The Relationship between Reading Comprehension and Adolescents with and without ADHD

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ABSTRACT

This study examined reading comprehension in adolescents with and without attention deficit hyperactivity disorder (ADHD). Forty-five youth with ADHD (26 males, 19 females) and 42 adolescents without ADHD (20 males, 22 females) between the ages of 13 and 18 completed standardized tests of achievement. The results of multiple regression analyses indicated that orthographic and semantic abilities were related to reading comprehension. Both the orthographic (i.e., spelling) measure and the semantic (i.e., oral vocabulary) measure explained unique amounts of variance on the reading comprehension measure. Next, it was found that adolescents with ADHD were significantly more likely to have a Specific Reading Comprehension Disability (S-RCD) than adolescents without ADHD. Last, it was found that adolescents with ADHD and an S-RCD demonstrated poorer performance on academic measures that depend in part on comprehension (e.g., math problem solving) than adolescents with ADHD without an S-RCD.
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TABLE OF CONTENTS

ABSTRACT....................................................................................................................... ii

ACKNOWLEDGEMENTS............................................................................................. iii

TABLE OF CONTENTS..................................................................................................... iv

LIST OF TABLES............................................................................................................. vi

LIST OF APPENDICES.................................................................................................. vii

CHAPTER ONE............................................................................................................... 1

Purpose and Background of the Study........................................................................... 1

CHAPTER TWO............................................................................................................... 3

Literature Review........................................................................................................... 3

2.1 Word Level Reading Skills, Spelling, Vocabulary and Reading Comprehension....... 3

2.2 Poor Comprehenders.............................................................................................. 8

2.3 ADHD..................................................................................................................... 11

2.3.1 Definition and Prevalence.................................................................................. 11

2.3.2 Academic Difficulties and ADHD................................................................. 12

2.3.3 Reading Disabilities and ADHD...................................................................... 12

2.3.4 Vocabulary and ADHD.................................................................................... 14

2.3.5 Reading Comprehension and ADHD.............................................................. 15

2.3.6 Listening Comprehension and ADHD............................................................. 20

2.4 Research Objectives and Hypotheses.................................................................. 21

CHAPTER THREE......................................................................................................... 24

Methodology.................................................................................................................. 24

3.1 Participants............................................................................................................. 24
3.2 Procedure ..................................................................................................................................25

3.3 Measures ..................................................................................................................................26

3.4 Statistical Analysis ....................................................................................................................28

CHAPTER 4 ..................................................................................................................................30

Results ..........................................................................................................................................30

4.1 Question 1 .................................................................................................................................30

4.2 Question 2 .................................................................................................................................32

4.3 Question 3 .................................................................................................................................33

CHAPTER 5 ..................................................................................................................................36

Discussion ...................................................................................................................................36

5.1 Review of the Findings ............................................................................................................36

5.2 Implications for Practice .........................................................................................................42

5.3 Limitations and Future Directions ..........................................................................................47

5.4 Conclusion ...............................................................................................................................50

References ....................................................................................................................................53

Appendix ......................................................................................................................................68

Tables ..........................................................................................................................................79
LIST OF TABLES

Table 1: Sample Characteristics of Male and Female Adolescents in the ADHD and Comparison Groups

Table 2: Correlations between each of the measures for both groups and the full sample

Table 3: Performance on Passage Comprehension based on the combination of PDE, Vocabulary and Spelling ability

Table 4: Performance on Passage Comprehension based on the combination of SWE, Vocabulary and Spelling ability

Table 5: Performance on Passage Comprehension based on the combination of PDE, Vocabulary and Letter-Word Identification

Table 6: Performance on Passage Comprehension based on the combination of SWE, Vocabulary and Letter-Word Identification

Table 7: Standard scores on four academic tasks by three groups of adolescents with ADHD of varying comprehension ability
LIST OF APPENDICES

Appendix: Adolescent and Parent Assent and Consent Forms and Letter
CHAPTER 1

Purpose and Background of the Study

The overall goal of this thesis is to examine reading comprehension among adolescents with Attention Deficit Hyperactivity Disorder (ADHD). There has been minimal research on reading comprehension ability in individuals with ADHD. However, the research that does exist suggests that those with ADHD perform more poorly on measures of reading comprehension than normally developing peers (Brock & Knapp, 1996; Ghelani, Sidhu, Jain, & Tannock, 2004). It is important to study reading comprehension skill in adolescents with ADHD because many typical academic tasks in high school require the ability to comprehend text. For instance, reading comprehension ability is important in both written expression and applied math problems (Berninger & Abbott, 2010; Rutherford-Becker & Vanderwood, 2009). There is also evidence that children who are skilled at reading comprehension read more than children who are poorer at comprehending, and reading for pleasure may result in better grades in college and university (Mol & Bus, 2011). In contrast, children with poor comprehension may choose to read less, which may limit the development of their reading skills (Mol & Bus, 2011). This, in part, may contribute to the finding that poor comprehenders are at risk of poor educational outcomes overall (Cain & Oakhill, 2006). Adequate comprehension skills are also important beyond academia. The work force often demands a high level of reading skill (Mikulecky, 1982). Further, poor comprehension has been found to impair health literacy (Needham, Wiemann, Tortolero & Chacko, 2010). Thus, proficient reading comprehension facilitates productivity and independence which are both consistent with successfully transitioning from adolescence to adulthood.
This thesis aims to further the understanding of the relationship between reading comprehension and ADHD. It poses the following questions:

1) What is the relationship between reading comprehension and word reading skills (i.e., decoding and fluency), spelling and oral vocabulary knowledge in adolescents with and without ADHD?

2) Are adolescents with ADHD more likely than their peers without ADHD to have a specific reading comprehension deficit (S-RCD) (i.e., exhibit adequate word recognition skills with poor reading comprehension)?

3) Do adolescents with ADHD who have an S-RCD exhibit poorer performance than adolescents with ADHD who are good comprehenders on measures that depend in part on comprehension (e.g., math problem solving)?

In the literature review I will first review a theoretical framework of comprehension to highlight the importance of word level (e.g., phonological, orthographic) and semantic knowledge in reading comprehension and then provide a brief discussion of research on poor comprehenders. Next, I will address the definition and prevalence of ADHD. I will also provide a brief review of the academic difficulties displayed by adolescents with ADHD. Finally, I will review research that examines reading and listening comprehension skills in individuals with ADHD.
CHAPTER 2

Literature Review

2.1 Word Level Reading Skills, Spelling, Vocabulary and Reading Comprehension

The lexical quality hypothesis (LQH) (Perfetti, 2007) highlights the role of word-level processes as well as vocabulary in reading comprehension. According to Perfetti (2007) “Lexical quality (LQ) refers to the extent to which the reader’s knowledge of a given word represents the word’s form and meaning constituents and knowledge of word use that combines meaning with pragmatic features” (p.359). Thus, reading comprehension of both adults and children is supported by their phonological, orthographic and semantic representations (Verhoeven & Van Leeuwe, 2008). A high quality representation requires knowledge of a word’s pronunciation, spelling and meaning. According to Perfetti individuals who are proficient at reading comprehension have many high quality representations whereas less skilled comprehenders have fewer. These skills are thought to enhance each other. Lexical skills facilitate comprehension, comprehension permits reading practice, and reading practice further develops lexical skills (Perfetti & Hart, 2002). Experiences in speaking, listening and writing are also thought to support the development of high quality representations (Perfetti & Hart, 2002). Thus, as children and adults move through life, the number of high quality lexical representations they have grows.

Knowledge of grapheme-phoneme connections drives not only the correct pronunciation of a word, but also the ability to spell it. However, to develop high quality orthographic representations requires extensive experience with specific words. The knowledge and use of spelling-sound correspondences is a key distinction between good and poor readers and spellers
(Juel, Griffith & Gough, 1986; Stanovich, Nathan & Valla-Rossi, 1986). Spelling a word correctly is evidence of high lexical quality and as such is correlated with reading skills (Juel et al. 1986). Knowledge of a word’s meaning (i.e., vocabulary) is also evidence of high lexical quality according to LQH. Evidence shows that oral vocabulary level is related to reading comprehension (Davis, 1972; Joshi, 2005). In addition, Hemphill and Tivnan (2008) found that the influence that vocabulary has on reading comprehension remains strong even among a diverse elementary school student population with relatively low levels of vocabulary. Hemphill and Tivnan (2008) report that their “Findings emphasize the strong and consistent role of vocabulary as a predictor of reading comprehension, a role that becomes relatively more important, compared to other predictors, as children move beyond the first two grades” (p.444).

Individuals who are skilled at reading comprehension have more coherent representations of words than those with less proficient reading comprehension abilities (Perfetti & Hart, 2002). This means that with knowledge of either a word’s pronunciation or spelling, the other two constituents of a word are likely to be known. For instance, knowledge of a word’s spelling is indicative of knowledge of pronunciation and meaning. Perfetti and Hart (2002) measured orthographic, phonological and semantic knowledge among college students. To measure orthographic knowledge, subjects were required to identify the correct spelling of a word in the presence of four incorrect spellings. A homophone choice task tapped both orthographic and semantic knowledge and a pseudoword decoding task was administered to index orthographic and phonological knowledge. Next, a single word reading task tapped orthographic, phonological and semantic knowledge and a phoneme elision task was used to assess phonological knowledge. Finally, in a multiple choice formant, participants were asked to select the correct definition of a word to index semantic knowledge. The main finding was that the orthographic and phonological
measures were more closely connected among skilled than less skilled comprehenders. Thus, in the less skilled group, orthographic knowledge was not serving their overall word knowledge to the same extent as the skilled group. There were fewer interconnections between orthographic knowledge and vocabulary and decoding ability in the less skilled comprehension group. The authors suggest that developing higher quality orthographic representations requires further experience retrieving and applying the pronunciations, spellings and meanings of words to build a foundation for reading comprehension ability (Perfetti & Hart, 2002).

An alternative model of reading comprehension, the Simple View of Reading (SVR; Gough & Tunmer, 1986) also emphasizes word-level reading processes (i.e., word decoding), in addition to listening comprehension, as being central contributors to reading comprehension. Hoover and Gough (1990) define decoding as “the ability to rapidly derive a representation from printed input that allows access to the appropriate entry in the mental lexicon, and thus, the retrieval of semantic information at the word level” (p.130). To assess decoding skill, Hoover and Gough (1990) had participants pronounce non-words. Proficient decoding skills, as indexed by ability to read non-words, facilitate an individual’s ability to identify words that are unfamiliar. It is decoding ability that leads to the retention of sight words (Ehri & McCormick, 1998). A well developed sight vocabulary allows for accurate and fluent word reading allowing attention to be allocated to comprehension (Ehri & McCormick, 1998).

Although decoding ability facilitates accuracy and fluency, Joshi and Aaron (2000) proposed the Componential Model of Reading, which states that accuracy and the rate at which individual words are read is a third and independent contributor to reading comprehension in the SVR model. Joshi and Aaron (2000) had third grade children name independent letters as quickly and accurately as possible. The speed at which the children named the letters explained
an additional 10% of the variance in reading comprehension controlling for word frequency and regularity. The authors suggested that the predictive ability of the Componential Model would increase among children and adolescents (Joshi & Aaron, 2000).

Verhoeven and Van Leeuwe (2008) provided evidence supporting the LQH as well as the SVR in a longitudinal study of Dutch-speaking children from grades one through to six. In support of LQH, the researchers found that differences in reading comprehension were associated with word level variables. They found that word decoding in first grade significantly influenced reading comprehension in second grade. Similarly, although not as influential, word decoding ability in fifth grade predicted sixth grade comprehension. Vocabulary was also found to strongly influence reading comprehension across the grade levels. At the start of literacy instruction, in grade 1, reading comprehension was predicted by the listening comprehension skills acquired in preschool and kindergarten. However, in the later grades listening and reading comprehension often had a reciprocal relationship. Finally, Verhoeven and Van Leeuwe (2008) found that components of LQH and SVR (i.e. decoding, vocabulary, listening comprehension and reading comprehension) remained highly stable across the elementary school years.

Similar to Verhoeven and Van Leeuwe’s (2008) findings, a longitudinal study by Adlof, Catts and Lee (2010) with English-speaking children found that kindergarteners’ performance on a letter identification task and a sentence imitation measure, which was used to assess oral language skill, best predicted reading comprehension in Grade 2. Vocabulary ability in kindergarten also had a role, although smaller, in second grade reading comprehension. Ouellette (2006) found that in a sample of fourth grade children vocabulary depth and breadth were both related to reading comprehension. It is possible that vocabulary plays a larger role in reading comprehension as children become older. Further studies using English-speaking children are
needed to determine the extent to which components of LQH and SVR mirror the same pattern of predictive ability as in Verhoeven and Van Leeuwe’s (2008) study.

Overall, both the LQH and SVR theoretical models highlight the importance of word level processes in reading comprehension. Greater word knowledge (i.e., phonological, orthographic, and semantic awareness) differentiates skilled comprehenders from less skilled comprehenders (Perfetti & Hart, 2002), and decoding, vocabulary, listening and reading comprehension skills are stable among individuals across the elementary school years (Verhoeven & Van Leeuwe, 2008). As many studies are confined to the elementary school years, it is less clear whether decoding (or fluency), spelling, and vocabulary predict reading comprehension among adolescents.

