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Factors Associated with Individual Differences in Reading Comprehension for Typically-Developing Students and for a Pilot Sample of Students Diagnosed with Autism Spectrum Disorder

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FACTORS ASSOCIATED WITH INDIVIDUAL DIFFERENCES IN READING COMPREHENSION FOR TYPICALLY-DEVELOPING STUDENTS AND FOR A PILOT SAMPLE OF STUDENTS DIAGNOSED WITH AUTISM SPECTRUM DISORDER

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ABSTRACT

This study investigated some of the underlying factors that may relate to and predict the reading comprehension of children in fourth through eighth grade (*N*=47). A subset of these children previously had been diagnosed with autism spectrum disorders (ASD; n=10); the remainder are classified as typically-developing (n=37). The participants were assessed on basic reading skills (i.e., word recognition, decoding, and reading fluency), receptive vocabulary, executive functioning (i.e., verbal working memory and planning/organization), and theory of mind. Correlational analyses were performed for each group to examine relationships between these measures and performance on the Comprehension subtest of the Stanford Diagnostic Reading Test, a standardized measure that includes different types of passages (i.e., narrative, expository, and functional) and asks different types of questions (e.g., literal, inferential). Next, the performance of the typically-developing participants was compared with children in the ASD group, and finally, predictors of overall reading comprehension and performance on the different passage types were explored.

The results indicate that, for typically-developing participants, reading fluency and receptive vocabulary were significantly correlated with overall reading comprehension, performance on all passage types, and on initial understanding and interpretation questions. Likewise, for children in the ASD group, strong relationships were found between receptive vocabulary and performance on the comprehension measure (i.e., overall comprehension as well as performance on all text and question types). These results are consistent with previous research that has underscored the importance of reading fluency and vocabulary knowledge to reading comprehension in

the general population (Fuchs, Fuchs, Hosp, & Jenkins, 2001; Catts, Adlof, and Ellis-Weismer, 2006; Storch & Whitehurst, 2002).

Upon examining the relationships between the executive function measures and reading comprehension, verbal working memory was found to be a significant correlate in both groups, whereas planning/organization was significantly related to performance in the ASD group only. These findings are somewhat consistent with previous research documenting the relationship between reading comprehension and executive function in non-ASD populations, although in prior studies executive function has been measured in various ways (e.g., verbal/nonverbal working memory, planning, and organization, etc.; Best, Floyd, & McNamara, 2008; Cain, Oakhill, & Bryant, 2004; Eason, Goldberg, Young, Geist, & Cutting, 2012; Nation, Adams, Bowyer-Crane, & Snowling, 1999; Samuelstuen & Braten, 2005).

Theory of mind did not contribute significantly to reading comprehension performance in the typically-developing group. However, as predicted, in the ASD group, strong associations were observed between theory of mind and narrative comprehension. Additionally, for this group, theory of mind significantly correlated with overall reading comprehension, performance on the other two types of passages, and scores on initial understanding and critical analysis/process strategies questions. These results were predicted in light of existing research that has found theory of mind impairments and other studies that have documented comprehension deficits in children diagnosed with ASD (Happé, 1994; Nation et al., 2006; O'Connor & Klein, 2004).

An examination of group differences found that the typically-developing group tended to perform significantly better than the ASD group on a majority of the independent measures (i.e., reading fluency, executive functioning, and theory of mind), as well as on the reading comprehension measure. Specifically, these typically-developing participants had better overall reading comprehension and scored higher on all types of texts and questions. These results are consistent with the aforementioned studies that have revealed deficits in these areas for children with ASD.

Hierarchical multiple regression analyses performed on the data for the typically-developing students had the result that reading fluency was a significant predictor of overall comprehension and performance on each of the passage types. Likewise, reading fluency explained the largest proportion of unique variance for these outcome measures. The findings corroborate previous research referring to reading fluency as an overall indicator of reading acquisition (e.g., Fuchs et al., 2001). In addition, receptive vocabulary contributed shared variance to the prediction of overall comprehension, and receptive vocabulary and word recognition each shared variance with reading fluency in the prediction of narrative comprehension. In combination, these results underscore the importance of basic reading skills and vocabulary knowledge for successful reading comprehension (Catts, Adlof, & Weismer, 2006; Perfetti, 1985; LaBerge & Samuels, 1974; Leach, Scarborough, & Rescorla, 2003).

Taken together, the results of the present study provide educators with information about the ways in which particular cognitive abilities may contribute to children's understanding of different types of text and their ability to answer varying

types of questions. Awareness of the roles these factors play in reading comprehension may facilitate decision-making related to assessment and intervention in this area, both for typically-developing pupils and those with ASD.

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CHAPTER 1

INTRODUCTION

In the general population, a number of factors have been found to predict reading comprehension performance, including basic reading skills, vocabulary and background knowledge, the ability to self-monitor or apply comprehension strategies, the age of the individual, and oral language skills. More recently, several studies have examined the role that executive functioning plays in reading comprehension, focusing in particular on working memory and planning/organization (e.g., Cutting, Materek, Cole, Levine, & Mahone, 2009; Eason, Goldberg, Young, Geist, & Cutting, 2012; Locascio et al., 2010; Seigneuric & Ehrlich, 2005; Seigneuric, Ehrlich, Oakhill, & Yuill, 2000; Sesma, Mahone, Levine, Eason, & Cutting, 2009).

