2012

INFERENCE GENERATION AND STORY COMPREHENSION AMONG CHILDREN WITH ADHD

Jessica S. Kosloski
University of Kentucky, jessica.kosloski@uky.edu

STUDENT AGREEMENT:

I represent that my thesis or dissertation and abstract are my original work. Proper attribution has been given to all outside sources. I understand that I am solely responsible for obtaining any needed copyright permissions. I have obtained and attached hereto needed written permission statements(s) from the owner(s) of each third-party copyrighted matter to be included in my work, allowing electronic distribution (if such use is not permitted by the fair use doctrine).

I hereby grant to The University of Kentucky and its agents the non-exclusive license to archive and make accessible my work in whole or in part in all forms of media, now or hereafter known. I agree that the document mentioned above may be made available immediately for worldwide access unless a preapproved embargo applies.

I retain all other ownership rights to the copyright of my work. I also retain the right to use in future works (such as articles or books) all or part of my work. I understand that I am free to register the copyright to my work.

REVIEW, APPROVAL AND ACCEPTANCE

The document mentioned above has been reviewed and accepted by the student's advisor, on behalf of the advisory committee, and by the Director of Graduate Studies (DGS), on behalf of the program; we verify that this is the final, approved version of the student's dissertation including all changes required by the advisory committee. The undersigned agree to abide by the statements above.

Jessica S. Kosloski, Student

Dr. Elizabeth Lorch, Major Professor

Dr. David Berry, Director of Graduate Studies

INFERENCE GENERATION AND STORY COMPREHENSION AMONG CHILDREN WITH ADHD

THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science
in the department of Experimental Psychology
at the University of Kentucky

By

Jessica S. Kosloski

Lexington, Kentucky

Director: Dr. Elizabeth Lorch, Professor of Psychology

Lexington, Kentucky

2012

ABSTRACT OF THESIS

INFERENCE GENERATION AND STORY COMPREHENSION AMONG CHILDREN WITH ADHD

Academic difficulties are well-documented among children with ADHD. Exploring these difficulties through story comprehension research has revealed deficits among children with ADHD in making causal connections between events, and using causal structure and thematic importance when recalling stories. Important to theories of story comprehension and implied in these deficits is the ability to make inferences. Often, characters' goals are implicit and explanations of events must be inferred. The purpose of the present study was to compare the ability of 7- to 11-year-old children with ADHD and their comparison peers to make inferences during story comprehension. Children watched two televised stories, each paused at five points. In the experimental condition, at each pause children told what they were thinking about the story, whereas in the control condition no responses were made during pauses. After viewing, children recalled the story. Several types of inferences and accuracy of inferences were coded. Children with ADHD generated fewer of the most essential inferences, accurate coherence inferences, than did comparison children, both during story processing and during story recall. The groups did not differ on production of other types of inferences. Generating fewer coherence inferences has important implications for story comprehension deficits in children with ADHD.

Keywords: Inferences, Attention Deficit Hyperactivity Disorder, Think-aloud, Story Comprehension, Academic Achievement.

Jessica S. Kosloski
5/4/12

INFERENCE GENERATION AND STORY COMPREHENSION AMONG CHILDREN WITH ADHD

By

Jessica S. Kosloski

Elizabeth Lorch, Ph.D.
Director of Thesis

David Berry, Ph.D.
Director of Graduate Studies

5/4/12

ACKNOWLEDGEMENTS

The following thesis, while an individual work, benefited from the insights and direction of several people. First, Drs. Elizabeth Lorch and Richard Milich have provided invaluable advice and direction throughout the process, without which this research would not have been possible. Dr. Robert Lorch provided wonderful insight by looking at this research from a fresh perspective and helping me to challenge my thinking and formulate ideas. Dr. Angela Hayden has provided so much help in formulating, running, and revising this thesis project, it is impossible to describe how grateful I am for her time and friendly help.

No person can reach this stage of her life without having the everyday support of family and friends. My fiancé, Joseph, has provided unending encouragement and emotional support. My parents have devoted their lives to raising and providing me with an excellent education; it has been their accomplishments and words of encouragement that has put me on this path and seen me through. Above all else, it is my Lord, who has blessed me and given me the abilities and opportunities to serve the community, and I hope to follow the path He has placed before me, wherever it may lead.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

Introduction

Children with Attention Deficit Hyperactivity Disorder (ADHD) often have academic difficulties that cause them to fall behind their peers. The problems that contribute to these academic difficulties are not purely behavioral (i.e., elevated levels of impulsivity, hyperactivity, and inattention) but also include higher order cognitive deficits (Barkley, 2006). Investigating the cognitive deficits that affect academic performance can lead researchers to be able to assist children with ADHD academically by creating interventions tailored specifically to address these problems. To this end, story comprehension tasks provide a promising direction for examining higher-order cognitive difficulties that may lead to academic problems for these children. Story comprehension research can provide us the vital clues needed to understand and potentially help these children academically.

According to the *Diagnostic and Statistic Manual of Mental Disorders* (DSM-IV-TR: American Psychiatric Association, 2000), ADHD consists of problems in hyperactivity, impulsivity, and inattention. Every child displays such behaviors from time to time, but children with ADHD exhibit them to such a degree that they interfere with their ability to function normally in multiple environments. In the United States estimates of prevalence range from 2-10% of the population; an estimated 5% of school age children have the disorder (Barkley, 2006).

The vast majority of children with ADHD struggle academically in several areas, including reading and math. These and other problems in the classroom are a common reason for treatment referral. These academic difficulties lead to a greater need for

tutoring, higher levels of repeating grades at least once, and higher suspension and dropout rates for children with ADHD in comparison to their peers (Barkley, 2006). Early interventions are ideal for preventing further academic failure. However, common treatments for young children: psychotropic medications, behavior modification, and parent training, while reducing behavioral symptoms, do not address the higher-order cognitive deficits still experienced by children with ADHD, as evidenced by problems in story narrations that are unaffected by medication (Bailey, Derefinko, Milich, Lorch, & Metze, 2011; Derefinko, Bailey, Lorch, & Milich, 2009).

Studying these academic problems through the lens of story comprehension has proven to be a useful methodology for investigating higher order cognitive skills of children with ADHD (Lorch, Berthiaume, Milich, & van den Broek, 2007). Some of the higher order cognitive skills required to understand stories include sustaining attention, monitoring comprehension, following causal structure, differentiating between important and unimportant information, and remembering and recalling important information. By investigating the story comprehension of children with ADHD and comparison children, researchers have identified narrative comprehension deficits specifically associated with ADHD that may be contributing to academic problems for these children. Among these deficits are problems using the causal structure of a story to aid comprehension, gaps in sustaining attention to information about characters' goals, and difficulties recognizing important information (Lorch, et al., 2007; Lorch, Sanchez, et al., 1999; Lorch, Eastham, et al., 2004; Lorch, O'Neil, et al., 2004; Renz et al., 2003). These deficits may be related to difficulties with an important aspect of story comprehension that has not been so thoroughly investigated: the ability to make inferences. The inference-making abilities of

children with ADHD in comparison to same-age peers will be the focus of the current study.

One of the areas of story comprehension that poses significant difficulties for children with ADHD is the detection of causal relations and causal structure. According to the Causal Network Model (Trabasso & van den Broek, 1985; Trabasso, van den Broek, & Suh, 1989), the causes and consequences of story events form the foundation of story structure. An event within a story, if it is important to the story line, will usually have preceding events that cause it to occur and consequences that will motivate future events, thus creating a network of interrelated events (Lorch, et al., 2007; van den Broek, 1989). The causal relationships between these interrelated events are termed causal connections.

The Causal Network Model suggests that the greater the number of causal connections an event has to other events, the greater the importance of that event in maintaining a coherent story representation (van den Broek, 1989). Events with many causal connections are often important to the story, and the likelihood that an event will be recalled increases with number of causal connections (Trabasso & van den Broek, 1985). This is true for adults as well as for children (van den Broek, 1989), illustrating the significance of causal connections to stories.

An early study by Tannock, Purvis, and Schachar (1993) showed that children with ADHD have problems with basic story comprehension. These children retold shorter stories with less organization, less structure, and more errors than their comparison peers. More recent lines of research suggest that these children exhibit a deficit in understanding causal connections relative to comparison peers under various

story conditions. When children listened to and subsequently retold an audiotaped story (Lorch, Deiner, et al., 1999) or a televised story (Lorch, Sanchez, et al., 1999), children with ADHD did not make use of causal structure and number of causal connections (Lorch, Deiner, et al., 1999; Lorch, Sanchez, et al., 1999) in the recall of stories to the same extent as their typically developing peers. Although both diagnostic groups recalled more information on the causal chain (a series of causally connected events that form a story line), this effect was weaker for children with ADHD (Lorch, Deiner, et al., 1999; Lorch, Sanchez, et al., 1999). After viewing a televised story, children with ADHD often perform more poorly on questions testing causal relations than do comparison children, a difference that may be related to less sustained cognitive engagement with the televised story (Lorch, Eastham et al., 2004).

As suggested above, events that have the most causal connections to other events should also be the most important events in the story (van den Broek, 1989), because without these events the story would not be coherent. It is not surprising, then, that deficits in the detection of causal connections exhibited by children with ADHD are also related to documented problems with recalling or explicitly identifying events rated to be important by skilled adult comprehenders (Flake, Lorch, & Milich, 2007). Children with ADHD do not utilize event importance to guide recall as well as comparison children. Both children with ADHD and comparison peers exhibit enhanced recall of an event as a function of its importance, but comparison children show a stronger increase in recall for higher levels of importance than children with ADHD (Flake, et al., 2007; Lorch, Diener, et al., 1999; Lorch, O'Neil, et al., 2004)

Two studies have investigated the developmental implications of these story comprehension deficits of children with ADHD. Bailey, Lorch, Milich, and Charnigo (2009) and Lorch, Milich, Flake, Ohlendorf, and Little (2010) both studied children with ADHD and their peers at two points in time separated by 21 months. At the first time point, children with ADHD demonstrated deficits in understanding causal relations (Bailey et al., 2009), in free recall as a function of the importance of events, and in the coherence of story recalls (Lorch et al., 2010). After 21 months, there was no evidence that gaps in performance had been reduced. In fact, group differences in understanding causal relations (Bailey et al., 2009) and in producing coherent recalls (Lorch et al., 2010) increased over time.

Inferences

Inference generation is an important aspect of story comprehension that has been given little attention in the study of story comprehension deficits exhibited by children with ADHD. An inference is an event or conclusion reached based on information contained in a text or story, but not stated explicitly (Trabasso & Magliano, 1996). Making inferences is as central to story comprehension as understanding causal relationships and recognizing importance of story events (van den Broek, et al., 2005; van den Broek, 1989; van Kleeck, 2008). While reading or listening to a story, the comprehender often must infer information that is not explicitly stated, including inferring causal connections among events. Inferences often are made so automatically that skilled readers do not realize that they are creating them. However, if readers did not create inferences, many stories would be incomprehensible (Thurlow & van den Broek,

1997) and could seem like series of disconnected events. For example, in a story titled *The Brave Knight,* there is a passage that reads:

> He gathered his sword and shield and went off to challenge the dragon. The Knight began to climb the Dragon's mountain, but just as he got close to the top, it started to rain. "Rain can't hurt me," said the Knight. But then he realized it was getting hard to move his arms and legs. He looked down and saw that his suit of armor had begun to rust! So he took off his armor and dropped it on the side of the mountain.

In order for listeners to comprehend this passage fully, they must infer that the rain caused the knight's armor to rust. In this example, failure to infer that rain caused the armor to rust would lead to an incomplete understanding of the story events (Thurlow & van den Broek, 1997).