Recent studies have explored the predictions of reading comprehension in adolescents and young adults. For example, the findings of Braze, Tabor, Shankweiler and Mencl’s study (2007) support both the LQH and SVR models. Their study used a heterogeneous sample of adolescents and young adults. It was found that in addition to listening comprehension and decoding predicting reading comprehension, orally assessed vocabulary also explained unique variance. Decoding ability and vocabulary skills were also examined in a study by Lesaux and Kieffer (2010). Two groups of young adolescents who were identified as struggling with reading comprehension (i.e., at or below the 35th percentile on a reading comprehension measure) were examined. One group was comprised of young adolescents who were minority language learners and the other group was comprised of native English speakers. In both groups, three skill profiles of struggling comprehenders emerged: 1) above average decoding skills but poor word reading efficiency and vocabulary skills (60.3% of the sample); 2) above average decoding and word reading efficiency but poor vocabulary skills (18.3% of the sample); and 3) poor decoding, word
reading efficiency and vocabulary skills (21.4% of the sample). Importantly, this study showed that poor vocabulary was characteristic of each of the three profiles. This finding suggests that reading comprehension deficits in adolescents are highly likely to be associated with weak vocabulary knowledge.

2.2 Poor Comprehenders

Although many children with poor reading comprehension will also exhibit significant word level reading difficulties, there is another group of children who display a Specific Reading Comprehension Deficit (S-RCD, Cain & Oakhill, 2006). Researchers vary somewhat in their definition of an S-RCD. For example, Catts, Adlof and Weismer (2006) identified children with an S-RCD if they had a discrepancy between reading comprehension performance and word recognition ability; children scoring below the 25th percentile on reading comprehension but above the 40th percentile on word recognition were classified as having an S-RCD. In their study, word recognition was indexed by children’s combined performance on tests that assessed word recognition and word attack skills. Similar to the Catts et al. (2006) study, Nation, Cocksey, Taylor and Bishop (2010) identified children with an S-RCD as performing below the 25th percentile (i.e., a standard score below 90) on a measure of reading comprehension. However, they had to perform above the 25th percentile (i.e., a standard score of above 90) on a measure assessing ability to accurately read a passage. Additionally, to be identified with an S-CRD there had to be a discrepancy of more than 10 standard score points between comprehension and accuracy.

Similar to the studies by Catts et al. (2006) and Nation et al. (2010), the 25th percentile will be used in this current study to identify adolescents with poor comprehension. Further, to be
considered proficient at word recognition the criterion is performance at or above the 25\textsuperscript{th} percentile, which is similar to the cut-off used in prior studies of reading disability (e.g., Fletcher et al., 1994; Stanovich & Siegel, 1994). Thus, a discrepancy of performing below the 25\textsuperscript{th} percentile on reading comprehension, but at or above the 25\textsuperscript{th} percentile on word recognition, will indicate an S-RCD. The cutoff of at or around the 25\textsuperscript{th} percentile to identify below average achievement compared to average or above average achievement has been found to be efficacious (Tang, 2008). As a result “good comprehenders” will be those individuals who perform at or above the 25\textsuperscript{th} percentile on both reading comprehension and word recognition. Additionally, to examine whether the severity of the cut-off for reading comprehension impairment is important, I will repeat the S-CRD analyses using a cut-off point of below the 16\textsuperscript{th} percentile on the reading comprehension measure and at or above the 25\textsuperscript{th} percentile on the word recognition measure. Even more stringent criteria to identify S-CRD have been employed by Carretti, Borella, Cornoldi and De Beni (2009) (i.e., 2 standard deviations below expected age average score). However, because of the relatively small sample size (87 participants) in this current study there would not have been enough participants who met Carretti et al.’s criteria to render significant results. Nevertheless, it is thought that examining S-RCD using the more and less severe criteria described above would provide greater insight into the nature of an S-RCD in adolescents with ADHD. Neither criterion is as rigorous as that needed to make a diagnosis within the educational system of a Learning Disability. In the educational system a discrepancy between IQ and achievement is often required (Fletcher et al., 1994).

Studies examining the characteristics of individuals with an S-RCD have shown that poor comprehenders’ ability to recognize words is comparable to that of students identified as good
comprehenders (Oakhill, 1982; Stothard & Hulme, 1992, 1995). The ability of students with an S-CRD to recognize words may be supported by their phonological and orthographic abilities, two constituents of LQH that have been found to be typical in children who were identified as having a S-RCD (Catts et al., 2006; Stothard & Hulme, 1995). The core weakness of students with S-RCD appears to be semantic ability. For example, Ricketts, Bishop and Nation (2008) found that children who were identified as poor comprehenders did not differ from control children on word attack skills and orthographic learning (i.e., pronouncing nonwords correctly, orthographic choice, and spelling); however, they did differ on semantic learning. Specifically, children who were poor comprehenders were less able to retain the meanings given to nonwords and less able to infer semantic information using context. Similarly, Nation, Snowling and Clarke (2007) found that poor comprehenders were as proficient as control children at phonological learning (i.e., learning to associate a new phonological form with an object), but not semantic learning. In addition to a semantic learning weakness, those with an S-RCD often also have a listening comprehension deficit (Nation & Snowling, 1997, Yuill & Oakhill, 1991). This finding is not surprising given the interconnectedness of reading and listening comprehension (Verhoeven & Van Leeuwe, 2008).

The impairments that are often exhibited by individuals with an S-RCD (i.e., vocabulary and listening comprehension weakness) are addressed in the theoretical models of reading comprehension, SVR and LQH respectively. SVR contends that a listening comprehension weakness will result in poor reading comprehension while LQH purports that a vocabulary weakness will impair reading comprehension. Although both theoretical models suggest that a
deficit at the word level (i.e., word decoding) will impair reading comprehension, this skill deficit is absent in individuals with an S-CRD.

An S-RCD may have an influence on written expression and applied math performance. Specifically, Berninger and Abbott (2010) found that a bidirectional relationship existed between reading comprehension and written expression in third, fifth, and seventh grade children. Inability to read and understand a topic will likely compromise a student’s ability to write about it. Also, students’ inability to understand written material will limit their ability to revise their own written work. Failure to infer meaning from written text can also impair math performance. For example, Rutherford-Becker and Vanderwood (2009) found that reading comprehension in fourth and fifth grade students was a significant predictor of applied math performance; students need to understand word problems before applying their math skills to solve them. The results by Berninger and Abbott (2010) and Rutherford-Becker and Vanderwood (2009) suggest that the academic areas affected by poor reading comprehension are likely widespread.

2.3 ADHD

2.3.1 Definition and Prevalence

Attention deficit/hyperactivity disorder (ADHD) is a persistent and pervasive neurobiological disorder characterized by one or both of two symptom groups: hyperactivity-impulsivity and inattention. The symptoms that affect approximately 5% of school-aged children worldwide (Faraone, Sergeant, Gillberg & Biederman, 2003; Polanczyk, de Lima, Horta, Biederman & Rohde, 2007) are frequent and severe enough to be considered inappropriate for the child’s age causing impairment in day-to-day functioning (American Psychiatric Association, 2000). The prevalence of ADHD among boys is higher than it is for girls; the male to female
ration ranges from 3:1 to 9:1 (Staller & Faraone, 2006). In community samples compared to clinical samples the prevalence of girls with ADHD is higher perhaps due to diagnosis and treatment obstacles in the referral process (Staller & Faraone, 2006). Once only recognized as a childhood disorder, it is now realized that the disorder does not abate in adolescence; up to 70% of children with ADHD will continue to meet the diagnostic criteria for ADHD in adolescence (Barkley & Murphy, 2006).

### 2.3.2 Academic Difficulties and ADHD

Academic underachievement is a typical characteristic of ADHD in adolescence (Wender, 1995). Students with ADHD are more likely to be off task and engage in disruptive behavior than their peers without ADHD (Abikoff & Gittelman, 1985; DuPaul, et al. 2004). The learning difficulties experienced by students frequently include problems with homework and academic enablers such as low engagement, low motivation and poor study skills (Habboushe et al., 2001; Power, Werba, Watkins, Angelucci & Eiraldi, 2006; Volpe et al., 2006). Unsurprisingly, a recent study’s findings indicated that adolescents who were identified as having ADHD as children obtained lower scores on standardized measures of reading and math and were at a greater risk of failure to graduate than peers without ADHD (Bussing, Mason, Bell, Porter & Garvan, 2010). While disorders of reading are common in individuals with ADHD (Mayes, Calhoun & Crowell, 2000) the majority of research has focused on Word Recognition Reading Disorders with a limited number of studies investigating specific reading comprehension weaknesses in ADHD (Ghelani, et al. 2004).

### 2.3.3 Reading Disabilities and ADHD
Students with ADHD are more likely to score lower than their peers on standardized reading achievement measures (Frazier, Youngstrom, Glutting & Watkins, 2007). It is estimated that between 16% and 38% of individuals with ADHD also have a reading disability (RD) (Barkley, 1990; Frick et al., 1991; Semrud-Clickeman, et al., 1992). Low reading proficiency is important to address in students with ADHD because it can have adverse effects on educational outcomes. For example, a recent study (Bus & Knighton, 2009) examined the relationship between reading proficiency and school dropout in a large sample of Canadian adolescents. They found that individuals who were less proficient readers took more time to complete high school than those who were skilled readers. Also, individuals who dropped out of high school were less likely to obtain a high school diploma by age 21 if they had lower reading proficiency levels. Finally, after controlling for factors that are considered to have an impact on participation in postsecondary education, including gender, family income, place of residence, mother tongue, and parental education, reading ability was., 2009). ADHD increases the risk of graduation failure (Bussing et al., 2010) and poor reading proficiency may exacerbate this risk.

There are two types of reading disorders that have been identified and examined in individuals with ADHD. One is a Word Recognition Disorder (WRD) and the other is an S-RCD (Burton, 2006). In general word-level reading difficulties have been studied to a greater extent than S-RCD’s – likely due to the complexity of examining and assessing reading comprehension processes (Lyon, Fletcher & Barnes, 2003). Individuals with a WRD are typically impaired in orthographic and phonological coding (for a review see Fletcher, Lyon, Fuchs & Barnes, 2007). These impairments are thought to limit the development of word recognition skills (Lyon, et al., 2003; Pennington, 2002; Teeter & Semrud-Clickeman, 1997). Considerable research has focused
on understanding why there is such a high degree of overlap between ADHD and WRD (Ebejer et al., 2010; Willcutt et al., 2010). Less research has specifically examined the co-occurrence of ADHD and S-RCD. Rather, the distinction between WRD and S-CRD is often not made (e.g., Semrud-Clickeman, et al. 1992). Nevertheless, it is known that the two conditions (i.e., RD and ADHD) co-occur at a rate that is greater than what would be probable on the basis of chance alone (Willcutt, Pennington, Olson, Chhabildas & Hulslander, 2005). Research generally supports the common etiology hypothesis in explaining the high comorbidity between ADHD and RD (Willcutt et al., 2005). This hypothesis puts forth the notion that the comorbidity between ADHD and RD is due to similar genetic etiology; a gene or genes put one at greater risk for having both disorders. For instance, twin studies have provided evidence that RD and ADHD are each polygenetic and very heritable (Willcutt et al. 2005). Additionally, bivariate twin analyses inform us that the comorbidity between RD and ADHD stems from similar genetic pressures (Willcutt et al., 2005). The limited research that has specifically examined comprehension problems and ADHD has in fact found that individuals with ADHD performed at a lower level on measures of reading comprehension (Brock & Knapp, 1996; Ghelani, et al. 2004). However, the contribution of word level reading difficulties that are often exhibited by children and adolescents with ADHD to reading comprehension performance has not been examined to a great extent.

2.3.4 Vocabulary and ADHD

Vocabulary weaknesses have been found in samples of children, adolescents and adults with ADHD with and without a co-existing WRD (e.g., Asberg, Kopp, Berg-Kelly & Gillberg, 2010; Biederman et al., 1993; Rucklidge & Tannock, 2001). Interestingly, vocabulary weaknesses are apparent in individuals with ADHD in the absence of a deficit in non-verbal
intellectual ability (e.g., Asberg et al. 2010; Rucklidge & Tannock, 2001). This finding indicates that poor vocabulary is not a reflection of low intelligence but rather a relative weakness in this group of individuals. De Jong and van der Leij (2002) suggest that reading ability may be responsible for individual differences in vocabulary. It is possible that word- or comprehension-level weaknesses in individuals with ADHD may prevent vocabulary growth. For instance, if a student has difficulty recognizing words then he or she may avoid reading, in turn preventing vocabulary development through exposure to words in written text. Print exposure has been found to be a predictor of vocabulary (Stanovich & Cunningham, 1992). Additionally, if one cannot adequately comprehend text, then one might find inferring the meaning of an unknown word to be difficult. Cain, Oakhill and Lemmon (2004) found that children who were poor at comprehending text were also less proficient at inferring the meaning of words from text. This pattern of findings suggests that the gap in vocabulary ability between proficient and weak readers may grow over time. This finding may explain why vocabulary weaknesses are not often found in children with ADHD (e.g., Brock & Knapp, 1996; Kim & Kaiser, 2000), but are frequently reported in adolescents and adults with ADHD (Rucklidge & Tannock, 2001; Biederman et al., 1993). Although poor reading comprehension may result in vocabulary weakness, it has also been suggested that a weak vocabulary plays a causative role in poor reading comprehension (e.g., Cromley & Azevedo, 2007). However, the relationship between vocabulary and reading comprehension is likely not unidirectional but bidirectional; being at risk of having a deficit in one, as with those who have ADHD, may lead to or exacerbate a weakness in the other. Overall, evidence of vocabulary deficits in students with ADHD suggests that comprehension of written text may be an area of weakness in adolescents with ADHD.

