READING COMPREHENSION DEFICITS IN STUDENTS WITH ADHD: CAUSES AND INTERVENTION STRATEGIES

by
Dawn Tolsma Hovie

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN EDUCATION AT NORTHERN MICHIGAN UNIVERSTIY

November 29, 2012

Table of Contents

Abstract

The connection between ADHD and reading comprehension deficits has been the topic of numerous studies over the past decade. This research of the literature found that working memory deficits contributed comprehension problems. Specifically metacognition, causal connections, and making inferences are directly linked to the inability to suppress no longer relevant information. However, this review went one step further to investigate literature which studied effective academic intervention strategies which could improve reading comprehension in students with ADHD, including self-monitoring and stimulant medication. Unfortunately, studies were scarce which led to a recommendation in which promising strategies could be studied using qualitative research within the classroom setting. Implications of these results could guide future academic interventions.

Chapter 1: Introduction

Within the past decade ADHD has been widely studied as it is one of the most commonly diagnosed behavioral conditions affecting children (Lorch, Milich, Flake, Oldendorf, & Little, 2009). The purpose of this document is first, to explore the connections to and reasons for reading comprehension deficits in children with ADHD. The second purpose is to discover strategies which could be used to improve reading comprehension skills in these students.

Background

Comprehension has been the topic of many studies in recent years; the primary reason is that approximately 10% of school-aged children show significant impairments in reading comprehension performance (Nation & Pimperton, 2010). More specifically, students with Attention Deficit/Hyperactivity Disorder (ADHD) exhibit reading disabilities in the area of comprehension. ADHD and reading disability are two of the most common diagnoses of school aged children and show lower than average reading comprehension with both groups displaying decreased academic motivation over time (Beike & Zentall, 2012). Students with ADHD can typically decode quite well in comparison to their peers. However, when asked to summarize, answer questions, infer, make connections, or visualize, students with ADHD are unable to demonstrate these skills. Children with ADHD experience problems in the focused and selective components of attention. They are inaccurate in processing information and might also have memory retrieval problems (Aaron, Joshi, Palmer, Smith, & Kirby, 2002). In fact, children with ADHD experience significant impairments in regards to the major components of story processing (Lorch, Milich, Flake, Ohlendorf, & Little, 2009). While some research exists, there

is a gap in the literature pertaining to remediation of comprehension difficulties in students with ADHD. Knowing why students with ADHD fail to comprehend written information will enable teachers to develop remediation strategies within classroom settings. Teachers of students with ADHD encounter unique challenges when attempting to remediate comprehension difficulties. Cognitive processes and executive function (including working memory and cognitive inhibition) intervention strategies show promise for guiding teachers to develop or implement effective remediation techniques.

Statement of the Problem

Teachers struggle with determining how to remediate comprehension problems with students who have ADHD. Although common treatment options for students with ADHD have been psychostimulant medication and incident managing strategies, the impact of these strategies on educational achievement were insignificant (Jitendra & DuPaul, 2007). For example, research was done using covered overlays on reading selections. Improvement for students with ADHD was immediate, but lost impact over time, (Beike & Zentall, 2012). Since comprehension requires more abstract thinking than decoding skills, teacher should know factors contributing to the problem, which is necessary for determining remediation strategies. Even though ADHD has been investigated extensively (Aaron, et.al. 2002), research in the area of remediation of comprehension deficits for students with ADHD is relatively new (Nation & Norbury, 2005). Many books have been published recently on reading comprehension. However, little has been found to address reading comprehension deficits related specifically to ADHD. A variety of

intervention strategies including Direct Instruction methods show promise in the area of comprehension; however, research studies are limited (Florez & Ganz, 2009).

Research Questions

1. What specific areas of deficit are common in students (grades K-8) with ADHD that limit comprehension of reading selections?
2. What intervention strategies have been effective in increasing comprehension skills in elementary and middle school aged students with ADHD?

Definition of Terms

Attention deficit/hyperactivity disorder (ADHD). Students with ADHD display developmentally inappropriate levels of inattention and/or hyperactivity-impulsivity that occur in more than one setting (Aaron, et.al. 2002).

Reading comprehension. Reading comprehension can be defined as understanding the written message that has been deciphered or decoded. This includes the ability to "select, encode, interpret, and retrieve relevant information, use story structure and background information, and draw inferences from the information presented" (Lorch, Berthiaume, Milich, & van den Broek, 2007).

Deficit. Deficits in reading comprehension are connected to impairments in decoding and word recognition, fluency and reading speed, oral language skills, and executive function including working memory and cognitive inhibition (Locascio, Mahoney, Eason, & Cutting, 2010).

Intervention strategies. Academic interventions are directly and explicitly taught which include teacher modeling, guided practice, and independent practice, (Beers, 2003).

Effective. An effective intervention strategy would be one in which the teacher models and explains and then the student practices the strategy independently with a range of texts (Beers, 2003).

Significant growth. Expected growth in reading is a year's growth for a year's classroom time. Significant growth would mean an accelerated rate of achievement that would be more than a year's growth over the course of a school year.

Elementary and middle school-aged children. For the purposes of this paper, elementary and middle school-aged children will be defined as those students in kindergarten through grade 8.

Theoretical Framework

Vygotsky theorized that children do not accumulate and rebuild thinking as individuals, but accept knowledge gained through interaction in society. Society is the very organizing principal for accumulating thinking and knowledge. Furthermore, the mentor draws upon these relationships between experiences to instill important social tools to the child and therefore drawing that child toward socially defined goals. The mentor systematically introduces new knowledge so that children can understand and develop concepts individually. The mentor creates learning situations so children can recognize mastery of an activity through interaction with the mentor (Glassman, 2001). Because students with ADHD are unable to make

connections, understand inferences, visualize, or answer questions, the teacher (mentor) must directly link those meanings to the children's experiences in the environment. If the mentor does not know what areas of deficit are found to be common in student with ADHD, the likelihood of success with academic intervention will be limited. Both background knowledge of the source of the problem and use of research based interventions will enable the teacher (mentor) to create effective situations of learning specifically for students with ADHD.

Summary

The assumption continues to be verified that students with ADHD truly show significant weakness in the area of reading comprehension. This review of literature will attempt to develop an understanding of reading comprehension difficulties in students with ADHD and then review the methods that studies have shown to improve comprehension skills for this population of students.

Chapter II: Review of the Literature

Reading Comprehension and ADHD

Attention Deficit/Hyperactivity Disorder (ADHD), was defined by Cardo & Severa (2003) as a condition in which children and adolescents exhibit a variety of inappropriate behaviors including hyperactivity, impulsivity, and inattention (as cited in Avarado, Puente, Jimenez, & Arregillaga, 2011). ADHD and Reading Disorder (RD) are typically associated with one another. August and Garfinkel (1990) estimated that the comorbidity of ADHD & RD were between 15% and 50% which depended on the criteria used to identify them (as cited in Avarado, Puente, Jimenez, & Arrebillaga, 2011). Extensive documentation of academic difficulties exist in regards to children with attention deficit/hyperactivity disorder (ADHD), yet

little is known about the developmental course of cognitive processes related to those difficulties. According to Lorch, Berthiaume, Milch, & van den Brock (2007), children with ADHD experience significant impairments that correspond to the major components of story processing including story structure and background information, making inferences and determining causal relations among story events(as cited in Lorch, Milich, Flake, Ohlendorf, & Little, 2010).

Effects of ADHD on reading comprehension. A study conducted by Asberg, Kopp, Berg-Kelly, & Gillberg (2010) had three aims. First, examine performance on standardized tests on reading decoding, reading comprehension, and spelling. Second, examine the rates of reading and writing disorders in students with ADHD and students in with ASD. Third, examine the basis of the connections between ADHD and ASD as they affect literacy. Reading comprehension has been shown to be an area of deficit for students with ADHD and ASD.

The children were tested on word decoding, spelling, reading comprehension, non-verbal ability, oral vocabulary, inattention and hyperactivity/impulsivity, and autistic symptomology. For the purposes of this paper, only the ADHD comprehension scores were examined. Overall, the girls with a main diagnosis of ADHD performed statistically lower than the control girls in the areas of reading decoding, comprehension, and spelling. Asberg et al. agreed with previous findings on all boy or mixed gender sample of general reading difficulties among children with ADHD.

The two most prevalent developmental disabilities in school children are learning disabilities and attention-deficit/hyperactivity disorder. Children with either reading disabilities (RD) or attention deficit/hyperactivity disorder-inattentive (ADHD-I) can experience difficulties

in reading comprehension. Efforts to separate true reading disabilities from disabilities related to inattention have not been overwhelmingly successful. This is because most assessments cannot differentiate poor performance on a test of reading comprehension due to and inability to retrieve information quickly or an inability to focus attention on the selection. Aaron, Joshi, Palmer, Smith, & Kriby (2002) conducted a research of 50 children at risk of reading failure in grades two through five to develop a clinical tool that could be useful in differentiating RD, ADHD-I, and RD + ADHD-I.

The mean reading comprehension score for the ADHD group was 95% and the RD group scored about 83%, which was well below average. The word attack score for the ADHD group was 92 and for the RD group was 78. The ADHD group fell close to the below-average range (85.52) for listening comprehension even though they scored with the average range for reading comprehension. What was interesting was that these scores are typically seen with students who have reading decoding difficulties (RD) which the ADHD group did not. Children with both ADHD and RD had difficulties in both areas and students with primarily ADHD showed difficulty with listening comprehension. One explanation was that listening comprehension required more sustained attention than reading. Therefore, children who have inconsistent attention might be penalized more on listening tasks than on reading tasks. This can be important information for teachers when they are trying to determine whether a comprehension problem is due to decoding problems or inattention. The results of this study although informative, did not address the question of reading comprehension problems in students with ADHD as the students in this study scored within the average range for reading comprehension.

A study by Lorch, Milich, Flake, Ohlendorf, & Little (2010), involving a total of 155 children was conducted to investigate and compare patterns of developmental change in story comprehension among children with ADHD and comparison children. A special focus was to determine the children's ability to include important information in story recall as well as communicating a coherent story representation. Fifty-seven children had been previously diagnosed with AHDD and the other 98 children were part of the comparison group.

The results of this study can be discussed with respect to each of the three developmental patterns of change. There was no support for the theory of developmental delay in story comprehension among children with ADHD. The hypothesis that early group differences remain stable through elementary school years was found to be consistent. However the patterns of effect over time were a bit different for the two measures of coherence. In regards to understanding the development of story comprehension in children with ADHD, findings showed that over time these children increased in the total number of story events they were able to recall. However, the control group children recalled more events than the children with ADHD. Also, older children with ADHD showed limited improvement over time.

Lorch, et al. (2010) noted two limitations. One was that production features used in the program (*Rugrats)* might have signaled the purpose of the show as being entertainment which may have influenced the nature of the story depictions that the children were likely to construct. Second the goal structures for the episodes may have been too complicated for younger children. However, the consistent patterns of performance across ages, groups, and thematic importance suggest that the program characteristics did not prevent valid or reliable information about the

children's story recall from being acquired. This study showed that the recall of students with ADHD was impaired as compared to their non-impaired peers. In addition to that, children with ADHD tended to lose ground in the ability to communicate clear story representations which highlighted the need for intervention strategies designed to keep children with ADHD from falling further behind their peers.

Cognitive tempo. Until 1989, most of the research on metacognition was based on contrasting subjects at different ability or developmental levels. Although cognitive tempo, which refers to the ways in which children respond in choice situations, had been studied widely, individual differences in comprehension monitoring had been for the most part, ignored. A quantitative study by Walczyk and Hall (1989) attempted to fill this gap by determining the significance of cognitive style as an aspect of individual differences. At the time, students with what is now known as ADHD were referred to as *impulsive* in this study and were compared with students who were referred to as *reflective.* The purpose was to support the argument that distinguishing inconsistent information in stories is in some ways similar to noticing detailed information contained in a sentence or picture. Walczyk & Hall hypothesized that reflective children would be more proficient at detecting errors than impulsive children.

The subjects consisted of forty-eight third and forty-eight fifth graders, equally male and female, drawn from a predominately white, suburban, middle-class school with no rationale given for the demographics. Of those students, twelve third graders and seventeen fifth graders were said to be reflective whereas thirteen third graders and seventeen fifth graders were classified as impulsive.

An analysis of covariance (ANCOVA) was computed for the data measuring whether subjects detailed information in memory for inconsistencies. The results showed a highly significant cognitive tempo main effect, $F(1, 55) = 14.77$, $MS = 0.69$, $p < .01$ which revealed that reflective children had significantly more of the critical information retained in memory. Reflective children could get crucial comprehension items correct 77% of the time while impulsive children got 67% of items correct. Additional analysis showed 57% of reflective students could detect inconsistencies compared to only 47% of impulsive children. However, impulsive and reflective children failed to detect inconsistencies for different reasons. The results demonstrated that reflective children were more likely to encode crucial information into memory than impulsive children, which was consistent with the proposed global-analytic framework. Although there were many variables affecting comprehension monitoring, reflective children were better at detecting errors because they focused on integrating detailed information in the passage, which is something the impulsive children did not do. Walczyk & Hall concluded that impulsive children were more likely to overlook inconsistencies.

ADHD and Brain Research

Executive function. Deficits in word recognition and oral language skills have been widely studied and have been shown to negatively affect reading comprehension. However, considerably less research has focused on other likely contributors to reading comprehension deficits in children with solid word recognition skills. A quantitative study was conducted by Locascio, Mahone, Eason, and Cutting (2010) to examine a wide range of executive function among children with word recognition deficit (WRD), specific reading comprehension deficit (S-

RCD) without word recognition difficulties, and typically developing children. The purpose was to examine a wide range of executive function skills and to determine if there were patterns of executive dysfunction unique to reading difficulty; which is important as previous studies had been limited in terms of which aspects of executive function were studied. Very few studies included S-RCD and WRD groups.

Executive function (EF) refers to a set of cognitive processes used in the management of goal-directed behaviors and the implementation and development of completing tasks that have not been routinely performed. EF includes such core processes as working memory, response inhibition, and planning. These are all cognitive skills which are necessary for reading comprehension. Likewise, students with ADHD-related executive function deficits experience poor reading comprehension even though they may not have word reading deficits. In regards to reading comprehension, the hypothesis for this quantitative study was that children with S-RCD would manifest deficits in components of executive function related to reading comprehension. Specifically, planning/organization would be studied with an open question being whether or not S-RCD would show deficits in other areas of executive function.

Executive function skills were widely measured in order to capture a diverse range of functions relevant to the development of word recognition and comprehension skills. EF skills measured were working memory using spatial span and digit span, planning, organization, and self-monitoring. The results of this study confirmed that children with reading disorders perform poorly on measures of executive function. On the whole, findings strongly suggested that children with specific reading comprehension deficits demonstrated executive dysfunction in

strategic planning. Locascio, Mahone, Eason, and Cutting found evidence to support the role of strategic planning in reading comprehension in that the children with reading comprehension deficits performed poorly in this area as opposed to the children with WRD who did not. Furthermore, these deficits remained even after controlling for contributing ADHD symptoms. Therefore, findings strongly suggest that the relationship between executive function and reading comprehension does not appear to originate exclusively from word recognition deficits. Findings suggested that the contribution of executive function skills were necessary for the development of reading comprehension.

Working memory. Word reading and reading comprehension go hand-in-hand for the majority of children. However, for some children, reading comprehension deficits can be observed due to impairments in working memory processes. It has been well documented that working memory is necessary for reading comprehension. Working memory falls under the larger umbrella of executive functioning. These tasks involve attentional control and are associated with a child's ability to complete typical academic tasks such as following directions. Children with poor working memory may show academic skill deficits. Difficulties in working memory are associated with weakness in organizing information, planning, and monitoring school work. The structural and functional role of working memory reading comprehension and how it is explained depends on the theoretical approach. Working memory is defined as a system of simultaneous storage and processing of information (Nation and Pimperton, 2010).

Variations in working memory ability are a vital predictor of educational outcomes. In order to build a coherent understanding of text while reading it, it is necessary to hold

information described by the text as well as at the same time, updating new information as it becomes available, particularly if the new information does not correspond with previous information. Cain (2006) and Yuill, Oakhill & Parkin (1989) explained that because of this relationship between working memory and comprehension, children with specific reading comprehension deficits show impairments in working memory (cited in Nation and Pimperton, 2010). Along with working memory problems are difficulties with cognitive inhibition, which result in the inability to suppress irrelevant information.

When Nation and Pimperton (2010) examined previous research into the suppression weaknesses of poor comprehenders, De Beni and Palladino (2000) made the assumption that there was a domain general, central executive problem with regulation of the contents of working memory (cited in Nation and Pimperton, 2010). However, if poor comprehenders did have a domain-general problem regulating the contents of working memory there would be a detrimental impact on both verbal and visuospatial working memory tasks. Nation and Pimperton conducted three separate experiments. Experiment one asked whether the dissociation between verbal and non-verbal working memory would be reproduced when children were compared on standardized and co-normed tests of visuospatial and verbal spans. Experiments two and three hypothesized that poor comprehenders' difficulties on suppression tasks would be limited to the verbal domain.

The memory skills of poor comprehenders were assessed in Experiment 1 using standardized tests. The researchers predicted that poor comprehenders would show normal short-term memory, which is assessed by the forward digit span, but poor working memory. Short-

term memory is different from working memory in that short –term memory can hold a very limited amount of information which can only be accessed temporarily. However Cowan (2008) explained that working memory is used to hold and process information while new information is received, requiring attention-related processes (cited in Nation and Pimperton, 2010). Because previous studies such as Nation, Adams, Bowyer-Crane, & Snowling (1999) used non-standardized tests, this study used co-normed and recently standardized tests to assess the claim that poor comprehenders' deficits were specific to the verbal domain (as cited in Nation and Pimperton, 2010). Pimperton and Nation predicted that those with poor comprehension skills would show deficits similar to control children on standardized tests of verbal, but not visuospatial, working memory. As Pimperton and Nation had predicted, no significant differences were found between the poor comprehenders (M=46.64, SD 6.35) and control group (M=49.43, SD 5.18). Findings also demonstrated that poor comprehenders' difficulties on working memory tasks were specific to the verbal domain.

After determining that poor comprehenders show memory deficits specific to the verbal domain within working memory, Pimperton and Nation developed a proactive interference paradigm which explored suppression in both the verbal and non-verbal domains for Experiment 2. Pimperton and Nation (2009) defined proactive interference (PI) as the interfering effect of previously encoded information on the recall of more recent information (as cited in Pimperton & Nation, 2010), which means that poor comprehenders have more trouble suppressing no-longer-relevant information from working memory than the controls. The children were given verbal PI and nonverbal PI assessments consisting of verbal memory and visual memory tasks.

The results of the verbal PI task showed no significant difference between poor comprehenders (M=4.43, SD = 1.65) and controls (M=5.29, SD=1.54) on the non-interference control trials. However, on trials including interference trials, poor comprehenders (M=2.50, SD=1.29) performed significantly below the controls (M=3.79, SD=1.05). The findings from Experiment 2 were clear in showing that poor comprehenders made more intrusion errors in the verbal proactive interference task. What was shown for the first time was that the suppression deficits of poor comprehenders were specific to the verbal domain. Pimperton and Nation found no evidence of group differences on nonverbal proactive inferences tasks.

Finally, Experiment 3 was performed by Pimperton and Nation to compare a verbal recognition task directly with a non-verbal recognition task. Once again, the results from Experiment 3 reinforced the results from Experiment 2. The poor comprehenders made more intrusion errors in recognition and recall versions of the verbal PI task, which was not the case in the non-verbal PI task. Pimperton and Nation concluded that poor comprehenders' suppression deficits are limited to the verbal domain. These findings conflict with the idea that poor comprehenders' difficulties originate from working memory in both domain-specific slave systems. Furthermore, the more difficult the verbal processing demands, the greater the difficulties in suppressing information that is no longer needed.

Carretti, Borella, Cornoldi, and DeBeni (2009) used a meta-analysis to examine the relevance of several working memory measures in order to distinguish between the performance of good and poor comprehenders in relation to the modality of the working memory task and the level of attention required to achieve that task. The purpose of this meta-analysis was to clarify

the specific role of working memory in reading comprehension difficulties of children with average decoding skills and intelligence and to the attentional control involved.

The authors carried out a search of published literature to find studies in which working memory was assessed in individuals with reading comprehension difficulties. The inclusion criteria allowed the authors to find 18 articles for use in the meta-analysis. The first criterion for inclusion was that articles included a group of children with poor comprehension abilities but reading levels within the normal ranges. The second requirement was that the articles had to include comparison groups of normally developing children. Finally, articles had to include a selection of good and poor comprehenders on the basis of standardized reading tasks in which poor comprehenders scored at least 2 standard deviations below average.

Through the examination of the *d* values, Carretti, Borella, Cornoldi, and DeBeni concluded that reading comprehension abilities vary according to the conditions and attentional control required. When verbal material is involved, poor comprehenders are at a disadvantage as compared to good comprehenders. However, poor and good comprehenders were comparable when it came to visuo-spatial complex span tasks. Thus, poor working memory performance of poor comprehenders depends partly on working memory modality, attentional control, updating, and intrusion errors. This meta-analysis showed that the working memory deficit of poor comprehenders related to tasks requiring storage and processing of information while updating memory content information and inhibiting irrelevant information. However, this is only true when considering verbal complex span tasks as opposed to visuo-spatial working memory complex span or verbal simple span tasks. Finally, the question was posed as to whether or not

verbal memory could be enhanced. Of the few studies found by the researchers that addressed the enhancement of verbal memory, evidence seemed to point to the use of mnemonic devices or decreasing attentional control demands. However, no suggestions are given as to activities that might assist in decreasing attentional control demands.

Cain's (2006) review of children with accurate decoding but reading comprehension difficulties establishes that the relations between semantic skills, inhibition-related processes, and poor comprehenders' verbal memory abilities are unclear. Cain conducted three experiments consisting of two groups of nine and ten year olds.

The first experiment consisted of two short term memory tasks consisting of a standard digit recall test and a word recall task. Each test had low processing demands involving just storage rather than storage and processing which would indicate working memory access. The results indicated that the good and poor comprehenders did not differ in their short –term retention and recall of words and digits. The findings strongly suggested that not all poor comprehenders have short-term memory problems which contributed to semantic factors. Likewise, the poor comprehenders did not have any obvious difficulties with vocabulary knowledge. Group differences did indicate that poor comprehenders made a greater number of intrusion errors. There could possibly have been an unreported comorbidity of children with ADHD in the poor comprehenders group as children with ADHD tend to have more intrusion errors than student without an ADHD diagnosis. Cain also noted that poor comprehenders were less likely to eliminate no-longer-relevant information from memory, which is also common in children with ADHD.

In Experiment 2, both groups completed two measures of working memory which required simultaneous processing and storage of symbols that could be supported by verbal codes. Although the poor comprehenders and good comprehenders did not differ in the short term memory tasks from Experiment 1, the poor comprehenders did more poorly on both tests of working memory. These scores became more significant as the storage load increased. The difference in scores was more prominent in the working memory sentence task than on the working memory counting task. These results support the hypothesis that poor comprehenders may be less able to use semantic skills to assist with memory. Poor comprehenders were less likely to recall an item in the correct position as compared to the control group.

The task for Experiment 3 consisted of two phases. The first phase was a sentence-completion and study phase while the second phase was an implicit memory task. The purpose of this experiment was to determine whether poor comprehenders differed in their ability to inhibit words that were no longer relevant ("direct ignoring") as compared to the control group. The good comprehenders in the disconfirmed and target conditions did not produce scores that differed significantly. However, poor comprehenders scores were significantly lower ($p<.05$) than in the target condition. This finding suggested that the poor comprehenders' performance on the priming tasks could not be credited to problems in sentence comprehension or word activation and retrieval abilities. For the inhibition task poor comprehenders found it harder to suppress no-longer relevant information when clearly directed to do so. The results of Experiment 3 demonstrated that poor comprehenders may have a generalized deficit in their ability to inhibit no-longer relevant information. Again, these findings were consistent in

children with ADHD even though this study did not specifically address children with comorbid ADHD and comprehension problems.

The literature continues to be relatively consistent in documenting working memory impairments in children with attention-deficit/hyperactivity disorder as compared to typically developing peers. A study by Kofler, Rapport, Bolden, Sarver, and Raiker (2009) investigated whether inattentive behavior in children with ADHD is linked to the domain-general central executive and/or lesser storage/probationary components of working memory. The central executive is an attentional controller responsible for overseeing and coordinating the secondary systems. Its primary functions are focusing attention, dividing attention among simultaneous tasks, and providing a boundary between long-term and short-term memory. The study used three tasks to test hypotheses regarding the probable relationship between working memory components and inattentive behavior in children.