Researchers have defined inferences in several different ways (Graesser, Swamer, Baggett, & Sell, 1996; Kendeou, Bohn-Gettler, White, & van den Broek, 2008; Thurlow & van den Broek, 1997; Trabasso & Magliano, 1996). Two major categories of inferences identified by Thurlow and van den Broek (1997), coherence inferences and elaborative inferences, are most relevant to the current study. Coherence inferences are essential inferences that must be made in order for the story to be comprehensible. A critical type of coherence inference is a causal inference. A causal inference is one that connects two or more story events as causes or consequences of one another, without the connection being explicitly stated or explained in the story. Inferring such cause and effect sequences enables the construction of coherent story representations.

The other main category of inference is the elaborative inference. This category adds additional information to the story, but unlike the coherence inference, is not essential to story comprehension. Thus, these inferences do not have to be created in order to continue to understand what is occurring in the story. This category includes two specific types of inferences: likely and enriching. Likely inferences, according to Thurlow and van den Broek (1997), are inferences that are reasonable to make in the context of story events but do not have to occur in the same way for every individual. For instance, different people could have different impressions of how long the knight in the above example was walking in the rain before he started to have trouble moving, or have different ideas of how large the mountain was. Such inferences are part of a coherent understanding of the story but inference differences between individuals will not affect the storyline. Enriching inferences simply add details that color or 'enrich' the passage. Was the dragon angry or frightened, was the knight annoyed when he lost his armor, did the hole the knight fell into exist naturally or was it made by the dragon or people? Readers do not have to ask such questions, but may make enrichment inferences in order to answer them. Elaborative inferences are not created as often as are coherence inferences because they are not essential to understanding stories (Long, Oppy, & Seely, 1994; Thurlow & van den Broek, 1997). Among other factors, the likelihood of making elaborative inferences is influenced by how much cognitive load the comprehender is experiencing and whether they have enough mental capacity to think about additional details (Thurlow & van den Broek, 1997).

A major subcategory of elaborative inference that the current study investigated separately is the forward, or predictive, inference. These inferences occur when the

comprehender makes some guess concerning future events based on previous events. In the example given above, the reader could predict either that the knight continues on his quest to defeat the dragon, or that he will give up after his armor has rusted. These predictive inferences do not need to be created in order to maintain a coherent story representation; therefore they are categorized as elaborative inferences. However, because of the potential relations of predictive inferences to the creation of causal connections, predictive inferences were coded as a distinct category.

Inference making is a major part of adults' story comprehension. When adults were asked to think aloud about a story, most of their statements were inferences (McGinnis, Goss, Tessmer, & Zelinski, 2008; Trabasso & Magliano, 1996). Trabasso and Magliano (1996) found that adults create causal inferences (also known as coherence inferences) more than other types of inferences. They found that children create more causal inferences relative to other types as well. This outcome indicates that causal inferences are vital to story comprehension for all age groups.

Children begin to make inferences as early as four years of age (Kendeou et al., 2008). The total number of inferences made predicts children's ability to recall a story (Lynch & van den Broek, 2001), suggesting that the ability to make inferences is vital to children's story comprehension. The inferences that children create become more numerous, more complex, and more accurate with age, thus more closely resembling adult inferences. For example, children can make causal inferences by 6 years of age, and their more refined understanding of stories allows them to make more complex inferences such as character emotions and actions by 8 years of age (Kendeou et al., 2008). Additionally, while children as young as 6 years old make causal inferences that

are important for story coherence (i.e., inferences related to causal connections and story plotline), older children create a *greater* number of these inferences (Casteel, 1993; van den Broek, 1989; van den Broek, Tzeng, Risden, Trabasso & Basche, 2001). Children who are poor story comprehenders make fewer inferences and create more inaccurate inferences than do skilled comprehenders. Importantly, children who are poor comprehenders make fewer causal inferences than do skilled comprehenders, indicating a more tenuous understanding of causal relationships between events (Laing & Kamhi, 2002). Cain and Oakhill (1999) found that poor comprehenders also make fewer inferences that require the child to connect different parts of the text together or infer supplemental information not provided by the text (comparable to enriching inferences). These differences may be due to less skilled readers' struggle with higher-order cognitive skills such as selectively attending to information necessary for story understanding (Cain & Oakhill, 1999: Cain, Oakhill, Barnes, & Bryant, 2001).

Most previous studies reporting differences in inference generation between poor and skilled comprehenders required children to read passages of text. Kendeou et al. (2008) investigated whether these documented differences in inference generation are based solely on reading skill, or if they are correlated across multiple types of media for 4- to 6-year-olds. In addition, they examined whether inference generation with various media types was predictive of story comprehension two years later. All children in this study viewed a televised story and listened to an audiotaped story at each time point, and at the two-year follow-up, children also read a story. Children then retold the stories and answered questions concerning the storyline. At the first time point, inference generation was predictive of story comprehension abilities above and beyond vocabulary skills for

each age group. The inference-making capabilities of the children at the first time point were also predictive of their comprehension skills when they were re-tested two years later. In addition, Kendeou et al. found that the capability to make inferences correlated across all three types of media: audio, audio/visual, and reading. Thus, inference abilities are not dependent upon media type, but rather are central to the story comprehension process no matter in what context the story is delivered.

Methods of Assessing Inference Generation

There are several different procedures that researchers have used in order to measure the types of inferences that children make. One common method relevant to the current study is the think-aloud procedure, in which children are asked to vocalize their thoughts about a story at various pauses throughout the story. This procedure allows researchers to probe for inferences on-line. This is in contrast to an alternative method of asking children to recall the story after the story is finished (Cain, & Oakhill, 1999; Cain et al., 2001; Inman & Dickerson, 1995; Kendeou et al., 2008), a method that requires children to maintain inferences in working memory over the course of the story or to generate inferences during the recall. Many researchers use the think-aloud procedure because it allows them to tap thinking processes, including inferences, as they occur (Laing & Kamhi, 2002; Lynch & van den Broek, 2007; McGinnis et al., 2008; van den Broek et al., 2001). However, there have been reports that frequent pauses in a story procedure to ask questions may impair children's comprehension (van den Broek et al., 2001).

Laing and Kamhi (2008) explored the think-aloud procedure and recall following a story for 8- to 9- year-old poor and average readers to determine what types of

inferences occurred during on-line story processing. Children 8 to 9 years of age were divided into two groups: poor and average readers. Each child either listened to an entire short story or were stopped after each sentence of a short story and asked to say what they understood about each story. After the stories were finished, children were asked to retell the first of the stories they heard and answer literal and inferential questions for each story. In their study, average readers created more inferences and fewer errors than poor comprehenders. In addition, the think-aloud procedure aided both poor and average comprehenders in answering cued recall questions testing for inference making. The think-aloud procedure should be used cautiously, however, because van den Broek et al., (2001) found that asking 4th grade children (approximately 10 years of age) questions every few sentences interfered with their story comprehension, perhaps by creating a cognitive overload. Lynch and van den Broek (2007) asked 6-to-8-year-old children what they were thinking significantly less often during a story (approximately 10 sentences between pauses) than did van den Broek et al. (2001). This allowed more of the story to develop between each point. Lynch and van den Broek found that the number of inferences generated significantly predicted recall of the story.

Inferences and Children with ADHD

Whereas there have been multiple studies investigating inference generation for typically-developing children, inference-making abilities have not been adequately addressed with children with ADHD. Given evidence that children with ADHD have difficulty effectively using story structure, causal connections, and importance of events, it is likely that these children would have problems drawing appropriate inferences from story events. To date, there has been only one study addressing the inference-making

ability of children with ADHD. Berthiaume, Lorch, and Milich (2010) investigated these children's inference-making capabilities using two tasks. In the first task, children were given between one and three clues about an ambiguous event or object, and then asked to guess (make an inference about) what the ambiguous word was based on those clues. In the second task, a think-aloud task, the children listened to a passage which was approximately 13 sentences long. After each sentence, the child was asked to say what they were thinking about the story in order to elicit on-line inferences.

For the first task in Berthiaume et al. (2010), children with ADHD were more confident in their incorrect answers to the clues but answered with the same accuracy as comparison children. Thus, children with ADHD were less likely to question false assumptions due to their overconfidence in comparison to non-diagnosed peers. This overconfidence may contribute to generating poor inferences. For the think-aloud task, children with ADHD made more incorrect explanatory inferences (comparable to Thurlow and van den Broek's [1997] coherence inferences), but were not significantly different from comparison children in how many correct or incorrect inferences were made in other categories. The explanatory inferences are the most important type of inference to create, as they are integral to causal structure. Thus, making incorrect explanatory inferences is problematic because causal structure directly affects construction of coherent story representations (Berthiaume et al., 2010).

The results of Berthiaume et al. (2010) seem to be surprisingly limited given the larger inference-generation differences seen between adept and poor comprehenders for non-diagnostic groups. One possible explanation for these limited findings is that children completed this task at the end of the session when they were already

experiencing fatigue. Another, perhaps more persuasive argument, is that the task itself required frequent questioning (i.e., after each sentence) during a very short story (i.e., only 13 sentences), which may have been too demanding for these young children. As suggested above, this may have created an excessive cognitive load for these children, and may not have left enough room for the story to develop in a meaningful way in between think-aloud questions. This may have resulted in limited group differences in inference generation because both groups were cognitively overloaded. The current study addressed the limitations in Berthiaume et al. and expanded upon the investigation of inferencing abilities of children with ADHD.

The Current Study

The current study investigated differences in inference generation between children with ADHD and their comparison peers, using a think-aloud procedure similar to Berthiaume et al. (2010). However, to address the limitations of Berthiaume et al., children were tested with longer stories and asked to think aloud less frequently. In addition, children's recall (including inferences during recall) was assessed in several ways after story completion. The present study explored two main questions related to inference generation. First, do children with ADHD create the same number and types of inferences as do their comparison peers, both while constructing a story representation and while recalling the story? Second, does experiencing the think-aloud procedure differentially affect story comprehension during recall for these diagnostic groups, when children are given ample time between think-aloud pause points?

In the current study, children were approximately 7 to 11 years of age. This age group was chosen because Kendeou et al. (2008) showed that children as young as 6

years of age can generate causal inferences. However, because there is ample evidence that children with ADHD exhibit story comprehension difficulties throughout the elementary school years (Berthiaume, et al., 2006; Derefinko, et al., 2009; Flake, et al., 2007; Flory, Milich, Lorch, Hayden, Strange, & Welsh, 2006; Lorch, et al., 2007; Lorch, Deiner, et al., 1999; Lorch, Sanchez, et al., 1999; Lorch, Eastham, et al., 2004; Lorch, O'Neil, et al., 2004; Lorch, Milich, Astrin, & Berthiaume, 2006; Lorch, et al., 2010; Renz, et al., 2003) a slightly older group than that of Kendeou et al. was chosen. Kendeou et al. also showed that inferences generalize across media types. Therefore, televised stories were used, to avoid any confounds with reading difficulties and to enable the use of stories with complex plotlines. Children watched episodes of a television program (*Growing Pains*) and were stopped periodically during the program and asked what they are thinking about the story. This procedure allowed for the collection of on-line information about the nature of the inferences that children were making. They had extended periods of time between the points where the story was paused in order to lessen the types of interference that may have affected the Berthiaume et al. study due to frequent pauses. Children also experienced a control condition in which the pause points remained, but they are not asked to think aloud. This allowed for a within-group comparison of the impact of the think-aloud procedure on story comprehension.

The first research question that this study sought to answer is whether children with ADHD create the same number and types of inferences as their comparison peers. This will be addressed in both the think-aloud pauses and free recall. If children with ADHD struggle with generating inferences, this deficit could be expressed in multiple ways through this procedure. Children with ADHD may not create as many inferences

overall, or they may create only certain types of inferences, such as the inferences generated by poor comprehenders (Laing & Kamhi, 2002). As discussed above, coherence inferences require the comprehender to infer implicit connections between multiple events from a story, whereas elaborative inferences only add unneeded details to an event within the story. Thus, if children with ADHD generate fewer coherence inferences, they are likely to miss causal connections among story events. Because children with ADHD have previously displayed deficits in understanding causal relations (e.g. Lorch, Sanchez, et al., 1999), it is likely they will display a deficit in generating coherence inferences relative to their peers. Inferences were also judged on the basis of whether they are accurate/plausible, or implausible/inaccurate. It was expected that children with ADHD would generated more inaccurate inferences, consistent with Berthiaume et al. (2010).