### 2.3.5 Reading Comprehension and ADHD
Relatively few studies have focused primarily on reading comprehension performance in children or adolescents with ADHD. Brock and Knapp (1996) found that children with ADHD performed lower on measures of reading comprehension than children without ADHD. Twenty-one children with ADHD and 21 comparison children were included in the study; the average age was 10.5 years. The study controlled for background knowledge that was related to the text content, word identification, and word attack skills. Children had to have average word identification reading ability to participate and those who had a reading disability were excluded from participating (i.e., had reading difficulties that required special education).

In their study they compared children with and without ADHD on macroprocessing and microprocessing. Macroprocessing refers to an overall understanding of a whole text whereas microprocessing refers to comprehension of individual sentences. To assess microprocessing participants were required to fill in words that were left blank within a passage. In assessing macroprocessing participants were asked to answer questions regarding the passage as a whole. Participants were also asked how well they understood the text on a five-point scale. The rating was used as an index of comprehension monitoring by the researchers. It was found that on measures of reading comprehension (i.e. macroprocessing and microprocessing) children with ADHD performed significantly lower compared to control children. Further, children with ADHD performed similarly poorly on both macroprocessing and micoprocessing compared to control children; there was no interaction between group membership and reading comprehension task. Finally, the comprehension monitoring abilities of children with ADHD were similar to those of the control children. Specifically, children with ADHD were as accurate at predicting their reading comprehension as control children. While children with ADHD may be accurate at predicting their comprehension performance, it is premature to conclude that they
are proficient at comprehension monitoring. A key component of comprehension monitoring requires readers to actively draw on their general knowledge or story information when comprehension problems arise. Evidence from a recent study suggests that children with ADHD struggle with this aspect of comprehension monitoring (Berthiaume, Lorch & Mulich, 2010).

While Brock and Knapp’s (1996) findings support the notion that children with ADHD have reading comprehension problems, the effect of stimulant medication in the ADHD group was not sufficiently controlled. Brock and Knapp reported that children with ADHD who were on medication at the time of the study did not differ from the control group on reading comprehension. However, the sample of children with ADHD on medication was small, so the finding that medication may improve reading comprehension is speculative. Nevertheless, given that a proportion of the participants took stimulant medication on the day of testing, the difference in reading comprehension performance between the ADHD and control groups may have been wider had all of the ADHD participants completed without receiving stimulant medication. Interestingly, McInnes, Bedard, Hogg-Johnson and Tannock (2007) found that the stimulant medication methylphenidate improved a key component of listening comprehension-making inferences from complex explanations. Given the relationship between listening and reading comprehension it is possible that stimulant medication also may improve reading comprehension.

A more recent study of comprehension abilities in individuals with ADHD (Ghelani, et al., 2004) did control for medication effects and the researchers took a more rigorous approach to identify an RD. In Ghelani et al.’s study, students were identified with an WRD if they had a score below the 25th percentile on either the Word Identification or Word Attack subtests of the Woodcock Reading Mastery Test-Revised (WRMT-R/NU) along with a past history of reading
problems or an official diagnosis of an RD. Students whose score was above the 25\textsuperscript{th} percentile on both subtests were considered to be free of an RD.

Ghelani et al.’s (2004) primary objective was to use both oral and silent reading passages to study reading comprehension in adolescents with ADHD and/or a reading disability. Four groups took part in the study: an ADHD only group, an RD only group, an ADHD+RD group and a typically developing comparison group. It was predicted that the ADHD and RD groups would obtain lower scores than the comparison group on the measures of reading comprehension. Although word reading and decoding were impaired in the RD groups, the ADHD-only group and comparison groups did not exhibit impairments in word reading accuracy or decoding skills. Further, when compared to the comparison group, both the ADHD+RD and RD groups had significantly weaker vocabularies whereas the ADHD-only group did not.

To measure oral reading comprehension participants were instructed to read passages out loud. After each passage the adolescent turned over the page and the examiner read aloud 5 multiple choice questions that the adolescent in turn answered orally. The level of accuracy of the answers yielded a comprehension score. The silent reading comprehension measure involved the adolescents reading a passage silently and then answering 5 multiple-choice questions. This was a self-paced task and unlike the oral reading comprehension measure, the adolescents were allowed to refer back to the passage in order to answer the multiple-choice questions.

It was found that adolescents in both ADHD groups performed at a significantly lower level than the typical comparison group on silent reading comprehension, but not on oral reading comprehension. It is important to note, however, that the mean score of the ADHD-only group was within the average range on both tasks. Although the RD group was also within the average
range on both of the measures, their performance was significantly worse than the comparison group. When estimated Full Scale IQ (FSIQ) (i.e., the average of scores from the Vocabulary measure and a nonverbal measure) was entered as a covariate the difference between the ADHD only and the typical comparison group on the silent reading comprehension task disappeared. The differences remained however for both RD groups. Similarly, when Vocabulary was entered as a covariate the difference between the ADHD only group and the typical comparison group on the silent reading comprehension task disappeared. The difference also disappeared for the ADHD + RD group but remained for the RD only group.

This pattern of findings suggests that the low scores for the RD groups on the comprehension measures were likely a reflection of their weaknesses in word reading. Decoding skills and efficient sight word reading allow attentional resources to be directed towards comprehension (LaBerge & Samuels, 1974). The ADHD without RD group, however, had intact word level skills, yet performed at a lower level on silent reading comprehension when compared to the typical comparison group. When IQ was controlled for in the analyses, the difference between the ADHD without WRD and typical comparison group was eliminated. It is possible that poorer performance on silent reading is a reflection of lower IQ. However, Vocabulary acted as both a covariate in FSIQ and by itself. Ghelani et al. (2004) suggested that the presence of ADHD may increase the risk of a weak vocabulary, thus controlling for vocabulary may eliminate the part of variance that is unique to ADHD. It would be interesting to determine whether controlling solely for nonverbal IQ would also eliminate the difference between the ADHD without WRD group and the typical control group. Ghelani et al., did not discuss why both ADHD groups performed comparably to the typical comparison group on the oral reading comprehension measure, but not on the silent reading comprehension task. This
discrepancy in findings between the two comprehension tasks is especially surprising given that participants were allowed to refer back to the passages in order to answer the multiple choice questions for the silent reading comprehension task but not for the oral reading comprehension measure. Both measures of comprehension had a similar content and format. One might therefore predict better performance on the silent reading measure given that participants were able to review the text. In the present study, the students completed a standardized silent reading comprehension task-, which is a typical comprehension task for high school students.

2.3.6 Listening Comprehension and ADHD

Two recent studies have examined listening comprehension skills in children with ADHD. Berthiaume et al., (2010) studied both inferencing ability and comprehension monitoring in boys with ADHD. Inference making is the process of applying general knowledge or information from the texts or story itself to understand what either the meaning of an ambiguous word is or to make connections between ideas within a text or story (Berthiaume, et al., 2010). Comprehension monitoring refers to monitoring one’s understanding of text and the ability to apply a strategy to repair comprehension when failure is realized (Berthiaume, et al., 2010). In this study three tasks were used: creating and evaluating inferences, differentiating between inconsistent and consistent information in a story and a think-aloud task that required the participants to verbally represent their understanding of a story as it occurred. Compared to the control group, boys with ADHD had greater difficulty forming correct inferences. Further, boys with ADHD reported greater confidence in their answers despite having limited information which to base their answers. Boys with ADHD were also more impaired compared to control group boys in identifying inconsistencies within the story. Finally, on the think-aloud task, boys with ADHD were found to report a greater number of unlikely explanatory inferences for events
within the story relative to comparison boys. Importantly, while carrying out the think-aloud task the boys with ADHD had problems thinking of things to report, communicated more uncertainty regarding what the task involved, and made more unrelated statements (Berthiaume, et al., 2010).

McInnes, Humphries, Hogg-Johnson and Tannock (2003) reported similar findings in their study. They found that children with ADHD with and without a co-existing language impairment performed significantly more poorly than the comparison children without ADHD or a language impairment on two expository listening comprehension tasks. Children with ADHD exhibited weakness in inference making and comprehension monitoring but not on fact recall. This finding suggests that children with ADHD may struggle with the aspects of reading comprehension that require the integration of information. Finally, Wassenberg, Hendriksen, Hurks, Feron, Vles and Jolles (2010) found that language comprehension deficits in ADHD persist into adolescence. In their study they examined the amount of time it took adolescents with ADHD to process complex sentences and they assessed whether the sentences were understood or not by the adolescents with and without ADHD. While children and adolescents with ADHD were found to understand individual sentences, they took longer to process them. Slower processing, in turn, could impair comprehension of a longer message.

Collectively, these findings suggest that a listening comprehension deficit is an area of difficulty for children with ADHD. As suggested by the research of Verhoeven and Van Leeuwe (2008), listening comprehension and reading comprehension are closely related and tend to be stable over time. As a deficit in listening comprehension is associated with ADHD, I predicted that adolescents with ADHD would be more likely than adolescents without ADHD to be identified with an S-RCD because they may struggle with comprehension processes (e.g., inferencing, comprehension monitoring) despite having adequate word level skills.
2.4 Research Objectives and Hypotheses

Overall, research indicates that the skills that underlie proficient comprehension are often weak in children and adolescents with ADHD. Furthermore, while the existing data studying reading comprehension in adolescents with ADHD is limited in scope, findings shows that children and adolescents with ADHD demonstrate weakness in comprehension compared to a control group. This study will examine the following research questions:

1) What is the relationship between reading comprehension and word reading skills (i.e., decoding and fluency), spelling and oral vocabulary knowledge in adolescents with and without ADHD?;

2) Are adolescents with ADHD more likely than their peers without ADHD to have an S-RCD; and

3) Do adolescents with ADHD who have an S-RCD exhibit poorer performance than adolescents with ADHD who are good comprehenders on measures that depend in part on comprehension (e.g., math problem solving)?

Based on the LQH and SVR models of comprehension, it is predicted that word knowledge (i.e., phonological, orthographic and semantic awareness) will predict reading comprehension performance in adolescents with and without ADHD. Similar to Perfetti and Hart’s (2002) study, phonological coding ability in the present study will be indexed by pseudoword decoding. I will also examine the relations between reading comprehension and word reading accuracy and sight word efficiency (which also taps phonological awareness) to determine whether these skills predict reading comprehension performance independent of spelling and vocabulary ability. Orthographic awareness will be indexed by a standardized
assessment of spelling. Finally, semantic awareness will be indexed by a standardized vocabulary measure. Given the prior evidence of reading and listening comprehension weaknesses in students with ADHD, it is predicted that adolescents with ADHD will be more likely to be identified with an S-SRD compared to adolescents without ADHD. Last, given the influence reading comprehension skill has on written expression and math problem solving it is predicted that adolescents with ADHD who have an S-RCD will perform at a lower level on measures that assess these two skills compared to adolescents with ADHD who do not have an S-CRD
CHAPTER 3
Methodology

3.1 Participants

Participants included 87 adolescents with and without ADHD (41 females and 46 males) aged 13-18 years ($M = 15.51$, $SD = 1.69$). A total of 45 adolescents (52% of the sample) had previously been identified with ADHD (26 males, 19 females), aged 13-18 years ($M = 15.54$, $SD = 1.83$). A total of 42 adolescents (48% of the sample) comprised the comparison group of adolescents without ADHD (20 males, 22 females), aged 13-18 years ($M = 15.48$, $SD = 1.54$). In order to be included in the ADHD sample adolescents needed to: 1) have an estimated Full Scale IQ of $\geq 80$ on the basis of the Matrix Reasoning and Vocabulary subtests from the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999); 2) a diagnosis from a physician or clinical psychologist of ADHD based on the criteria outlined within the Diagnostic & Statistical Manuel for Mental Disorder, Fourth Edition (DSM-IV); 3) not have a diagnosis of a genetic or neurological disorder (e.g., Tourettes syndrome, autism spectrum disorder, psychotic disorder) and 4) have a T-score of $\geq 70$ on one or more of the central ADHD indices (i.e., DSM-IV Hyperactive Impulsive, DSM-IV Inattentive, and DSM-IV Global) based on Conners’ 3 Parent Rating Scale, Long Form (Conners 3-P; Conners, 2008). Inclusion criteria for the control group was similar to that of the ADHD group: 1) an estimated Full Scale IQ of $\geq 80$ on the WASI; 2) no previous diagnosis of ADHD, (although, -a learning disability was permitted); and 3) T-scores $\leq 60$ on the DSM-IV subscales of the Conners 3-P.

Participants with and without ADHD were recruited through postings within the community including libraries, community centers, local agencies and clinics and local
newspapers. The participants were fluent in reading, speaking and writing in English. Further, participants taking medication for ADHD, 60% of the ADHD sample, were asked to discontinue their medication for the day that they participated in the study. Co-morbid diagnoses, as reported by parents, were common in the ADHD sample: 26(57.8%) had a Learning Disability, 9(20%) had an Anxiety Disorder, 3(6.7%) had Depression and 4(8.9%) had a diagnosis of Oppositional Defiant Disorder. Conversely, only 2(4.8%) of the participants in the control group had been identified as having a disorder (Learning Disability in both cases).

Table 1 presents the characteristics of the two subgroups by gender and subgroup. Teacher, parent and self ratings indicate that adolescents (males and females) with ADHD exhibited significantly higher symptoms of ADHD (i.e., hyperactivity, impulsivity, and inattention) than adolescents without ADHD. They also exhibited lower performance on each of the academic measures. Interestingly there was no difference between males with and without ADHD on self-reported symptoms of hyperactivity-impulsivity.

3.2 Procedure

Participants were each individually tested within a laboratory at the Ontario Institute for Studies in Education (OISE). The parents of the adolescents who were interested in participating were first asked to complete an intake screen. To assess whether their child was eligible to participate each parent/guardian was given the Conners-3 parent rating scale over the phone after receiving verbal permission from the parent/guardian to complete the screening. The adolescents who met the initial inclusion criteria were then scheduled for an assessment session. Additionally consent forms were mailed out to the participants. Once the adolescents arrived for their session, the consent forms were collected from the parents and all participants were asked to provide their
assent after being given an overview of the study and the procedures by the research assistant. While the adolescents were completing the study measures, parents were asked to fill out questionnaires. If the parent did not accompany his/her child to the assessment session, the questionnaires were given to the adolescent to give to their parent to complete and send back through the mail. Parents were asked to have one teacher who knew the adolescents well to complete the C3-T. The Conners 3-Teacher (C3-T) forms were given to parents and/or adolescents to give to teachers and were returned by mail. Parents were asked to provide written permission for the teacher to complete the Conners-3T on their child.

Research assistants worked individually for 5-6 hours with the adolescents. During the assessment the adolescents completed standardized tests and a battery of self-report measures relating to beliefs and attributions for behavior that were a part of a larger study. The research assistants were graduate students trained in psychological test administration. Each of the participants received an educational and social-emotional report describing his or her performance on the standardized educational assessment measures. Additionally, all the adolescents were given the choice of receiving community service hours (necessary for receiving a high school diploma in Ontario) or $30 cash to compensate for travel costs and time.

3.3 Measures

The Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) was administered to each of the participants. It is a standardized abbreviated measure of cognitive ability. For the purpose of this study the Matrix Reasoning and Vocabulary subtests were administered to gain an estimate of FSIQ. Importantly, the estimated FSIQ from the WASI
correlates strongly with the Wechsler Intelligence Scale for Children \(r = .83\) to \( .89\) a commonly used measure of cognitive ability.

The *Woodcock Johnson Test of Achievement-Third Edition* (WJ-III; Woodcock, McGrew, Mather, 2001) is a commonly used norm-referenced measure of achievement. A subset of subtests from this battery was administered to each of the participants. In this study the participants were administered Calculation and Applied Problems, the Spelling and Writing Samples subtests, and Letter-Word Identification and Passage Comprehension subtests. There is evidence that the WJ-III has high internal consistency (Bradley-Johnson, Morgan & Nutkins 2004).

The *Test of Word Reading Efficiency* (TOWRE; Torgesen, Wagner & Rashotte, 1999) was administered to a subset of participants. This test includes two subtests: Sight Word Efficiency (SWE) and Phonetic Decoding Efficiency (PDE). While SWE assesses the number of real words that can be orally read from a list within a period of 45 seconds, PDE assesses the number of pseudowords that can be orally read from a list within a period of 45 seconds. As a measure of word reading ability the TOWRE has demonstrated to have both validity and reliability (Torgesen, Wagner & Rashotte, 1997).

To measure symptoms of ADHD the parent, adolescents and teacher Conners Rating Scales-Third Edition (Conners 3; Conners 2008) were used. The Conners Rating Scales have commonly been utilized in clinical settings to assess ADHD symptoms in children and adolescents. The parent version (Conners 3-P) allowed us to assess whether or not the adolescent was suitable to participate in the study. Parent ratings of adolescent’s ADHD have been found to be very informative (Biederman, Ball, Mick, Monuteaux, Kaiser, Bristol & Faraone, 2007).
Although teacher rating (Conners-T) were collected to obtain information about the adolescent’s symptoms from a second informant they were not used as inclusion criteria because of the low rates of agreement among teachers’ ratings of adolescents with ADHD (Evans, Allen, Moore, & Strauss, 2005). Further, agreement among teacher and parent ratings on the psychological symptoms of adolescents has been found to be low (Dirks, Boyle & Georgiades, 2011). The prevalence of ADHD is higher based on teacher report than parent report (Dirks et al., 2011). Finally, adolescents with and without ADHD were given the self-report version (Conners 3-SR) as method of understanding how they perceive their own ADHD symptoms. They were also not used as inclusion criteria due to the finding that adolescents with ADHD under report their symptoms (Biederman et al., 2007).

Each of the Conners rating scales (Conners 3-P, Conners 3-SR, Conners-T) is made up of a series of items that translate to several subscales, two of which were used for this present study: DSM ADHD Inattentive and DSM ADHD Hyperactive-Impulsive. Parents, teachers and adolescents rate the behavior on a 4-point Likert scale ranging from 0 (“not true at all”) to 3 (“very much true”). In turn, a T-score adjusted for age and gender is produced for each subscale with higher T-scores indicating greater levels of symptom expression. The Conners has high internal consistency (.79 to .96 across subscales) (Conners, Sitarenios, Parker, & Epstein, 1998).

### 3.4 Statistical Analysis

Two separate multiple regressions will be performed in order to examine the relative contributions of phonological, orthographical and semantic ability to reading comprehension in adolescents with and without ADHD (Question 1). The first regression will examine the contribution of PDE, Spelling and Vocabulary to reading comprehension. The second regression
will examine the contribution of SWE, Spelling and Vocabulary to reading comprehension. Letter-Word Identification was not included in either of these regression analyses due to the high correlation between it and Spelling (see Table 2). Similarly, PDE and SWE were not included in the same regression due to their high correlation (See Table 2). These two regressions were conducted to determine whether either decoding ability or Sight Word Reading Efficiency was a unique predictor of reading comprehension independent of spelling and vocabulary ability. I decided to examine each of the TOWRE subtests because PDE provides an index of fluency and word attack skills whereas SWE provides an index of overall word attack and word identification skills as well as fluency. Because only 68 of the 87 participants completed the SWE and PDE subtests, all of the regression analyses were performed with only the 68 participants. Independent t-tests revealed that there were no significant differences on the aptitude and achievement measures between the group that completed SWE and PDE and the group that did not.

I conducted chi square analyses to determine whether adolescents with ADHD are more likely to exhibit an S-RCD deficit than their peers without ADHD (Question 2). A cut-off of both the 25th percentile and 16th percentile were applied. Finally, a multivariate analyses of variance (MANOVA) was carried out to assess whether or not adolescents with ADHD and an S-RCD perform at a lower level than adolescents with ADHD without any word-or text-level reading difficulties on two academic measures that depend in part on comprehension (mathematical reasoning and written expression) compared to adolescents with ADHD without an S-RCD (Question 3). A cut-off of both the 25th percentile and 16th percentile will be applied.
CHAPTER 4
Results

4.1 Question 1

For the purpose of the first question only the 68 participants that were assessed on all the measures were included in the regression. To assess whether the correlations between the measures in each group were significantly different I conducted a statistical transformation called Fisher’s Z on the following pairs of measures: 1) Passage Comprehension and Vocabulary; 2) Passage comprehension and Letter-Word Identification; 3) Passage comprehension and Spelling; 4) Passage comprehension and PDE; 5) Passage Comprehension and SWE; 6) Vocabulary and Letter-Word Identification; 7) Vocabulary and Spelling; 8) Vocabulary and PDE; 9) Vocabulary and SWE; 10) Letter-Word Identification and Spelling; 11) Letter-word Identification and PDE; 12) Letter-Word Identification and SWE; 13) Spelling and PDE; 14) Spelling and SWE; and 15) PDE and SWE. Table 2 presents the correlations among each pair of measures for each group and the full group. The correlations between each pairs of measures in each group were not significantly different from each other. Thus, the ADHD and non-ADHD groups were collapsed for the regression analysis.

The first multiple regression was conducted to evaluate how well PDE, Spelling and Vocabulary predicted Passage Comprehension. The linear combination of PDE, Spelling and Vocabulary was significantly related to Passage Comprehension, $F(3,64) = 25.63, p < .001$. The sample multiple correlation coefficient was .74 indicating that approximately 55% of the variance in performance on Passage Comprehension can be accounted for by the linear combination of PDE, Spelling and Vocabulary. Beta values, standard errors and constants can
seen in Table 3. It was found that both Vocabulary, $t(64) = 4.68, p < .001$, and Spelling, $t(64) = 2.30, p < .05$, explained significant variance in reading comprehension whereas PDE, $t(64) = .19, p = .85$ did not. This multiple regression suggests that both Vocabulary and Spelling predict reading comprehension performance in adolescents with and without ADHD.

The second multiple regression was conducted to evaluate how well SWE, Spelling and Vocabulary predicted Passage Comprehension. The linear combination of SWE, Spelling and Vocabulary was significantly related to Passage Comprehension, $F(3,64) = 25.88, p < .001$. The sample multiple correlation coefficient was .74, indicating that approximately 55% of the variance of performance on Passage Comprehension can be accounted for by the linear combination of SWE, Spelling and Vocabulary. Beta values, standard errors and constants can be seen in Table 4. It was found that both Vocabulary, $t(64) = 4.62, p < .001$, and Spelling, $t(64) = 2.42, p < .05$ explained significant variance in Passage Comprehension whereas SWE, $t(64) = .61, p = .55$ did not. This multiple regression suggests that both Vocabulary and Spelling predict reading comprehension performance in adolescents with and without ADHD.

Two supplemental multiple regressions were performed. The first included Letter-Word Identification, PDE, and Vocabulary and the second included Letter-Word Identification, SWE, and Vocabulary. Spelling was not included in these regression analyses as the correlation between Letter-Word Identification and Spelling was high ($r = .826$) indicating multicollinearity. Similarly, I analyzed PDE and SWE in separate analysis, as the correlation between the two was also high ($r = .795$).

The first multiple regression was conducted to evaluate how well Letter-Word Identification, PDE and Vocabulary predicted Passage Comprehension. In this case, the Letter-
Word subtest is acting as an alternate indicator of both orthographic and phonological skills but not fluency. The linear combination of Letter-Word Identification, PDE, and Vocabulary was significantly related to Passage Comprehension, $F(3,64) = 24.23, p<.001$. The sample multiple coefficient was .73, indicating that approximately 53% of the variance of performance on Passage Comprehension can be accounted for by the linear combination of Letter-Word Identification, PDE, and Vocabulary. Beta values, standard errors and constants can be seen in Table 5. It was found that only Vocabulary, $t(64) = 4.40, p <.001$, explained significant variance in Passage Comprehension, whereas Letter-Word Identification, $t(64) = 1.80, p = .08$, and PDE, $t(64) = .10, p = .92$, did not.

The second supplemental multiple regression was conducted to evaluate how well Letter-Word Identification, SWE and Vocabulary predicted Passage Comprehension. The linear combination of Letter-Word Identification, SWE and Vocabulary was significantly related to Passage Comprehension, $F(3, 64) = 24.47, p<.001$. The sample multiple coefficient was .73, indicating that approximately 53% of the variance of performance on Passage Comprehension can be accounted for by the linear combination of Letter-Word Identification, SWE and Vocabulary. Beta values, standard errors and constancies can be seen in Table 6. It was found that only Vocabulary, $t(64) = 4.48, p <.001$, explained significant variance in Passage Comprehension whereas Letter-Word Identification, $t(64) = 1.94, p = .06$, and SWE, $t(64) = .59, p = .56$, did not. Overall, these supplementary regression analyses demonstrate that word recognition accuracy and fluency are not independent contributors to comprehension performance independent of vocabulary ability.

**4.2 Question 2**
When an S-RCD is defined as performance below the 25\textsuperscript{th} percentile on Passage Comprehension and at or above the 25\textsuperscript{th} percentile on Letter-Word Identification, 14 of the 45 (31\%) adolescents with ADHD met the criteria for S-RCD whereas only 3 of the 42 (7.14\%) adolescents without ADHD met the same criteria. A chi-square was conducted to evaluate whether there was a significant association between ADHD and S-RCD (<25\textsuperscript{th}\%). There was a significant association, $X^2(1) = 7.94$, $p < .01$. While the sample size is relatively small the expected frequencies were greater than 5 and the probability of the chi-square distribution two-sided is .006.

When a more conservative definition of an S-RCD was utilized (i.e., below the 16\textsuperscript{th} percentile on Passage Comprehension and at or above the 25\textsuperscript{th} percentile on Letter-Word Identification), 6 of the 45 (13.33\%) adolescents with ADHD had an S-RCD whereas only 1 of the 42 (2.38\%) adolescents without ADHD had an S-RCD. A chi square analysis was conducted to evaluate whether there was a significant association between whether or not an adolescent was identified with ADHD and whether or not an adolescent was identified with an S-RCD (<16\textsuperscript{th}\%). There was not a significant association, $X^2(1) = 3.52$, $p = .06$. This means that when an S-RCD is defined by more stringent criteria adolescents with ADHD are not more likely to meet the criteria compared to adolescents without ADHD. However, the expected frequencies were less than five and the Fisher’s exact test revealed that the probability of the chi-square distribution is .111.

4.3 Question 3

A MANOVA was performed to assess whether the performance of adolescents with ADHD and an S-RCD (<25\textsuperscript{th}\%) differed from adolescents with ADHD who were considered good comprehenders on Applied Problems and Writing Samples. Significant differences were
found between the two groups on the dependent measures, Wilks’s $\Lambda = .69, F(2, 32) = 7.30, p < .01$. The multivariate $\eta^2$ based on Willk’s $\Lambda$ was quite high (.31).

Follow-up procedures similar to Enders (2003) were carried out. Analyses of variances (ANOVA) on the dependent variables were conducted as follow-up tests to the MANOVA. Using the Bonferroni method, each ANOVA was tested at the .025 level. The ANOVA on Writing Samples was significant, $F(1, 33) = 13.83, p < .01, \eta^2 = .30$, while the ANOVA on Applied Problems was not significant at the adjusted alpha level, $F(1, 33) = 4.50, p = .04, \eta^2 = .12$. As can be seen in Table 7, the ADHD group with comprehension weaknesses had lower mean scores on the Writing Samples subtest and on the Applied Problems subtest than the ADHD group without comprehension problems.

A second MANOVA was performed to find whether there were differences on Applied Problems and Writing Samples between adolescents with ADHD who met the criteria for a more conservative definition of a S-RCD ($<16^{th}$%) and the adolescents with ADHD who were identified as good comprehenders. There was an overall significant difference between the two groups, Wilks’s $\Lambda = .47, F(2, 24) = 13.42, p < .001$. The multivariate $\eta^2$ based on Willk’s $\Lambda$ was high (.58).

Analyses of variances (ANOVA) on the dependent variables were conducted as follow-up tests to the MANOVA. Using the Bonferroni method, each ANOVA was tested at the .025 level. The ANOVA on the Writing Samples was significant, $F(1, 25) = 23.88, p < .001, \eta^2 = .49$. The ANOVA on the Applied Problems was also significant, $F(1, 25) = 6.56, p < .025, \eta^2 = .21$.

When a more rigid definition of S-CRD was applied (i.e., $<16^{th}$ percentile), adolescents with ADHD who met this criterion performed at a significantly lower level on both the Writing
Samples and Applied Problems subtests compared to adolescents with ADHD who did not have an S-CRD. Table 7 shows the mean scores for both groups on the relevant measures.

In a supplementary analysis I explored whether the subgroup with ADHD and an S-CRD (<25th percentile) differed from the subgroup with ADHD who were good comprehenders on basic skills including Letter-Word Identification and Calculation skills. A MANOVA was conducted and no significant differences were found among the two groups on the two measures, Wilks’s Λ = .90, $F(2, 32) = 1.87, p = .17$. A second MANOVA was conducted comparing participants with ADHD who met the more conservative definition of S-CRD (i.e. <16th percentile) against those students with ADHD who were identified as good comprehenders, Again it was found that there were no significant differences between the two groups on the basic skill measures, Wilks’s Λ = .84, $F(2, 24) = 2.31, p = .12$. Table 7 shows the mean scores for each of the groups.
CHAPTER 5
Discussion

5.1 Review of the Findings

This study explored reading comprehension performance in adolescents with and without ADHD. I first examined the contributions of word-level-reading skills, spelling and oral vocabulary to reading comprehension ability. I drew upon two theoretical models of reading comprehension, LQH and SVR, to hypothesize that each skill (word reading, spelling and vocabulary) would uniquely contribute to reading comprehension ability. My second research objective was to determine whether adolescents with ADHD were more likely than their peers without ADHD to have an S-RCD. I predicted that adolescents with ADHD would be more likely to exhibit an S-RCD than peers without ADHD given recent evidence of listening and reading comprehension weaknesses in students with ADHD (e.g., Brock & Knapp, 1996; Ghelani, et al., 2004; Wassenberg, et al., 2010). Finally, my third goal was to investigate whether adolescents with ADHD who have an S-CRD exhibit poorer performance than adolescents with ADHD without an S-RCD on academic tasks that depend in part on comprehension (e.g., written math problems). I hypothesized that adolescents with ADHD with concurrent reading comprehension difficulties would show poorer performance on the writing and math problem solving measures than youth with ADHD without comprehension problems as both these academic skills have been shown to be dependent on comprehension.
Predictors of Reading Comprehension Performance

To answer the first question, two multiple regressions were performed. Each of the regressions included a measure of phonological, orthographic and semantic ability. These three skills are said to support reading comprehension across the lifespan (Verhoeven & Van Leeuwe, 2008). The selection of measures representing each construct was based on Perfetti and Hart’s (2002) study. Spelling, a measure of orthographic ability, and Vocabulary, a measure of semantic ability, were included in both regressions. The influences of two measures of phonological ability were examined independently. In the first regression PDE was used to index phonological/decoding skills ability; however decoding measures are also thought to tap orthographic knowledge (Perfetti & Hart, 2002). PDE also assesses speed of decoding ability. In the second regression Sight Word Efficiency (SWE) was used to assess phonological ability, but it too can be considered to tap orthographic as well as semantic knowledge. Importantly, SWE is also a measure of word recognition fluency. Joshi and Aaron’s (2000) Componential Model of Reading argues that fluency is a unique contributor of reading comprehension.

It was found that neither word-level measure (PDE and SWE) accounted for unique variance in reading comprehension independent of spelling and vocabulary. To determine whether Letter-Word Identification explained unique variance in Passage Comprehension, two supplemental regressions were performed. Spelling was not included in the supplemental regressions because of the high correlation between Spelling and Letter-Word Identification. Similar to the initial two regressions, SWE and PDE did not explain any unique variance in text comprehension, nor did Letter-Word Identification. This is surprising given that both the SVR
and LQH theoretical models suggest that word level reading skills are an independent contributor to reading comprehension (Verhoeven & Van Leeuwe, 2008). Further, the finding that word recognition fluency as measured through SWE, did not account for any unique variance is in contrast to Joshi and Aaron’s (2000) finding that fluency adds additional variance to reading comprehension beyond that of decoding and listening comprehension. Importantly, Joshi and Aaron (2000) examined fluency ability in third grade children, whereas this study examined adolescents with and without ADHD. It is possible that as children become older phonological ability and fluency play less of a role in reading comprehension. Braze et al., (2007), however, found this not to be the case. Specifically, Braze et al. found that decoding ability predicted reading comprehension in a sample of adolescents and young adults along with listening comprehension and vocabulary. Many of the adolescents and young adults participating in Braze et al.’s study had limited literacy skills. It is possible that decoding only plays a role in reading comprehension when decoding skills are weak. In this current study the majority of the adolescents were generally proficient at decoding with the majority (80%) of the participants scoring at or above the 25th percentile on PDE indicating the absence of a decoding deficit. It is possible that a different pattern of results would have been found had the majority of the participants performed below the 25th percentile on the word-level reading measures.

Thus, in a sample of adolescents with generally average or better word-level reading skills, individual differences in word reading ability and efficiency did not explain performance on the reading comprehension measure. However, orthographic ability (Spelling) and semantic (Vocabulary) ability consistently explained unique variance in reading comprehension performance. Although orthographic knowledge is emphasized in LQH and was measured in
Perfetti and Hart’s (2002) study, it is often not considered in research examining the predictors of reading comprehension (e.g., Verhoeven & Van Leeuwe, 2008). The findings of this study suggest that orthographic ability should be considered as an independent contributor to reading comprehension in adolescents. Vocabulary, on the other hand, is frequently examined in studies on reading comprehension (e.g., Braze et al. 2007; Lesaux & Kieffer, 2010; Verhoeven & Van Leeuwe, 2008) and has been found to be influential (Braze et al. 2007; Verhoeven & Van Leeuwe, 2008). Thus, it is not surprising that vocabulary played a strong role in reading comprehension in adolescents with and without ADHD.

As previously suggested, it is possible that phonological abilities would have played a greater role in reading comprehension had the sample consisted of adolescents with WRD. Future research needs to examine the relative contribution of phonological, orthographic, and semantic ability across diverse groups of adolescents. In addition, beyond these three abilities the contribution of listening comprehension needs to be examined. The SVR theoretical framework suggests that listening comprehension (along with decoding ability) contributes to reading comprehension. Both Braze et al. (2007) and Verhoeven and Van Leeuwe (2008) have found that listening comprehension predicts reading comprehension. Importantly, children with ADHD have been found to have a listening comprehension deficit (Berthiaume et al., 2010; McInnes, et al., 2003). Future studies need to examine whether listening comprehension deficits in students with ADHD persist into adolescence and examine the relationship between listening and reading comprehension skills in adolescents with and without ADHD. Listening comprehension is particularly important for adolescents given that oral lectures are often an instructional activity that high school teachers utilize to convey information about a topic in subjects such as science
and math (Smith, 2002; Whittington, 2002). It is also important to consider that both listening and reading comprehension depend on similar processes such as inferencing ability, working memory, and oral language abilities (Cain, Oakhill & Bryant, 2004; Gough & Tunmer, 1986; McInnes et al. 2003). It is possible that adolescents with ADHD are at risk for both listening and reading comprehension weaknesses because of deficits in processes that contribute to comprehension of text. Future studies need to examine whether adolescents with ADHD who have an S-RCD are characterized by a pattern of deficits similar to that of poor comprehenders (i.e., semantic learning weakness and listening comprehension deficit).

*S-RCD in Youth with and without ADHD*

A chi square analysis was conducted to determine whether adolescents with ADHD are more likely to exhibit an S-RCD than adolescents without ADHD. The first compared participants with ADHD who met the more lenient criteria for an S-CRD (i.e., <25th percentile on Passage Comprehension and ≥ 25th percentile on Letter-Word Identification) with participants without ADHD who met the same criteria for an S-CRD. The second also compared participants with ADHD who met the criteria for an S-CRD; however in this analysis a more conservative definition of an S-CRD was applied (i.e., <16th percentile on Passage Comprehension and ≥ 25th percentile on Letter-Word Identification).

In the first analysis it was found that having ADHD was significantly associated with also having an S-CRD. In the second analysis with the more conservative criteria, ADHD was not significantly associated with having an S-CRD. However, in the second analysis the sample size was likely too small to render accurate results. Specifically only 6 of the participants in the
ADHD group met the conservative definition of an S-CRD whereas 1 participant in the group without ADHD met the criteria. It is possible that a significant association between meeting both S-CRD criteria and ADHD would have been found had the sample been larger.

It is also necessary to note that the proportion of individuals who meet the criteria for an S-RCD may depend on the nature of the comprehension tasks. Thus, the extent to which ADHD is associated with an S-RCD may depend on the comprehension task. For instance, in this current study the comprehension passages were relatively brief and required only the selection of a word to complete a cloze passage. Such a task may not place high demands on working memory or on text integration and analysis. Given that weaknesses in working memory and inferencing are evident in individuals with ADHD (Berthiaume et al., 2010; Engelhardt, Nigg, Carr, Ferreira, 2008; McInnes et al., 2003), it is possible that more adolescents with ADHD would meet the criteria for an S-CRD had the comprehension measure required the students to answer implicit text comprehension questions that often involve inferencing ability.

**Written Expression and Mathematical Reasoning in Adolescents with ADHD with and without an S-RCD**

A MANOVA was performed to resolve the final question of whether adolescents with ADHD and an S-CRD perform lower on measures that depend in part on reading comprehension (i.e., Writing Samples and Applied Problems) compared to adolescents with ADHD without comprehension weaknesses. When the more lenient criteria for an S-CRD was used, adolescents with ADHD and an S-CRD obtained a lower score on Writing Samples, but not on Applied Problems, compared to adolescents with ADHD without comprehension weakness. Because
reading comprehension is important to written expression and understanding applied math problems presented in text format (Berninger & Abbott, 2010; Rutherford-Becker & Vanderwood, 2009), it is possible that the criteria to be identified with an S-CRD may need to be more rigorous to detect a difference in performance between the two ADHD groups. As predicted, when a more conservative definition (i.e. <16th percentile on Passage Comprehension but ≥ 25th percentile on Letter-Word Identification) was utilized, it was found that adolescents with ADHD who met the more conservative classification of an S-CRD performed at a lower level on both Writing Samples and Applied Problems when compared to adolescents with ADHD who were considered good comprehenders.

This pattern of findings suggests that adolescents with an S-CRD may also struggle with academic tasks that depend on reading comprehension despite having average or better word-level reading ability. Beyond Writing Samples and Applied Problems, it would be worthwhile to examine whether listening comprehension is impaired in adolescents with an S-CRD. Listening comprehension is thought to draw on the same processes as reading comprehension. Verhoeven and Van Leeuwe (2008) found that as children got older listening comprehension and reading comprehension had a reciprocal relationship. Thus, it would not be surprising individuals with an S-CRD demonstrated less proficient listening comprehension compared to good comprehenders.

5.2 Implications for Practice

Reading is a fundamental skill that is necessary for independence and productivity. The findings from this study suggest that adolescents with weak comprehension skills may find it difficult to learn from written material, write about a topic, and perform text-based applied math problems. Additionally, given that listening comprehension is intertwined with reading
comprehension, it is possible that students with a reading comprehension deficit may also struggle to learn from teachers’ oral lectures. This study has found that adolescents with ADHD are at an increased risk of having an S-RCD. The co-occurrence of each condition may lead to the exacerbation of one by the other and thereby increase the risk of academic failure. The findings of the present study have implications for assessment of adolescents with ADHD as well as instruction and intervention planning.