Measurement tasks included, visual attention to task, phonological (PH) working memory task, visuospatial (VS) working memory task, and control (C) conditions. The control conditions were given before and after the phonological and visuospatial tasks. Children were allowed to use an interactive paint computer program to control for demand characteristics. Interestingly, the program was also used to provide an experimental means by which to make comparisons between tasks that require and do not require central executive processing. Those scores were averaged separately. The final task measured intelligence.

Findings by Koefler, Rapport, Bolden, Sarver, & Raiker (2009) showed that group differences in attentive behavior were not evident across conditions after controlling for working memory abilities. The working memory performance of children with ADHD remains

considerably impaired across modalities after allowing for differences in attentive behavior. This study demonstrated a functional relationship between working memory and children's attentive behavior. These findings suggest that working memory demands manipulated experimentally in a controlled environment may be similar to those experienced in classroom settings. These findings indicate that inattentive and hyperactive behaviors in children with ADHD are related to central executive deficits and that attention is impaired in all children when task demands exceed storage/rehearsal capacities.

The finding that children with ADHD are not less attentive than typically developing children after allowing for their working memory deficits, may explain why children with ADHD remain engaged in certain tasks and activities with no deficits in attention (e.g. television, video games) yet display significant difficulty maintaining attention during most academic learning activities within the classroom setting. This is an important consideration when planning for instruction for students with ADHD that experience difficulties with reading comprehension.

Metacognition. Comprehension monitoring consists of awareness of one's ongoing understanding of the text and identifying when gaps in comprehension are present so that steps can be taken to fill in those gaps with missing information. The purpose of a study done by Alvarado, Puente, Jimenez, and Arrebillaga (2011) was to examine the cognitive functioning of students with Attention Deficit/Hyperactivity Disorder (ADHD). This study was conducted in order to discover the impact of executive function on metacomprehension. The primary hypothesis was that those with ADHD would perform worse on metacomprehension tests because of their need to invest more cognitive resources to recognize words. The study by Alvarado et al. consisting of 187 Argentine students (93 of which were diagnosed with ADHD)

had two objectives. The first was to examine executive functions of students with ADHD by evaluating metacognition as it applies to processes, situations, and variables involved in reading comprehension. Second, the researchers evaluated the diagnostic utility of metacognitive tests in classifying symptom characteristics of children ADHD as compared to similar characteristics of students without the disorder.

The confirmation of a close relationship between ADHD and the components of comprehension and metacognition that form part of RD was the main result of this research. These results bring to light that some of the learning deficits observed in children with ADHD might relate more to their metacognitive functions than to just reading comprehension because when the subjects' reading levels were equalized, the children with ADHD continued to exhibit a clear weakening in cognitive level. Executive functions were found to be important to metacognitive processes.

Berthiaume, Lorch, & Milich (2010) conducted a study to examine the ability of children with ADHD to monitor ongoing understanding of text. In order to determine the cause of academic difficulties, the types of problems children displayed had to be explored. The purpose of this study was to extend the story comprehension literature to include an examination of aspects of story comprehension critical to academic performance among children with ADHD. These aspects included the ability to make appropriate inferences and to monitor ongoing comprehension. van den Broek, Kendeou, Kremer, Lynch, Butler, White, et al. (2005) defined inferential processing as the process of using information from texts and stories to obtain meaning of unknown words or phrases or to make connections between ideas or events in the text and is needed to connect story events in order for the reader to integrate them into a coherent

mental representation (cited in Berthiaume, Lorch, & Milich, 2010). Berthiaume, Lorch, & Milich had two purposes for their investigation. First, it examined how children with ADHD generated and evaluated explanatory inferences. The second purpose was to investigate how children with ADHD monitored their ongoing understanding of text events and how they retrieved relevant information. The ADHD group was expected to perform poorly compared to the comparison group on forming and maintaining accurate inferences as well as having difficulty monitoring the connections they made.

The findings suggested first, that children with ADHD had difficulty understanding causal relations among story events. Second, findings indicated that children with ADHD based understanding of stories on some inaccurate information, leading to incorrect explanations for story events. Third, children with ADHD had difficulty self-monitoring comprehension during reading. Without the skills to monitor understanding of comprehension, children were less likely to take steps to implement fix-it strategies such as questioning and re-reading. Finally, because impulsivity is a core symptom of ADHD, responses contained more irrelevant information than responses given by students without a diagnosis of ADHD. The limitations to this study related to the lack of strategies for teachers to use when remediating reading comprehension difficulties in students with ADHD.

Positive and retroactive interference. Reduced self-control is one of the hallmark symptoms of ADHD which is responsible for the majority of academic failure that students with ADHD experience. A study conducted by Brown, Reichel & Quinlan (2011) asked three questions. The first question asked whether there was a lack of semantic organization during

reading. The second question asked whether there was an impaired build-up of proactive interference (PI), a normal process in which previous learning interferes with new learning. The third question was if there was an elevated retroactive interference (RI), the phenomenon in which new learning interferes with effective retrieval of prior knowledge. Simply put, PI depends on the original learning material still being remembered while RI is forgetting due to new learning overriding the effect of old learning. This created the hypothesis that the participants with ADHD would display a larger RI than the control group. The final question was regarding serial position effect. Serial position effect states that the most difficult items to remember from a list are the words in the middle of a list because they exceed the attention span of the participants. Brown, Reichel and Quinlan (2011) expected to find that participants with ADHD would not be able to remember items from the middle section of a list. Specifically, Brown Reichel and Quinlan sought to show that impaired effort is an additional symptom of ADHD in addition to the comorbid symptoms of hyperactivity, inattention and impulsivity.

The findings showed that participants with ADHD apply less effort in learning strategies and that it could not be justified by differences in IQ or comorbid ODD which suggested that difficulty in free-recall causes reduced motivation and could explain memory impairments in children with ADHD. A limitation of this study was that the ADHD students were slightly older, but had lower IQ's than the control group. Also the sample was not random, as teachers nominated students from their classes and the ADHD group participants were chosen as well.

The information from this study can be important for teachers as they learn to understand how children with ADHD may not be simply avoidant of work, but rather are overwhelmed by it.

Focusing on the determiners of impaired performance such as RI and PI could lead the way to new ideas for the development of unique interventions that take these difficulties into consideration.

Intervention Research

Effects of stimulant medications. Attention Deficit/Hyperactivity Disorder (ADHD) affects approximately 5% of children according to an article written by Martinussen and Major (2011). Students with ADHD can be described as having developmentally inappropriate symptoms of hyperactivity-impulsivity and inattention which occur in more than one setting. Math, reading, and written expression weaknesses are common in children with ADHD. According to information gathered by Martinussen and Major, pharmacological treatments for symptoms associated with ADHD do not normalize academic performance. Loe and Feldman (2007) found that stimulant medications are the most common treatment for ADHD for reducing classroom disruptions and for improving academic progress (as cited in Bailey et al., 2011). However, evidence is lacking as to whether these medications have a lasting impact on performance. Most studies regarding comprehension and students with ADHD are conducted without medication. Because of this, the effect of stimulant medication on reading comprehension abilities remains unclear.

According to many of the articles that have been critiqued thus far, executive function has been shown to be a major contributing factor in reading comprehension. When there is a deficit in executive function processes such as working memory, reading comprehension skills are compromised. The purpose of a study by Kempton, Vance, Maruff, Luk, Costin, and

Pantelis (1999), was to investigate executive function in children using stimulant medication for management of ADHD symptoms as compared to matched controls.

The result from this study indicated that unmedicated children with ADHD showed deficits on tasks of executive function, including planning ability, movement time, and spatial working memory. These children also showed poor performance on some tests of visuospatial memory and learning. The children with ADHD who took medication showed no impairments on any of the executive function tasks. However they did perform poorly on the spatial recognition memory task. Kempton et al. also found that the majority of the medicated group showed little to no abnormality in of executive function indicating that an ADHD-related disruption in brain structure may be compensated with the use of stimulant mediation. These findings are important for children with comprehension problems resulting from impaired executive function. If ADHD medication corrects these deficits, classroom teachers should see improvement in comprehension skills in the children who are currently taking stimulant medication.

Comprehension abilities play a crucial role in academic achievement. A study was conducted by Bailey, Derefinko, Milich, Lorch, and Metze (2011) to investigate group differences in free recall of stories by children with ADHD and comparison children. The study explored the potential impact of stimulant medication on comprehension in children with ADHD.

The purpose of this study was to determine if stimulant medication would improve story recall among children with ADHD. According to the findings, stimulant medication only had limited effects on the recall performance of children with ADHD. Although the children were

able to recall more story events while on the medication, the medication did not selectively aide recall of information important to the stories which conflicts with the findings of Kempton et al. (1999). If stimulant medication improves executive function, the study by Bailey, et al. should have produced similar results.