The second research question focuses on whether giving children with ADHD and comparison children the opportunity to think aloud during a televised story would differentially affect children's comprehension of the story during free recall and/or cued recall following the story. The think-aloud task may have a positive effect on later comprehension for both groups but a stronger positive effect for typically developing children, such as the pattern seen in average and below average comprehenders (Laing & Kamhi, 2002). This may occur because the think-aloud condition may encourage extra processing of the story, which typically developing children may utilize more effectively than children with ADHD. However, the think-aloud task could have a neutral or negative effect on either one or both diagnostic groups. A negative effect would be consistent with van den Broek et al. (2001)'s finding that the requirement to pause and

answer questions interfered with comprehension for some age groups. However, the current methodology questioned significantly less often, which may help to avoid the problem van den Broek et al. observed. The finally possibility would be a reduction of the comprehension gap between groups. If comparison children already are doing very well, they may not need the extra processing occurring during the think-aloud condition, but an opportunity for extra reflection on the story may assist children with ADHD. If thinking aloud is associated with improved comprehension for children with ADHD, it may be a useful tool to include in story comprehension interventions for these children.

Chapter 2

Method

Participants

A total of 59 children participated in the study. Of these children, 22 were formally diagnosed with either combined type or inattentive type ADHD, and the remaining 37 children were part of the non-referred comparison group. Children's ages ranged between 7 years 0 months to 11 years 2 months. The groups were not different in mean age or in the distributions of gender, $\chi^2(1) = 1.14$, $p > .10$, or ethnicity, $\chi^2(1) = 3.88$, $p > .10$, (see Table 1). Reflecting the demographics of the region, 76.3% were Caucasian and 15.3% were African American. An additional 6 children were recruited (five with ADHD), but had to be excluded from analyses for the following reasons: two did not fit symptoms for their respective diagnostic groups (one comparison child), two had IQ scores below 70, one exhibited co-morbid Asperger Syndrome, and one had several speech difficulties.

Children with ADHD were recruited from local clinics and participant pools from previous studies. Twenty of the children with ADHD were diagnosed with ADHD/combined type according to the DSM-IV-TR criteria, and two children were diagnosed with inattentive type. In order to be included in this study, children with ADHD must have had a diagnosis of ADHD/combined or inattentive type. The diagnosis was based on parental report of the clinical diagnosis of their child and confirmed with a structured interview and ratings on the Conners Parent Rating Scale (1997).

If they expressed an interest in participating, they were asked to sign a form giving permission to be contacted by the researcher about participation in this study.

Table 1

Demographic and diagnostic information for children with ADHD and comparison peers.

Category	ADHD	Comparison	*T*
Age in months	108.00 (14.94)	110.11 (13.86)	0.55
Mother's years of education	14.77 (2.27)	15.94 (2.36)	1.91
Father's years of Education	15.05 (2.61)	16.24 (2.71)	1.55
KBIT- Total IQ	109.23 (13.25)	120.41 (10.94)	3.51**
KBIT –Matrices IQ	104.36 (18.27)	113.86 (10.82)	2.52*
KBIT- Verbal IQ	111.95 (12.21)	121.35 (13.17)	2.72*
OWLS Expressive Language	90.23 (10.09)	108.81 (18.26)	4.38**
Gender (male)	15 (68.2%)	20 (54.1%)	1.060
DSM Inattentive Symptoms	7.09 (1.66)	0.19 (4.62)	23.92**
DSM Hyperactive	6.82 (1.71)	0.65 (1.14)`	16.67**
DSM ODD symptoms	3.95 (2.59)	0.54 (0.99)	7.21**
Conners ADHD T-score	73.55 (9.82)	45.89 (6.21)	13.28**
Gender (% male)	68	54	
Ethnicity (%)			
Caucasian	15 (68.2%)	30 (81.1%)	
African American	5 (22.7%)	4 (10.8%)	
Biracial	2 (9.1%)	1 (2.7%)	
Other (Asian, Hispanic)	0	2 (5.4%)	

* p value ≤ 0.05

** p value ≤ 0.001

Comparison children and additional children with ADHD were recruited through an announcement in local newspapers, from fliers distributed throughout the community, and from participants from previous studies who stated that they wished to be contacted about other research opportunities. Comparison peers were not be required to be symptom-free, but had fewer than three symptoms for either dimension of the ADHD/combined type. The ADHD and comparison groups were significantly different on all diagnostic measures (see Table 1).

Parents who expressed an interest were contacted by phone and asked screening questions related to exclusion criteria. Because the purpose is to understand the effects of ADHD and not the effects of medication, children were excluded from the study if they are taking any psychoactive medication that could not be discontinued for the 24 hours prior to participating in the study. In addition, comparison children were excluded if they had ever been referred for any behavioral or learning disabilities.

Upon arriving at the Child Development Research Facility, informed consent was obtained from the parent by a graduate research assistant. Children were asked to give their verbal assent to participate in the study. For their participation, children were paid $15 dollars for the first session and $25 for the second session. They also were allowed to choose a small toy at each session.

Materials

Growing Pains. Two episodes of the situation comedy *Growing Pains* were used as the narrative stories in the think-aloud task. The episodes were originally aired on commercial television in 1986 and last approximately 22 minutes. The two episodes are called 'Charity Begins at Home' (Birthday) and 'Do You Believe in Magic?' (Magic).

Both episodes have a complex plot, containing a main character attempting to solve a problem and multiple sub-plots, ending with a moral lesson. See Appendix A for plot summaries. The episodes were broken down into story units for earlier studies (Lorch et al., 2000), where each unit represents a single idea or event. The Birthday episode has 407 units and the Magic episode has 615. Each unit had been rated by undergraduate students on the importance of the event to the overall story, using a Likert scale ranging from one (least important) to seven (most important) to the plot of the story. Those in the highest quartile are defined as highly important events, and those in the lowest quartile were defined as low important events.

Each of these episodes had pauses inserted at five points. At these points, a black screen was edited into the episode to indicate the beginning of the pause. Each pause occurred near an event of high importance (ranked in the top quartile), and generally occurred before key events are explained by the characters.

A set of 20 questions developed for previous studies was used to test story recall. Five questions tested factual events and the remainder tested causal relations among events, either explicitly stated (seven) or needing to be inferred (eight) (see Appendix B and C).

Think-aloud Practice Story. A short story, 'The Father, His Son, and Their Donkey,' was used during a think-aloud training procedure. This fable is 426 words long and contains 63 story events. The story line of this fable concerns a father and son who, while on their way to sell their donkey, encounter conflicting advice from local townsfolk about who should ride the donkey. By the end of the story they find themselves taking

ridiculous steps to follow the advice and lose their donkey in the process (see Appendix D for full story).

Standardized Testing. Two standardized tests were used to estimate intelligence and to assess oral expressive language. The Kaufman Brief Intelligence Test (KBIT-2) and the Expressive Language subtest of the Oral and Written Language Scale (OWLS) were used.

The KBIT-2 (Kaufman & Kaufman, 2004) takes approximately 20 minutes to administer and provides an estimate of intelligence. It has two scales: Crystallized and Fluid intelligence. The crystallized scale is a verbal scale that tests intelligence with two types of items: verbal knowledge and riddles. Reading and spelling are not required for these subtests. The Fluid scale is a nonverbal test that uses matrices. An average intelligence on the KBIT-2 is 100 with a standard deviation of 15. In the current study, only the verbal knowledge and matrices portions were administered. The verbal portion of this test consists of showing children pictures and asking them to point to the picture that fits a word or definition best, and produces an estimate of verbal intelligence. The matrices subtest requires children to choose a picture that is analogous to or fits into a pattern of other pictures, and thus provides an estimate of non-verbal intelligence. The K-BIT2 has a test re-test reliability of .88 for the composite IQ, and has a .77 correlation to a full IQ score from the WISC-IV (Kaufman & Kaufman, 2004). In the current study, although the groups differed on average IQ scores, both ADHD and Comparison groups had above average IQ scores (see Table 1)

The Oral and Written Language Scale (OWLS) consists of both receptive and expressive subtests (Carrow-Woolfolk, 1995) but only the oral expressive portion was

administered in this study. This test takes between 20 and 40 minutes. Children were shown pictures and verbally prompted to complete or create sentences using the pictures as cues. Items were scored for their accuracy and labeled as preferred, acceptable, or incorrect. Answers may be incorrect based on lack of response or errors in grammar, semantics, or pragmatics. The standardized score for the oral expression scale was calculated. This test has a mean of 100 and standard deviation of 15 points. The test re-test reliability for 8-11 year old children is .80 for the expressive language scale, and the inter-rater reliability is between .96 for 7 year old children and .93 for 10 year old children (Carrow-Woolfolk, 1995). In the current study, the comparison children scored significantly above the mean, but children with ADHD scored below the mean (see Table 1).

Facility. Sessions took place at the Child Development Research Facility, which is a small home-like laboratory located at the University of Kentucky. The structured interview was administered to the parent in the waiting room. Children completed all tasks in a small room with a single experimenter. The child sat at the long side of 2.5 by 3.5 ft table with their back to the door, and the experimenter sat perpendicular to the child at the table and remained in the room for the entire session. A television and DVD player were located on a cart on the other side of the table, and positioned so that the child had to turn 45º to see the screen. A box of toys and any materials the experimenter may have needed were on a desk in the corner of the room. The entire session was recorded from a camera mounted on the wall, which captured the child, the TV screen, and edge of where the experimenter sits. The child's responses during the entire session were also recorded by the experimenter on a digital voice recorder.

Procedure

The parent/guardian brought their child to the Child Development Research Facility on the university campus on two separate occasions. The data collected for this study consisted of two parts: Information collected from the parent about his or her child, and data collected from the child in the tasks and on the standardized tests. Parents were interviewed by a trained graduate student during the first session in order to confirm ADHD diagnosis or its absence for comparison children. The parents answered questions in a semi-structured interview that contains questions based on the DSM-IV criteria for ADHD, oppositional defiant disorder (ODD), and conduct disorder (CD). Each question asked about symptoms relating to these disorders. If the parent affirmed that the child does have that symptom the parent was asked to give an example of the typical behavior, whether the parent believes the behavior is age appropriate, and if the behavior impairs performance in school or in a social setting. If a child with ADHD failed to meet DSM-IV criteria per the parent's endorsement of the symptoms of ADHD then the child's data was excluded from this study. Data from comparison children were excluded if the parent endorsed three or more items on the hyperactivity/impulsivity or inattentive scales. To confirm the diagnosis, parents also completed the Conner's Parent Rating Scales (CPRS-R:S) and the Child Behavior Checklist (CBCL), which provided information about internalizing and externalizing behavior. These tests are widely used rating forms to measure a child's level of ADHD symptoms in a reliable and standardized method. On these forms, parents checked to what extent their child displays certain behaviors.

While the parent was completing the measures listed above, the child began the tasks with a trained researcher. The current study was a part of a larger study, and each

session lasted approximately 90 minutes. During each session, the child experienced one televised episode of *Growing Pains*, a standardized test, and one audio-taped story. The experimenter escorted the child to the testing room and talked with the child to establish rapport. The study was verbally described to the child and assent was obtained. After the child became comfortable in the testing room, the researcher either began a control episode of a television program, or in the case of the experimental condition began the think-aloud training protocol.