Other research has tested a theory of mind account, hypothesizing that theory of mind impairments (i.e., the inability to infer the thoughts or feelings of others) may contribute to deficits in the comprehension of certain types of texts (e.g., narrative or fictional) (e.g., Mar, 2011; Mar & Oatley, 2008; Saldaña & Frith, 2007). Single or multiple sources of weakness may play a role in poor reading comprehension (e.g., Edmonds, Vaughn, Wexler, Reutebuch, Cable, Tackett, & Schnakenberg, 2009). Moreover, text variables (i.e., the type of text used and the way in which questions are asked) also may contribute to performance on reading comprehension measures (e.g., Eason et al., 2012).

In a related vein, there has begun to be interest in the bases of the reading comprehension deficits for children diagnosed with Autism Spectrum Disorders (ASD). At the severely impaired end of the autism spectrum, children experience a broad array of language difficulties and, as a consequence, literacy may not be viewed as a realistic goal. However, children at higher levels of functioning (i.e., Asperger Syndrome, high functioning autism[1]) often have reading skills comparable to the general population (e.g., Nation, Clarke, Wright, & Williams, 2006). Despite overall adequate reading attainment, some researchers have reported that a large proportion of these higher functioning individuals diagnosed with ASD have significant deficits in reading comprehension (e.g., Nation et al., 2006; O'Connor & Klein, 2004). Perhaps particular features commonly associated with ASD (e.g., executive dysfunction, theory of mind impairment) may contribute to weaknesses in this domain.

The purpose of this study was to investigate the reading comprehension abilities of a sample of typically-developing children and children diagnosed with ASD who are between the ages of nine and fourteen. The extent to which executive functioning (i.e., verbal working memory and planning/organization) is related to and may contribute to or predict reading comprehension was evaluated in both groups. Corresponding with these cognitive domains, a related goal was to ascertain whether children with ASD exhibit more difficulties comprehending particular types of texts that vary in theory of mind demands, or answering certain types of questions. Therefore, all participants read narrative, expository, and functional passages, and

[1] Although there is much debate on whether Asperger syndrome (AS) is a distinct disorder from autism, the major difference between AS and high functioning autism (HFA) pertains to language development: unlike individuals diagnosed with HFA, individuals diagnosed with AS are not typically language-delayed in childhood (Howlin, 2003).

were assessed on both literal and inferential questions. The performance of typically-developing students was then compared with the ASD participants.

CHAPTER 2

REVIEW OF LITERATURE

Factors influencing reading comprehension in the general population

While numerous empirical studies document the acquisition of word reading skills (i.e., phonological awareness, word recognition, decoding, fluency), less is known about reading comprehension development and disabilities (e.g., Johnston, Barnes, & Desrochers, 2008). Although decoding and phonological skills are important predictors of reading comprehension, they are not the only factors that may contribute to weaknesses in this area. Accordingly, difficulties with reading comprehension within the general population may arise for a number of reasons (e.g., Edmonds et al., 2009).

Many older children and adolescents experience difficulties with reading comprehension because they continue to struggle with word-level deficits that impede the extraction of meaning from text, a higher-level cognitive skill (LaBerge & Samuels, 1974; Leach, Scarborough, & Rescorla, 2003; Perfetti, 1985). In addition, ten to twenty-five percent of the reading-disabled population, and four percent of the school-aged population, particularly upper-elementary and older students, are designated as poor comprehenders (Leach et al., 2003). That is, they have difficulty understanding text despite adequate word-level skills (Cutting & Scarborough, 2006; Leach et al., 2003). Other factors, such as those in the domain of oral language, also have been found to predict reading comprehension (Cutting & Scarborough, 2006).

Results of a study by Catts, Adlof, and Ellis-Weismer (2006) showed that poor comprehenders performed significantly worse on measures of receptive vocabulary, grammatical understanding, and listening comprehension.

Age also plays a role in which underlying factors will most strongly predict reading comprehension development. As children get older, word recognition and fluency typically improve, contributing to individual differences in comprehension less than they did during the early grades (Storch & Whitehurst, 2002). In turn, skill in listening comprehension becomes more highly correlated with reading comprehension, accounting for more of the variance in comprehension (Catts et al., 2006). Therefore, developmental changes associated with literacy development complicate the determination of the sources of individual variability (Johnston et al., 2008).

Studies documenting the role weaknesses in word-level skills and oral language play in reading comprehension deficits are more abundant than those that focus on other potential contributors to difficulties in this area (Locascio, Mahone, Eason, & Cutting, 2010). This is particularly relevant for children who are poor comprehenders, when word recognition and oral language may be ruled out, but it is not clear what factors *can* be attributed to comprehension weaknesses. Two areas that researchers have addressed include executive functioning (verbal working memory and planning/organization) and theory of mind.

Executive functioning. Over the last decade, researchers have begun to examine the role that executive function plays in reading comprehension (Cutting, Materek, Cole, Levine, & Mahone, 2009; Eason, Goldberg, Young, Geist, & Cutting, 2012; Locascio et al., 2010; