Total number of words- a word was counted as any meaningful utterance. Therefore, "um" or "uh", were not counted here, but "yeah" or "yup" were counted when the use indicated approval.

Total number of sentences- a sentence was made up of all comments made by the child. Comments were considered complete sentences or fragments as long as the utterances of the sentence had meaning. Therefore, as with number of words, "um" was not counted here but "no" was counted as a sentence when it was used in isolation to answer a question.

Descriptives- this was the total number of adjectives, adverbs, and modifiers that were used to support the descriptions used in answering each question. Any repetitions were counted as many times as they were spoken.

Time statements- each narrative was analyzed for the total use of temporal markers. Consistent with Han et al. (1998) both simple and complex temporal markers were coded. Statements concerning when the described event occurred, references to the past and future, statements such as then, next, first, second, and third, so and when, and conditional statements (e.g., if-then) were counted here.

Specific Dialogue- each narrative was coded for whether or not the child quoted others or themselves, as in a conversation (e.g., ...and I said "No don't go in there!" Then my friend said, "Why not?").

General versus specific- each narrative was coded as specific if the answer contained an "explicit description of people, places, events, times and so on, which indicate a particular occurrence of an event" (Han, et al.,1998, p. 704). For example, a specific answer might include, "on my last birthday I turned 8; we had a party at my house. I received great big boxes of gifts from

my parents and grandparents. I got a new toy truck and a Shoots and Ladders." The specific description distinguishes the specific occurrence of the event from other general occurrences or repeated occurrences of the event. Each answer was considered general if the answer did not contain distinguishing descriptions (i.e., "I remember a party").

Three trained research assistants coded all of the narratives. Thirty percent of the narratives were coded by the head researcher in order to assess reliability. Agreement between the raters ranged from 94% to 100%. Any disagreements were collaboratively reviewed and settled by the head researcher.

Story Recall Task. The story recall task was created specifically for this study and was intended to assess long-term episodic, non- personal event, memory *(see Appendix C)*. The task consisted of each child viewing ten novel stories, which contained both narration and pictures, and then being questioned about different aspects of each story after a two- to three-hour delay.

The Stories. The stories' pictures and narration were presented via computer. There were a total of ten stories about fictitious people, a description of an activity or object that the individual likes, and a made-up story related to that like. Along with each story narration there were six pictures that corresponded to a part of the story, e.g., a picture of a fictitious person's face, a picture of an object that the individual likes, in the center of

the computer screen. For half of the pictures there were four irrelevant pictures presented in the corners of the computer screen, e.g., there might be a picture of the object of interest in the center and four unrelated and unmentioned objects in corners. Each story was balanced for length (one minute each), central and peripheral details (seven each), and central (6) and peripheral (12) pictures. This task was episodic because the stories were completely new to the child and the recall was based on a one-time experience where the child did not have an opportunity to study and learn the stories.

More specifically, each story was made up of plot relevant details and pictures, i.e. gender, age, specific event that occurs, and a picture of a person, that were central to the story about the protagonist. Each story also included plot irrelevant details and pictures that were peripheral to the story, i.e. colors of objects and names of other people and background pictures (See Appendix C for examples). In these stories any detail that was necessary to maintain the plot of the story was considered a central detail; whereas, any detail that did not change the composition or meaning of the story was considered peripheral. Central pictures were those pictures that were directly related to the story line, i.e., a picture of a bike accompanying the verbal description of a bike. Peripheral, or seductive, pictures were those pictures that were unrelated to any aspect of the story, i.e. pictures of household objects were shown with the picture of bike. There were a total of

six color pictures presented in each story, three with peripheral pictures and three without. Each story lasted approximately one minute for a total of approximately ten minutes of stories. There was a five second delay in between each story.

Story Recall. Recall of the stories came from open-ended and direct questions. The free recall was initiated by showing the child the picture of the protagonist and then asking the child to report everything they could remember about that person (See Appendix C for examples). The free recall was recorded and transcribed for further analysis. (Note: initially these stories were to be analyzed for verbatim versus paraphrased recall; however, none of the stories were recalled verbatim and most children never even recalled one sentence verbatim.) The cued recall consisted of four questions related to central and peripheral details (2 each) and questions about the central and peripheral pictures in the story. When questioning the child as to whether or not they could recall any of the peripheral pictures the child was presented with the corresponding central picture (i.e., the child was shown the picture of the bike from the story and asked "do you remember any of the pictures in the corners of the screen around this bike?"). Each correct answer in relation to either the central or peripheral detail questions was scored as a "1". Each story recall resulted in four separate scores: (1) a score for the number of correct answers to central questions in a story (max score of 2), (2) a score for the number of correct answers to peripheral questions in a story (max

score of 2), (3) an aggregate score across all 10 stories for all correct answers to all central questions (max score of 20), and (4) an aggregate score across all 10 stories for all correct answers to all peripheral questions (max score of 20).

Picture Recognition. In the recognition task, the child was shown 60 pictures, one at a time, from a computer screen. Thirty of the pictures were seen in one of the ten stories, while 30 were not used in any of the stories. The child was instructed to simply answer "yes" if they recognized seeing the picture in the corner of any of the stories and "no" if they did not recognize the picture. The child's responses to each picture were written down and then coded. If the child answered correctly they received a score of one and if the child answered incorrectly they received a score of zero. As a result, a number of scores were obtained: (1) the actual answer for each picture- yes or no, (2) the total number of times the child said yes or no, (3) the number of correct responses for both yes and no (i.e., the number of correct responses divided by the highest possible score of 30), and (4) the number of times the child said yes or no and was correct (i.e., the quotient of the child's correct responses divided by the number of times the responses occurred: the child could have correctly answered yes 20 times and this was divided by the total times the answer yes was given).

CHAPTER III

RESULTS

Data Analyses

There are a wide range of variables being examined in this study. The main independent variables include: group (ADHD or non-ADHD), gender, and age. Dependent variables include: parental responses to the quantitative variables of the parental questionnaire, working memory performance on both digit span and the Simon game, all coded components of the personal event narratives, and recall and recognition performance on the story recall tasks.

Throughout this results section, each analysis is presented twice: first for the whole sample (52 children: 21 with ADHD, 31 without) and then for the smaller sample (29 males: 12 with ADHD, 17 without). In the smaller sample all children with ADHD with any comorbid disorders were excluded. This two analysis approach provides the full spectrum of results (through the whole sample) and the most easily interpretable and purest form of the results (through the smaller sample) in which issues of comorbidity are ruled out. In most cases the patterns of the results were similar for the two samples; whenever this is not the case it is noted.

Parental Questionnaire

A t-test for the difference between groups (ADHD versus non-ADHD) was run on each qualitative variable in the parent questionnaire; the raw scores for every answer were used for data analyses. The mean parent ratings for children with and without ADHD are presented in Table 1 and the overall regression models are presented in Table 2. For every variable that had a significant (or marginally significant) difference between the groups, a regression was run to control for the other independent variables. A standard linear multiple regression was performed to see how well scores on the various ratings could be predicted from group, gender, and age in the whole sample and group and age in the smaller sample (there were only males in the subset so gender was excluded).

Regardless of the significance of each overall model, the contribution of each predictor was assessed separately by examining two pieces of information: the β and *t*- test results, which tested whether or not the independent variable was a significant predictor of the ratings, and the squared part correlation (sr^2), which estimated the proportion of variance that was uniquely predicted by each independent variable. Because the contribution of each independent variable was assessed regardless of the statistical significance of the overall model, only the β, *t*, and sr^2 for significant predictors are reported and the direction of the effect is described. For a review of the exact wording of the questions and the rating scales see Appendix A. Mean parental ratings for all qualitative questions for children

with and without ADHD are presented in Table 1. The adjusted R^2, *F*, and *p* for the overall model are listed in Table 2.

Ability to Tell Jokes. Children with ADHD were rating as being significantly worse than children without ADHD at telling jokes. Of the three predictor variables for the whole sample, only group made a statistically significant contribution for the whole sample. For group, the sr^2 was .206, $t(50) = 3.54$, $p = .001$ and the $\beta = .492$. A similar pattern was found for the smaller sample. Of the two predictors, only group made a statistically significant contribution. For group, the sr^2 was .227, $t(27) = 2.78$, $p = .010$ and the $\beta = .489$.

Children with ADHD were rated as significantly more likely than children without ADHD to forget parts of a joke. Of the three predictor variables for the whole sample, only group made a statistically significant contribution. For group, the sr^2 was .160, $t(50) = -3.07$, $p = .004$ and the $\beta = -.435$. A similar pattern was found for the smaller sample. Of the two predictors, only group made a statistically significant contribution. For group, the sr^2 was .179, $t(27) = -2.41$, $p = .024$ and the $\beta = -.435$.

Children with ADHD were rated as significantly more likely than children without ADHD to tell jokes in the wrong order. Of the three predictor variables for the whole sample, only group made a statistically significant contribution. For group, the sr^2 was .197, $t(50) = -3.48$, $p = .001$ and the $\beta = -.481$. A similar pattern was found for the smaller sample. Of the two

predictors, only group made a statistically significant contribution. For group, the sr^2 was .219, $t(27) = -2.82$, $p = .009$ and the $\beta = -.482$.

Memory Retention for School-related Abilities. Parents rated children without ADHD as significantly better than children with ADHD at remembering spelling. Of the three variables used to predict spelling memory for the whole sample, only group made a statistically significant contribution. For group, the sr^2 was .281, $t(50) = 4.72$, $p = .001$ and the $\beta = .576$. A similar pattern was found for the smaller sample. Of the two predictors, only group made a statistically significant contribution. For group, the sr^2 was .204, $t(27) = 2.73$, $p = .011$ and the $\beta = .465$.

Children without ADHD were also rated as significantly better than children with ADHD at remembering math. Of the three variables used to predict math memory for the whole sample, only group made a statistically significant contribution. For group, the sr^2 was .154, $t(50) = 2.98$, $p = .005$ and the $\beta = .426$. A similar pattern was found for the smaller sample. Of the two predictors, only group made a statistically significant contribution. For group, the sr^2 was .135, $t(27) = 2.03$, $p = .050$ and the $\beta = .379$.

Children without ADHD were rated as significantly better than children with ADHD at remembering geography, history, and science for the whole sample. Of the three variables used to predict geography memory, only group made a statistically significant contribution. For group, the sr^2 was .152, $t(50) = 2.99$, $p = .004$ and the $\beta = .423$. Of the three variables used to predict

history memory, again only group made a statistically significant contribution. For group, the sr^2 was .122, $t(50) = 2.57$, $p = .013$ and the $\beta = .375$. Of the three variables used to predict science memory, only group made a statistically significant contribution. For group, the sr^2 was .189, $t(50) = 3.32$, $p = .002$ and the $\beta = .468$. Although the pattern of the means was similar for the smaller sample (children without ADHD were rated better), there was no significant difference between groups for these variables.

Memory for Songs, Names, and Faces. Children without ADHD were rated as significantly better than children with ADHD at remembering words to songs, remembering people's names, and matching names with faces. Of the three variables used to predict ratings for remembering words in songs, only group made a statistically significant contribution. For group, the sr^2 was .126, $t(50) = 2.83$, $p = .007$ and the $\beta = .385$. Of the three predictors of ratings for remembering people's names, only group made a statistically significant contribution. For group, the sr^2 was .284, $t(50) = 4.50$, $p = .001$ and the $\beta = .578$. Of the three variables predicting ratings for being able to match faces with names, only group made a statistically significant contribution. For group, the sr^2 was .145, $t(50) = 2.86$, $p = .006$ and the $\beta = .415$.

Although a statistically significant difference between groups in the smaller sample was found with the *t*-test (children without ADHD were rated better), this pattern did not hold for ratings of memory for words in songs and matching names with faces when including group and age as predictors in the

regression model. Of the two variables predicting ratings for memory for people's names in the smaller sample, group made a statistically significant contribution. Children without ADHD were rated better than children with ADHD. The sr^2 was .161, $t(27) = 2.23$, $p = .034$ and the $\beta = .412$.

Memory Compared to the Rest of the Family. Although there was no significant difference found between the groups in the whole sample, a comparison of the means between the children with and without ADHD in the smaller sample revealed parents rated the children with ADHD as having a significantly better memory than children without ADHD for specific details of past experience when compared to the rest of the family (t (27) = 1.99, p = .05). Group had a marginally statistically significant contribution to predicting these ratings when controlling for age. The sr^2 was .114, $t(27) = -1.85$, p = .075 and the $\beta = -.349$.

Gender Differences in Parental Ratings. Females were rated as significantly more likely to become upset when others could not recall the same information from past experiences ($M = 2.68$, $SD = 1.00$) when compared to males ($M = 1.88$, $SD = .94$). Of the three variables predicting this rating, only gender had a statistically significant contribution. For gender, the sr^2 was .155, $t(50) = -3.04$, $p = .004$ and the $\beta = -.407$.

Two other gender effects are worth noting. For the whole sample, a statistically significant difference was found between children with and without ADHD for parent's ratings of how good their child was at telling stories ($t(48)$ =

-2.22, $p = .035$) and including details when telling stories ($t(49) = -2.10$, $p = .045$). However, both of these group effects dropped out due to a marginally significant contribution of gender when group, gender, and age were included in a regression model predicting these variables.

Of the three variables used to predict ratings of the ability to tell stories, group and gender had marginally significant contributions. For group, the sr^2 was .055, $t(50) = 1.75$, $p = .087$ and the $\beta = .252$. For gender, the sr^2 was .063, $t(49) = -1.88$, $p = .067$ and the $\beta = -.261$. Females were rated as much more likely to be better story tellers (mean = 4.33, $SD = .181$) when compared to males (mean = 3.63, $SD = .205$). Age did not explain a significant amount of variance in ratings.

Of the three variables used to predict the parental ratings on how many details the child includes when telling a story, group was no longer significant and only gender had a marginally statistically significant contribution. Females were rated as much more likely to include more details when telling a story ($M = 4.44$, $SD = .217$) when compared to males ($M = 3.59$, $SD = .219$). For gender, the sr^2 was .065, $t(49) = -1.91$, $p = .063$ and the $\beta = -.265$.

To summarize, the results were all in the hypothesized direction. As can be seen from the means in Table 1, independent of gender and age, children with ADHD were rated significantly worse than controls on a number of semantic and school- related memory abilities, and better on episodic (event) memory ability, assessed in the parental questionnaire. For both the

whole sample and the smaller sample, children with ADHD were rated significantly worse on the following: the ability to tell jokes, remember parts of jokes, tell jokes in the correct order, and the ability to remember spelling and math, and remember people's names. Results that were specific to only the whole sample, in which children with ADHD were rated significantly worse, included: the ability to remember geography, science, history, memory for songs, and matching faces with names. The variance explained by the unique contribution of group in the whole sample ranged from about 13% to 28%. Once children with comorbid disorders were removed from the analyses, there was one result that was specific to the smaller sample. Children with ADHD were rated as marginally significantly better than controls at remembering specific details from past experiences when compared to the rest of the family.

Additionally, there were a few gender differences worth noting. Independent of group and age, gender significantly predicted how upset a child was rated to become when others could not remember the same information as they did, with females being rated as becoming more upset. Gender also made a marginally significant contribution to ratings on how good a child was perceived to be at telling stories and how many details a child included when telling a story. Females were rated as being better on story telling and including details. The variance explained by the unique contribution of gender ranged from 6% to 15%.

Working Memory

The working memory scores were analyzed in the same format as the parental questionnaire ratings; that is, *t*-tests were performed and then standard multiple linear regressions controlling for group, gender, and age in the whole sample and group and age in the smaller sample were performed and the contributions of each predictor were assessed. The mean scores for children with and without ADHD on all working memory tasks are presented in Table 3 and the overall regression models are presented in Table 4.

Digit Span-Forward. Children with ADHD performed significantly worse than children without ADHD on Digit Span-Forward. Of the three predictors in the whole sample, group made a statistically significant contribution in predicting the digit span forward scores. For group, the sr^2 was .120, $t(50) = 2.60$, $p = .012$ and the $\beta = .376$. A similar pattern was found for the smaller sample. Of the two predictors, group made a statistically significant contribution in predicting the digit span- forward scores. For group, the sr^2 was .139, $t(27) = 2.11$, $p = .045$ and the $\beta = .383$.

Digit Span-Backward. Children with ADHD performed significantly worse than children without ADHD on Digit Span- Backward. Of the three predictors, once again only group made a statistically significant contribution in predicting the digit span- backward scores in the whole sample. For group, the sr^2 was .157, $t(50) = 3.00$, $p = .004$ and the $\beta = .429$. A similar pattern was found for the smaller sample. Of the two predictors, group made a statistically

significant contribution in predicting the digit span- backward scores. For group, the sr^2 was .233, $t(27) = 2.83$, $p = .009$ and the $\beta = .496$.

Digit Span-Total. As would be expected based on the above findings, children with ADHD performed significantly worse than children without ADHD on Digit Span-Total. As with digit span-forward and- backward, in the whole sample only group made a statistically significant contribution. For group, the sr^2 was .171, $t(50) = 3.19$, $p = .002$ and the $\beta = .449$. A similar pattern was found in the smaller sample. Of the two predictors, group made a statistically significant contribution in predicting the digit span- total scores. For group, the sr^2 was .223, $t(27) = 2.19$, $p = .010$ and the $\beta = .486$.

Simon Game. Children with ADHD performed significantly worse than children without ADHD on the Simon Game. As with all digit span scores, only group had a statistically significant contribution in the whole sample. For group, the sr^2 was .201, $t(50) = 3.51$, $p = .001$ and the $\beta = .487$. A similar pattern was found for the smaller sample. Of the two predictors, group had a statistically significant contribution in predicting the scores on the game Simon. For group, the sr^2 was .214, $t(27) = 2.67$, $p = .013$ and the $\beta = .476$.

To summarize, the results were all in the hypothesized direction. As can be seen in the means in Table 3, independent of gender and age, children with ADHD showed significant impairments for all working memory tasks relative to controls. In the whole sample, group was the only variable that uniquely explained a significant amount of variance when predicting

scores on all working memory tasks and controlling for group, gender, and age. The percentage of variance explained by group ranged from 12% to 20%. The pattern was the same when using the smaller sample. The amount of variance explained by group ranged from approximately 13% to 23%.

Personal Event Narratives

The personal event narratives were analyzed in the same format as the previous analyses. That is, *t*-tests were performed and then standard multiple linear regressions controlling for group, gender, and age in the whole sample and group and age in the smaller sample were performed and the contributions of each predictor were assessed. The dependent variables predicted included: words, sentences, descriptives, time statements, and details (the sum of descriptives and time statements) in the first day of school narrative and the special-event narrative. For a review of how the variables were coded see "Chapter 2: Method" and for the exact wording of the questions asked see Appendix B. Means for children with and without ADHD are presented in Table 5 and the overall regression models are presented in Table 6.

First Day of School Narrative. There were no significant differences between children with and without ADHD in the first day of school narrative reports.

Special-Event Narrative. Children with ADHD provided significantly more words than children without ADHD in the special-event narrative. Of the three variables used to predict number of words spoken in the special-event

narrative, only group made a statistically significant contribution. For group, the sr^2 was .152, $t(50) = -3.08$, $p = .003$ and the $\beta = -.423$. A similar pattern was found for the smaller sample. Of the two predictors, only group had a statistically significant contribution. For group, the sr^2 was .184, $t(29) = -2.49$, $p = .020$ and the $\beta = -.441$.

Children with ADHD provided significantly more sentences than children without ADHD in the special-event narrative. Of the three variables used to predict number of sentences, only group made a statistically significant contribution. For group, the sr^2 was .116 $t(50) = -2.58$, $p = .013$ and the $\beta = -.369$. A similar pattern was found for the smaller sample. Of the two predictors, only group made a marginally statistically significant contribution. For group, the sr^2 was .127, $t(29) = -1.97$, $p = .060$ and the $\beta = -.366$.

Children with ADHD also provided significantly more descriptives than children without ADHD in the special-event narrative. Of the three variables used to predict number of descriptives, only group had a statistically significant contribution. For group, the sr^2 was .072, $t(50) = -1.99$, $p = .053$ and the $\beta = -.291$. A similar pattern was found in the smaller sample. Of the two predictors, group had a marginally statistically significant contribution. For group, the sr^2 was .109, $t(29) = -1.82$, $p = .081$ and the $\beta = -.339$.

Children with ADHD provided marginally more details (sum of descriptives and time statements) than children without ADHD in the special-event narrative. Of the three variables used to predict number of details,

group had a statistically significant contribution. For group, the sr^2 was .073, $t(50) = -2.02$, $p = .049$ and the $\beta = -.294$. There was no significant difference in number of details in the smaller sample.

To summarize, the results were in the hypothesized direction. As can be seen in the means in Table 5, independent of gender and age, children with ADHD provided much longer and more detailed special-event narratives than controls in both the whole sample and the smaller sample. There were no similar differences in the first day of school narrative reports. The variance explained by the unique contribution of group in the whole sample ranged from about 5% to 15%; the variance explained in the smaller sample ranged from about 12% to 18%.

Parent Perceptions and Children's Narrative Performance. In order to explore the relationship between parental ratings- on the parent questionnaire- and the child's performance in the narrative reports, Pearson correlations controlling for group were performed for the whole sample and the smaller sample. Controlling for group ensured that the correlations were not confounded by the fact that children were in separate groups. This method is believed to provide the purest relationship between parental perception and performance without any influence of the group the rated child was in.

The correlations were run on parent ratings for the following questions: how good the child was at telling stories (question #1), including details when telling stories (question #2), including details no one else remembers

(question #3), including small details of past experiences (question #4), all questions that asked parents to compare their child's memory to the rest of the family (questions 10a,b, and c), and how upset a child becomes when others do not recall the same information as they do (question 11). These questions were chosen because they are believed to be the items that most closely reflect perceptions of children's episodic, personal event, memory including the child's perceived abilities compared to other family members. The ratings on these questions were correlated with the performance on the first day of school and special event narratives separately. All the significant (and marginally significant) correlations are presented in Table 7.

In the whole sample, parent ratings of the child's memory for factual information compared to the rest of the family was significantly and positively correlated with the amount of words, sentences, descriptives, and details in the special event narrative. The correlations for these variables ranged from r (45)= .288 to .337, with p-values ranging from .050 to .021. There was a marginally significant and positive correlation with the amount of time statements (r (45)= .266, p = .071). These ratings were also significantly and positively correlated with the amount of words, descriptives, time statements, and details in the first day of school narrative (r (45)= .279 to .363, p = .057 to .012). There was a positive marginally significant correlation with sentences (r (45) = .279, p = .057).

A similar pattern was found in the smaller sample for parent ratings of the child's memory for factual information compared to the rest of the family. The amount of sentences and descriptives (r (24)= .390 to .476, p = .049 to .014) in the special event narrative were significantly and positively correlated to the ratings, while the amount of words and details in the special event narrative were marginally significantly and positively correlated to the ratings (r (24)= .362 to .378, p = .069 to .057). These ratings were also significantly and positively correlated with the amount of sentences, descriptives, and details in the first day of school narrative (r (24)= .432 to .455, p = .027 to .020). There was a positive marginally significant correlation with the amount of words (r (24)= .369, p = .063) and time statements (r (24) = .376, p = .059).

In the whole sample, parent ratings of the child's memory for how much detail a child includes when telling a story was significantly and positively correlated with the amount of words, descriptives, time statements, and details in the special event narrative. The correlations for these variables ranged from r (45)= .349 to .371, with p-values ranging from .016 to .010. These ratings were also positively and marginally significantly correlated with the amount of words, descriptives, time statements, and details in the first day of school narrative (r (45)= .261 to .282, p = .076 to .055).These correlations were not significant in the smaller sample.

There were no significant correlations between parent ratings for the memory of factual information in specific domains compared to the rest of the

family and the special event narrative. However, in the whole sample these ratings were positively and significantly correlated with sentences, descriptives, time statements, and details in the first day of school narrative ($r(45) = .291$ to .326, $p = .047$ to .027). There was a positive marginally significant correlation between parent ratings for the memory of factual information in specific domains compared to the rest of the family with words ($r(45) = .275$, $p = .072$).

There was a similar pattern in the smaller sample. Parent ratings for the memory of factual information in specific domains compared to the rest of the family were correlated with the amount of sentences, descriptives, and details in the first day of school narrative ($r(24) = .469$ to .422, $p = .032$ to .015). There was a positive marginally significant correlation with amount of words ($r(24) = .381$, $p = .055$).

In a pattern only observed in the smaller sample, parent ratings of how upset a child became when others did not recall the same information as they did was significantly and positively correlated with the amount of words, descriptives, time statements, and details in the first day of school narrative, but not the special event narrative. These correlations ranged from $r(24) =$ ..412 to .504, $p = .025$ to .009. There was a positive marginally significant correlation with the amount of sentences ($r(24) = .369$, $p = .063$).

To summarize, and can be seen from the correlations in Table 7, when controlling for group, there were a number of positive and significant (or

marginally significant) correlations between parental ratings and child's narrative performance. For both the whole sample and the smaller sample, the higher the parent's ratings of a child's memory for factual information in general and in specific domains, when compared to the rest of the family, the more likely the child was to use more words, sentences, descriptives, time statements, and/ or details in the special event and first day of school narratives. There was no relationship between parent's ratings of a child's memory for specific details of past experiences compared to the rest of the family, as might be expected. There was, however, a comparable relationship in the whole sample; the higher the parent's ratings on the amount of details a child includes when telling a story the more likely the child was to use more words, descriptives, time statements, and details in the special event narrative and first day of school narratives.

Story Recall

The free recall and recognition tasks based on the ten novel stories were analyzed in the same format as the previous analyses. That is, *t*-tests and then standard multiple linear regressions controlling for group, gender, and age in the whole sample and group and age in the smaller sample were performed followed by an assessment of the contributions of each predictor. There were a number of dependent variables to analyze, including: (1) the total times the child correctly answered a question related to the central details or the peripheral details from the stories, (2) the total times the child

said "yes" or "no" to recognizing a peripheral picture in one of the stories, (3) the total times the child was correct when responding "yes" or "no", (4) acquiescence or rejection accuracy- computed by dividing the total correct responses by 30- and (5) the percentage of time the child said yes or no to recognizing a picture and was correct in that response- computed by dividing the times the child was correct (3 above) by the total times that answer was given (2 above) (i.e., correct acquiescence divided by total acquiescence). Pearson correlations were also performed comparing the relationship between the total number of correct answers to questions related to central details and questions related to peripheral details. For a review of the stories and what constituted a central and peripheral detail or central and peripheral picture see "Chapter 2: Methods." For a review of the stories and questions related to the central and peripheral see details Appendix C. Means for children with and without ADHD are presented in Table 8 for recognition and Table 9 for recall.

Recognition of Peripheral Pictures. There was a floor effect for the recall of peripheral pictures (those pictures presented in the corners of the computer screen that were completely unrelated to the story); the children could not recall any of the peripheral pictures from any of the stories. However, there were a number of significant (and marginally significant) differences between children with and without ADHD on the recognition of the peripheral pictures. In the whole sample, children without ADHD were more likely to say "yes" to

recognizing a picture ($t(50) = -2.01$, $p = .050$) and had a higher accuracy rate for acquiescence ($t(50) = -1.79$, $p = .079$). In contrast, children with ADHD were more likely to say "no" to recognizing a picture ($t(50) = 2.01$, $p = .050$) and had a higher accuracy rate for rejection ($t(50) = 1.77$, $p = .084$). In both the whole sample ($t(50) = 1.99$, $p = .053$) and the smaller sample($t(27) = 1.92$, $p = .065$), children with ADHD were marginally significantly more likely to be correct when acquiescing. That is, children with ADHD had a higher percentage of time in which they were correct when they said "yes."

When predicting recognition of peripheral pictures in regression models controlling for gender and age, all the significant group differences dropped out. In both the whole sample and the smaller sample, there were a few marginally significant overall models, but in these models none of the predictors contributed significantly. When assessing the contributions of each predictor only gender had a marginally significant ($p = .093$) contribution in predicting the acquiescence accuracy (total correct yes responses divided by 30). In this model, females ($M = .46$, $SD = .20$) were slightly more accurate than males ($M = .35$, $SD = .18$).

Relationship between Answers to Central and Peripheral Detail Questions.

There was a positive and significant correlation between the number of correct answers given to questions related to central details and the number of correct answers given to questions related to peripheral details for both the whole sample ($r(52) = .590$, $p = .001$) and the smaller sample ($r(29) = .511$, p

= .005). When comparing this pattern between the two groups, the correlation was higher for the children with ADHD than the controls. In the whole sample, the correlation for both groups was significant: children with ADHD ($r(21)$ = .714, p = .001) and children without ADHD ($r(52)$ = .463, p = .009). In the smaller sample, the correlation for the children with ADHD was significant ($r(12)$ = .642, p = .024), while the correlation for the children without ADHD was only marginally significant ($r(17)$ = .427, p = .087).

To summarize, and as can be seen from Table 8, there were a number of significant group mean differences in the recognition of peripheral pictures; however, when controlling for variables such as gender and age, these differences dropped out. For the story recall, there was a strong, positive and significant relationship between the number of correct answers on central detail questions and peripheral detail questions in both samples (see Table 9 for means). Interestingly, this relationship was stronger for the children with ADHD in both samples, such that the more questions the children with ADHD answered correctly for one type of detail the more likely they were to correctly answer questions for the other type of detail.

CHAPTER IV

DISCUSSION

Primary Analyses

Working Memory. Based on the results from the working memory tasks, past findings of working memory impairments in children with ADHD have been replicated (e.g., Barkley, 1997, 1998a; Kerns, McInerney, & Wilde, 2001; Murphy, Barkley, & Bush, 2001, etc.). These results serve to validate the diagnosed sample in the current study. Although the children were all diagnosed by an appropriate professional (or several professionals in some instances), finding the performance deficits in working memory assures that these children compare cognitively to other diagnosed children in previous ADHD studies. It also rules out the possibility that any new results are a function of a differential diagnosis in the current study's diagnosed sample because these children are comparable to those diagnosed children in previous studies.

The fact that the group difference for the digit span- forward task was less robust is easily explained by the nature of the task. Barkley (1997) noted that children with ADHD have "difficulties with repetition of digit spans (particularly backwards)" (p.78). The nature of the digit span- backwards requires the child to take in increasingly longer sequences of numbers and

manipulate that information to recall the numbers in reverse order; this is referred to as a "manipulation task" (Kerns, McInerney, & Wilde, 2001). These types of tasks are thought to be much harder because they require both reordering and reorganizing to-be-recalled material. The digit span- forward places much less demand on working memory because it is more of a "maintenance task." These types of tasks only require holding the information in mind long enough to repeat exactly what was heard. This reduced demand on working memory allows for better performance. Even with this reduced demand, however, the performance trend on the digit span- forward was similar to the significant performance deficits found in all the other working memory tasks.

In addition to replicating past findings, the results of this study also add to the normative differences in memory performance and validate anecdotal accounts, through finding considerable performance differences between children with and without ADHD.

Parental Ratings. The first area in which normative differences and validation were found was in the parental responses to the 22-item questionnaire. In line with suggestions by Levine (2002) and other anecdotal reports, parents of children with ADHD rated their children much lower on items assessing memory abilities in semantic/school-oriented tasks. These ratings could be directly related to poor school performance in certain domains rather than an overall perceived deficit. When compared to the rest of the family, there were

no differences between the groups for ratings related to factual information in general and for specific domains. This null effect may be explained by the fact that there are other things in the world besides school facts that can be factual (i.e., actions performed the day before or what was eaten for breakfast) that are not school-related. This suggests that parents recognize the specificity of the memory deficits, rather than generalizing the problem in certain areas to all domains.

Three group differences that were consistent across both samples were the deficits in the ability to tell jokes. Parents consistently rated children with ADHD as much worse at telling jokes, being unable to remember parts of a joke, and to tell jokes in the wrong order. This appears to be the first support for the notion that children with ADHD should be worse at telling jokes. This inability may be a result of the working memory deficits and problems with sequencing and temporal order (Barkley, 1997). When first encoding a joke, an individual must be able to hold in mind the plot while attending to and anticipating the punch line. Once the whole joke is heard the individual must be able to store the joke in the proper sequence and then retrieve/recall the joke in the proper sequential order. Deficits in behavioral inhibition allow for interference in this process and predict a temporally disorganized recall in which "the very syntax should be deficient" (Barkley, 1997, p. 77). This is evident in the parent's rating the children with ADHD as often forgetting parts of a joke and often telling jokes in the wrong order, both

possible problems in encoding and retrieval. Obviously, these deficits would make telling a joke problematic and it follows that these children would not be rated as very good at telling jokes. Along these lines, it is also not surprising that children with ADHD were rated as worse at remembering words to songs, people's names, and matching faces with names in the whole sample. Especially when matching faces with names, these tasks all require manipulation in working memory and proper interference control at the time of encoding. Interestingly, these results were not significant with the smaller sample, suggesting that comorbidity may have exacerbated the effect in these domains.

Although there were marked perceived deficits, in the smaller sample parents rated children with ADHD as much better at recalling specific details of past experiences compared to the rest of the family. This trend was maintained even when controlling for age. This result was not found with the whole sample; it is possible the inclusion of females and children with comorbid disorders actually reversed this result. This provides the first empirical support to the anecdotal accounts of parents suggesting children with ADHD have the best memory for specific details of past experiences of anyone in a family. This result combined with the ratings of deficiencies, lends some insight into the struggles that have been anecdotally expressed by parents (Levine, 2002). How can a parent make sense out of this paradoxical

relationship; their child appears to recall specific details from the past, but cannot remember their spelling words?

Children's Narrative Performance. In both the whole sample and smaller sample, children with ADHD consistently outperformed children without ADHD using more words, sentences, descriptives, and/or overall details in the special event narrative. These trends were maintained even when controlling for variables such as gender and age. These results lend some validation to the parental ratings, but also provide the first empirical support that children with ADHD appear to exhibit more elaborate long-term episodic memory performance coupled with deficient working memory.

The finding that children with ADHD used more words and sentences is somewhat consistent with past findings that suggest, in general, children with ADHD talk more to others or themselves as a result of poor behavioral inhibition (Barkley, 1997, 1998b). In fact, one of the criteria for diagnosing hyperactivity is excessive talking (APA, 1994). However, if the use of more words and sentences was just a function of the diagnoses and of poor behavioral inhibition, we would expect to see these differences between children who have been diagnosed with ADHD primarily hyperactivity/ impulsivity and ADHD primarily inattention and also in the first day of school and special event narratives. This was not the case for both comparisons. In fact, the lack of any difference between the groups in the first day of school narrative may actually further strengthen the result of superior long-term

episodic memory abilities of children with ADHD. The first day of school is more of a general script memory; every year there will be a first day of school and the same thing typically occurs on each first day (e.g., students find their classes, learn who their teachers are and what is expected of them for each subject). The lack of any difference suggests that there may be something specific to one-moment-in-time-personal-events that children with ADHD appear to recall better than other children.

Additionally, if the effects for words and sentences were merely a function of the disorder, when talking about the special event, we would not expect to see any contextual differences. This was not the case. Children with ADHD provided more descriptives (subset of sample) and details (whole sample) about the special event they were talking about. Although the results were marginally significant, the trends could not be explained by gender, age, or comorbidity. A null effect that is worth noting is there were no group differences found for the use of time statements. According to Barkley (1997), conversations with children with ADHD "should reflect fewer references to time, the past, and especially the future" (p.78). Although researchers have found deficits in sequencing and temporal organization, this suggests that recall of personal events memory may not be as "temporally disorganized" (Barkley, 1997, p. 77) as other aspects of memory. Rather, this specific, enhanced recall may actually serve to maintain proper temporal sequencing. Personal events may also be more conducive to temporal organization

because recalling what happened first in an event leads to what happened second and may further strengthen the account.

The children's performance on the personal event narratives, combined with the parental ratings, are the first empirical results to support the anecdotal accounts of parents, clinicians, and pediatricians. Additionally, they may help to explain the struggles that parents and educators experience when dealing with children with ADHD, who appear to have the potential to recall specific, minute details of events and yet struggle in school to recall semantically oriented information. This pattern of enhanced episodic memory amid poor semantic memory appears to lay in the deficit with behavioral inhibition that children with ADHD experience. This deficit results in poor interference control, which is associated with dysfunctions of the prefrontal cortex- more specifically the right prefrontal region, which has been found to be smaller in children with ADHD (Barkley, 1997).

When encoding, the inability to block out extraneous, irrelevant, inputs results in the child with ADHD attending to and taking in a different subset of information. Taking in the extraneous information can have one of two effects based on the relationship to the central information to be encoded: (1) if this extraneous information is unrelated to the central information it can reduce the ability to recall the central information, if that information was encoded, or (2) if this extraneous information is related to the central information it may actually serve to help get back to the central information during recall.

The first account, one in which the extraneous and central information is unrelated, is one that is more likely to occur in a classroom. Semantic/school-related information is the central focus in a classroom, any diversion from that focus can only hinder the accurate recall of that information. If a child is unable to inhibit prepotent response to attend to extraneous stimuli, especially during a goal-oriented task such as learning spelling words or historical facts, then the child will not be able to recall that central information because this interference will prevent proper encoding and storage. Not only will the recall of central information be deficient, but the extraneous information will be so far removed from having any relatedness to the central information that recall of extraneous information will have no affect in activating the recall of the central information.

This is not the case when experiencing specific, one moment in time personal events, which may be more consistent with the second account in which the extraneous information is related to the central information. In a personal event, taking in and recalling extraneous information may actually make the overall recall much better. For example, remembering the hotel room number, as little Vance does in the example in Chapter 1, serves as an anchor of sorts for recall of the whole event. This piece of extraneous information may activate the recollection of being in Florida, which may lead to the recall of other, more central, events that occurred on that trip. When recounting the event, these extraneous pieces of information make for a

much better account of the event; however, it is this same pattern of taking in extraneous information that creates difficulties in more goal-oriented school-related tasks.

Story Recall. It appears as if the results of the story recall task may lend some support to this idea of related irrelevant information enhancing the recall of central information. While there were some interesting group differences, all the effects from the recognition task were explained by some contributing effects of either gender or age of the child (limitations of this task will be discussed later). One result that was highly significant, in both the whole and smaller sample, was a strong, positive correlation between the number of correct answers to central questions and correct answers to peripheral questions. That is, the more correct answers a child gave for one type of detail the more correct answers the child was likely to give for the other type of detail. Interestingly, this effect was stronger for children with ADHD. In fact, in the smaller sample (with comorbidity removed), this correlation was only significant for the children with ADHD.

Combine this result with the results of the narrative task and we see a possible glimpse into the effect of extraneous, but related, information. Similar to the idea that the extraneous information may serve to activate information related to the central information in a personal event, it appears that the related peripheral details aided in the recall of central details (and vice versa). Unfortunately, the correlational nature of this result and the fact that all the

peripheral details were somewhat related to the story (e.g., the color of a bike is irrelevant to the story, but is related to a central piece of the story- the bike) does not allow for a causal statement, such as the peripheral details caused better recall of central details. The combination of these results lends some insight in to a way to help children with ADHD improve their performance in the educational system. As suggested by Nuthall and Alton-Lee (1995) and Pillemer (1998), the use of specific one-moment-in-time-episodes in the classroom may allow for the integration of related peripheral information into the semantic-oriented learning tasks that take place in the classroom. This can be done through the use of hands-on experiences, jokes, anecdotes, and mnemonics when teaching different disciplines. Even field trips can be beneficial in creating these episodes. This integration may help children with ADHD as they may be more likely to remember specific details of the event, which may aid in the recall and possibly the understanding of the semantic information. As mentioned earlier, Martin noted (1993) that the recall of specific events from education is quite common. In fact, often the event is the impetus for recalling learning the semantic information. It would not be surprising, based on the results from the parent ratings, narrative performance, and story recall, that children with ADHD would recall more details of the "educational episodes" (Pillemer, 1998, p. 8) and this recall may be correlated with the recall of the more central, semantically-oriented information. In these cases, the inability to inhibit responses to extraneous

information may actually serve to aid in the recall of the central information, which is now semantic knowledge.

Secondary Analyses

Gender Differences in Parent Ratings. There was only one significant gender difference found within this study's analyses. Parents rated females as more likely to become more upset when others do not recall the same information as they do. This difference may lie in a biased perception from parents, in which the same emotional response is perceived differently for different genders, or in the different purposes that memories play for males and females. If males' memories are less detailed and more general then there would be fewer differences in the teller's and listener's recall and fewer chances to not recall the same information. Two other marginally significant results were expected based on previous research (e.g., Buckner & Fivush, 2000). Parents rated females as much better at telling stories and including more details than males. Based on the *t*-test resulst there were initially significant differences between the two groups, but when gender was entered into a regression model with group (and age), the group differences dropped out. These trends in the results add some support to the small body of literature on personal event, autobiographical recall in young children.

Relationship between Parental Ratings and Children's Performance. Parent ratings on only a few questions were correlated to the child's actual narrative performance: how many details the child includes in a story (whole sample),

memory for factual information in general and in specific domains compared to the rest of the family (both samples), and how upset the child becomes when others do not remember the same information as they do (smaller sample). It makes senses that the higher the parents rated their child on including details when telling stories, the lengthier and more detailed the child's narratives were likely to be. Surprisingly there was no relationship between the child's performance and ratings on how good the child was at telling stories, including details no one else remembers when telling stories, and memory for specific details of past experiences compared to the rest of the family. These results, however, may not be that surprising. When telling stories, of interest to the parents may not be how good the story is or whether or not they themselves remember the information, but rather whether or not the stories include many factual/accurate details (i.e., that the child is not exaggerating or embellishing the story). Therefore, including specific details that no one remembers or being a good story teller would not be as important as being accurate. The end result would be parents' rating their child as having a better memory for factual information (general or specific) compared to the family and this being correlated with the child's narrative performance. Unfortunately, accuracy of the stories could not be assessed to tell how these were related to parent ratings. There is no explanation readily available for why the more upset a child was rated to become, the lengthier and more detailed their first day of school narrative was likely to be. If, however, parents

or other adults consistently do not recall the same information as a child, and the child is certain the information is true, the child may learn to be more detailed in their narrative reports in an attempt to convince the listener. This idea is at best purely speculative, but makes sense if this is a pattern that develops over a number of years. This pattern was not found for the special event narrative though, suggesting there may be another explanation that might be related to overall accuracy of the report or general event versus specific event memories.

Limitations and Future Directions

As might be expected in an exploratory study, there are a number of limitations to the current study. In this section, the limitations and possible ways to amend the problems, along with future directions, will be described.

Among the materials of this study, the story recall appeared to have the most flaws. The major flaw was the structure of the stories as a whole. Although novel to each child, the stories were still too much like a school-related task. Each child sat quietly and encoded information narrated and shown from a computer. The children knew they would be asked about the components of the story at a later time and therefore the major focus became the stories, forcing each child to attend to the central elements and block out anything extraneous. The structure of this task then was not much different from what a child would have to do in any other class in school. When reviewing the components of the stories, two issues are notable: stimulus

overload and task difficulty. Each story was made up of six slides with central and peripheral pictures. Three of the slides had only one picture, the central picture, while three of the slides had five pictures, the central picture and four peripheral pictures presented in the four corners of the slide. In total, this meant that each child saw a total of 60 central pictures (ten stories with six each) and 120 peripheral pictures (ten stories with 12 each) while hearing ten stories. This may have resulted in all children having an attentional capacity overload, such that a number of children noted there were too many pictures to look at during the stories. As a result, there was a floor effect for recalling any of the peripheral pictures from all the stories, even though the central pictures were easily identifiable.

This overload makes any group differences initially found in the recognition task even more intriguing, especially the finding that children with ADHD were more likely to be correct when they made the decision to acquiesce to seeing a picture in one of the stories. This result was marginally significant ($p = .053$ in the whole sample, $p = .065$ in the smaller sample), but the effect dropped out when included in a regression model. Had the task of recalling peripheral pictures been more age appropriate, it is probable that there would not have been any influence of age. In fact, an ANOVA comparing the different age groups was significant for the smaller sample ($F = 2.71$, $p = .046$) and the youngest children performed the worst overall. Neither of these differences, however, remains significant in a regression. This

suggests that if the task were more age appropriate for all involved, especially the younger children, then there would be no age difference and the group difference would become more pronounced in a regression model.

Another issue that may have caused this age difference was the overall complexity of the stories. For the younger children, these stories may have been more interesting or more difficult to comprehend. Therefore, they would pay closer attention to the stories to make sure they heard everything. For the older children, these stories were too "childish" and many expressed boredom even halfway through the task. The ease of comprehension could have allowed the older children more time to divert their attention to the peripheral pictures. Either way, a revision of the task to be more appropriate for all age levels and not overload attentional capacity should allow for a more accurate assessment of the long-term memory ability on this story task.

Even with these limitations, it is worth noting that there was no difference between children with and without ADHD on how many correct answers were given for the central or peripheral details. Because we would expect to see performance deficits in a school-related task, this lends further support to the idea that related peripheral information may help children with ADHD in school-related tasks. There are a number of assessments that can be done in the future. In addition to making the stories more appropriate for all ages, possibly by adding some more substance to the stories and reducing the anumber of peripheral pictures, some stories could be created without any

peripheral details and/or peripheral pictures. This would allow for a direct comparison of recall for central details based on the inclusion or exclusion of peripheral details and/or pictures. The order of the questioning may also allow for a comparison of the effect of peripheral details. If a child gets more central questions correct when answering peripheral questions first than when answering peripheral questions second, this might suggest that the peripheral information activates the recall of the central details. If the child performs worse in this model, it might suggest that the peripheral details actually inhibit the recall of the central details, but based on the correlations found in the current study this result seems unlikely.

Although there appear to be no issues with the parental questionnaire and the personal event narrative tasks, there are a few things that can be done in the future to further explore the findings in this study. The parental questionnaire could benefit from adding a few more questions related to the family of the child being rated. Although we know that each family had on average 2-3 children, we do not know if other children in the family were also diagnosed with any disorders/disabilities. We also do not know if the parents had any diagnosed problems as well. Both of these pieces of information would be of interest to understanding whom these children were being compared to in the ratings. Although all of the ratings related to personal event memory were correlated (i.e., ratings for being good at telling stories were correlated with how many specific details a child is likely to include) and

ratings related to school-related abilities were correlated (i.e., ratings for memory for spelling were correlated with memory for math), the questionnaire could benefit from some reverse coded questions to ensure answer accuracy and honesty. Additionally, based on parent responses, it would be interesting to see if in fact children with ADHD are worse at telling jokes.

An addition to the personal event narrative task would be to ask questions related to certain emotions (e.g., positive vs. negative experiences) and see how children with ADHD differ on their recall of these stories and how they differ from children without ADHD in the recall. Choosing stories that were experienced by the whole family would allow for an assessment of how accurate the story recall is, although if the parents are recalling fewer details than the child it would be possible that the parents would be more likely to say the child's recall might be inaccurate due to the discrepancy. Still, the recall of different emotive memories would allow for the exploration of how children with ADHD recall all types of personal events and if the amount of information recalled increases with an increase in the emotions involved in the experience.

The biggest limitation of this study, however, is the small sample size, which was further reduced by issues of comorbidity. The small sample size clearly presents an issue with having the statistical power to find a significant result. It is not surprising that almost all of the group differences were slightly reduced when removing the children with comorbid disorders, as these

results were based on the comparison of 12 children with ADHD and 17 without, all of whom were males. There were also issues with unequal variances between the two groups. These differences were probably a result of the small sample size. This unequal variance is not a major concern, however, because the results were not markedly altered when considering the violation. Additionally, each group comparison was based on an unequal n, which should make it even more unlikely to find significant findings without heterogeneity of variance. Additionally, there were no specific patterns of variability: in some analyses the children with ADHD were more variable, in some analyses the children without ADHD were more variable, and in others there were no differences at all. Lastly, issues with variance might be expected because these two groups were not randomly chosen. Although the children within each group were chosen at random, the groups themselves, children with or without ADHD, were chosen specifically for this study. Therefore, the variance patterns observed might be accurate representation for each group making the violation of heterogeneity unsurprising.

Final Remarks

The results of this study are still very compelling in light of the issues with variance and small sample size, or even more compelling because of them. Although a replication of the main findings for parental ratings and children's performance on the personal event narratives is vital, this exploratory study is the first to empirically validate the anecdotal accounts of

parents, teachers, clinicians, and other professionals who work closely with children with ADHD. It does appear that children with ADHD have more elaborate episodic memory for personal events and poor working memory, while being thought of as having the best memory for specific past experiences compared to the rest of the family. In many cases even the lack of any significant difference, as in the recall of the central and peripheral details of the stories or in the parental ratings of story telling, provide insight into the memory pattern of children with ADHD.

Combining the results of the parental ratings, story recall, and children's personal event narrative performance, points to a different cognitive style in the memory abilities of children with ADHD. Understanding this stylistic difference is important and valuable for parents, teachers, clinicians, and even children, who can all begin to understand why these children appear to struggle so much in the classroom but can recall the smallest details of personal, real-life, events. Overall, these results provide some insight into better understanding children with ADHD; we may be able to use this strength in episodic memory to help these children meet their potential and succeed in other domains, such as the educational system, where failure and frustration for all involved has too often been the norm.

REFERENCES

American Academy of Pediatrics (2000). Clinical practice guideline: Diagnosis and evaluation of the child with attention- deficit/ hyperactivity disorder. *Pediatrics, 105,* 1158- 1170.

American Psychiatric Association (1968). *Diagnostic and statistical manual of mental disorders* (2nd ed.) Washington, DC: Author.

American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Ashcraft, M.H. (2002). *Cognition, 3rd edition.* Upper Saddle River, NJ: Prentice Hall.

August, G.J. (1987). Production deficiencies in free recall: A comparison of hyperactive, learning- disabled, and normal children. *Journal of Abnormal Child Psychology, 15,* 429- 440.

Baddeley, A. (2001). Is working memory still working? *American Psychologist, 56,* 851- 864.

Barkley, R.A. (1989). Hyperactive Girls and Boys: stimulant drug effects on mother- child interactions. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 30,* 379-390.

Barkley, R.A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin, 121,* 65- 94.

Barkley, R.A. (1998a). *Attention-Deficit Hyperactivity Disorder: A handbook for diagnosis and treatment.* New York: Guilford Press

Barkley, R.A. (1998b). Attention-deficit hyperactivity disorder. *Scientific American, September, 1998.* http://www.sciam.com/1998/0998issue/0998barkley.html

Barkley, R.A. (1999) Theories of Attention- Deficit/ Hyperactivity Disorder. In H.C. Quay & A.E. Hogan (eds.) *Handbook of disruptive behavior disorders.* pp. 295- 313. New York: Kluwer Academic.

Bronowski, J. (1967). Human and animal languages. In *To honor Roman Jakobson* (Vol. 1). The Hague, Netherlands: Mouton.

Bronowski, J. (1976). *The ascent of man.* Cambridge, MA: MIT Press.

Bronowski, J, (1977). Human and animal languages. In J. Bronowski (Ed.), *A sense of the future* (pp, 104-131). Cambridge, MA: MIT Press.

Burke, A., Heuer, F., & Reisberg, D. (1992). Remembering Emotional Events. *Memory and Cognition, 20,* 277- 290.

Buckner, J.P. & Fivush, R. (2000). Gendered themes in family reminiscing. *Memory,* 8, 401- 412.

Carey, W.B. (1998). Temperament and behavior problems in the classroom. *School Psychology Review, 27,* 522-533.

Christianson, S.A., & Loftus, E. (1991). Remembering emotional events: The fate of detailed information. *Cognition & Emotion,* 5, 81- 108.

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.

Goldman- Rakic, P.S. (1995). Anatomical and functional circuits in prefrontal cortex of nonhuman primates: relevance 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, NY: Raven Press.

Haines (2002). *Fundamental Neuroscience, 2nd edition.* St. Louis, MO: Isevier Science.

Han, J.J., Leichtman, M. D., & Wang, Q. (1998). Autobiographical memory in Korean, Chinese, and American Children. *Developmental Psychology, 34,* 701- 713.

Harp, S. F., & Mayer, R.E. (1998). How seductive details do their damage: A theory of cognitive interest in science learning. *Journal of Educational Psychology, 90,* 414- 434.

Herlitz, A., Nilsson, L.G., & Backman, L. (1997). Gender differences in episodic memory. *Memory and Cognition, 25,* 801- 811.

Jonides, J., Lacey, S.C., & Nee, D.E. (2005) Processes of working memory in

Mind and Brain. *Current Directions in Psychological Science, 14,* 2-5.

Kaplan, B.J., Dewey, D., Crawford, S.G., & Fisher, G.C., (1998). Deficits in Long-term Memory are not characteristic of ADHD. *Journal of Clinical and Experimental Psychology, 20,* 518-528.

Kerns, K.A., McInerney, R.J., & Wilde, N.J. (2001). Time reproduction, working memory, and behavioral inhibition in children with ADHD. *Child Neuropsychology, 7,* 21- 31.

Kirby, E.A. & Kirby, S.H. (1994). Classroom discipline with attention deficit hyperactivity disorder children. *Contemporary Education, 65,* 142-144.

Klingber, T., Forssberg, H., & Westerberg, H. (2002). Training of working memory in children with ADHD. *Journal of Clinical and Experimental Neuropsychology, 24,* 781- 791.

Klorman, R., Hazel- Fernandez, L.A., Shaywitz, S.E., Fletcher, J.M., Marchione, K.E., Holahan, J.M., Stuebing, K.K., & Shaywitz, B.A. (1999). Executive functioning deficits in attention- deficits/ hyperactivity disorder are independent of oppositional defiant or reading disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 38,* 1148- 1155.

Leichtman, M.D., Pillemer, D. B., Wang, Q., Koreishi, A., & Han, J.J. (2000). When Baby Maisy came to school. Mothers' interview styles and preschoolers' event memories. *Cognitive Development, 15,* 99- 114.

Leichtman, M.D., Wang, Q., & Pillemer, D.B. (2003). Cultural variations in interdependence and autobiographical memory: Lessons from Korea, China, India, and the United States. To appear in R. Fivush & C. Haden (eds.) *Connecting culture and memory: The social construction of the autobiographical self.* Mahwah, NJ: Lawrence Erlbaum Associates.

Levine, M. (2002). *A mind at a time: America's top learning expert shows how every child can succeed.* New York, NY: Simon and Schuster.

Lorch, E.P., Sanchex, R.P., van den Broek, P., Milich, R., Murphy, E.L., Lorch, R.F. Jr., & Welsh, R. (1999). The relation of story structure properties to recall of television stories in young children with Attention-Deficit Hyperactivity Disorder and nonreferred peers. *Journal of Abnormal Child Psychology, 27,* 292-309,

Martin, J. (1993). Episodic memory: A neglected phenomenon in the psychology of education. *Educational Psychologist, 28,* 169- 183.

Martin, R.P. (1994). Child temperament and common problems in schooling: Hypotheses about casual connections. *Journal of School Psychology, 32,* 119-134.

Marzocchi, G.M., Lucangeli, D., De Meo,T., Fini, F., & Cornoldi, C. (2002). The disturbing effect of irrelevant information on arithmetic problem solving in inattentive children. *Developmental Neuropsychology, 21,* 73- 92.

McKoon, G., Ratcliff, R., & Del, G.S. (1985). The role of semantic information in episodic retrieval. *Journal of Experimental Psychology, 11,* 742-751.

McKoon, G., Ratcliff, R., & Del, G.S. (1986). A critical evaluation of the semantic- episodic distinction. *Journal of Experimental Psychology, 12,* 295- 306.

Mealer, C., Morgan, S., Luscomb, R. (1996). Cognitive functioning of ADHD boys on the WISC-III and WRAML: An analysis within a memory model. *Journal of Attention Disorders, 1,* 133-145.

Miller, G.A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63,* 81- 97.

Murphy, K.R., Barkley, R.A., & Bush, T. (2001). Executive functioning and olfactory identification in young adults with attention deficit-hyperactivity disorder. *Neuropsychology, 15,* 211- 220.

Myers, J.L., O'Brien, E.J., Balota, D.A., & Toyofuku, M.L. (1984). Memory search without interference: The role of integration. *Cognitive Psychology, 16,* 217- 242.

National Institute of Mental Health (1996). Attention Deficit Hyperactivity Disorder.

Neely, J.H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited- capacity attention. *Journal of Experimental Psychology: General, 106,* 226- 254.

Nelson, K. (1993). The psychological and social origins of autobiographical

memory. *Psychological Science, 4,* 7- 14.

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,* 468- 480.

Nuthall, G. & Alton- Lee, A. (1995). Assessing classroom learning: How students use their knowledge and experience to answer classroom achievement test questions in science and social studies. *American Educational Research Journal, 32,* 185- 223.

Nyberg, L., Marklund, P., Persson, J., Cabeza, R., Forkstam, C., Petersson, K.M., & Ingvar, M. (2003). Common prefrontal activations during working memory, episodic memory, and semantic memory. *Neuropsychologia, 41,* 371- 377.

O'Neill, M.E., & Douglas, V.I. (1996). Rehearsal strategies and recall performance in boys with and without attention deficit hyperactivity disorder. *Journal of Pediatric Psychology, 21,* 73- 88.

Paule, M.G., Rowland, A.S., Ferguson, S.A., Chelonis, J.J., Tannock, R. Swanson, J.M., & Catellanos, F.X. (2000). Symposium overview- Attention deficit/ hyperactivity disorder: Characteristics, interventions, and models. *Neurotoxicology and Teratology, 22,* 631- 651.

Pillemer, D.B. (1998). *Momentous events, vivid memories: How unforgettable moments help us understand the meaning of our lives.* Cambridge, MA: Harvard University Press.

Ranganath, C., Johnson, M.K., & D'Esposito, M. (2003). Prefrontal activity associated with working memory and episodic long-term memory. *Neuropsychologia, 41,* 378- 389.

Rayner, K., & Pollatsek, A. (1989). *The psychology of reading.* Hillsdale, NJ: Erlbaum.

Rizzella, M.L. & O'Brien, E.J. (2002). Retrieval of concepts in script- based texts and narratives: The influence of general world knowledge. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28,* 780- 790.

Sergeant, J.A., Oosterlaan, J., & Van der Meere, J. (1999). Information processing and energetic factors in Attention- Deficit/ Hyperactivity Disorder. In H.C. Quay & A.E. Hogan (eds.). *Handbook of Disruptive*

Behavior Disorders. pp. 75- 104. Kluwer Academic: New York.

Scahill, L. & Schwab- Stone, M. (2000). Epidemiology of ADHD in school-age children. *Child and Adolescent Psychiatric Clinics of North America, 9,* 541-555.

Schraw, G. (1998). Processing and recall differences among seductive details. *Journal of Educational Psychology, 90,* 3- 12.

Sehulster, J. R. (1981). Structure and pragmatics of a self- theory of memory. *Memory and Cognition, 9,* 263- 276.

Sehulster, J. R. (1995). Memory styles an related abilities in presentation of self. *American Journal of Psychology, 108,* 67-88.

Shakil, A. (2001). Finding guidance amid uncertainty of ADHD diagnosis. *American Family Physician, 63,* 1695-1695.

Squire, L.R. (1993). The organization of declarative and nondeclarative memory. In T. Ono, L.R. Squire, M.E. Raichle, D.I. Perrett, M. Fukuda (Eds.) *Brain mechanisms of perception and memory: From neuron to behavior* (pp. 219- 227). New York, NY: Oxford press University.

Tannen, D. (1990). *You just don't understand.* New York: Ballantine Books.

Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp.382-403). New York, NY: Academic Press.

Tulving, E. (1993). What is Episodic Memory? *Current Directions in Psychological Science, 2,* 67-70.

Tulving, E., & Markowitsch, H.J. (1998). Episodic and Declarative memory: Role of the Hippocampus. *Hippocampus, 8,* 198- 204.

Vassileva, J.L., Vongher, J. M., Fisher, M., Conant, L, Risinger, R.C., Salmeron, B.J., Stein, E.A., Barkley, R.A., & Rao, S.M. (2001). Working memory deificits in adults with ADHD. *Brain Cognition, 47,* 216- 219.

Voelker, S.L., Carter, R.A., Sprague, D.J., Gdowski, C.L., & Lachar, D. (1989). Developmental trends in memory and metamemory in children with attention deficit disorder. *Journal of Pediatric Psychology, 14,* 75-88.

Webster, R.E., Hall, C.W., Brown, M.B., & Bolen, L.M. (1996). Memory modality differences in children with Attention Deficit Hyperactive Disorder with and without learning disabilities. *Psychology in Schools, 33,* 193-201.

Wechsler, D. (1991). *Wechsler Intelligence Scale for Children- Third Edition.* The Psychological Corporation. San Antonio: Harcourt Brace Jovanovich, Inc.

Wessel, I., van der Kooy, P., & Merckelbach, H. (2000). Differential recall of central and peripheral details of emotional slides is not a stable phenomenon. *Memory, 8,* 95- 109.

White, J.D. (1999). Personality, temperament, and ADHD: A review of the literature. *Personality and Individual Differences, 27,* 589-598.

Appendix A
Parental Questionnaire

Parent's Name: _____ Child's Name:_____

Child's Age:_____ Child's Gender: Female Male

Grade in school _____ Child's Teacher: _____

How many siblings are in the family, including this child?

_____

What are their ages? _____

If your child is selected for participation, are there any classes that you would prefer that your child not be removed from? If yes, please list below:

_____

_____

Your child's memory (*please circle your answer*)

1) How good is your child at telling stories about things that he or she has experienced (for example, talking about something that happened during the day or on a family trip) to you or other people?

1	2	3	4	5
Poor		Okay		Excellent

2) When your child tells a story about something he or she has experienced, how much detail is he or she likely to include?

1	2	3	4	5
Little detail		Some detail		A great deal of detail

3) When your child talks about things that he or she has experienced, does he or she often include accurate details that no one else seems to remember?

1	2	3	4	5
Never		Sometimes		Always

4) How good is your child at remembering the small details of past conversations?

1 2 3 4 5
Poor Okay Excellent

5) Is your child good at telling jokes?

1 2 3 4 5
No, not at all Yes, somewhat Yes, very good

6) When telling a joke, how often does your child appear to forget parts of the joke?

1 2 3 4 5
Never Sometimes Always

7) When telling a joke, how often does your child tell the joke in the wrong order?

1 2 3 4 5
Never Sometimes Always

8) How easily does your child **retain in memory** factual information in the following domains? (i.e., does your child tend to remember effortlessly after one exposure or with difficulty, requiring a great deal of exposure in order to retain the material over time?)

8a) *Spelling*

1 2 3 4 5
Not at all easily Somewhat easily Very easily

8b) *Geography*

1 2 3 4 5
Not at all easily Somewhat easily Very easily

8c) *Math*

1 2 3 4 5
Not at all easily Somewhat easily Very easily

8d) *History*

1 2 3 4 5
Not at all easily Somewhat easily Very easily

8e) *Science*

1 2 3 4 5
Not at all easily Somewhat easily Very easily

9) Is there a domain in which your child's memory is outstanding? If so, please describe below.

_____
_____
_____
_____
_____
_____

10) Compared to the rest of your family, how is your child's memory for:

10a) *The specific details of past experiences, such as family events?*

1 2 3 4 5
Much Worse Same Much better

10b) *Factual information in general?*

1 2 3 4 5
Much Worse Same Much better

10c) *Factual information in specific domains of interest (e.g., facts about dinosaurs or baseball)?*

1 2 3 4 5
Much Worse Same Much better

11) Does you child sometimes get frustrated or upset when other people cannot recall the same details as he or she can?

1 2 3 4 5
Never Sometimes Always

12) Does your child have a good memory for words in songs?

1 2 3 4 5
No, not at all Yes, somewhat Yes, very good

13) Is your child good at remembering people's names?

1 2 3 4 5
No, not at all Yes, somewhat Yes, very good

14) Is your child good at matching faces with names?

1 2 3 4 5
No, not at all Yes, somewhat Yes, very good

15) What else can you tell us about your child's memory?

_____
_____
_____
_____
_____
_____
_____

More about your child

16) Do you believe your child has difficulties in school? Yes No

16a) If yes, in what subject areas? _____

17) Has your child ever received Title I reading tutoring in school? Yes No

18) Has your child ever had a Section 504 accommodation plan in school?
Yes No

19) Has your child ever had an IEP under Special Education? Yes No

20) Has your child been diagnosed with Attention- Deficit / Hyperactivity Disorder? Yes No

20a) ***If yes***, with or without the hyperactivity? With Without

20b) ***If yes***, is your child taking medication? Yes No

20c) ***If yes***, is your child receiving any other treatment for ADHD?
Yes No

20d) Please state what kind of treatment(s) _____

21) Has your child been diagnosed with a Learning Disability? Yes No

21a) ***If yes,*** please state what kind: _____

22) Has you child been diagnosed with any other disability? Yes No

22a) ***If yes,*** please state what kind: _____

Thank you for your time and help!

Appendix B
Personal Event Memory Task

Open ended questions:

I have never met you before and would like to find out all about you. I'd like to ask you about you memories of things you've done:

1. Do you remember your first day of school this year? Tell me everything you remember from your first day of school this year?
2. Now I am going to ask you to think back, can you tell me something special that happened to you recently? Image yourself there and tell me everything that happened.

Standard prompts which will be used to elicit more information and child talk (from Han, Leichtman, & Wang, 1998): What else happened? Anything else? Think real hard and tell me everything you can remember.

Appendix C
Stories for Story Recall Task & Questions for Story Recall Task

Stories used for story recall task with sentence length, picture breakdown, and questions used in the second interview
(Central and peripheral details are denoted by either a C or P. Central and seductive pictures are based on there location in the picture, central details are in the forefront and seductive picture are the four unrelated pictures in the background).

Story 1- Jimmy is a 13- year- old boy (insert picture of a boy). He loves to ride his shining (P) black (P) bike (C) (insert picture of bike with four unrelated objects in background). The other day, Jimmy went out bike riding and met up with three of his friends (C), whom he has known for four years (P). Together they rode to the park (P) (show picture of a park). On the way they began racing their bikes (C). Jimmy was winning (P) until he fell off his bike(C) (insert picture of boy falling off bike). Luckily he was wearing his helmet and did not get hurt (C) (insert picture of helmet and four unrelated objects). Unfortunately, the back wheel fell off his bike (C) (show picture of wheel with four unrelated objects). He had to carry his bike (P) all the way home. When he got home his parents were happy he did not get hurt (C). It costs $10 (P) to replace the wheel on the bike. He road the bike the day it was fixed.
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details
Open ended question- This is Jimmy (show picture). Tell me everything you remember about Jimmy.
Direct questions- What happened when Jimmy was racing on his bike? (Central)
What happened to Jimmy's bike when he fell off? (Central)
What color was Jimmy's bike? (Peripheral)
How much did it cost to fix the bike? (Peripheral)
Questions pertaining to pictures: Show picture of bike, do you know what this is a picture
of? This was in the story about Jimmy. Can you tell me what other pictures were around this one? Show picture of helmet, repeat questions.

Story 2- Sara is a 12- year- old girl (insert picture of girl). She loves to play her flute(C), which was given to her by her mother (P) (insert picture of flute and four unrelated objects). Sara is in the school band(C). In the band she sits next to her best friend (P), Jen, who is smaller than she (P) (show picture of friend). Jen plays the clarinet (P). Before leaving for school one day, she couldn't find her brown flute case(C). As the bus honked (P) outside, she searched all over her house for the case (C) (show picture of bus and four unrelated objects). Finally, Sara found it by the back door (P) of her house (C)

(insert picture of door and four unrelated objects). When she got into band class she open her case and found no flute inside(C). It turns out she had left the flute by the drum section (P)(show picture of drums) in the band room (C) the day before.
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details
Open ended question- This is Sara (show picture). Tell me everything you remember about Sara.
Direct questions- What instruments does Sara play? (Central)
Where did she find her case? (Central)
What instrument does her friend play? (Peripheral)
What color was her case? (Peripheral)
Questions pertaining to pictures: Show picture of flute, do you know what this is a picture
of? This was in the story about Sara. Can you tell me what other pictures were around this one? Show picture of door, repeat questions.

Story 3- Mike is a 52- year- old accountant (show person). Everyday Mike takes the train (C) 25 minutes (P) to work (Show train and four unrelated objects). Before Mike gets on the train he gets breakfast (C) at a local diner (P) (show diner and four unrelated pictures). Today he had bacon, eggs, and coffee (P). He was very tired (C) and fell asleep on the train (C) (show man sleeping and four unrelated pictures). When he awoke he was shocked he had missed his stop(C) (show shocked man). Because he missed his stop he was now 10 minutes (P) late to work(C). He got off the train and took a cab with two other riders (P) to his office (C) (show picture of cab). He had much to do at work and he thought it was going to be a bad day (P). However, later that day his boss told him he was doing a great job at work (P)!
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details
Open ended question- This is Mike (show picture). Tell me everything you remember about Mike.
Direct questions- What is Mike's job? (Central)
What happened on his way to work? (Central)
How many other rider's were in the cab he took to work? (Peripheral)
What did Mike have for breakfast? (Peripheral)
Questions pertaining to pictures: Show picture of train, do you know what this is a picture
of? This was in the story about Mike. Can you tell me what other pictures were around
this one? Show picture of man sleeping, repeat questions.

Story 4- Carrie is a 48- year- old teacher (show person). She has been teaching 4th grade (C) for 20 years (P). Her classroom is really big and full of colors (P) (show classroom). Today, Carrie is wearing her favorite blue (P) shirt (C). Every day the students get into groups (P) in different corners of the class (C) (show a group of children with unrelated pictures). Some go by the reading area, some by the computer area and still other go in the middle of the room (P). While they were talking Carrie couldn't find the chalk (P) to write with (show chalk and unrelated pictures). When John (C), a male student, (show John) returned from lunch he was full of dirt (C) from playing soccer (C) (show soccer ball and unrelated pictures). When Carrie went to help clean him up she got dirt all over her shirt (C). John felt really bad (C) but it was ok because the dirt came off the shirt easily.
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details
Open ended question- This is Carrie (show picture). Tell me everything you remember about Carrie.
Direct questions- What did Carrie get on her shirt? (Central)
What grade does Carrie teach? (Central)
What sport was John playing at lunch? (Peripheral)
What could Carrie not find during class? (Peripheral)
Questions pertaining to pictures: Show picture of chalk, do you know what this is a picture of? This was in the story about Carrie. Can you tell me what other pictures were around this one? Show picture of soccer ball, repeat questions.

Story 5- Charles is a 1- year- old boy (show person). He is big for his age and many people think he is actually 3 years old (P). His favorite stuffed animals are his black and brown (P) stuffed bear and his Scooby-Doo (P) (show stuffed animal and unrelated pictures). Over the summer he went to the beach (C) for the first time (C) (show beach). Charles crawled around (C) in the hot (P) sand for hours. When it got too hot his parent took him under the rainbow colored (P) beach umbrella (C) so he would not get sun burned (show umbrella and unrelated pictures). Charles father took him into the ocean (C) but they didn't stay long because it cold (C) (show ocean). Charles mother forgot to put on sun block (P). They brought a sand bucket and shovel but no one used it (P) (show bucket and unrelated pictures). The family was at the beach for only an hour because they thought it was going to rain (C) but it never rained.
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details

Open ended question- This is Charles (show picture). Tell me everything you remember about Charles.
Direct questions- Where did Charles go for the first time? (Central)
Why did the family leave the beach? (Central)
What did Charles mother forgot? (Peripheral)
How long did the family stay at the beach? (Peripheral)
Questions pertaining to pictures: Show picture of stuffed animal, do you know what this is a picture of? This was in the story about Charles. Can you tell me what other pictures were around this one? Show picture of umbrella, repeat questions.

Story 6- Melissa is a girl who just turned 1- year- old (show person). She is just starting to stand on her own and speak some words (P). Yesterday, her mom and dad took her to the zoo (C) for the first time (C) (show picture of front of zoo). Her favorite animals were the black (P) monkeys (C) and polar bears (C) (show monkey with unrelated pictures). It was a really nice day and the sky was very clear (P). When Melissa heard the lion roar she cried (C) really loud (P) (show lion). She cried all over her favorite blanky (P) she brought with her to the zoo (show blanket with unrelated pictures). She stopped crying when her mother held her (C) and gave Melissa her pacifier (C) (show pacifier with unrelated pictures). When it was time to leave Melissa's mom bought her a new stuffed animal that looked like a polar bear (P). Melissa slept (P) in the car the whole way home.
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details
Open ended question- This is Melissa (show picture). Tell me everything you remember about Melissa.
Direct questions- Where did Melissa go? (Central)
What made Melissa stop crying? (Central)
What did the stuffed animal she bought look like? (Peripheral)
What did Melissa do on the way home? (Peripheral)
Questions pertaining to pictures: Show picture of monkey, do you know what this is a picture of? This was in the story about Melissa. Can you tell me what other pictures were around this one? Show picture of blanky, repeat questions.

Story 7- Bobby is a 9- year- old boy (show boy). This summer he will be going to sleep away
camp (C) for the first time (C). The camp is near a big lake (P) far from his home (P). He is very excited to go and is leaving in three days (P). His mother is helping him pack his big (P) green (P) duffle bag (C) (show bag and our unrelated pictures). Bobby was going to be taking a long bus ride to camp (C) (show bus and four unrelated pictures). While his mother was

driving him to the bus stop he realized he forgot his favorite gray (P) sweatshirt (C) (show gray sweatshirt). His mother remembered that it was in the dryer (C) (show dryer and four unrelated pictures). The dryer was very old (P) and it took a long time to dry (C). His mother went back home (show picture of a house) to get the sweatshirt and they made it to the bus just in time.
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details
Open ended question- This is Bobby (show picture). Tell me everything you remember about Bobby.
Direct questions- Where was Bobby going? (Central)
What did he forget to pack? (Central)
What color was his bag? (Peripheral)
Where was the camp? (Peripheral)
Questions pertaining to pictures: Show picture of bag, do you know what this is a picture of? This was in the story about Bobby. Can you tell me what other pictures were around this one? Show picture of bus, repeat questions.

Story 8- Jennifer is a 7- year- old girl (show girl). In three days (P) it will be her eighth birthday (C). Her dad took her to the mall to buy her a birthday present (C) (show picture of birthday present and four unrelated). While driving to the mall, she was very excited in their blue (P) car (show car and four unrelated pictures) thinking of what she would choose. When they got to the mall they parked near the main entrance (P) (show mall entrance). Together they went from store to store but Jennifer could not find anything she liked (C). Then they walked past the pet store (C) (show pet store). Jennifer ran inside to see the puppies (C). She begged her father to buy her a 6- month old (P), little (P) white (P) poodle (C) (show poodle and four unrelated pictures). Because it was her birthday her father said yes (C) and they took the poodle home (P).
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details
Open ended question- This is Jennifer (show picture). Tell me everything you remember about Jennifer.
Direct questions- Why was Jennifer going to the mall? (Central)
What kind of dog did she get? (Central)
What color was their car? (Peripheral)
How old was the dog? (Peripheral)
Questions pertaining to pictures: Show picture of car, do you know what this is a picture of? This was in the story about Jennifer. Can you tell me what other pictures were around this one? Show picture of puppy, repeat questions.

Story 9- Maggie is a 65- year- old woman (show person). Every Sunday after breakfast together, Maggie takes her 5- year- old granddaughter, Alison (C), to the pond (C) (show pond). Today they had French toast and juice for breakfast (P). Maggie always brings a loaf of bread (C) with her to feed the ducks (C) (show bread and four unrelated objects). When they go to the pond they always sit at the same red (P) wooden bench (C) (show bench). The bench is underneath an old (P) oak tree (C) (show oak tree and four unrelated pictures). There is a squirrel gathering nuts in the tree (P). Maggie and her granddaughter being throwing food to the ducks (show duck and four unrelated objects), some even take the bread right of their hands (P). Every week the same duck (C) with a white stripe (P) comes up to them. Alison has named this duck Howard (C).
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details
Open ended question- This is Maggie (show picture). Tell me everything you remember about Maggie.
Direct questions- Where did Maggie go every Sunday? (Central)
What did she bring with her? (Central)
What was the name of the duck that came up to them? (Peripheral)
What did they have for breakfast? (Peripheral)
Questions pertaining to pictures: Show picture of bread, do you know what this is a picture of? This was in the story about Maggie. Can you tell me what other pictures were around this one? Show picture of oak tree, repeat questions.

Story 10- Andy is a 60- year- old man (show person). Every Friday he meets four of his closest friends (C) at the local coffee shop (C) (show coffee shop). He usually orders a bagel (P) and coffee (show bagel with four unrelated pictures) with cream and sugar (P). He does not like cream cheese (P) so he has butter on his bagel (P). He usually arrives before all of his friends (C). While he waits he read the morning newspaper (C) (show newspaper). He usually reads the sports section first then current events (P). His favorite sport is baseball (P) (show baseball and four unrelated objects). The four men always sit in the same table (C) (show table and four unrelated objects) with yellow seats (P) near the front window (C). When his friends arrive he catches them up on the current news (C).
10 sentences, 6 pictures to be included (3 with unrelated pictures in background and three without), 7 central and 7 peripheral verbal/ auditory details
Open ended question- This is Andy (show picture). Tell me everything you remember about Andy.

Direct questions- Where did Andy go every Friday? (Central)
What did he read while waiting for friends? (Central)
What color were the seats at their table? (Peripheral)
What is Andy's favorite sport? (Peripheral)
Questions pertaining to pictures: Show picture of bagel, do you know what this is a picture of? This was in the story about Andy. Can you tell me what other pictures were around this one? Show picture of table, repeat questions.

Appendix D

Institutional Review Board Approval Page

UNIVERSITY of NEW HAMPSHIRE

April 16, 2004

Skowronek, Jeffrey S
Psychology, Conant Hall
429 Tri-City Road
Somersworth, NH 03878

IRB #: 3086
Study: Long-Term Episodic Memory in Children with Attention-Deficity/ Hyperactivity Disorder
Approval Date: 04/16/2004

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) has reviewed and approved the protocol for your study.

Approval is granted to conduct your study as described in your protocol for one year from the approval date above. At the end of the approval period you will be asked to submit a report with regard to the involvement of human subjects in this study. If your study is still active, you may request an extension of IRB approval.

Researchers who conduct studies involving human subjects have responsibilities as outlined in the attached document, *Responsibilities of Directors of Research Studies Involving Human Subjects.* (This document is also available at http://www.unh.edu/osr/compliance/IRB.html.) Please read this document carefully before commencing your work involving human subjects.

If you have questions or concerns about your study or this approval, please feel free to contact me at 603-862-2003 or Julie.simpson@unh.edu. Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,

Julie F. Simpson
Manager

cc: File
Michelle Leichtman

Research Conduct and Compliance Services, Office of Sponsored Research, Service Building, 51 College Road, Durham, NH 03824-3585 * Fax: 603-862-3564

Table 1

Means and standard deviations (SD) for Parental Questionnaire responses in the whole sample and then smaller sample

For the whole sample

Variable (Question #)	ADHD (n =21)		Non-ADHD (n = 31)	
	Mean	*SD*	*Mean*	*SD*
Good at telling stories (#1)	3.42	1.30	4.16	.82
Include detail in story (#2)	3.45	1.50	4.23	.84
Details no one else remembers (#3)	3.50	1.19	3.45	.89
Small details of past conversations (#4)	3.24	1.26	3.65	1.02
Good at telling jokes (#5) ***	2.48	1.21	3.45	.81
Forget parts of joke (#6) **	3.19	1.12	2.42	.67
Joke in wrong order (#7) ***	2.86	1.01	1.97	.79
Spelling memory (#8a) ***	2.33	1.32	4.00	.86
Geography memory (#8b) **	2.95	1.24	3.87	.72
Math memory (#8c) **	3.09	1.26	4.00	.97
History memory (#8d) *	3.15	1.39	3.97	.75

Science memory (#8e) **	3.40	1.19	4.23	.72
Details of past experiences (compared to family) (#10a)	3.29	1.01	3.35	.71
Factual information in general (compared to family) (#10b)	3.00	.92	3.35	.71
Factual information for specific domains (compared to family) (#10c)	4.19	.87	4.03	1.02
Upset when others do not recall same information (#11)	2.35	1.27	2.06	.85
Memory for words in songs (#12) **	3.24	1.34	4.39	.95
Memory for people's names (#13) ***	2.62	1.16	3.94	.81
Matching faces with names (#14) **	2.95	1.39	3.90	.79

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

For the smaller sample

	ADHD (n =12)		Non-ADHD (n =17)	
Variable (Question #)	*Mean*	*SD*	*Mean*	*SD*
Good at telling stories (#1)	3.75	1.36	3.76	.83

Include detail in story (#2)	3.67	1.44	3.88	.86
Details no one else remembers (#3)	3.83	1.11	3.29	.69
Small details of past conversations (#4)	3.58	1.08	3.29	1.05
Good at telling jokes (#5) **	2.58	1.16	3.47	.72
Forget parts of joke (#6) *	3.00	.95	2.23	.66
Joke in wrong order (#7) **	2.75	.87	1.82	.73
Spelling memory (#8a) **	2.58	1.31	3.82	.88
Geography memory (#8b)	3.50	1.17	3.76	.75
Math memory (#8c) *	3.17	1.27	4.12	1.11
History memory (#8d)	3.73	1.35	3.88	.78
Science memory (#8e)	3.82	1.17	4.35	.70
Details of past experiences (compared to family) (#10a) [a]	3.92	.90	3.29	.77
Factual information in general (compared to family) (#10b)	3.36	.92	3.18	.64
Factual information for specific domains (compared to family) (#10c)	4.33	.78	4.00	1.12
Upset when others do	1.56	.69	1.82	.81

not recall same information (#11)				
Memory for words in songs (#12)	3.58	1.38	4.12	1.11
Memory for people's names (#13) *	2.92	1.31	3.76	.83
Matching faces with names (#14)	3.64	1.43	3.76	.90

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 2

Results of the overall regression models for ratings on the parental questionnaire in the whole sample and smaller sample

For the whole sample- controlling for group, gender, and age

Variable	Adj. R^2	*F*	*df*	p
Ability to tell jokes	.162	4.29	3,48	.009
Forget parts of joke	.129	3.51	3,48	.022
Jokes in wrong order	.169	4.46	3,48	.008
Spelling	.355	10.37	3,48	.001
Geography	.135	2.99	3,48	.004
Math	.111	3.13	3,48	.034
History	.079	2.43	3,48	.077
Science	.141	3.74	3,48	.017
Words in songs	.200	5.24	3,48	.003
People's names	.286	7.80	3,48	.001
Faces with names	.115	3.17	3,48	.033
Upset when others do not recall same info.	.159	4.15	3,48	.011
Telling stories	.124	3.30	3,48	.028
Details in story	.113	3.13	3,48	.034

For the smaller sample- controlling for group and age

Variable	Adj. R^2	*F*	*df*	p
Ability to tell jokes	.178	4.03	2,26	.030

Forget parts of joke	.133	3.15	2,26	.060
Jokes in wrong order	.230	5.18	2,26	.013
Spelling	.232	5.23	2,26	.012
Math	.08	2.21	2,26	.130
Specific details of the past compared to rest of family	.064	1.95	2,26	.162
People's names	.098	2.52	2,26	.100

Table 3

Means and standard deviations (SD) for all working memory scores in the whole sample and the smaller sample

For the whole sample

	ADHD (n =21)		Non-ADHD (n = 31)	
Variable	*Mean*	*SD*	*Mean*	*SD*
Digit Span- Forward *	7.86	1.74	9.23	2.40
Digit Span- Backward **	4.14	1.42	5.42	1.88
Digit Span- Total **	12	2.55	14.65	3.86
Simon***	8.05	2.67	10.55	2.88

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

For the smaller sample

	ADHD (n =12)		Non-ADHD (n = 17)	
Variable	*Mean*	*SD*	*Mean*	*SD*
Digit Span- Forward *	7.92	1.78	9.24	2.19
Digit Span- Backward **	3.83	1.03	5.59	2.18
Digit Span- Total **	11.75	1.96	14.82	4.11
Simon *	8.00	2.80	11.05	3.17

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 4

Results of the overall regression models for working memory scores in the whole sample and smaller sample

For the whole sample- controlling for group, gender, and age

Variable	Adj. R^2	*F*	*df*	*p*
Digit Span- Forward	.09	2.67	3,48	.057
Digit Span- Backward	.117	3.24	3,48	.03
Digit Span- Total	.143	3.84	3,48	.015
Simon Game	.164	4.33	3,48	.009

For the smaller sample- controlling for group and age

Variable	Adj. R^2	*F*	*df*	*p*
Digit Span- Forward	.121	2.92	2,26	.071
Digit Span- Backward	.187	4.21	2,26	.026
Digit Span- Total	.198	4.47	2,26	.022
Simon Game	.156	3.58	2,26	.042

Table 5

Means and standard deviations (SD) for components of the personal event narratives for the whole sample and then the smaller sample (SE = Special-event narrative)

For the whole sample

	ADHD (n =21)		Non-ADHD (n = 31)	
Variable	Mean	SD	Mean	SD
# of words in SE **	271.00	270.34	103.06	73.74
# of sentences in SE**	15.05	9.82	9.06	6.29
# of descriptives in SE *	20.86	19.97	12.25	10.34
# of time statements in SE	7.48	8.86	4.06	3.63
# of details (descriptives + time statements) in SE *	28.33	27.59	16.32	12.84

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

For the smaller sample

	ADHD (n =12)		Non-ADHD (n = 17)	
Variable	Mean	SD	Mean	SD
total # of words in SE *	245.42	227.17	89.12	58.71
total # of sentences in SE [a]	13.50	10.04	7.94	3.19

total # of descriptives in SE [a]	19.00	14.55	11.06	6.12
# of time statements in SE	6.42	9.08	3.65	3.32
# of details in SE	25.42	22.55	14.71	8.45

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 6

Results of the overall regression models for the personal event narrative in the whole sample and smaller sample (SE = Special event narrative)

For the whole sample- controlling for group, gender, and age

Variable	Adj. R^2	*F*	*df*	*p*
Words- SE	.180	4.73	3,48	.006
Sentences- SE	.112	3.15	3,48	.033
Descriptives- SE	.076	2.33	3,48	.086
Details- SE	.083	2.54	3,48	.068

For the smaller sample- controlling for group and age

Variable	Adj. R^2	*F*	*df*	*p*
Words- SE	.167	3.81	2,26	.035
Sentences- SE	.085	2.30	2,26	.120
Descriptives- SE	.076	2.14	2,26	.137

Table 7

Correlations between parent perceptions (measured by the parental questionnaire) and components of child narrative for the whole sample and then the smaller sample controlling for group (SE= Special-event narrative, FD= First day of school narrative)

For the whole sample

N= 45	Parent ratings		
Variable	# of details child is likely to include in story (item #2) *r*	Factual information in general, compared to family (item #10b) *r*	Factual information in specific domains, compared to family (item #10c) *r*
Words in SE	.353*	.332*	-
Sentences in SE	.199	.288*	-
Descriptives in SE	.349*	.337*	-
Time Statements in SE	.361*	.266[a]	-
Details in SE	.371**	.332*	-
Words in FD	.282 [a]	.357*	.245[a]
Sentences in FD	.234	.279[a]	.302*
Descriptives in FD	.261[a]	.354*	.326*
Time Statements in FD	.264[a]	.345*	.291*
Details in FD	.271[a]	.363*	.323*

Note- Correlation significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

For the smaller sample

N= 24	Parent ratings		
Variable	Factual information in general, compared to family (item #10b) *r*	Factual information in specific domains, compared to family (item #10c) *r*	Upset when other do not recall same information (item #11) *r*
Words in SE	.378[a]	-	-
Sentences in SE	.476*	-	-
Descriptives in SE	.390*	-	-
Time Statements in SE	.263	-	-
Details in SE	.362[a]	-	-
Words in FD	.369[a]	.381[a]	.504**
Sentences in FD	.432*	.461*	.369[a]
Descriptives in FD	.455*	.469*	.412*
Time Statements in FD	.376[a]	.289	.438*
Details in FD	.450*	.422*	.450*

Note- Correlation significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 8

Means and standard deviations (SD) for performance of the recognition of the peripheral pictures for the whole sample and the smaller sample

For the whole sample (these differences were only significant for the t-test. When controlling for gender and age these difference were no longer significant)

	ADHD (n =21)		Non-ADHD (n = 31)	
Variable	*Mean*	*SD*	*Mean*	*SD*
Total times child acquiesced	13.95	9.57	19.26	9.52
Acquiescence accuracy	.33	.19	.43	.19
Total times child rejected	46.04	9.37	40.74	9.32
Rejection accuracy	.87	.14	.79	.17
% of time child acquiesced and was correct	.79	.15	.69	.16

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

For the smaller sample (This differences was only significant for the t-test. When controlling for age this difference were no longer significant)

	ADHD (n =12)		Non-ADHD (n = 17)	
Variable	*Mean*	*SD*	*Mean*	*SD*

% of time child acquiesced and was correct	.81	.14	.69	.18

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 9

Means and standard deviations (SD) for correct answers the central and peripheral details for whole sample and subset of sample

For the whole sample

	ADHD (n =21)		Non-ADHD (n = 31)	
Variable	Mean	SD	Mean	SD
Central details	12.86	3.47	13.13	2.99
Peripheral details	11.38	3.98	11.97	3.25

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

For the smaller sample

	ADHD (n =21)		Non-ADHD (n = 31)	
Variable	Mean	SD	Mean	SD
Central details	13.75	3.47	13.59	2.99
Peripheral details	11.25	3.98	12	3.25

Note- Mean difference significant at: [a] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$