It was a concern that children at first would not be comfortable speaking about their thoughts to the unfamiliar experimenter, would not know what to say, or would say things off topic. Therefore, *The Father, Son, and Their Donkey,* mentioned above, was used as a training story before the think-aloud condition of the first task (Lynch and van den Broek, 2007). If the control condition occurred during the first session, the training was done in the second session before the think-aloud condition. The story was read out loud by the researcher, who would stop during the story in order to teach the child about thinking aloud. This teaching process was scaffolded across three pauses. At the first pause the experimenter gave the child an example of three things that the experimenter could be thinking about the story. During the second pause the child responded. If the child did not know what to say, or said things inappropriate to story events, the experimenter gave further think-aloud examples. The child was also prompted for more information to ensure he or she had said everything that he or she was thinking. During the final pause in the story, the child was prompted again but only was given examples if the child failed to respond at first. If the child failed to give more information after a second prompt the child was allowed to pause without being given further examples. All

of the examples given by the experimenter were either factual or inferential think-aloud responses. Once this training procedure was finished the think-aloud condition of *Growing Pains* began.

To begin the think-aloud task the experimenter explained the first task, which in each session involved viewing an episode of the television program *Growing Pains*. Across the two sessions, children participated in two conditions with order counterbalanced: think-aloud and control. The episode that was assigned to each condition also was counterbalanced. The child watched the programs with a set of toys available and was allowed to play with the toys. The toys were a transformer figure, a remote control car, a handheld game, a drawing toy (either Magna Doodle or Etch-a-Sketch), a plastic doll (human or dinosaur), and either a slinky or a pin-impression toy. The toys were present in order to provide a more natural environment where distractions were possible and attention to the program could vary (Lorch, Sanchez, et al., 1999). For the think-aloud condition, the child was asked to think aloud during five 30-second pauses (think-aloud condition). For the other story the child was not be asked to think aloud during the pause and instead was allowed to continue playing with the toys that were available during the show. The control condition was designed to make sure any differences in later recall were not due to pauses in the story but to the opportunity to think aloud.

To begin the think-aloud condition episode, the experimenter gave a general explanation of the procedure: the child would watch a show that would pause occasionally and at which time they would be asked questions. In the control condition, instead of explaining that the child was going to be asked a question, the experimenter

said that the child could just continue playing with the toys during the pauses. The show was then started. At each pause the experimenter stopped the show during the pre-inserted blank screen so that the pause lasted 30 seconds. In the think-aloud condition, the experimenter asked the child to "Tell me everything you are thinking about what is happening in the story." The child was then prompted once to make sure that the child's response was complete. If the child had not finished thinking aloud before the 30-second pause was over, the experimenter continued to hold the show until the child had finished. In the control condition, the child was allowed to continue playing with toys during the 30-second pauses in the story. If in the control condition the child began to say what they are thinking, then the experimenter would say, "Remember, you can keep playing with these toys if you like, but we aren't going to talk about the story this time." After the questioning was finished and at least 30 seconds had passed, the experimenter resumed the show.

After the *Growing Pains* episode, the experimenter showed the child a picture of the characters and reminded the child of the characters' names. Then the child was asked to retell the entire story from beginning to end. The child was given two prompts to elicit a complete recall. Finally, the experimenter asked cued recall questions about the episode. The questions probed for recall of factual events and causal connections between events. Some questions tested causal connections that had been explicitly stated and others tested connects that had to be inferred (see Appendix B and C for questions).

After recall testing for the *Growing Pains* episode, the experimenter administered either the KBIT-2 intelligence test during the first session or the OWLS subtest for

expressive language in the second session. This study was part of a larger experiment, so the child completed other tasks after the break following the KBIT-2 or OWLS.

In summary, on each of two days the children participated in the study, they experienced an episode of *Growing Pains* and a standardized test. The first task is a televised story during which they were asked to think aloud about the story on one day, or in the control condition on the other day wait for the story to resume. Next they completed a verbally administered standardized test, either KBIT-2 or OWLS. Finally, they completed tasks that were part of the larger study.

Coding

Children's responses to think-aloud prompts, recall, and questions were transcribed verbatim from the voice recordings and video tapes and double checked for accuracy. Think-aloud and recall transcripts were parsed into event units.

Think-Aloud Statements. The primary purpose of examining the statements the child makes during the think-aloud condition of the *Growing Pains* episodes was to determine to what extent the children spontaneously generated inferences. Thus, only the inferences related to the story line were of interest. In order to determine whether an event was a story-line inference or another type of statement, event units from the think-aloud transcripts were be compared to the transcript of all event units contained in the original story up to the current pause. If the child states an event that does not correspond to an event in the complete event transcript but is still related to the story line, then it was coded as an inference. For example, during a pause in the *Growing Pains* episode Magic, a child might say, "I'm thinking that when Ben offered to clean Mike's room/ he was really trying to trick him/ and get him to think that the rock really is magic." The first part

of this statement retells an event in which the younger brother walks up to Mike saying he will clean Mike's room for money. The next two parts of this statement refer to Ben tricking his brother and his purpose in tricking him. These have not yet been explained by any character in the show, or even necessarily have to be true given what has already been seen. Therefore, this statement would have been coded as having one fact (Ben offered to clean Mike's room) and two inferential components (Ben is tricking his brother; Ben is trying to get Mike to think that the rock is magic). Two coders developed and agreed upon a system for finding inferences. Reliability for indentifying inferences was calculated on 60 stories (34% for recall and pauses) and achieved a reliability of κ =.73.

After events were coded as inferences or other statements, the inferences were further coded by type: coherence, elaborative, or predictive. *Coherence* inferences were defined as those statements that explain events or connect events in order to help make sense of the story line. Often, these explanations of events answer 'why' questions, such as 'why did the mother and sister come out of Mike's closet in Magic?' *Elaborative* inferences are defined as those statements that add information to the events of the story, but are unnecessary to movement of the story line. An example of an elaborative inference could be a character showing an emotion, if that emotion does not cause future events. Finally, *Predictive* inferences are statements of events that have not yet occurred. These predictions usually are based on events and facts that have already occurred, and suggest possible future outcomes.

Next, each inference statement was scored as accurate/plausible, or implausible/inaccurate. Inferences were coded as *accurate/plausible* when the child talks

about an event that is not explicitly stated in the story but either does indeed occur later in the story or is a reasonable conclusion based on the events in the story. For instance, immediately after the pause for the statement above when Ben offers to clean Mike's room, the family discusses their purpose for tricking Mike, so an inference describing their reasons for tricking Mike could be determined to be accurate or not. *Implausible/inaccurate* inferences fail to take into account all the facts or events already seen in the story and/or include an error in logic. Two coders scored all story pauses for inference types and accuracy, and averages were computed for each category. Pearson's r was above .85 for all categories (see Table 2)

Statements made during the think-aloud task that were not inferences about the story line were not coded. Such events may include retelling of events that explicitly occurred in the story, extraneous statements not related to the events of the story (" I am thinking it is a sunny day outside"), statements relating the events of the story to events in the child's personal life (" this reminds me of a time I tried to trick my brother…"), and inferences about the characters fictional universe outside of the immediate story line (such as "Mike will one day become an accountant") (Berthiaume et al., 2010).

Free Recall of Story. After the program, the child retold the entire story that he or she just saw. As noted above, the recall transcripts were parsed into individual event units. Each unit was classified as an event that explicitly occurred in the story or as one of the other types of statements discussed above. Those events that explicitly occurred in the story were compared to the full list of story units and matched to the unit they best represented. Two coders scored 45 recall stories (38%) for event units and achieved a reliability of $\kappa = .72$. For inferences coded during the recall, 36 (30%) stories were coded

reliability was excellent for most categories (Pearson $r < .90$), with the except of elaborative inaccurate ($r = .71$) and predictive accurate ($r = .80$) which were relatively rare. (see Table 2)

Table 2

Pearson's r Reliability Scores as a function of Inference Types and Accuracy

	Pauses (100%)	Recall (30%)
Coherence Accurate	0.96	0.93
Coherence Inaccurate	0.89	0.90
Elaborative Accurate	0.97	0.96
Elaborative Inaccurate	0.95	0.70
Predictive Accurate	1.00	0.80
Predictive Inaccurate	0.87	1.00

Events described by the child that were not a retelling of something that explicitly occurred in the story were coded into one of the other types of statements: story-line inferences or extraneous statements. Story-line inferences were coded for type and accuracy.

Cued recall questions. The correct answer(s) were defined for each of the cued recall questions. Children's responses were scored as correct or incorrect relative to what has been defined as the targeted response.

Chapter 3

Results

Preliminary Analyses

Preliminary analyses were conducted to determine whether the pattern of findings for any of the dependent variables (inferences generated during pauses, inferences generated during recall, free recall of story units, performance on cued recall questions) varied as a function of the order of experiencing conditions (think-aloud first, control first) or the specific *Growing Pains* story episode (Magic, Birthday). For condition order, there were no significant interactions with diagnostic group for any of the dependent measures, so condition order was not included in any of the primary analyses. Similarly, story episode did not interact with group for most of the dependent measures. The only exceptions occurred when free recall was analyzed as a function of the causal chain status or of the importance level of story units. These exceptions will be addressed in the relevant sections below.

All effects were evaluated in mixed analyses of variance (ANOVA), with planned contrasts for interactions involving group. The Bonferroni procedure was used to control for family-wise error rate, with alpha < .05 unless otherwise noted. As indicated earlier, comparison children scored significantly higher on the K-BIT-2 test of IQ and the OWLS expressive language test than did children with ADHD. Both groups demonstrated above average mean IQ scores, but the mean expressive language scores of children with ADHD were below average. Because expressive language difficulties have been linked to verbal production of stories (Freer, Hayden, Lorch, & Milich, 2011), analyses also were conducted considering the OWLS expressive language score as a covariate. Except

for specific instances reported below, the covariate was not significantly related to the dependent measure or did not change the pattern of significant effects.

Inference Generation

The primary research question was whether children with ADHD differ in the inferences that they generate while forming their understanding of a story (as measured during story pauses) and while recalling the story. For inferences generated during pauses, this question was addressed in group (comparison, ADHD) x accuracy (accurate, inaccurate) mixed ANOVAs for each type of inference (i.e., coherence, elaborative, predictive). For each type of inference, children generated more accurate than inaccurate inferences: coherence, F (1, 57) = 78.30, $p < .001$, $\eta^2 = .58$, elaborative, F (1, 57) = 38.32, $p < .001$, $\eta^2 = .40$, and predictive, F (1, 57) = 14.88, $p < .001$, $\eta^2 = .21$. Comparison children generated more coherence inferences than did children with ADHD, F (1, 57) = 4.10, $p < .05$, $\eta^2 = .07$, and this effect was qualified by a significant diagnostic group x accuracy interaction, F (1, 57) = 13.50, $p = .001$, $\eta^2 = .19$ (see Table 3 and Figure 1). Children with ADHD made significantly fewer accurate coherence inferences than did comparison children, t (57) = 2.88, $p < .05$, d =.76, but the groups were not significantly different in the number of inaccurate coherence inferences, t (57) = -1.16, $p > .10$, d = .31. In other words, the difference between the number of accurate and inaccurate coherence inferences was greater for comparison children than for children with ADHD, t (57) = 3.67, $p < .01$, d = .97 (see Table 3). The groups did not differ significantly on the number of elaborative, F (1, 57) = 2.24, $p > 0.10$, $\eta^2 = .04$, or predictive inferences, F (1, 57) = 0.08, $p > 0.10$, $\eta^2 = .01$, nor were the interactions of

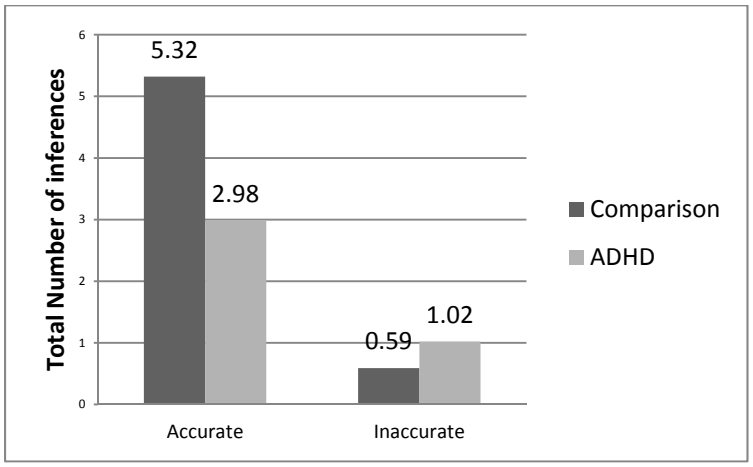
Table 3

Mean number (standard deviations) of coherence inferences generated during story pauses as a function of diagnostic group and accuracy of inferences

Coherence Inferences	Comparison	ADHD
Accurate	5.32 (3.38)	2.98 (2.28)
Inaccurate	0.59 (0.86)	1.02 (1.17)
Difference	4.73 (3.19)	1.95 (1.97)

Figure 1

Mean number (standard deviations) of coherence inferences generated during story pauses as a function of group and accuracy of inferences



group and accuracy significant for elaborative, F (1, 57) = 2.50, $p > 0.10$, $\eta^2 = .04$, or predictive inferences , F (1, 57) = 1.10, $p < 0.10$, $\eta^2 = .02$.