Both orthographic and semantic ability explained performance on a reading comprehension measure in the present sample of youth. Word reading skills (i.e., decoding, word recognition and fluency) did not. Thus, while an adolescent may be proficient at word reading skills, this is not indicative of his or her ability to successfully comprehend what he/she has read. A comprehensive assessment of an adolescent’s academic strengths and weaknesses ought to include a measure of reading comprehension. If reading comprehension is a relative weakness of the adolescent, this may partly explain poorer performance on other academic tasks such as written math problems or written expression. Additionally, poor performance on a reading comprehension measure may indicate that listening comprehension is also an area of weakness. Although this study did not examine listening comprehension, assessing both listening and reading comprehension would be worthwhile.

Spelling and vocabulary instruction may be one possible way to improve reading comprehension in adolescents. However, according to Perfetti and Hart (2002) it is not that those who are less skilled at reading comprehension need to be specifically taught spelling or vocabulary in order for the reading problem to abate; rather “experience with words, retrieving
and using spellings, pronunciations and meaning is a critical foundation of reading skill” (pp. 211-212). Thus, a comprehensive intervention aimed at improving reading comprehension is necessary. While many interventions include vocabulary instruction, spelling is often neglected (e.g., Lubliner & Smetana, 2005).

In a meta-analysis by Stahl and Fairbanks (1986), it was found that effective vocabulary instruction involved providing both definitional information and contextual knowledge. Definitional information is understood as one’s knowledge of a word and its relationship to other words (Stahl & Fairbanks, 1986). Contextual knowledge refers to knowledge of a fundamental concept and how that understanding is applied across varying circumstances (Stahl & Fairbanks, 1986). Stahl and Fairbanks also suggest that encouraging deeper processing of words improves vocabulary. The following scale by Stahl (1985) highlights successive depth of processing demands for vocabulary teaching; First, Stahl and Fairbanks state that in the first level “association” a student learns a relationship between a new word and either its definition or a specific context. Next, in “comprehension”, the student demonstrates his or her understanding of the word by writing a sentence involving the word or through generating antonyms. Last, in “generation”, in written or oral form the student either generates a new sentence or alternatively in his or her own words reinstates the definition (Stahl & Fairbanks, 1986). Stahl and Fairbanks (1986) additionally found that student’s vocabulary improved when they were exposed to words more than one or two times. Finally, they reported that the mnemonic key word method improved recall of definitions and sentence comprehension. In the mnemonic key word methods students first learn a keyword that is concrete and that sounds like the word to be learnt. The
keyword is used to ignite an image in the student’s mind that connects the new word to its definition.

More recent work (e.g., Joshi, 2005; Rupley & Nichols, 2005) also highlights the importance of vocabulary instruction. However, it would be remiss not to mention the reciprocal relationship between vocabulary and reading comprehension: As the student learns the meaning of new words he is able to comprehend more and as he comprehends more he is able to derive the meaning of a new word from context. Thus, exposure to printed materials in and of itself offers the opportunity to improve one’s vocabulary (Cunningham & Stanovich, 1998).

While both Stahl and Fairbanks (1986) and Rupley and Nichols (2005) research examined vocabulary instruction aimed at children, this current study suggests that it may be fruitful to broaden the scope of research to include adolescents as well as implement vocabulary instruction in high schools. Further, it may be beneficial for researchers to explore the influence of spelling instruction on reading comprehension. On the other hand, it is also likely that spelling improves through reading practice. It is possible that a reciprocal relationship also exists between spelling and reading comprehension.

The findings from this study indicate that a reading comprehension deficit is a common problem experienced by adolescents with ADHD. Those identified with an S-CRD also performed at a lower level compared to good comprehenders with ADHD on measures that involve comprehension (i.e., Writing Samples and Applied Problems). Further it is important to highlight that the consequences of comprehension deficits reach beyond academic
underachievement; in Ontario such weaknesses could result in failure to graduate from high school. The Ontario Secondary School Literacy Test (OSSLT) includes writing and reading components and must be passed in order to receive a high school diploma. Thus, it is important to monitor comprehension abilities in adolescents with ADHD and provide appropriate instructional support when weaknesses are identified to facilitate academic success and high school graduation in this population of high-risk adolescents.

The findings of recent studies by Johnson, Reid and Mason (2011) and Rogevich and Perin (2008) suggest that self-management techniques and the use of a multi-component reading comprehension strategy (TWA: *Think Before Reading, Think While Reading, Think After Reading*) leads to improvements in reading comprehension in adolescents with ADHD. With respect to self-management techniques, Johnson et al. provided explicit instruction in self-monitoring, goal setting and self-instruction whereas Rogevich and Perin (2008) only taught self-monitoring. TWA encompasses a series of skills: “Think Before Reading” includes questioning the author’s purpose, what is already known and what is wanted to learn. “Think While Reading” includes realizing reading speed, connecting knowledge and re-reading. “Think After Reading” includes identifying the main idea, summarizing information and realizing what has been learnt (Johnson et al., 2011).

Johnson et al. (2011) found that gains in reading comprehension were maintained along with some improvement at two and four week follow-ups. Rogevich and Perin (2008) also found that adolescents with ADHD improved their ability to comprehend. Compared to their peers without ADHD, however, it was found that the students with ADHD were less able to maintain
their literacy gains over time. Moreover, students with ADHD were less able to apply the taught literacy skills to different tasks. In addition to ADHD, the participants in Rogevich and Perin’s study also had a behavioral disorder (BD). An examination of students with coexisting BD and ADHD may yield dissimilar results to an examination of students with ADHD in the absence of a BD. While the participants in Johnson et al.’s study did not have a BD only three students were examined and each was on medication for ADHD. Had the students with ADHD been free of medication treatments, it is possible that gains would not have been maintained. Future studies examining comprehension interventions in adolescents with ADHD should also aim to have a greater number and a more heterogeneous sample of adolescents with ADHD. Further, assessing whether gains are maintained over a period of months is necessary. Last, it should be ascertained whether the skills that are learnt are being applied across diverse situations. As Rogevich and Perin, suggest, applying learnt skills to a novel situation might be challenging for students with ADHD. With this in mind, having students with ADHD practice the learnt skills in diverse conditions may be beneficial.

5.3 Limitations and Future Directions

When interpreting the findings of this study it is necessary to consider several limitations. First, causation cannot be inferred. Although a relationship between orthographic ability, semantic ability and reading comprehension performance was found, the direction of this relationship is unknown. For instance, it is possible that that reading comprehension explains orthographic ability rather than vice versa. An additional limitation was the sample size. Only 45 adolescents with ADHD participated in this current study. Thus, the number of adolescents with ADHD who also had an S-CRD may not be generalizable to the larger population of adolescents with ADHD. Future studies should aim to have larger and more representative
samples to see if the patterns in this current study can be replicated. A larger sample size may also allow researchers to make a distinction between adolescents who score below the 25th percentile on a reading comprehension measure and adolescents who score below the 16th percentile. In this study those who scored below the 25th percentile were grouped together with adolescents who scored below the 16th percentile. It is possible that there is no difference between adolescents with ADHD who score between the 16th and 24th percentile on measures that depend in part on comprehension (i.e., Applied Problems and Writing Samples).

This study examined the contributions of phonological, orthographic and semantic ability to reading comprehension in adolescents. Other contributors to reading comprehension include listening comprehension, working memory, executive function and attention capacity. Listening comprehension, a key component of SVR, has been found to be a significant contributor to reading comprehension (Braze, et al. 2007; Gough & Tunmer, 1986). Thus, it would be worthwhile for future studies to examine the contribution of listening comprehension to reading comprehension in adolescents with ADHD. It is known that children with ADHD have impairments in listening comprehension (Berthiaume et al. 2010; McInnes, et al., 2003) but the connection between this deficit and reading comprehension in adolescents with ADHD has yet to be examined.

It is also recognized that ADHD involves a deficit in working memory (WM) (Engelhardt et al., 2008). Working memory is a memory system responsible for the transient storage and management of information (Hunt & Ellis, 2004). Individuals who are poor reading comprehenders exhibit poor working memory (Nation, Adams, Bowyer-Crane & Snowling,
The role that working memory has in reading comprehension in adolescents with ADHD needs to be further studied. I predict, however, that working memory would have had only had a minimal role in predicting Passage Comprehension performance in this study because this particular measure of comprehension involves a cloze procedure and does not seem to place a high demand on working memory ability. Rather, the cloze procedure required the participants to complete sentences with missing words. Future studies should assess reading comprehension without using the cloze technique as this format likely does not mirror the working memory demands that exist in the reading material that adolescents are required to understand in high school.

Executive functions (EF) are “control processes in the brain that activate, integrate, and manage other brain functions” (Mash & Wolfe, 2007, p.118). The contribution of EF to reading comprehension was explored by Locascio, Mahone, Eason and Cutting (2010). They reported an association between poor strategic planning/organizing and reading comprehension problems. Cognitive processes such as organizing and planning are worthwhile to consider when examining reading comprehension in adolescents with ADHD as a deficit in EF is thought to underlie the symptoms of ADHD (Barkley, 1997).

Inattention is a core symptom in individuals with ADHD primarily inattentive type and combined type. It has been found that sustained attention is more related to story comprehension weaknesses in children with ADHD than basic language skills problems (Flory, Milich, Lorch, Hayden, Strange & Welsh, 2006; Pugzles Lorch, et al., 2004). Ability to attend to and integrate information from within a text may depend on the length of the passage. Examining the
relationship between passage length and both comprehension performance and level of engagement (on-task behavior) should be the focus of future studies.

Furthermore, it is possible that varying the characteristics of the reading comprehension measure may result in differing performances. For instance, Ghelani, et al. (2004) found that while adolescents with ADHD performed at a lower level than a comparison group on a measure of silent reading comprehension, they performed comparably to the adolescents without ADHD on a measure of oral reading comprehension. In addition, the passage was available to participants to assist in answering the comprehension questions in the silent reading comprehension measure but not the oral reading comprehension measure. Further investigations ought to incorporate the following variations: oral reading of the text, silent reading of the text, availability or unavailability of the text for reference when answering questions on it, different question formats and passages of different lengths. If oral reading comprehension ability in the ADHD group is similar to that of the typical control group, then reading orally may be a useful strategy in overcoming comprehension problems that are found in silent reading.

5.4 Conclusion

The ability to comprehend written words is a necessary skill in both day-to-day life and for success in school and the work force. One key theoretical model of reading comprehension proposes that proficient reading comprehension draws on phonological, orthographical and semantic ability (Perfetti, 2007). The role each plays in reading comprehension performance was examined in a group of adolescents with and without ADHD. It was found that, while orthographical and semantic ability explained unique variance in reading comprehension
performance, phonological ability and word recognition skills did not. This finding may be due to the participants having, for the most part, average decoding and word recognition abilities.

Adolescents with ADHD were found to be at a greater risk of having an S-RCD compared to adolescents without ADHD. It is possible that having an S-CRD may exacerbate the problems experienced by adolescents with ADHD. For instance, Mayes et al., (2000) found that children and adolescents with both an LD and ADHD had more learning problems than children and adolescents with LD alone and were less attentive than children and adolescents with ADHD alone. This finding by Mayes et al. (2000) includes children and adolescents with a reading comprehension disability. The specific consequences of having both an S-CRD and ADHD need to be explored. In the current study, adolescents with both ADHD and an S-CRD performed at a lower level on measures that depend in part on comprehension (i.e., Writing Samples and Applied Problems) relative to adolescents with ADHD without specific comprehension difficulties. Comprehension weaknesses may hinder these adolescents’ ability to complete assignments and tests successfully; moreover; adolescents with an S-CRD may be at risk for not graduating from high school; in Ontario high school students need to pass a literacy test to graduate.

Last, research-driven interventions aimed at improving the comprehension abilities of adolescents with ADHD need to be carried out. Johnson et al., (2011) and Rogevich and Perin (2008) have demonstrated the benefits of teaching self-management techniques as well as a multi-component reading comprehension strategy (TWA) to adolescents with ADHD. Educators need to become aware that reading comprehension, especially for adolescents with ADHD, is a skill that often needs to be taught in a very systematic and explicit manner with support for self-
monitoring and self-management. Effective teaching methods will likely promote academic success and open the doors to the work world.
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APPENDIX

Adolescent and Parent Assent and Consent Forms and Letters

ADOLESCENT CONSENT LETTER

Dear __________:

My name is Judith Wiener, and I am a professor at the Ontario Institute for Studies in Education of the University of Toronto (OISE/UT). My colleagues (Dr. Rosemary Tannock, Dr. Tom Humphries, Dr. Martinussen, and I) are doing a research project on teenagers with Attention-Deficit Hyperactivity Disorder (ADHD). We are writing to ask you if you would like to take part in this research. For this, we need the participation of a group of teenagers who have been previously been diagnosed with ADHD and a group of teenagers without ADHD. We are asking you to take part in this research, because we believe that your feelings and opinions are valuable information.

Purpose of the Research

We want to learn more about the beliefs that teenagers have about ADHD and about behaviors that commonly occur with ADHD, their views about themselves, and their social relationships. So far, there is little research on these areas of study. We believe that knowing how teenagers think about their behaviors and about their ADHD is important, so that people like teachers, parents, and other professionals can consider their beliefs when they try to help them. This research has been funded by the Social Sciences and Humanities Research Council.

Description of the Research

If you take part in this research study, the testing session will take approximately 5 to 6 hours. The session will take place in a quiet room at OISE/UT. During the session, my research assistant will ask you to answer some questions about yourself, such as what you think about your behaviors, and about ADHD. He or she will read the questions to you if you wish. Sometimes he or she will write the answers down for you and sometimes you will have to check off or circle an item on a form or a questionnaire. You will also fill out some rating scales that tell about how you view yourself, your behaviors, your self-esteem and your relationships with peers and others. You will also do some reading, writing, and math activities. We will ask you to look at some pictures with a teenager in them behaving in different ways and ask you to point out which of the pictures are like you. We will also interview you about your beliefs about your behaviour and ADHD. We will give you a few breaks, including a lunch break. We are also going to send a rating scale for your teacher to fill out in a teacher package.

Benefits

A benefit of this study is that it will help us learn more about adolescents with ADHD. We want to listen to what you say and think, and then use that information to help other teens with ADHD.
Another benefit about this study is that your answers to the questions from the reading, writing, and math activities and the questionnaires will let us know what your strengths are and what areas you need to work on a little bit more. After about one month after you take part in the study, we will mail a report to you and your family about these different areas, and about some ways that might help you do better in school. Knowing these types of things is important, because they can help you, your parents and teachers understand how to help you do better in school and in life in general.

**Potential Harms and Withdrawal**

There are no harms associated with taking part in the study. The only thing that might happen is that you may feel a little uncomfortable talking about yourself and how you feel about some things. If you feel that you don’t want to answer some of the questions, you can tell the research assistant, and talk about it. You may also say that you want to stop, skip a question, or that you need a break and want to continue some other time. Also, if you say that you will take part in the study and then change your mind, that is okay. You can decide at any time to stop taking part in the study.

**Confidentiality**

Everything you tell me in the session will stay between you, the research assistant, and Dr. Wiener. No information that reveals your identity will be released without consent unless required by law. The information that we collect from you, your parents, and teacher will be analyzed and stored in locked files in a locked office. The data will be kept at OISE/UT in locked files for 10 years. The questionnaires will not have your name on them. A number code will be used in place of your name. We will analyze the information, talk about it at meetings, and write about it, so that parents, teachers, and doctors can learn from what we have found. The results of the questionnaires and activities described above will be used for research purposes only. We would need your permission and signed consent if you want to send these scores to another professional.

Because we are working with many teenagers on this project, people hearing our presentations or reading what we write will not know which teenager said what. When we do this, or when we publish our research in academic journals/books, we will only present group information. We will not tell anyone your name or give any information that could help them know who you are.

We will not be able to provide you with your responses on some of the questionnaires and interviews, because they were developed for the purpose of the research. We will not tell your parents the specific answers that you gave to the questions, but we will write a report about how you did and mail it to them.

The only time that we would have to tell somebody something you have said is if you tell us that you will do serious harm to yourself or someone else, or someone is seriously harming you. In that case, as required by law, we would have to make sure you get help by contacting appropriate mental health, or law enforcement professionals. Otherwise, everything you tell me is kept confidential.

**Compensation**
Participation in research is voluntary. If you do decide to take part in the study, you can choose between getting $30.00 for your participation, or, (for teenagers in high school), the time you spend taking part in the study can be counted towards your community service hours, which we will provide a certificate for.

Access to Results

The results of this research will be shared in the form of a summary report upon completion of the study. We are in the process of developing a website on which we will place all relevant information and will contact you about this when it is ready.

You may contact Dr. Judith Wiener with any questions you may have about the study, and all of your inquiries will be addressed.

Sincerely,

__________________________
Judith Wiener, Ph. D
Program Chair
School and Clinical Child Psychology
(416) 978-0935
Department of Human Development and Applied Psychology
Ontario Institute for Studies in Education of the University of Toronto (OISE/UT)
Toronto, Ontario M5S 1V6
ADORLESCENT CONSENT FORM

“I acknowledge that the research procedures described above have been explained to me and that any questions that I have asked have been answered to my satisfaction. As well, the potential harms and discomforts have been explained to me and I also understand the benefits of participating in the research study. I know that I may ask now, or in the future, any questions that I have about the study. I have been assured that no information will be released or printed that would disclose my identity without my permission, unless required by law. I understand that I will receive a copy of this signed consent. I understand that participation is voluntary and I can withdraw at any time.”

I hereby consent to take part in this research.

___________________________________
Name of Teenager

___________________________________
Signature

___________________________________
Date

___________________________________
Name of person who obtained consent

___________________________________
Signature

“I agree to be contacted in the future regarding other studies being conducted by the ADHD Laboratory at OISE/UT.”

___________________________________
Signature

“I agree that the information collected about me in this study can be used for future data analysis provided that all identifying is removed and that I cannot be identified.”

___________________________________
Signature
ASSENT SCRIPT

Why are we doing this study?

My Professor and I are doing a research project on teenagers with ADHD. We are interested in finding out about how teenagers who have been given a previous diagnosis of ADHD think about their behaviours. We also want to know about their self-esteem and their social relationships. We want to learn more about the beliefs that teenagers have about ADHD and about some of their behaviours that commonly occur with ADHD. We believe that knowing how teenagers think about their behaviours and about their ADHD is important, so that people like teachers, parents, and other professionals can consider their beliefs when they try to help them. I am asking you to participate in this research, because I believe that your feelings and opinions are valuable information.

What will happen during the study?

If you take part in this study today, it will take approximately 5 to 6 hours. I will ask you to answer some questions about yourself, such as what you think about your behaviours, and about ADHD. I will read the questions to you if you want. Sometimes I will write the answers down for you and sometimes you will have to check off or circle an item on a form. Your answers to these questions will help me understand how you think about your behaviours and about ADHD. I will also ask you to look at some pictures with a teenager in them behaving in different ways and ask you to tell me which of the pictures are like you. I will ask you about your beliefs about those behaviours. We will also do some reading, writing, and math activities. Since you are here for a few hours, we will take a few breaks including a lunch break.

Your mother/father filled out a rating scale before you came in. I am also going to send a rating scale for your teacher to fill out.

Who will know about what I did in the study?

Do you know what confidentiality is? It means that everything you tell me today will stay between you, myself, and Dr. Wiener, who is my Professor. My Professor and I will analyze it, talk about it at meetings, and write about it, so that parents, teachers, and doctors can learn from what we have found. The questionnaires will not have your name on them. A number code will be used in place of your name. Because I am working with many teenagers on this project, people hearing my presentations or reading what I write will not know which teenager said what. When I do this, I will not tell anyone your name or give any information that could help them know who you are.

For the reading, writing, and math activities and the other questionnaires, I will not tell your parents the specific answers that you gave to the questions. But I will write a report about how you did and mail it to them.
The only time that I would have to tell somebody something you have said is if you tell me that you will do serious harm to yourself or someone else, or someone is seriously harming you. In that case, I would have to tell your parents and make sure you get help. Otherwise, everything you tell me is kept confidential.

**Participation in this study is your choice.**

Before you came here, your mother/father signed a letter saying that she/he agrees for you to be in the study, but you don’t have to participate if you don’t want to. If you say you will take part and then change your mind, that is okay. You can decide at any time to stop taking part in the study.

If you do decide to take part in the study, you can choose between getting $30.00 for your participation, or, (for participants in high school), the time you spend here can count towards your community service hours, which we will provide a certificate for.

**Are there good things and bad things about the study?**

There are no bad things about the study. The only thing that might happen is that you may feel uncomfortable talking about yourself and how you feel about some things. If you feel that you don’t want to answer some of the questions, you can tell me, and we will talk about it. You may also tell me that you want to stop, skip the question, or that you need a break and want to continue some other time.

A good thing about this study is that it will help us learn more about adolescents with ADHD. We want to listen to what you say and think, and then use that information to help other teens with ADHD.

Finally, your answers to the questions from the reading, writing, and math activities and the questionnaires will help me know what your strengths are and what areas you need to work on a little bit more. Knowing these types of things is important, because they can help your parents and teachers understand how to help you do better in school and will help you figure out what you can do for yourself.

**How do I find out the results of the study?**

If you want information about the results of this research when it is completed, you can check the website we are making for the research. We will let your parents know when it is ready. Your name will not be in the report, but it will give you an idea of how other teenagers think and feel about their behaviours and about ADHD.
Do you have any questions?

Do you agree to participate in this research?

“I was present when ____________________________ read this form and gave his/her verbal assent to participate in this study.”

Name of person who obtained assent:

________________________________

Signature

Date
PARENTAL CONSENT LETTER

Dear Parent:

My name is Dr. Judith Wiener. I am a Professor in the Department of Human Development and Applied Psychology at the Ontario Institute for Studies in Education of the University of Toronto (OISE/UT). I am writing to ask your permission for your adolescent to participate in a research project that I am conducting with my colleagues (Dr. Rosemary Tannock, Dr. Tom Humphries, Dr. Molly Malone, and Dr. Martinussen) about adolescents with Attention Deficit/Hyperactivity Disorder (ADHD). For this, we need the participation of adolescents who have been previously been diagnosed with ADHD as well as normally functioning adolescents.

Purpose of the Research

The purpose of this research to enhance our understanding about the self-perceptions of adolescents’ with ADHD including their self-esteem and self-concept, their beliefs regarding ADHD and about behaviors that commonly occur with ADHD, and their perceptions of their social relationships. Currently, little research exists on these areas of study. We believe that gaining a better understanding of the self-perceptions of adolescents with ADHD will help mental health professionals provide better services and develop appropriate interventions for them. This study is funded by the Social Sciences and Humanities Research Council of Canada.

Description of the Research

If you agree to allow your son/daughter to participate, my research assistants, who are graduate students in school and clinical child psychology, will work with him/her for a period of 5 to 6 hours in a quiet room at OISE/UT. He or she will complete a standardized educational test (Woodcock Johnson-Third Edition) that is recognized as being a valid measure of achievement in reading, writing and mathematics, and a brief cognitive measure (Wechsler Abbreviated Scale of Intelligence). He or she will also fill out several questionnaires designed to assess self-esteem, self-concept, peer relationships, social support, and problem behaviors that commonly occur with ADHD. He or she will also be asked to look at pictures with a teenager in them engaging in various behaviors characteristics of teens with ADHD and asked whether they are like the teenager in the picture. This will be followed up with an interview about his/her beliefs about why this behaviour is a problem, how controllable it is, how often it occurs, and whether it bothers other people. A similar interview will then be conducted about his or her beliefs about ADHD. The results of these measures will be used for research purposes only in the context of this study. We would need your permission and signed consent should you need to send these test scores to another professional involved in your case. With your permission we will also send the teacher who knows your son/daughter well a rating scale to complete. This rating scale assesses for symptoms of ADHD and other disorders.

The results of the educational and cognitive measures will be interpreted by a registered psychologist and be communicated to you in a written report. We will not be able to provide
you with your adolescent’s responses on some of the questionnaires and interviews, because they were developed for the purpose of the research and we will not know what individual adolescent’s scores mean until the data are collected and analyzed from all of the participants.

Benefits

The direct benefit of this study is that you will receive a report on your son/daughter’s educational and social-emotional functioning with specific recommendations for intervention.

We believe that the study may also indirectly benefit adolescents with ADHD. More specifically, enhanced knowledge about adolescents’ self-perceptions and beliefs about ADHD and ADHD-related behaviors may provide important information for parents, teachers, and clinicians working with them.

Potential Harms and Withdrawal

There are no known harms associated with participation in the study. The only potential risk is that your son/daughter may feel some discomfort when talking about his/her behavior. We will clearly inform him/her that he/she may decline to participate and that if he/she decides to participate, he/she may skip any questions, request a break, or withdraw from the study at any time. Following the session, if you find the discomfort to be more than minor, please contact us so that we can discuss how to provide support for him/her. In addition, should we feel, during or after the session that he/she would benefit from referral to a mental health professional, we would inform you of that recommendation and would provide an appropriate referral.

Confidentiality

Confidentiality will be respected and no information that discloses the identity of the participants will be released without consent unless required by law. For your information, all research files will be stored in locked files at OISE/UT. The results of the tests described above will be used for research purposes only. We would need your permission and signed consent should you need to send these scores to another professional.

The data we collect will be analyzed and stored in locked files in a locked office. The data will be retained at OISE/UT in locked files for 10 years. Your name and that of your son/daughter will be deleted and replaced by a number when filed in order to assure anonymity. In these ways, the information provided by you, your son/daughter and his/her teacher will be kept confidential. The one exception to this is in the event that your adolescent indicates that he/she might do serious harm to him/herself or others, or that he/she is being harmed. If that were to happen, as required by law, we would inform you and appropriate mental health, child protection, or law enforcement professionals.

When the results of this research are published in the form of scholarly presentation and/or academic journal/books, only group data will be presented, ensuring that it will be impossible for anyone to identify you or your son/daughter.

Compensation
Participation in research is voluntary. If your son/daughter chooses to participate in this study, he/she will receive $30 to defray expenses. If he/she is in high school, he/she may alternatively opt to count his/her participation in the study toward his/her community service hours; in this case, a certificate attesting to his/her participation would be provided. As mentioned above, you will also receive a report of your adolescent’s academic and social emotional competencies.

**Access to Results**

The results of this research will be shared in the form of a summary report upon completion of the study. We are in the process of developing a website on which we will place all relevant information and will contact you about this when it is ready.

You may contact Dr. Judith Wiener with any questions you may have about the study, and all of your inquiries will be addressed.

Sincerely,

__________________________________________

Judith Wiener, Ph. D
Program Chair
(416) 978-0935

Department of Human Development and Applied Psychology

Ontario Institute for Studies in Education of the University of Toronto (OISE/UT)

Toronto, Ontario M5S 1V6
PARENTAL CONSENT FORM

“I acknowledge that the research procedures described above have been explained to me and that any questions that I have asked have been answered to my satisfaction. As well, the potential harms and discomforts have been explained to me and I also understand the benefits of participating in the research study. I know that I may ask now, or in the future, any questions that I have about the study. I have been assured that no information will be released or printed that would disclose the personal identity of my son/daughter without my permission, unless required by law. I understand that I will receive a copy of this signed consent. I understand that participation is voluntary and I can withdraw my adolescent at any time.”

I hereby consent for my son/daughter to participate.

___________________________________
Name of Parent

___________________________________
Signature

___________________________________
Date

___________________________________
Name of person who obtained consent

___________________________________
Signature

The person who may be contacted about this research is:

___________________________________
who may be contacted at:

(416) 978-0933

“I agree to be contacted in the future regarding other studies being conducted by the ADHD Laboratory at OISE/UT.”

___________________________________
Signature of parent

“I agree that the information collected on my adolescent in this study can be used for future data analysis provided that all identifying is removed and my adolescent cannot be identified.”

___________________________________
Signature of parent
<table>
<thead>
<tr>
<th></th>
<th>Comparison Females (n=22)</th>
<th>Comparison Males (n=20)</th>
<th>ADHD Females (n=19)</th>
<th>ADHD Males (n=26)</th>
<th>F</th>
<th>Sig.</th>
<th>Post-hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>15.86 1.64</td>
<td>15.07 1.33</td>
<td>15.94 1.95</td>
<td>15.25 1.72</td>
<td>1.41</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>IQ (WASI Full Scale)</td>
<td>110.0 9.50</td>
<td>111.1 9.39</td>
<td>95.89 10.7</td>
<td>102.4 8.19</td>
<td>11.4</td>
<td>***</td>
<td>1,2&gt;3.4</td>
</tr>
<tr>
<td>Calculation- Standard Score (WJ-III)</td>
<td>108.5 12.2</td>
<td>107.9 13.6</td>
<td>73.79 17.1</td>
<td>88.77 16.3</td>
<td>25.0</td>
<td>***</td>
<td>1,2&gt;3&gt;4</td>
</tr>
<tr>
<td>Applied Problems- Standard Score (WJ-III)</td>
<td>106.1 9.89</td>
<td>108.5 7.52</td>
<td>88.21 9.91</td>
<td>98.54 7.74</td>
<td>21.4</td>
<td>***</td>
<td>1,2&gt;3&gt;4</td>
</tr>
<tr>
<td>Spelling-Standard Score (WJ-III)</td>
<td>111.0 11.7</td>
<td>113.4 11.8</td>
<td>95.79 13.4</td>
<td>93.69 12.3</td>
<td>14.9</td>
<td>***</td>
<td>1,2&gt;3,4</td>
</tr>
<tr>
<td>Writing Samples- Standard Score (WJ-III)</td>
<td>112.6 9.23</td>
<td>114.4 13.6</td>
<td>96.94 10.6</td>
<td>98.81 10.3</td>
<td>14.2</td>
<td>***</td>
<td>1,2&gt;3,4</td>
</tr>
<tr>
<td>Letter-Word Identification-Standard Score (WJ-III)</td>
<td>108.0 10.6</td>
<td>110.9 7.40</td>
<td>95.42 11.1</td>
<td>99.58 8.45</td>
<td>11.9</td>
<td>***</td>
<td>1,2&gt;3,4</td>
</tr>
<tr>
<td>Passage Comprehension-Standard Score (WJ-III)</td>
<td>107.3 10.2</td>
<td>105.5 12.4</td>
<td>88.95 9.89</td>
<td>93.15 11.5</td>
<td>13.9</td>
<td>***</td>
<td>1,2&gt;3,4</td>
</tr>
<tr>
<td>Self-reported inattention (Conners 3-SR DSM ADHD Inattentive)</td>
<td>49.55 10.0</td>
<td>52.35 8.41</td>
<td>66.63 15.8</td>
<td>64.69 13.9</td>
<td>10.3</td>
<td>***</td>
<td>3,4&gt;1,2</td>
</tr>
<tr>
<td>Self-reported hyperactivity-impulsivity (Conners 3-SR DSM ADHD Hyperactive-Impulsive)</td>
<td>48.95 10.0</td>
<td>54.90 9.31</td>
<td>64.11 16.0</td>
<td>63.88 17.1</td>
<td>6.60</td>
<td>***</td>
<td>3,4&gt;1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2,4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2,1</td>
</tr>
</tbody>
</table>
Note: WASI= Wechsler Abbreviated Scale of Intelligence; WJ-III= Woodcock Johnson Tests of Achievement-Third Edition; DSM= Diagnostic Statistical Manual; ADHD= Attention Deficit Hyperactivity Disorder; Conners-P = parent rating scale; Conners 3T = teacher rating scale; Conners SR = self-report rating scale;

1Only 77 of the participants had their teacher report their level of inattention and hyperactivity/impulsivity. 2Gabriel’s test was used for the post hoc comparisons

**p<0.01, ***p<0.001.

<p>| | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent-reported inattention (Conners 3-P DSM ADHD Inattentive)</td>
<td>51.23</td>
<td>7.36</td>
<td>49.35</td>
<td>7.67</td>
<td>84.58</td>
<td>5.71</td>
<td>83.16</td>
<td>6.33</td>
<td>175.*** 3,4&gt;1,2</td>
</tr>
<tr>
<td>Parent-reported hyperactivity-impulsivity (Conners 3-P DSM ADHD Hyperactive-Impulsive)</td>
<td>52.00</td>
<td>7.65</td>
<td>49.00</td>
<td>6.46</td>
<td>82.79</td>
<td>9.47</td>
<td>78.54</td>
<td>11.0</td>
<td>80.7*** 3,4&gt;1,2</td>
</tr>
<tr>
<td>Teacher-reported inattention (Conners 3-T DSM ADHD Inattentive)</td>
<td>48.47</td>
<td>8.53</td>
<td>52.83</td>
<td>13.0</td>
<td>73.06</td>
<td>13.8</td>
<td>69.50</td>
<td>12.1</td>
<td>19.3*** 3,4&gt;1,2</td>
</tr>
<tr>
<td>Teacher-reported hyperactivity-impulsivity (Conners 3-T DSM ADHD Hyperactive-Impulsive)</td>
<td>51.05</td>
<td>10.3</td>
<td>52.06</td>
<td>12.6</td>
<td>71.65</td>
<td>18.1</td>
<td>65.73</td>
<td>15.6</td>
<td>9.06*** 3,4&gt;1,2</td>
</tr>
</tbody>
</table>
Table 2

*Correlations between each of the measures for both groups and the full sample*

<table>
<thead>
<tr>
<th>Measure of Correlation</th>
<th>Comparison (n=32)</th>
<th>ADHD (n=36)</th>
<th>Full Sample (n=68)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage Comprehension and Spelling</td>
<td>.51**</td>
<td>.46**</td>
<td>.62**</td>
</tr>
<tr>
<td>Passage Comprehension and Letter-Word ID</td>
<td>.42*</td>
<td>.50**</td>
<td>.62**</td>
</tr>
<tr>
<td>Passage Comprehension and Vocabulary</td>
<td>.42*</td>
<td>.70**</td>
<td>.70**</td>
</tr>
<tr>
<td>Passage Comprehension and PDE</td>
<td>.19</td>
<td>.14</td>
<td>.34**</td>
</tr>
<tr>
<td>Passage Comprehension and SWE</td>
<td>.28</td>
<td>.19</td>
<td>.36**</td>
</tr>
<tr>
<td>Spelling and Letter-Word ID</td>
<td>.81**</td>
<td>.71**</td>
<td>.83**</td>
</tr>
<tr>
<td>Spelling and Vocabulary</td>
<td>.44*</td>
<td>.51**</td>
<td>.64**</td>
</tr>
<tr>
<td>Spelling and PDE</td>
<td>.54**</td>
<td>.37*</td>
<td>.56**</td>
</tr>
<tr>
<td>Spelling and SWE</td>
<td>.52**</td>
<td>.22</td>
<td>.46**</td>
</tr>
<tr>
<td>Letter-Word ID and Vocabulary</td>
<td>.46**</td>
<td>.57**</td>
<td>.67**</td>
</tr>
<tr>
<td>Letter-Word ID and PDE</td>
<td>.57**</td>
<td>.52**</td>
<td>.63**</td>
</tr>
<tr>
<td>Letter-Word ID and SWE</td>
<td>.43*</td>
<td>.38*</td>
<td>.50**</td>
</tr>
<tr>
<td>Vocabulary and PDE</td>
<td>.03</td>
<td>.15</td>
<td>.31*</td>
</tr>
<tr>
<td>Vocabulary and SWE</td>
<td>.16</td>
<td>.24</td>
<td>.35**</td>
</tr>
<tr>
<td>PDE and SWE</td>
<td>.78**</td>
<td>.76**</td>
<td>.80**</td>
</tr>
</tbody>
</table>

Note: ADHD = Attention Deficit Hyperactivity Disorder; ID = Identification; PDE = Phonetic Decoding Efficiency; SWE = Sight Word Efficiency

**. Correlation is significant at the .01 level (two-tailed)

*.Correlation is significant at the .05 level (two-tailed
Table 3

*Performance on Passage Comprehension based on the combination of PDE, Vocabulary and Spelling Ability*

<table>
<thead>
<tr>
<th></th>
<th>$B$</th>
<th>$SE$ $B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>Sig. ($p$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>27.57</td>
<td>10.10</td>
<td></td>
<td>2.73</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>.02</td>
<td>.11</td>
<td>.02</td>
<td>.19</td>
<td>.85</td>
</tr>
<tr>
<td>PDE</td>
<td>.78</td>
<td>.17</td>
<td>.51</td>
<td>4.68</td>
<td>.00</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>.28</td>
<td>.12</td>
<td>.29</td>
<td>2.30</td>
<td>.02</td>
</tr>
</tbody>
</table>

$R^2 = .55, p < .001$ Note: PDE = Phonetic Decoding Efficiency
Table 4

*Performance on Passage Comprehension based on the combination of SWE, Vocabulary and Spelling Ability*

<table>
<thead>
<tr>
<th></th>
<th>$B$</th>
<th>$SE,B$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>Sig. ($p$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>25.48</td>
<td>9.97</td>
<td>2.56</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td>SWE</td>
<td>.06</td>
<td>.10</td>
<td>.06</td>
<td>.61</td>
<td>.55</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>.76</td>
<td>.17</td>
<td>.50</td>
<td>4.62</td>
<td>.00</td>
</tr>
<tr>
<td>Spelling</td>
<td>.27</td>
<td>.11</td>
<td>.28</td>
<td>2.42</td>
<td>.02</td>
</tr>
</tbody>
</table>

$R^2 = .55, \, p < .001$  Note: SWE = Sight Word Efficiency
Table 5

Performance on Passage Comprehension based on the combination of PDE, Vocabulary and Letter-Word Identification

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>23.33</td>
<td>11.19</td>
<td></td>
<td>2.09</td>
<td>.04</td>
</tr>
<tr>
<td>PDE</td>
<td>.01</td>
<td>.12</td>
<td>.01</td>
<td>.10</td>
<td>.92</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>.79</td>
<td>.18</td>
<td>.52</td>
<td>4.40</td>
<td>.00</td>
</tr>
<tr>
<td>Letter-Word Identification</td>
<td>.32</td>
<td>.18</td>
<td>.26</td>
<td>1.80</td>
<td>.08</td>
</tr>
</tbody>
</table>

$R^2 = .53, p<.001$ Note: PDE = Phonetic Decoding Efficiency
Table 6

*Performance on Passage Comprehension based on the combination of SWE, Vocabulary and Letter-Word Identification*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>21.40</td>
<td>11.42</td>
<td>1.87</td>
<td>1.87</td>
<td>.07</td>
</tr>
<tr>
<td>SWE</td>
<td>.06</td>
<td>.10</td>
<td>.06</td>
<td>.59</td>
<td>.56</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>.78</td>
<td>.18</td>
<td>.52</td>
<td>4.48</td>
<td>.00</td>
</tr>
<tr>
<td>Letter-Word Identification</td>
<td>.30</td>
<td>.15</td>
<td>.24</td>
<td>1.94</td>
<td>.06</td>
</tr>
</tbody>
</table>

$R^2 = .53, p < .001$ Note: SWE = Sight Word Efficiency
Table 7

Standard scores on four academic tasks by three groups of adolescents with ADHD of varying comprehension ability

<table>
<thead>
<tr>
<th></th>
<th>ADHD Poor Comprehender (&lt;16&lt;sup&gt;th&lt;/sup&gt; percentile)</th>
<th>ADHD Poor Comprehender (&lt;25&lt;sup&gt;th&lt;/sup&gt; percentile)</th>
<th>ADHD Good Comprehender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing Samples</td>
<td>83.67</td>
<td>91.29</td>
<td>103.67</td>
</tr>
<tr>
<td>Applied Problems</td>
<td>88.33</td>
<td>92.36</td>
<td>98.81</td>
</tr>
<tr>
<td>Calculation</td>
<td>74.00</td>
<td>83.29</td>
<td>85.48</td>
</tr>
<tr>
<td>Letter-Word Identification</td>
<td>97.50</td>
<td>99.00</td>
<td>103.52</td>
</tr>
</tbody>
</table>

Note: ADHD = Attention Deficit/Hyperactivity Disorder