One limitation of this study was that the medication was not a set standard prescription drug or dosage. Parents were trusted to have given the medication one hour prior to testing. Also the placebo procedure was not standard as the children were told that they would be taking something different than their regular medication. This study would have benefitted from standardized procedures to further establish stimulant medication efficacy. This study did not address the effects of medication on reading comprehension as stories were either watched in the form of television programs or listened to. Lack of interest in the content presented could have affected the attentiveness of the children whether or not they were diagnosed with ADHD. The findings were important to take in consideration when exploring options for academic interventions; however this study merely skimmed the surface of the medication issue as it relates to reading comprehension and ADHD.

Academic interventions. Why children with ADHD show a delay in engagement with important story material is unclear. There may be an inability to filter story information quickly enough to determine what is important or the children simply do not notice semantic cueing of important information. Intervention strategies should focus on assisting children with learning what makes an event important versus information that is part of the story structure (Berthaiume, 2006).

The purpose of a study done by Beike and Zentall (2012) was to learn whether content novelty added to reading materials could increase motivation or interest enough to enhance attention in students with RD and ADHD. The hypothesis was that content novelty would produce increased recall for students at risk for ADHD and RD. Bieke & Zentall based their predictions on the knowledge that children with ADHD and RD have decreased vocabulary which interferes with their ability to engage in and therefore comprehend text. Content novelty, or high novelty refers to changing verbs from passive to active, changing characters from familiar to less familiar, or by adding adjectives, in order to make the passage more engaging to the reader.

Original fables from Aesop's Fables were retrieved from www.aesopfables.com and were selected as a basis for story development because they were stories not previously read and presented situations not typically experienced. In order to challenge the attention span of the ADHD group, the fables chosen tended to be long enough to do just that. Words from the archaic language in fables were replaced with modern terms. Each fable had an average of five changes so as to make the passage more understandable. Five reading comprehension questions were developed to assess literal and inferential comprehension. An oral retell was also given.

For the ADHD group there was significantly better performance in response to high rather than low-novelty conditions for the Inferential Questions. Both the ADHD and RD groups appeared to enjoy the high-novelty fables. The main effect of condition indicated that the students were more interested in the high-novelty fables than the low-novelty fables.

Bieke & Zentall hypothesized that the gains in the study could be attributed to effective motivation which allowed the students to maintain engagement with the text. However, it is not clear the novelty produced increased interest because the intervening variables were not measured and could only be presumed from previous research findings. There were significant and consistent gains in inferential and causality reading comprehension in response to high-novelty text which lead Bieke & Zentall to determine that novel content in stories could improve reading comprehension in students with ADHD. This is not new information to classroom teachers who work with students, especially boys, with or without disabilities. Students tend to respond to high interest materials better than low interest, especially if vocabulary is modified to meet the language needs of the student. Locating materials that engage students with ADHD is an important component for teachers to implement within the classroom setting.

The study conducted by Shimabukuro, Prater, Jenkins, and Edelen-Smith (1999) was chosen so that the connection between self-monitoring of academic performance and self-performance of reading comprehension could be reviewed. The purpose of this study was to investigate the effects of self-monitoring of academic accuracy and productivity on the performance of students with learning disabilities and ADHD during independent class assignments.

Self-monitoring of academic performance produced greater positive effects for productivity than for accuracy for reading comprehension and math for all of the students. Self-monitoring of academic performance also resulted in improvements of on-task behavior for the three students in all academic areas although some results were higher in some academic areas.

Shimabukuro, Prater, Jenkins, and Edelen-Smith determined from the findings of this study that self-monitoring of academic performance might result in increased academic productivity and accuracy. They also determined that self-monitoring may increase on-task behavior during independent class work.

This study raised several red flags right from the start. Only three male students participated in the study, which is an extremely small sample. Also, scores were not tested for statistical significance. The testing took place in a special education classroom in a segregated school. These results most likely could not be replicated in a general education classroom of 20+ students with no teaching assistant. Although this study was selected to determine if it would be valuable for further investigation (within the context of self-monitoring of reading comprehension), very little can be used for comparison.

In recent years emphasis has been put on fluency speed through the use of timed assessments. For students with ADHD who have difficulty with reading comprehension, increased reading speed can result in the need for these students to re-read passages multiple times in order to comprehend text information. Children with ADHD have been found to have difficulty with executive functions such as working memory; therefore if a selection does not hold strong personal interest for the student, comprehension might be limited under timed reading circumstances such as testing.

Brown, Reichel, & Quinlan (2011) conducted a study in which they hypothesized that adolescents with ADHD and reading comprehension problems (without reading decoding problems) would demonstrate relative weakness in executive functions and processing speed.

Further, they hypothesized that extended time on reading comprehension and vocabulary tests would help students with ADHD compensate for their ADHD-related reading impairments, resulting in higher reading comprehension scores. These scores would then be more consist with verbal comprehension abilities gathered from IQ scores. Verbal comprehension scores were measured by the Verbal Comprehension Index (VCI). To assess working memory and processing speed the student Working Memory Index (WMI) and Processing Speed Index (PSI) came from the WISC or the WAIS IQ tests. The Nelson-Denny Reading Test (NDRT) was used to measure the impact of extended time on for reading comprehension. If a student was unable to complete the vocabulary section, he was allowed up to 9 additional minutes and if he was unable to complete the comprehension section, he was allowed an extra 12 minutes.

After being given extended time, scores improved to 72.9% for vocabulary and 77.9% for comprehension. These scores were much closer to what the general population would have been expected to achieve according to the normative data from the WAIT. Many of the students with ADHD were able to complete the NDRT within the standard time constraints. However, 48% were unable to even attempt all of the vocabulary questions and 53% were unable to attempt the reading comprehension questions without extended time. Brown, Reichel, & Quinlan determined that it was more likely that weaknesses in processing speed and working memory contributed to the relatively low sores on reading measures administered using standard time. These data provided evidence that when given modest extension of time on longer, more complex texts, students with ADHD could demonstrate reading comprehension abilities more consistent with their actual verbal abilities. They also found that extra time could improve the overall performance of all students, not just those with ADHD.

One limitation to this study was that although 145 students were used to determine the effects of extended time, there was no control group with which to compare scores directly. Instead, scores were compared to what the general population would have been expected to achieve according to the normative data from the tests. Second, the sample was characterized by students who had high average verbal comprehension abilities, which is not always the case with students with ADHD. This study used older students but the results raise important considerations when working with elementary and middle school aged students with ADHD and comprehension problems. Pressing students to read faster in order to show improved fluency may be detrimental to their comprehension output. Students with ADHD might benefit from added time and a decreased emphasis on reading speed with more emphasis placed on the comprehension strategies of metacognition and re-reading.

Berthiaume (2006) conducted a review of existing support for a link between attention difficulties and academic problems of children with ADHD as well as the complex processing deficits that contribute to those difficulties. Berthiaume drew from existing literature to explore possible academic interventions which could remediate reading comprehension deficits experienced by children with ADHD. According to the research presented by Berthiaume, children with ADHD have satisfactory recall of factual events that are high in importance, which means that these children, when compared to same age peers, can recall factual information from stories even when their attention is divided. Because children with ADHD experience difficulty focusing on character goals while building story representations, instruction should focus on helping children connect what characters are trying to accomplish to ongoing events and how characters must change their behavior to achieve goals.

The article went on to explore reading comprehension and strategy training through inference making, self-questioning, and multiple-strategy training. However, these strategies were not specifically connected to comprehension problems in children with ADHD. Berthiaume suggested that new academic intervention strategies would need to be created to assist children with ADHD to make connections and accurately retell text.

The findings of Berthaiume were that the literature rarely recommends interventions that focus on training children with ADHD to use causal relations to enhance processing of story information. A shift toward use of strategies which target deficits in story comprehension skills would be an important addition to the literature. Such interventions would work best if used in conjunction with current treatments recommended for children with ADHD. Finally, Berthaiume indicated that additional research is needed to determine whether strategy training works to improve reading comprehension if the burdens placed on working memory were reduced.

The article by Pimperton and Nation (2009) presented strategies that classroom teachers can implement to assist students with ADHD in reducing the demands of working memory when it comes to complex academic tasks. These strategies include scaffolding complex and /or multistep tasks, delivering instruction in short chunks, and the use of external memory aids such as cue cards or graphic organizers. Teachers should provide instruction in comprehension monitoring strategies such as asking questions to check for understanding along with guided practice in using comprehension strategies. However, these are fairly common interventions for all students struggling with comprehension and are not specific to students with ADHD.

Teacher consultation model. A report was published to summarize earlier research which described a large-scale longitudinal study by Jitendra and DuPaul (2007). The purpose of

the study was to compare two different models of school-based consultation. The consultation models were used on the academic achievement of children with ADHD. The two approaches included evidence-based academic interventions such as peer tutoring, computer-assisted instruction, and direct instruction.

The consultation groups consisted of the Intensive Data-Based Academic Intervention (IDAI) and the Traditional Data-Based Academic Intervention (TDAI). The hypothesis was that children in the IDAI group receiving individualized academic interventions would demonstrate greater academic growth in achievement the children in the TDAI group. The two groups received intervention in reading or math. The TDAI and IDAI consultants were assigned to work with teachers and students for the consultation procedure of approximately fifteen months. The TDAI and IDAI groups differed in several important ways. After an ADHD informational session, the TDAI group met twice to interview teachers while the IDAI met with teachers three different times. The TDAI groups were more traditional conducting interviews and reviewing data. Interventions in the TDAI groups were driven by teacher choice. The IDAI groups designed interventions based on data and used a consultative problem-solving model. Goals were set and problem identification was used to discuss academic behavior problems as well as determining observation and data collection procedures. While the TDAI groups were more teacher-driven, the IDAI consultants trained teachers on implementation of interventions while establishing weekly contact. The TDAI groups met less frequently with consultants. IDAI teachers were also provided with feedback linked to the intervention plan.

The findings of the study were that both consultative groups successfully improved academic outcomes for children with ADHD. However, the IDAI group did not progress significantly compared to the TDAI group as was originally hypothesized. Results suggested that both the TDAI and IDAI consultation approaches held promise for children with ADHD by helping to close the achievement gap. The recommendation was that further research should be conducted with a larger sample size over a longer period of time in order to increase confidence in the effectiveness of either treatment approach.

Summary

The research gathered indicates that the main cause of comprehension problems in children with ADHD are related to deficits in working memory as they relate to the larger executive functioning within the brain. Children with ADHD also tend to show deficits through the verbal domain. These children exhibit comprehension difficulties through the inability to make causal connections within a story. Cognitive interference and the inability to suppress previous information cause confusion and overload which contribute to inattentive behaviors. Likewise, as the workload increased, performance and comprehension decreased. Unfortunately, the research was sparse at best when considering effective interventions specific to children with ADHD.

Chapter III: Results and Analysis Relative to the Problem

Reading Comprehension and ADHD

Children with Attention Deficit/Hyperactivity Disorder (ADHD) experience a variety of difficulties based on the very nature of the disorder. Students with ADHD have typically displayed a pattern of behaviors that inhibit academic success in the school setting such as reading comprehension and listening comprehension difficulties. In students with ADHD and students with reading disability (RD), listening and reading comprehension require sufficient activation to focus and attention effort and attention. A study by Asberg, Kopp, Berg-Kelly, & Gillberg (2010) demonstrated that girls with ADHD scored significantly lower than female controls on tests of reading comprehension skills. Children with ADHD also demonstrated difficulty in making causal connections within stories as well as being unable to use inferential processing to connect story events and develop an understanding of story structure as a whole (Lorch, Milich, Flacke, Ohlendorf, & Little, 2010; Berthiaume, Lorch, Milich, 2010). Aaron, Joshi, Palmer, Smith, & Kriby (2002) were successful in differentiating RD, ADHD-I, and RD + ADHD-I. This could be important information for teachers trying to determine whether poor comprehension is due to decoding problems or inattention.

Lorch, Milich, Flake, Ohlendorf, & Little (2010) found that although children with ADHD were not able to recall as many story events as control children, given time the children were able to recall more events yet not as many events as control children. Nonverbal ability surfaced as area of concern (Asberg, Kopp, Berg-Kelly, & Gillberg, 2010), along with listening

comprehension (Aaron, Joshi, Palmer, Smith, & Kriby, 2002), because listening comprehension requires more sustained attention.

Walczyk and Hall (1989) added to early research by determining that impulsive children (children with ADHD) were not as proficient at noticing details as children without ADHD. Likewise, skills in noticing inconsistencies in text were poor. Compared to the control group, students with ADHD were less likely to process critical information into memory. Combined, these studies demonstrated that there was a pattern of deficit in reading comprehension among children with ADHD. Developing an understanding of why such difficulties exist might lead to effective intervention strategies that teachers can utilize in the classroom setting.

ADHD and Brain Research

A considerable amount of research has been conducted to determine which cognitive functions are responsible for the difficulties that students with ADHD have in comprehending text. Studies revealed that poor comprehenders (including those without a diagnosis of ADHD) have deficits in executive function to some extent. Executive function skills were studied in order to narrow down the specific domains in which reading comprehension difficulties took place. The common threads were in the areas of working memory and strategic planning, (Locascio, Mahone, Easton, & Cutting, 2010; Cain, 2006).

Working memory. Falling under the larger umbrella of executive function is working memory. Working memory is divided into the verbal and visuospatial domains. Within those domains working memory is responsible for spatial and digit span, planning, organizing, and self-monitoring. Working memory is important because it is the place where information is held

and organized before being moved into short term memory. Deficits in working memory disrupt this process and can be responsible for causing intrusion of no longer needed information, (Nation and Pimperton, 2010; Cain, 2006; Kofler, Rappaport, Bolden, Sarver, & Raiker, 2009). The research in several articles confirmed that working memory deficits were confined to the verbal domain, which means that children with ADHD have difficulty processing information that is spoken or listened to, rather than read. These children still have difficulty with reading comprehension, but the difficulties are more pronounced when they are processed through the verbal domain. (Nation and Pimpertion, 2010; Caretti, Borella, Cornoldi, DeBeni, 2009; Cain, 2006).

Intrusion errors. Areas of working memory responsible for attentional control also wreak havoc on children with ADHD when it comes to reading comprehension. The most prominent area of weakness is regarding intrusion errors. Retroactive interference is the inability to suppress no longer relevant information as new information is being processed (Pimperton and Nation, 2010). Children with ADHD consistently made more intrusion errors throughout the research gathered than the controls. These errors were more pronounced as processing demands increased (Nation and Pimperton, 2010; Caretti et al., 2009; Cain, 2006; Berthiaume, Lorch, & Milich, 2010; Brown, Reichel and Quinlain,2011). The increased processing demands on working memory problems involving intrusion errors were repeatedly shown to cause a decrease in motivation and reduction in effort over time. When children are unable to sort through new and no longer relevant information overload can occur causing students to display inattentive behaviors. Kolfer et al., (2009) suggested that inattention was relevant to task as a result of central executive dysfunction rather than being a symptom of ADHD.

Metacognition. Another area of working memory that was addressed was metacognition. Metacognition was shown to be linked to executive function processes. Frequently, students with ADHD will read a text without realizing that information is not being processed. If students cannot identify when gaps are present they will also be unable to make causal connections or inferences. A lack of metacognition also increases the risk of intrusion errors. As the reader continues on questioning, re-reading, and other comprehension fix-up strategies are less likely to be implemented (Berthiaume, Lorch, & Milich, 2010; Alvardo et al., 2011).

Given the knowledge that reading comprehension deficits for students with ADHD are directly linked to executive functions such as working memory, teachers need to know what interventions have been shown to be effective in working with students who have working memory problems. Many of the interventions suggested within the previous literature were generalized and not exclusive to students experiencing comprehension problems caused by ADHD.

Intervention Research

No investigation of intervention into problems caused by ADHD symptoms is complete without looking into research studying the effects of stimulants. Stimulant medication continues to be a popular intervention for ADHD symptoms; however research regarding effectiveness produces mixed results (Martinussen & Major, 2011; Bailey, Derefinko, Milich, Lorch, & Metze, 2011, Kempton, Vance, Maruff, Luk, Costin & Pantelis, 1999). Of the two articles found for this paper, one found that stimulants improved executive function in students with ADHD, which would result in positive improvements in reading comprehension skills by improving the

functioning of working memory tasks (Kempton et al., 1999). However, years later a study done by Baliey et al. (2011) showed the opposite when the results determined that stimulant medications had only limited effects on reading comprehension performance. The conflicting results indicate that teachers should take care when depending on stimulants alone to improve reading comprehension abilities.

Although the research shed light on causes of reading comprehension difficulties in students with ADHD, studies of effective interventions were limited. Use of content novelty in the form of familiar vocabulary or high interest materials was shown to be effective in improving reading comprehension performance and motivation (Bieke & Zentall, 2010). This strategy would be consistent with the findings of Kofler et al. (2009) showing that children with ADHD will remain engaged in tasks that are familiar. If the learning of new vocabulary is not part of the content novelty then the students should be able to maintain attention as long as storage load does not increase significantly (Cain, 2006). This strategy would be effective as long as material presented was of considerable interest to the student which is not always the case in regards to academic curriculum within the classroom setting.

Instruction in self-monitoring strategies could be useful for students who lack metacognitive awareness (Shimbabukuro, Prater, Jenkins, and Edelen-Smith, 1999). Although this study had considerable limitations, self-monitoring is an important skill when teaching students metacognition strategies. Improved metacognition skills would result in an increase in attentional control and a decrease in an interruption of memory due to intrusion errors (Alvardo et al., 2011; Berthiaume, Lorch & Milich, 2010). In addition to self-monitoring, students with

ADHD also benefitted from increased time on reading comprehension and vocabulary tests. Again, this is an intervention that benefits all students, not just those with ADHD related comprehension problems (Brown, Reichel, & Quinlan, 2011). These findings were consistent with suggested intervention strategies such as instruction focusing on character goals, inference-making, and multiple-strategy training (Berthiaume, 2006; Pimperton & Nation, 2009).

Finally, a teacher consultation model in which teachers were coached on effective teaching practices resulted in improved academic outcomes for students with ADHD. Teachers do need support and strategies when it comes to working with students with ADHD (Jitendra & DuPaul, 2007). Of the limited research on effective reading comprehension intervention for students with ADHD, findings were disappointing at best. The common theme was that further research would be necessary to effectively answer the question of how to remediate comprehension difficulties in students with ADHD.

Summary

Working memory plays a key role in reading comprehension. When children have problems with executive functions, specifically working memory, comprehension is compromised. Common elements of difficulty were in making causal connections, metacognition, and making inferences. Problems were limited to the verbal domain. Deficits in working memory were also responsible for students with ADHD having difficulty suppressing irrelevant information which caused overload resulting in inattentive behaviors. Intervention research was limited at best with most suggestions being rather general and nonspecific to ADHD related comprehension problems prompting the need for further research.

Chapter IV: Recommendations and Conclusion

Recommendations

Research has shown that working memory problems exist in students with ADHD which inhibits their ability to comprehend text. Of these problems, the verbal domain is mainly affected. The inability to make causal connections and the interference of previously learned information make comprehension challenging at best. Unfortunately, the research is lacking in effective techniques for children with ADHD related comprehension problems. Methods suggested were either vague generalities such as using standard comprehension fix-up strategies or allowing extended time and self-monitoring. None of the suggested strategies took into consideration the specific working memory deficits of children with ADHD.

The book *When Kids Can't Read: What Teachers Can Do, A Guide for Teachers 6-12* by Kylene Beers (2003) contained a few strategies that could in fact, assist children with ADHD in improving comprehension of text in spite of known working memory problems. Although the book isn't specifically written for children with ADHD, there are unique strategies that were not presented in the existing literature.

Intervention Strategies

Somebody wanted but so. The first strategy that has promise is called "Somebody Wanted But So" (SWBS). The activity is a modified version of the traditional written summary as summaries can at times be overwhelming for many students (Beers, 2003). Somebody Wanted But So, originally designed by MacOn, Bewell, and Vogt (1991) is a framework consisting of four columns labeled Somebody (characterization), Wanted (plot events), But (problem/conflict),

and So (resolution) that students fill out as they read (as cited in Beers, 2003). Students learn to use this through scaffolded modeling by the teacher with gradual release of responsibility. This strategy could be effective with students with ADHD because the framework can be filled in as the student reads, circumventing the working memory by not requiring the student to hold the new information in memory where it could be confused with prior information. Rather, the information is held onto outside of the brain, on the framework where the students can see it (visuospatial domain) and retell the story while referring to the framework. This strategy is more specifically geared towards children with retroactive interference problems as no recommendations for strategies were suggested in the article by Brown, Reichel and Quinlan (2011). Carretti, Borella, Cornoldi, and DeBeni (2009) suggested the use of activities that reduce the need for attentional control. SWBS might be an appropriate activity to do just that. Likewise, other during-reading strategies could also be helpful to students with ADHD.

Logographic cues. The second strategy is Logographic Cues which are visual symbols. Logographic cues are seen day to day in the form of familiar traffic symbols and signs such as a yield sign. Logographic cues allow the reader to design logographs of her own design. These symbols are then inserted into text and become "signposts" indicating the direction the text is taking (Beers, 2003). For example, a lightning bolt could indicate conflict. A question mark might signal confusion and a chain link could indicate a causal connection. Beers suggest that these could be written in the text on or sticky notes. The use of logographic cues would use the stronger visuospatial domain and would again, help to inhibit prior information because the logographs are directly within the text so as to discourage confusion.

Rereading. Beers describes a rereading as a strategy for improving comprehension. Rereading is important for children with ADHD for two reasons. First, rereading is directly connected with metacognition. Children with ADHD need to be directly taught how to think about their thinking in order to understand when meaning is lost or attention is being compromised. Second, since the dysfunctional working memory holds on to previously learned information, even when new information is being introduced, it is only logical to ascertain that the information from the same text being read over several times would reinforce the information from the previous readings of that same text. Each time the student rereads, logographic cues and other notes should be added to the text. Beers suggests that a student needs to formulate a list of personal reasons to reread. At first, rereading should be teacher directed and intentional, until the child is proficient at knowing when to reread and implement the strategy independently (Beers, 2003). Rereading can be used with both the SWBS and Logographic Cues. Although these strategies are suggested in the Beers text, they have not been subject to qualitative research thus addressing the need for interventions which educators can use in the classroom to assist students with ADHD in comprehending text.

Areas for Further Research

A grounded theory qualitiative study might be conducted to determine whether or not these three strategies would be effective in improving the comprehension skills of students with ADHD. A qualitiative study is necessary because the study will take place in an unstructured setting where the data may be analyzed using informed judgment making the data difficult to quantify.

Participants. For example, subjects of the study could be 50-60 special education students grades three and four who meet the criteria for having and ADHD diagnosis. The children would be selected from special education teacher caseloads from ISD's across the state. The rationale for having special education teachers test the strategies is that the ADHD students will most likely be seeing the teachers for direct and intensive instruction in reading comprehension. The setting is ideal for providing directed instruction of the strategies with limited interruption that occurs in a larger classroom setting. However, these strategies could be taught using explicit teaching and guided modeling in the larger general education setting in order to gain insight as to whether the strategy is effective in showing progress for ADHD students as compared to the progress of their peers. The children should be within one grade level for oral reading skills and at least 2 years below in reading comprehension skills as indicated by school reading assessments such as the DRA2. This would remove comprehension problems due to impaired decoding skills as a factor. If the children are currently taking stimulant medication for ADHD symptoms, the parents will be asked to have the children suspend medication for the duration of the study. Parents will be notified of the study and permission will be sought.

Method. At the onset of the study an unbiased researcher will give the Developmental Reading Assessment 2 (Beaver, 2003) to each child in order to determine a baseline score. For triangulation of data, the test will be given two more times by different researchers each time. Because the DRA2 is subjective, triangulation is needed to determine a mean baseline score. Following the DRA2, the teacher will model and teach each of the three comprehension strategies, (SWBS, Logographic Cues, and Rereading) over the course of 3 months which give at

least one month of practice per strategy and give the student time to determine which strategy (or combination of strategies) is preferred. After the 3 month period, the researchers will retest the student using the same form of the test. However, the second time the student will be allowed to use learned strategies while taking the DRA2.

Data analysis. Once the data is collected it will be analyzed using the grounded theory. Charmaz (2000; 2006) would be used as a guide for grounding the methodology as a constructivist approach to grounded theory is necessary for interpreting results. The data would be constructed through the ongoing interaction between the researcher and the child during the DRA2. The researchers would interpret how the participants create meaning (as cited in Ghezeljeh & Emami 2009). The retells will be recorded so that responses can be coded and then analyzed through axial coding based on the work of Glaser. Questions pertaining to the when, where, and why relate a set of variables to a focal variable in order to develop hypotheses about relationships between and among variables such as the causal connections within text (LaRossa, 2005). Glaser (1992) indicated that axial coding should be done early in the analysis so that conceptual linkages between and among variables would emerge (as cited in LaRossa, 2005). Through constant comparison, similarities will be established so that a theory can be developed as to whether or not the strategies cause increased reading comprehension during the second round of assessment.

Conclusion

Teaching students to comprehend can be a challenge for those learners with or without a high incidence disability. Remediation of comprehension difficulties comes with

unique challenges. Students with ADHD have deficits originating within the working memory portion of the overall executive functioning in the brain, primarily from the verbal domain. These deficits make attention to causal connections difficult as previously learned information interferes with newly learned information causing overload and resulting in inattentive behaviors. Likewise, when children have no knowledge of metacognition or how it assists in recall children with ADHD fail to notice when meaning has broken down.

Research is in its infancy, mostly focusing on reasons for comprehension deficits. The majority of journal articles referenced in this review indicated the need for further research into intervention strategies beyond the vague and simplistic suggestions offered by researchers themselves. Further research must be done in order for educators to assist students in gaining the skills needed to improve reading comprehension. Techniques that show promise are those which take stress off of the working memory and require less attention control by using strategies such as SWBS (Beers, 2003). Knowledge of why comprehension breaks down is key to developing and teaching strategies that will take working memory deficits into consideration. The good news is that with the work of researchers such as Cain, Lorch, and Nation we are closer than ever to successfully discovering effective strategies for students with ADHD and comprehension difficulties.

References

Aaron, P., Joshi, R., Palmer, H., Smith, N., & Kirby, E. (2002). Separating genuine cases of reading disability from reading deficits caused by predominantly inattentive ADHD behavior. *Journal of Learning Disabilities,* 425-436, doi: 10.1177/00222194020350050301.

Asberg, J., Kopp, S., Berg-Kelly, K., & Gillberg, C. (2010). Reading comprehension, word decoding, and spelling in girls with autism spectrum disorders (ASD) or attention-deficite/hyperactivity disorder (AD/HD): Performance and predictors. *International Journal of Language & Communication Disorders*, 61-71. doi:10.1007/s10803-010-0938-6.

August, G.J. & Garfinkel, G.D. (1990). Comorbidity of ADHD and reading disability among clinic referred children. *Journal of Abnormal Psychology*, 29-45.

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. *Juvenille Psycholopathol Behavoir Assessment,* 409-419. doi: 10.1007/s10862-011-9249-2.

Beaver, J. (2003). *Teacher guide: Developmental Reading Assessment, Grades K– 3,*. Parsippany: Pearson Education, Inc.

Beers, K. (2003). *When Kids Can't Read What Teachers Can Do: A Guide for Teachers 6-12.* Portsmouth: Heinemann.

Berthiaume, K., Lorch, E., & Milich, R. (2010). Getting clued in: Inferential processing and comprehension monitoring in boys with adhd. *Journal of Attention Disorders*, 31-42. doi:10.1177/1087054709347197.

Bieke, S.M. & Zentall, S.S. (2012). "The snake raised it's head": Content novelty alters the reading performance of students at risk for reading disabilities and ADHD. *Journal of Educational Psychology*, 529-540.

Brown, T.E., Reichel, P.C., Quinlan, D.M. (2011). Do low-effort learning strategies mediate impaired memory in ADHD? *Open Journal of Psychiatry*, 79-87.

Cain, K. (2006). Individual differences in children's memory and reading comprehension: An investigation of semantic and inhibitory deficits. *Memory*, 553-569, doi:10.1080/09658210600624481.

Cardo, E., & Servera, M. (2003). Attention deficit hyperactivity disorder: A global view. *Anales de Pediatria*, 225-228.

Carretti, B., Borella, E., Cornoldi, C., & De Beni, R. (2009). Role of working memory in explaining the perforamnce of individuals with specific reading comprehension difficulties. *Learning and Individual Differences*, 246-251, doi: 10.1016.jlindif.2008.10.002.

Cowan, N. (2008). What are the differences between long term, short term, and working memory? *Progressive Brain Research*, 323–338. doi:10.1016/S0079-6123(07)00020-9.

De Beni, R., & Palladino, P. (2000). Intrusion errors in working memory tasks- Are they related to reading comprehension ability? *Learning and Individual Differences*, 131-143.

Florez, M., & Ganz, J. (2009). Effects of direct instruction on the reading comprehension of students with autism and developmental disabilities. *Education and Training in Developmental Disabilites*, 39-53. Retrieved from http://www.eric.ed.gov/.

Ghezeljeh, T.N. & Emami, A. (2009). Grounded theory: methodology and philosophical perspective. *Nurse Researcher,* 15-23.

Glaser, B. (1992). *Basics of Grounded Theory Analysis.* Mill Valley: Sociology Press.

Glassman, M. (2001). Dewey and Vygotsky: Society, experience, and inquiry in educational practice. *Educational Researcher, 30,* 3-14, http://www.jstor.org/stable/3594354.

Jitendra, A.K. & DuPaul, G.J. (2007). Enhancing academic performance in children with ADHD. *The ADHD Report,* 1-5.

Kempton, S., Vance, A., Maruff, P., Luk, E., Costin, J., and Pantelis, C. (1999). Executive function and attention deficit hyperactivity disorder: Stimulant medication and better executive function performance in children. *Psychological Medicine,* 527-538.

Kofler, M.J., Rapport, M.D., Bolden, J., Sarver, D.E., & Raiker, J.S. (2009). ADHD and working memory; The impact of central executive deficits and exceeding storage/rehersal capacity on observed inattentive behavior. *Abnormal Child Psychology,* doi: 10.1007/s10802-009-9357-6.

LaRossa, R. (2005). Grounded theory methods and qualitiative family research. *Journal of Marriage and Family*, 837-857.

Locascio, G., Mahone, M., Eason, S., & Cutting, L. (2010). Executive dysfuction among children with reading comprehension deficits. *Journal of Learning Disabilities*, 441-454, doi: 10.1177/0022219409355476.

Loe, I.M., & Feldman, H.M. (2007). Academic and educational outcomes of children with ADHD. *Journal of Pediatric Psychology*, 643-654.

Lorch, E., Milich, R., Flake, R., Ohlendorf, J., & Little, S. (2010). A developmental examination of story recall and coherence among children with ADHD. *Journal of Abnormal Child Psychology*, 291-301, doi:10.1007/s10802-009-9377-2.

Lorch, E.P., Berthiaume, K., Milich, R., & van den Broek, P. (2007). Story comprehension impairments in children with attention-deficit/hyperactivity disorder. In K. &. Cain, *Children's Comprehension Problems in Oral and Written Language* (pp. 128-156). New York: Guilford.

MacOn, J., Bewell, D., & Vogt, M. (1991). *Responses to Literature.* Newark: International Reading Association.

Martinussen, R. & Major A. (2011). Working memory weaknesses in students with ADHD" Implications for instruction. *Theory Into Practice*, 68-75, doi: 10.1080/00405841.2011.534943.

Nation, K. & Norbury, C. (2005). Why reading comprehension fails: Insights from developmental disorders. *Topics in Language Disorders*, 21-32.

Nation, K. & Pimperton, H. (2010). Supressing irrelevant information from working memory: Evidence for domain specific deficits in poor comprehenders. *Journal of Memory and Language*, 380-391, doi:10.1016/j.jml.2010.02.005.

Nation, K., Adams, J.W., Bowyer-Crane, C.A., & Snowling, M.J. (1999). Working memory deficits in poor comprehenders reflect underlying language impairments. *Journal of Experimental Child Psychology*, 139-158.

Shimabukuro, S.M., Prater, M.A., Jenkins, A., & Edelen-Smith, P. (1999). The effects of self-monitoring of academic performance on students with learning disabilities and ADD/ADHD. *Education & Treatment of Children*, 397-414.

van den Broek, P., Kendeou, P., Kremer, K., Lynch, J.S., Butler, J., White, M.J., et.al. (2005). *Assessment of comprehension abilities in young children.* Mahwah: Lawrence Erlbaum.

Walczyk, J., & Hall, V. (1989). Is the failure to monitor comprehension an instance of cognitive impulsivity? *Journal of Educational Psychology*, 294-298, doi:0022-0663/89/500.75.

Yuill, N., Oakhill, J., & Parkin, A. . (1989). Working memory, comprehension ability and th eresolution of text anomaly. *British Journal of Psychology*, 351-361.