For inferences generated during recall, group x condition x accuracy mixed ANOVAs were conducted for coherence and elaborative inferences; not surprisingly, children rarely made predictive inferences during recall. Again, children generated more accurate than inaccurate coherence, F (1, 57) = 79.75, $p < .001$, $\eta^2 = .58$, and elaborative inferences, F (1, 57) = 54.54, $p < .001$, $\eta^2 = .49$. Similar to the results for inferences during story pauses, comparison children generated more coherence inferences than did

children with ADHD, F (1, 57) = 13.06, p =.001, η^2 = .19. This effect was qualified by a significant group x accuracy interaction, F (1, 57) = 11.29, p = .001, η^2 = .17 (see Table 4 and Figure 2). Comparison children stated more accurate coherence inferences than did children with ADHD, t (57) =3.61, p < .01, d = .95, but the group difference did not reach significance for inaccurate coherence inferences, t (57) = 1.90, p > *.10,* d = .50. The difference between the number of accurate and inaccurate coherence inferences generated in the recall was greater for comparison children than for children with ADHD, t (57) = 3.36, p < .01, d = .89. Comparison children also tended to generate more elaborative inferences during recall than did children with ADHD, F (1, 57) =3.89, p = .053, η^2 = .06,

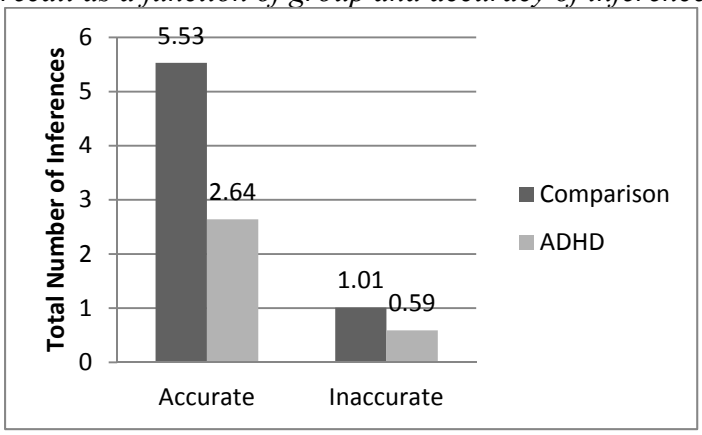
Table 4

Mean number (standard deviations) of coherence and elaborative inferences generated during story recall as a function of diagnostic group and accuracy of inferences

Coherence Inf.	Comparison	ADHD
Accurate	5.53 (3.33)	2.64 (2.22)
Inaccurate	1.01 (.93)	0.59 (.61)
Elaborative Inf.		
Accurate	6.41 (4.94)	3.98 (3.93)
Inaccurate	0.92 (.85)	0.73 (.83)

Figure 2

Mean number (standard deviations) of coherence inferences generated during story recall as a function of group and accuracy of inferences



a trend qualified by a marginally significant group x accuracy interaction, F (1, 57) =3.57, p = .064, η^2 = .06 (see Table 4 and Figure 2). Although pattern of means for elaborative inferences resembled that of coherence inferences, none of the follow-ups reached significance on t tests.

Impact of Thinking Aloud

Free recall. The second research question was whether asking children to think aloud during story pauses over the course of the story would differentially affect the story representation of comparison and ADHD groups. The impact of thinking aloud during story pauses was evaluated for free recall as a function of each of two story structure variables (causal chain status and importance level of story units), percent correct on three types of cued recall questions (inferred causal relations, explicit causal relations, and factual information), and for inferences generated during recall (based on the analysis described above). For recall of events as a function of causal chain status, a group (comparison, ADHD) x condition (think-aloud, control) x causal chain status (on or off the causal chain) mixed ANOVA was conducted. Replicating past findings (Lorch et al., 2000; Lorch, Eastham, et al., 2004), comparison children recalled more story events than did children with ADHD, F (1, 57) = 20.46, $p < .001$, η^2 = .26, and children remembered more story events on the causal chain than events off the causal chain, F (1, 57) = 202.67, $p < .001$, η^2 = .78. These effects were qualified by a significant group by causal chain status interaction, F (1, 57) = 27.09, $p < .001$, η^2 = .32, such that the effects of causal chain status on recall was greater for comparison children than for children with ADHD (see Table 5 and Figure 3). Similarly, in a group (comparison, ADHD) x condition (think-aloud, control) x importance level (high, medium, low) mixed ANOVA of free

Table 5

Mean percent (standard deviations) of events recalled during recall as a function of causal chain status or importance or events and diagnostic group.

	Comparison	ADHD
Causal Chain Recall		
On Chain	17.60 (9.29)	7.93 (12.06)
Off Chain	6.00 (4.69)	2.55 (6.07)
Importance Levels		
High	17.66 (8.76)	8.27 (11.37)
Medium	7.77 (5.30)	3.11 (6.91)
low	6.09 (5.45)	2.80 (7.07)

Figure 3

Mean percent of story events recalled as a function of diagnostic group and causal chain status.

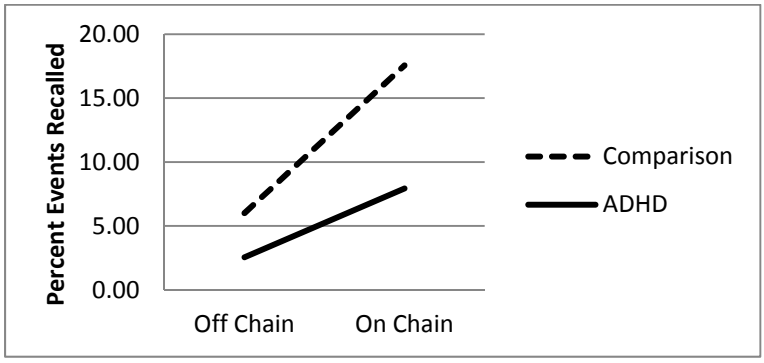
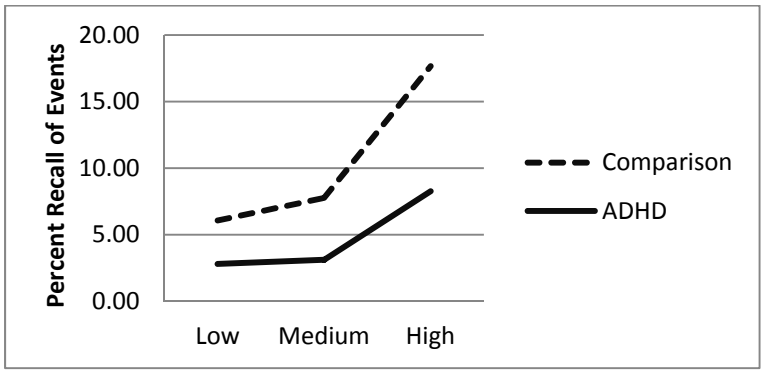


Figure 4

Mean percent of story events recalled as a function of diagnostic group and importance level



recall events, comparison children remembered more story events than did children with ADHD, F (1, 57) = 19.50, p < .001, η^2 = .26, and recall increased as importance level increased, F (2, 114) = 180.95, p< .001, η^2 = .76. These effects once again were qualified by a group x importance level interaction, F (2, 114) = 21.39, p < .001, η^2 = .27. Although recall for both groups increased as importance increased, the slope of this function was steeper for comparison children than for children with ADHD, F (1, 57) = 26.81, p < .001, η^2 = .32. At the highest level of importance, children with ADHD recalled fewer than half as many units of high importance than their comparison peers (see Table 5 and Figure 4).

Important to the present research question, group differences in recall and interactions with the story structure variables did not differ for the think-aloud and control conditions. However, for the recall measures there were several cases in which both groups were affected in the same way by the think-aloud condition. Children recalled more events on the casual chain when in the think-aloud condition as opposed to the control condition, F (1, 57) =9.25, p < .01, η^2 = .14. Children's recall also increased as importance level increased more sharply in the think-aloud condition than in the

Table 6

Mean percent (standard deviations) of events recalled during recall as a function of causal chain status or importance or events and condition story experienced in.

	Think-aloud	Control
Causal Chain Recall		
On Chain	13.85 (8.08)	11.68 (8.23)
Off Chain	4.10 (4.02)	4.45 (4.61)
Importance Levels*		
High	13.78 (8.24)	12.16 (7.76)
Medium	5.31 (4.61)	5.57 (5.00)
Low	4.22 (4.87)	4.64 (5.57)

control condition, F (1, 57) = 3.23, p = .078, η^2 = .05. Thus, they recalled more events of high importance when in the think-aloud condition (see Table 6).

Cued recall. Another way to determine if the conditions affected performance is to analyze the cued recall questions. In a group x condition mixed ANOVA conducted for each type of recall question (factual, explicit causal, and inferred causal), diagnostic groups differed significantly on all question types: inferred causal, F (1, 57) = 13.28, p = .001, η^2 = .19, factual, F (1, 57) = 22.05, $p < .001$, η^2 = .28, and explicit causal questions, F (1, 57) = 10.75, $p < .01$, η^2 = .16 (see Table 7). The condition that the story was experienced in did not have any significant differential effects between diagnostic groups on any of the questions types: inferred causal, F (1, 57) = .25, $p > 0.10$, $\eta^2 < .00$, factual, F (1, 57) = .53, $p > 0.10$, η^2 = .01, and explicit causal, F (1, 57) = 1.80, $p > 0.10$, η^2 = .03.

Expressive language scores on the OWLS were a significant covariate on all three questions types, however it did not affect the significance of the inferred or factual questions. After accounting for OWLS the group effect for explicit causal questions was marginal, F (1, 57) = 2.85, p = .097, η^2 = .05. Children with ADHD were not able to answer any type of question with the same level of accuracy as did their peers.

Table 7

Mean percent of questions answer correctly as a function of diagnostic and question type.

	Comparison Mean	ADHD Mean
Explicit Questions %	59.85 (28.90)	39.29 (37.48)
Inferred Question %	51.96 (26.53)	32.71 (31.58)
Factual Question %	75.95 (25.81)	49.66 (33.47)

Secondary Findings

In addition to major question addressed in this study, secondary analyses were conducted to evaluate effects of condition order and story episode. In addition to the effects that the conditions had on the recall of the stories, there were several effects of what order the conditions were experienced. However, no diagnostic group differences were found as an effect of the order of conditions. When conducting think-aloud order (think-aloud first, think-aloud second) x condition (think-aloud, control) x causal chain status (on, off), as well think-aloud order x condition x importance level mixed ANOVAs, significant think-aloud order x condition interactions emerged (Causal chain $F(1,55) = 6.34$, $p < .05$, $\eta^2 = .10$; Importance Level $F(1,55) = 4.670$, $p < .05$, $\eta^2 = .08$) such that if the control condition occurred first, children were more likely recall fewer events during the control condition than the think-aloud condition, but if the think-aloud occurred first then children recalled events equally in both conditions.

As stated in the preliminary analyses, a preliminary analysis was conducted to see if episode had any effects involving groups, there were 2 cases in which a significant effect was found involving recall. However these results did not change the pattern of the results found in this study. The two episodes of *Growing Pains*, Magic and Birthday, were included in group x episode x causal chain and group x episode x importance level mixed ANOVAs. The recall of comparison children was more sharply differentiated as a function of causal chain status, $F(1, 57) = 5.75$, $p < .05$, $\eta^2 = .09$, and as a function of importance level for the Magic episode than for the Birthday episode, $F(2, 114) = 5.87$, $p < .01$, $\eta^2 = .09$. Similarly, when episodes were included in analyses of inference generation, both groups generated more coherence inferences during recall for the Magic

episode than for the Birthday episode, F (1, 57) = 12.68, p = .001, η^2 = .18, especially accurate coherence inferences, F (1, 57) = 4.20, p < .05, η^2 = .70. There were no effect for the other types of inferences, nor did the episodes have effects on the recall questions.

Chapter 4

Discussion

The current study sought to answer two main questions: whether children with ADHD differ from comparison peers on the number and type of inferences that they generate, and whether a think-aloud procedure would have differential effects on the story recall of these diagnostic groups. As to the first question, children with ADHD generated fewer accurate coherence inferences both while forming their understanding of the story (think-aloud task) and while recalling it after having completed the story (free recall task). In addition, the relative divergence between accurate and inaccurate coherence inferences was smaller for children with ADHD than for comparison peers. For the types of inferences less central to story comprehension, elaborative and predictive inferences, significant diagnostic group differences were not observed, although during free recall comparison children tended to generate more elaborative inferences than did children with ADHD. Thus, children with ADHD are not different from their peers in the less essential categories but fall behind on generating the type of inference that is most essential to effective story comprehension, coherence inferences. Regarding the second research question concerning the impact of the think-aloud condition, no significant interactions of group and condition were found for any recall measures, indicating that children with ADHD were not affected differently from their peers by thinking aloud. However, there is some evidence that the think-aloud condition improved recall for both groups.

Children with ADHD make fewer accurate coherence inferences and exhibited a smaller difference between the number of accurate and inaccurate inferences than did

their comparison peers. This deficit in the creation of the most essential category of inferences held true for both the think-aloud task and for the recall task. In order to generate coherence inferences in the think-aloud task, children must integrate the information they have experienced and attempt to make sense of the story using this incomplete information. This may include filling in missing information and creating causal connections for incomplete event sequences. In order to generate coherence inferences during free recall, children must consolidate and organize story information into a logical story line, then add inferences to this storyline in order to fill in gaps of missing information that were not explained by the characters and to connect events across a completed sequence. Why did children with ADHD fail to generate as many accurate coherence inferences as their peers in both these tasks?

One reason that children with ADHD produce fewer accurate coherence inferences than do comparison children may relate to deficits in cognitive engagement and sustained attention that have previously been found to contribute to story comprehension difficulties (Flory et al., 2006; Lorch, Eastham, et al., 2004; Lorch et al., 2006). For example, prior to these studies difficulties in answering questions tapping causal relations have been tied to fewer periods of sustained cognitive engagement among children with ADHD than among comparison children (Lorch, Eastham, et al., 2004), and unlike comparison children, children with ADHD fail to show increased cognitive engagement as sequences of important events develop (Lorch et al., 2006). If children with ADHD in the current study also became less cognitively engaged with story events between pauses, they may have sought fewer connections among events when asked to think aloud during pauses and may have retained fewer connections on which to

base inferences during recall. Related to cognitive engagement, problems in sustained attention have been found to mediate difficulties in maintaining goal structure during story narration among children with ADHD (Flory et al., 2006). Inattention may cause children with ADHD to be more likely to miss critical story events. Because inferences are generated from story events, missing some of these events due to inattention could prevent children from being able to connect story events together with coherence inferences. In contrast, elaborative inferences often can be generated from a single event. Therefore, if children remember the single event, they have the information necessary to make an elaborative inference. This is consistent with the finding in the current study that group differences were specific to coherence inferences.

Another explanation for the diagnostic group difference in the number of accurate coherence inferences may be problems in executive function for children with ADHD (Barkley, 2006). Executive functioning is the ability to organize, think critically, and integrate new information into an existing representation. In particular as a story develops more fully, forming accurate coherence inferences may depend on effective executive function skills to integrate new information and organize the story into a coherent story representation. Thus, generating accurate coherence inferences during pauses later in the story or during recall would depend on how well children have cumulatively integrated story events. If children's ongoing story representation consists of a relatively unorganized series of events, this disorganization and failure to integrate new information may prevent children from generating accurate coherence inferences to connect the events (Lynch & van den Broek, 2001).

Often classed with executive functions, working memory deficits among children with ADHD (Barkley, 2006) limit their capacity to hold and manipulate information stored in memory. In order to generate accurate coherence inferences during the pauses, children must hold onto recent events but also connect those events with what has come before. During the free recall task, the entire story has been completed, so children's coherence inferences may depend on holding even more information in memory. If comparison peers have more working memory resources available than do children with ADHD, comparison children may be able to keep active a greater number of important pieces of information, thus allowing them a better foundation from which to generate inferences that connect story events.

In the current study, significant group differences in the number of accurate coherence inferences were observed across both tasks, but there were no significant group differences in the number of inaccurate coherence inferences in either task. In contrast, Berthiaume et al. (2010)'s think-aloud procedure revealed no significant group difference in the number of accurate causal inferences, but children with ADHD made significantly more inaccurate causal inferences than did comparison peers. This seeming discrepancy in findings may be rooted in differences in the demands of the two think-aloud procedures, allowing the two studies to reveal different problems with causal inference generation among children with ADHD. The current study asked children to hold several minutes of a story in their memory, using any or all of that information at occasional pauses. To the extent that children are successful at maintaining key story events in working memory, such a procedure provides ample material on which to base coherence inferences, and might allow for considerable variability in the number of

accurate inferences that could be generated. In contrast, the think-aloud procedure used by Berthiaume et al. provided minimal new information between pauses, but demanded that children hold pieces of information in memory across frequent pauses, with children sometimes spending more time thinking aloud than hearing story information. Although differences in task demands of the two think-aloud procedures may have led to different specific findings, the finding common to both studies is that children with ADHD showed a deficit in causal inference making relative to comparison peers.

Deficits in generating accurate coherence inferences among children with ADHD have implications for important aspects of story comprehension. Coherence inferences are often necessary to make causal connections and to maintain goal sequences, both of which children with ADHD have been found to struggle with (Flory et al., 2006; Lorch, Deiner, et al., 1999; Lorch, Sanchez, et al., 1999; Renz, et al., 2003). Consistent with these past findings (Lorch, Deiner, et al., 1999; Lorch, Sanchez, et al., 1999; Lorch, Eastham, et al., 2004), in the current study the recall of children with ADHD showed less sensitivity to causal structure and the importance level of events. In addition children with ADHD performed more poorly on questions testing important factual information and on questions testing understanding of causal relations. It is possible that one reason children with ADHD struggle with these aspects of story comprehension is because many connections and goals have to be inferred, because they are not always explicitly made during stories. In the current study, causal inferences included only the implicit and not the explicit causal connections and goals of the stories, and children with ADHD generated fewer accurate coherence inferences that causally connected story events. Making fewer accurate coherence inferences may be a contributing factor to the broader

deficits in story comprehension. In order to more thoroughly address the relationship between coherence inference deficits and story comprehension deficits (including memory for events, comprehension of causal relations, and sensitivity to the goal plan of stories) among children with ADHD, further testing should determine if there is a mediating relationship between the two deficits.

The way that children with ADHD and comparison peers process a story and create inferences seems to be essentially different. Children with ADHD seem to fail to realize that they need to infer causal connections, or they do not know how to use these connections to guide their recall. Such problems are similar to those that are characteristic of poor comprehenders. Analogous to the results of the current study, poor comprehenders make fewer connecting, or causal inferences than do skilled comprehenders (Cain & Oakhill, 1999; Laing & Kamhi, 2002). As is the case for poor comprehenders without ADHD, it seems unlikely that children's skills will improve without intervention. Some story comprehension deficits observed in children with ADHD have been found to grow more severe as children develop (Bailey et al., 2009; Lorch et al., 2010), and this may be the case as well with the ability to generate coherence inferences. In addition, medications commonly used to treat children with ADHD do not normalize story comprehension (Bailey, et al., 2011; Derefinko et al., 2009). Research should now focus on how to prevent these deficits from becoming worse as children develop or to ameliorate these deficits. Interventions can be tested that focus on teaching children how to develop skills needed to make appropriate inferences and use story structure to guide comprehension and recall.

The second purpose of this study was to determine if being asked to think aloud during formation of a story representation would affect children with ADHD differently from comparison peers. Surprisingly, both groups seem to have been affected in the same way by the think-aloud and control conditions, as no significant interactions of group with condition were found for any recall measures. Although no studies had previously tested to see if a think-aloud task would aid story recall among children with ADHD, van den Broek et al. (2001) found diminished comprehension during their think-aloud protocol among typically developing younger children, approximately the same age as those who participated in the current study, when compared to older teenagers and adults abilities under the same circumstances. A potentially critical difference is that the current study asked children to think aloud relatively infrequently during the story task, which allowed a greater number of story events to pass by between pauses. In the current study, both groups benefited from the think-aloud experience; tending to perform better in the think-aloud condition than in the control condition on recall of events as a function of causal chain status and importance of events.

Evidence that suggests that the think-aloud condition improves recall for children with ADHD is an important finding. Whereas the effect of experiencing a think-aloud procedure does not normalize the recall of children with ADHD, both groups showed improved recall associated with the think-aloud procedure. A modification of the think-aloud task could potentially be used to help children with ADHD focus on and recall events that are significant to the story line. Perhaps, the think-aloud procedure could be used as a context to further comprehension, by encouraging children to make connections and appropriate inferences during think-aloud pauses. Children with ADHD (as well as

comparison peers) showed better recall in the current study without any guidance during pauses. By building upon this encouraging result, it may be possible to correct erroneous thinking and to focus children's thoughts on story themes and inferred causal connections. If effective, children could be taught to use these strategies on their own to improve schoolwork. Future research may empirically test whether guided think-aloud procedures can be used as a context for teaching strategies to improve comprehension.

It also may be noted that for free recall, the order in which the children experienced the conditions had an effect. Although there were no differential effects between the groups, both groups recalled a greater number of events when the think-aloud condition occurred during the first session than if the control condition occurred first. It is possible that experiencing the think-aloud condition first created performance expectations or suggested strategies that might be used during the second session. Until such an effect is replicated, any interpretation should be made with caution.

Limitations and future directions

There are several limitations to the current study. One class of limitations concerns the sample of children that was selected. Children with ADHD were recruited from previous studies, local psychiatric clinics, advertisements, and word of mouth. Children were all from the surrounding city. This method of recruiting may have led to a sample that was not representative of the entire community of children with ADHD. Similarly, the comparison children were also recruited from previous studies, advertisements, and word of mouth. For both groups, families who choose to participate in research may not reflect the general population. A second sampling issue concerns whether diagnoses were accurate. Although parents reported that a diagnosis had been

received, clinical records were not requested nor teacher interviews obtained for the children. Although errors in diagnosis are possible, such errors are unlikely because diagnoses were confirmed with detailed parent interviews and well-known and reliable rating scales. Finally, the sample size of the ADHD group was considerably smaller than the comparison group; thus it is possible that some tests did not have the necessary power to reach significance.

A second limitation is that children, as a part of the larger study, experienced a second story on control days that required them to make predictive inferences. If children experienced a control condition for Growing Pains on the first day and this predictive think-aloud task later in the same session, they may on the second day have been more likely to make predictive inferences. We do not believe this was a problem, however, as no effects were found for predictive inferences based on session order.

A third limitation is that the use of the think-aloud procedure requires pauses, which may be interruptions of story processing or opportunities for reflection. Therefore, both the think-aloud condition and the control condition of the current study incorporated similar pauses. However, it is unknown how story recall in the current study would compare with the same measures if children experienced no pauses during the stories, because including an additional condition without pauses was not feasible in the present investigation. Similarly, both conditions allowed children to play with toys during the episode. Although, toys were present inorder to produce more natural variability in attention, it is unknown how children would have performed in each condition had viewing the televised at story been the only available task.

Finally, the scope of the current study is limited to the realm of story comprehension, which is a useful domain for gaining understanding of academic deficits. However, inference generation is not limited to narrative stories, but is relevant to other academic domains. Causal relationships may have to be inferred in order to understand historical causes and effects. In a science class, causes of phenomena may have to be inferred from scientific experiments. Future research could investigate whether deficits that children with ADHD demonstrate in inference generation within narratives generalize to other subjects that children would frequently encounter in a classroom.

Chapter 5

Conclusion

The findings of this study have expanded understanding of the deficits that children with ADHD exhibit in their ability to understand stories. While in the process of comprehending an ongoing story, relative to comparison peers, children with ADHD generated fewer of the most important type of inferences: accurate coherence inferences. Problems in cognitive engagement, inattention, executive function, and working memory are potential contributing factors to the group difference in inference making. Generating fewer coherence inferences likely contributes to problems that children with ADHD experience in other domains of story comprehension. Future research should focus on creating interventions that help children with ADHD create appropriate coherence inferences in order to improve story comprehension and recall.

References

American Psychiatric Association. (2000). Diagnostic and statistical manual of mental disorders (4th ed., text revision). Washington, DC: Author.

Bailey, U. L., Derefinko, K. J., Milich, R., Lorch, E. P., & Metze, A. (2011). The effects of stimulant medication on free recall of story events among children with ADHD. *Journal Of Psychopathology And Behavioral Assessment, 33*(4), 409-419.

Bailey, U. L., Lorch, E. P., Milich, R., & Charnigo, R. (2009). Developmental changes in attention and comprehension among children with attention deficit hyperactivity disorder. *Child Development, 80*(6), 1842-1855.

Barkley, R. A. (2006). Attention-deficit hyperactivity disorder, 3rd ed.: A handbook for diagnosis and treatment. New York, NY: Guilford Press.

Berthiaume, K., Lorch, E., & Milich, R. (2010). Getting clued in: Inferential processing and comprehension monitoring in boys with ADHD. *Journal of Attention Disorders*, *14*(1), 31-42.

Cain, K., & Oakhill, J. (1999). Inference making ability and its relation to comprehension failure in young children. *Reading and Writing*, *11*(5-6), 489-503

Cain, K., Oakhill, J., Barnes, M., & Bryant, P. (2001). Comprehension skill, inference-making ability, and the relation to knowledge. *Memory & Cognition*, *29*(6), 850-859

Carrow-Woolfolk, E. (1995). *Oral and Written Language Scales Manual.* Circle Pines, MN: American Guidance Service, Inc.

Casteel, M. (1993). Effects of inference necessity and reading goal on children's inferential generation. *Developmental Psychology*, *29*(2), 346-357.

Conners, C. K. (1997). Conners' parent rating scales revised-short version. North Tonawanda, NY: Multi Health Systems.

Derefinko, K., Bailey, U., Milich, R., Lorch, E., & Riley, E. (2009). The effects of stimulant medication on the online story narrations of children with ADHD. *School Mental Health*, *1*(4), 171-182.

Flake, R., Lorch, E., & Milich, R. (2007). The effects of thematic importance on story recall among children with attention deficit hyperactivity disorder and comparison children. *Journal of Abnormal Child Psychology*, *35*(1), 43-53.

Flory, K., Milich, R., Lorch, E., Hayden, A., Strange, C., & Welsh, R. (2006). Online Story Comprehension among Children with ADHD: Which Core Deficits are Involved?. *Journal of Abnormal Child Psychology*, *34*(6), 853-865

Freer, B. D., Hayden, A., Lorch, E. P., & Milich, R. (2011). The stories they tell: Story production difficulties of children with ADHD. *School Psychology Review,* 40(3), 352-366.

Graesser, A. C., Swamer, S. S., Baggett, W. B., & Sell, M. A. (1996). New models of deep comprehension. In B. K. Britton, A. C. Graesser, B. K. Britton, A. C. Graesser (Eds.) , *Models of understanding text* (pp. 1-32). Hillsdale, NJ England: Lawrence Erlbaum Associates, Inc.

Inman, T., & Dickerson, D. (1995). Children's inferences of causal events during story understanding. *Journal of Genetic Psychology*, *156*(3), 265-277.

Kendeou, P., Bohn-Gettler, C., White, M., & van den Broek, P. (2008). Children's inference generation across different media. *Journal of Research in Reading*, *31*(3), 259-272.

Kaufman, A. S., & Kaufman, N. L. (2004). Kaufman Brief Intelligence Test, Second Edition, Manual. Minneapolis, MN: NCS Pearson, Inc.

Laing, S.P., & Kamhi, A.G. (2002). The use of Think-aloud protocols to compare inferencing abilities in average and below-average readers. *Journal of Learning Disabilities, 35*, 436-447.

Long, D. L., Oppy, B. J., & Seely, M. R. (1994). Individual differences in the time course of inferential processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*, 1456-1470.

Lorch, E., Berthiaume, K., Milich, R., & van den Broek, P. (2007). Story Comprehension Impairments in Children with Attention-Deficit/Hyperactivity Disorder. *Children's comprehension problems in oral and written language: A cognitive perspective* (pp. 128-156). New York, NY US: Guilford Press.

Lorch, E., Diener, M., Sanchez, R., Milich, R., Welsh, R., & van den Broek, P. (1999). The effects of story structure on the recall of stories in children with attention deficit hyperactivity disorder. *Journal of Educational Psychology*, *91*(2), 273-283.

Lorch, E. P., Eastham, D., Milich, R., Lemberger, C., Polley Sanchez, R., Welsh, R., et al. (2004). Difficulties in Comprehending Causal Relations Among Children With ADHD: The Role of Cognitive Engagement. *Journal of Abnormal Psychology*, *113*(1), 56-63

Lorch, E., Milich, R., Astrin, C., & Berthiaume, K. (2006). Cognitive engagement and story comprehension in typically developing children and children with ADHD from preschool through elementary school. *Developmental Psychology*, *42*(6), 1206-1219.

Lorch, E., Milich, R., Sanchez, R., van den Broek, P., Baer, S., Hooks, K., ... Welsh, R. (2000). Comprehension of televised stories in boys with attention deficit/hyperactivity disorder and nonreferred boys. *Journal Of Abnormal Psychology,* 109(2), 321-330

Lorch, E., O'Neil, K., Berthiaume, K., Milich, R., Eastham, D., & Brooks, T. (2004). Story comprehension and the impact of studying on recall in children with attention deficit hyperactivity disorder. *Journal of Clinical Child and Adolescent Psychology*, *33*(3), 506-515

Lorch, E. P., Milich, R., Flake, R. A., Ohlendorf, J., & Little, S. (2010). A developmental examination of story recall and coherence among children with ADHD. *Journal of Abnormal Child Psychology: An official publication of the International Society for Research in Child and Adolescent Psychopathology*, 38(3), 291-301.

Lorch, E., Sanchez, R., van den Broek, P., Milich, R., Murphy, E. L., Lorch, R. R., & 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: An official publication of the International Society for Research in Child and Adolescent Psychopathology*, 27(4), 293-309

Lynch, J., & van den Broek, P. (2007). Understanding the glue of narrative structure: Children's on- and off-line inferences about characters' goals. *Cognitive Development*, *22*(3), 323-340.

McGinnis, D., Goss, R., Tessmer, C., & Zelinski, E. (2008). Inference generation in young, young-old and old-old adults: Evidence for semantic architecture stability. *Applied Cognitive Psychology*, *22*(2), 171-192.

Renz, K., Lorch, E. P., Milich, R., Lemberger, C., Bodner, A., & Welsh, R. (2003). On-Line Story Representation in Boys With Attention Deficit Hyperactivity Disorder. *Journal of Abnormal Child Psychology*, *31*(1), 93-104.

Tannock, R., Purvis, K., & Schachar, R. (1993). Narrative abilities in children with attention deficit hyperactivity disorder and normal peers. *Journal of Abnormal Child Psychology: An official publication of the International Society for Research in Child and Adolescent Psychopathology*, *21*(1), 103-117.

Thurlow, R., & van den Broek, P. (1997). Automaticity and inference generation during reading comprehension. *Reading & Writing Quarterly: Overcoming Learning Difficulties*, *13*(2), 165-181.

Trabasso, T., & Magliano, J. P. (1996). Conscious understanding during comprehension. *Discourse Processes, 21*(3), 255-287

Trabasso, T., & van den Broek, P. (1985). Causal thinking and the representation of narrative events. *Journal of Memory and Language*, *24*(5), 612-630.

Trabasso, T., van den Broek, P., & Suh, S. (1989). Logical necessity and transitivity of causal relations in stories. *Discourse Processes*, *12*(1), 1-25.

Van den Broek, P., Kendeou, P., Kremer, K., Lynch, J., Butler, J., White, M., & Lorch, E. (2005). Assessment of Comprehension Abilities in Young Children. In S. G. Paris, S. A. Stahl, S. G. Paris, S. A. Stahl (Eds.) , *Children's reading*

comprehension and assessment (pp. 107-130). Mahwah, NJ US: Lawrence Erlbaum Associates Publishers.

Van den Broek, P., Tzeng, Y., Risden, K., Trabasso, T., & Basche, P. (2001). Inferential questioning: Effects on comprehension of narrative texts as a function of grade and timing. *Journal of Educational Psychology*, *93*(3), 521-529.

Van den Broek, P. (1989). Causal reasoning and inference making in judging the importance of story statements. *Child Development*, *60*(2), 286-297

Van Kleeck, A. (2008). Providing preschool foundations for later reading comprehension: The importance of and ideas for targeting inferencing in storybook-sharing interventions. *Psychology in the Schools, 45*(7), 627-643.

Appendix A

Plot summary of *Growing Pains*:

Charity Begins at Home: (Birthday)

The family children, Mike, Carol, and Ben, are seen dancing and talking on the phone when their father comes home. They quickly pretend to be doing chores and collect their allowance from their dad, which turns out to be twice the normal amount. They all realize their father's birthday is coming up. Meanwhile the Mother pretends to have forgotten the birthday so as to make a party a surprise. Mike and Carol argue about how much to spend on the birthday. Ben realizes he does not have enough money for a big present, feeling that an ashtray he made school is not a good enough present. Ben eventually prays for money, and thinks his pray is answered when a woman asking for money for the needy comes to the door. He takes the money from her, then quickly has to return it. Mike teases him and makes a sarcastic suggestion to go door to door asking for money. Later at the surprise birthday party the father begins opening presents from each member. When he opens Ben's present, which turns out to be an expensive camera, the family begins asking him where he got the money. Ben explains that he went door to door asking for money for charity, and he got the idea from God and Mike. Both Mike and Ben are punished. Ben must return the camera and money. Finally, while the father is putting Ben to bed, Ben apologizes and gives the father the ashtray he made. The father explains it is the perfect present.

Do You Believe in Magic?: (Magic)

Mike is putting off doing his homework, and instead tries to go to the arcade with a friend, Boner. He decides to get money from his brother and sister. Mike offers to teach his younger brother Ben a card trick and cons him and Carol into betting $10. Later after returning from the arcade, Ben and Carol subtly tell on Mike. Mike gets in trouble both for tricking his siblings out of money and for not doing his homework. The next day, Ben comes home is a rock he bought for $5 that he claims is magic, and apparently heals his mother's tooth ache with this rock. After the family dinner, Mike is told to clean is room, but Ben offers do clean it for a dollar with his magic rock. It apparently works, and now Mike wants to buy the rock from Ben. Meanwhile it turns out the mother and sister were hiding in the closet and had actually cleaned the room in secret. Ben convinces Mike to pay $50 for the rock. Mike tries to use the rock at school to get through a speech worth a large part of his grade, and realizes while in front of the class that he has been tricked. Back at home, the parents realized how much Ben tricked Mike into paying for the rock, and Mike's friend Boner comes over saying he too was tricked into buying the rock, for $60. After the family repays Boner, he leaves, and turns out to be meeting Mike who he is working with in conspiracy. Finally, Mike says Boner can keep the fake magic rock, Boner then tells him it is made out of a valuable material and Boner intends to sell. Everyone learns, "If you con somebody, you're gonna get hurt."

Appendix B

Growing Pains Questions:
Magic

1. Explicit- At the beginning of the show, Mike is supposed to be studying. Then, his friend Boner calls. Why did Boner call Mike? *(To see if he wanted to go to the arcade)*

2. Explicit- Boner asks Mike to go to the arcade. Even though Mike knows Dad wouldn't want him to go, Mike wants to go. Why is it still a problem for him? *(He's broke)*

3. Inferred- Why does Ben walk by Mike and say "Not a chance?" *(Mike wants money, or Mike is a con artist)*

4. Factual- Mike tries to borrow money from Boner, Carol, and Ben, but no one wants to lend him money. What does Mike offer Ben to get Ben to lend him money? *(Offers to teach him a card trick)*

5. Inferred- Why do Ben and Carol decide to bet real money on the card trick?*(Mike failed the card trick twice)*

6. Factual- After Ben and Carol bet real money, what happens when Mike tries the card trick again? *(He gets it right, or he wins, or he gets their money)*

7. Inferred- After Carol tells Dad that Mike stole money from them, why does Ben ask Mike if he spent all the money at the arcade?*(Trying to get Mike in trouble)*

8. Explicit- Why was Dad upset when he found out Mike was at the arcade playing video games?
(He was supposed to be working on his speech, studying, etc.)

9. Explicit- Why was Dad mad at Mike when he found out how Mike got the money to go to the arcade? *(He had conned Carol and Ben)*

10. Factual- Just after that, Ben tells Mom and Mike that he bought something for $5. What was it? *(A magic rock)*

11. Inferred- Ben offered to clean Mike's room for a dollar. What was another reason he offered to do this? *(To convince Mike that the rock was really magic)*

12. Factual- After Mike leaves the room, Mom and Carol come out of Mike's closet giggling. What are they carrying?*(Garbage bags, Mike's stuff, etc.)*

13. Inferred- Why did Mom and Carol come out of Mike's closet?

(They had cleaned the room and were hiding, or to convince Mike that the rock was really magic)

14. Explicit- Why did Mike's family decide to con him?*(To teach him a lesson, or because he had conned Carol and Ben, or to get Carol and Ben's money back)*

15. Inferred- Mike gets mad at Ben and lifts his hands to choke him. Why does Mike stop and call him a terrific kid instead?*(He was mad at him, but realized that he needed Ben's help)*

16. Explicit- Mike agrees to do Ben's chores and to pay him $50 for the rock. Why does Mike want the magic rock? *(To do his speech)*

17. Explicit- Why are Mom and Dad surprised when Ben comes home with a catcher's mitt?
(They wonder where he got the money)

18. Factual- That night, Boner comes over to the Seaver house and says he is angry and looking for Mike. What does he tell the Seavers that Mike did?*(Sold him the magic rock)*

19. Inferred- Boner says he bought the magic rock from Mike and nearly killed himself on his skateboard. Why is he asking Mike's parents for money? *(Mike and Boner are conning Mike's parents to get Mike's money back, etc.)*

20. Inferred- When Boner says that the chemistry teacher has offered to pay him $200 for the rock, why does Mike say that isn't fair? *(Boner tricked Mike)*

Appendix C

Growing Pains Questions: Birthday

1. Factual- After Dad comes in, he gives Mike, Carol, and Ben their allowance. What is unusual about the allowance he gives them? *(It is double, or too much)*

2. Factual- What does Ben tell Mike and Carol that he's giving Dad for his birthday?*(An ashtray)*

3. Explicit- Why does Mike think the ashtray is a stupid present for Dad?*(Dad doesn't smoke)*

4. Inferred- When Mom asks Dad if they have plans for the weekend that she doesn't know about, why doesn't Dad tell her that it's his birthday?*(He wants her to remember on her own, it would spoil it if he had to tell her, etc.)*

5. Inferred- Why do Carol and Mike argue about how much to spend on Dad's birthday present?
(Competing about looking good to Dad, trying to "one-up" each other, etc.)

6. Inferred- When Mike and Carol are talking about how much money to spend on a birthday present for Dad, why does Carol make a sound like a chicken?*(She's saying he's afraid to spend much on Dad's gift)*

7. Inferred -Ben joins Mom and Dad in the kitchen and Dad asks Ben to tell Mom exactly what Saturday is. Why does Mom wink at Ben?*(She knows it's Dad's birthday, but doesn't want Ben to let on that he knows)*

8. Explicit- Mom tells Ben that she'd like to get Dad a Mercedes car but she can't afford to, so she's getting him a fishing rod. Why does she explain this to him?
(To show Ben it's the thought that counts, not how much you spend)

9. Explicit- Ben wants more money so that he can get Dad a nicer gift. He is watching TV and gets down on his knees to pray to God for money. Why did he decide to pray for the money? *(He got the idea from a TV minister)*

10. Explicit- A the woman comes to the door collecting money for the needy and Ben takes the can. Why does Ben say that he took the can? *(Because he's needy too)*

11. Factual- Ben asks Mike what to do to get money. What does Mike tell him to do?*(Go door to door asking)*

12. Explicit- Why was everybody surprised that Ben gave Dad a camera?*(It's expensive)*

13. Inferred- When Ben said he got the money for the camera by collecting money for the needy, why does Mike look shocked and start to walk away?
(Because he knows he gave Ben the idea)

14. Factual- When Mom asks Ben where he got the idea to collect money from the neighbors, Ben names two things. One is Mike. What is the other? *(God)*

15. Inferred- As dad is questioning Ben about why he collected money from the neighbors, why does Ben remind Dad that the camera is self-winding and automatic focus?
(To distract him from punishment, get his mind off of it, to make him want to keep the gift)

16. Explicit- Ben suggests that his punishment should be going to bed at 9:00 every night for a week. Why does Dad say that can't be his punishment?*(That is already his bedtime)*

17. Factual- Ben has to return the camera. What else does he have to do as part of his punishment?
(Return the money to the neighbors and/or apologize)

18. Inferred- Why does Mike bring Mom a cup of tea and a muffin?
(To placate her, so he won't have to donate a month's allowance)

19. Explicit- Why does Dad say the ashtray is a good gift to use with some of his patients?*(Because they're trying to quit smoking)*

20. Inferred- The ashtray looks like a heart. Why would that help Dad's patients stop smoking?
(It reminds them of their own heart, and smoking is bad for your heart)

Appendix D

The Father, His Son, and Their Donkey (Before Experimental Condition ONLY)

A father and his son were taking their donkey to town to sell him at the marketplace. They had not gone a great distance, when they met a group of pretty maidens who were returning from the town. The young girls were talking and laughing when one of them cried out, "Look there. Did you ever see such fools, to be walking along side the donkey when they might be riding it?" The father, when he heard this, told his son to get up on the donkey, and he continued to stroll along merrily. The traveled a little further down the road, and soon came upon a group of old men talking. "There," said one of them, "that proves what I was saying. What respect is shown to old age in these days? Do you see that idle young boy riding the donkey, while his father has to walk?" (**Pause 1)**
"You should get down and let your father ride!" the old men said. Upon this the son got down from the donkey and the father took his place. They had not gone far when they happened upon a group of women and children. "Why, you lazy old fellow, you should be ashamed." cried several women at once. "How can you ride upon the beast, when that poor little boy can hardly keep up with you?" So the good-natured father hoisted his son up behind him. By now they had almost reached the town. "Tell me friend," said a townsman, "is that donkey your own?" "Why yes," said the father. "I would not have thought so," said the other, "by the way you overwork him. Why, you two are strong and are better able to carry the poor beast than he is to carry you." (**Pause 2)**
"Anything to please you, sir," said the father, "we can only try." So he and his son got down from the donkey. They tied the animal's legs together, and, taking a pole, tried to carry him on their shoulders over a bridge that led to the marketplace. This was such an odd sight that crowds of people gathered around to see it, and to laugh at it. The donkey did not like to be tied. (**Pause 3)**
So, the Donkey kicked so ferociously that he broke the rope, tumbled off the pole into the water, and scrambled away into the thicket. With this, the father and his son hung down their heads and made their way home again, having learned that by trying to please everybody, they had pleased nobody, and lost their donkey, too.

Curriculum Vitae

Jessica Kosloski
Born: 8/20/86 in Mayville, NY

Education:

University of Kentucky, Master of Science Degree — Developmental Psychology
Expected May, 2012

Thesis: "Inference Generation During Story Comprehension Among Children with ADHD"

Franciscan University of Steubenville, Bachelor of Arts Degree — Major: Psychology
(Cum Laude) — Minor: History
May, 2009

Professional Positions Held:

Research Assistant — 2010 - Present
Story Comprehension Laboratory

Grading Assistant — 2010-Present
Personality, Brain and Behavior, Developmental Psychology

Research Assistant-
Science Education Project — 2009-2010

Teaching Assistant
Introduction to Psychology — 2009-2010

Undergraduate Research Assistant — 2008-2009
Psychology Statistics

Scholastic and Professional Honors

Fellowships/Grants

RCTF Travel Award — 2010, 2011
Graduate School Travel Award — 2010, 2011

Awards

The Gemelli Award in Psychology — 2009
Franciscan University of Steubenville

Publications

Submitted for Review:

Lorch, R.F., Lorch, E.P., Freer, B.D., Dunlap, E., Calderhead, W., **Kosloski, J.S., &** Chen, H.T., *Two Instructive Failures to Improve Student Learning of the Control of Variables Strategy.* Cognition and Instruction.

Invited Symposium

Presentations

Freer, B.D., Dunlap, E., **Kosloski, J.S.**, Chen, M., Calderhead, W., Lorch, E.P., Lorch, R.F. *Very long-term effects of teaching the Control of Variables Strategy to elementary school children.* Poster to be presented at Society for Research on Child Development, Montreal Canada. 2011

Kosloski, J.S., Chen, H.T., Freer, B.D., Dunlap, E., Calderhead, W.J., Lorch, E.P., Lorch, R.F. *Effects of variable complexity and planning support on 4th graders acquisition of the Control of Variables Strategy.* Poster presented at Children at Risk Conference, Lexington, Kentucky. 2011

Kosloski, J.S., Chen, H.T., Freer, B.D., Dunlap, E., Calderhead, W.J., Lorch, E.P., Lorch, R.F. *Effects of variable complexity and planning support on 4th graders acquisition of the **Control** of Variables Strategy.* Poster presented at Society for Research on Child Development, Montreal, Canada. 2011

Kosloski, J.S., Hayden, A., Lorch, E., Milich, R. *Inference Generation and Story Comprehension Among Children with ADHD.* Poster presented at Children at Risk Conference, Lexington, Kentucky. 2012

Milich, R.S., **Kosloski, J.S.**, Hayden, A., & Lorch, E.P. *Inference making difficulties among children with ADHD.* Invited symposium at Association for Psychological Science Convention, Chicago, Illinois. 2012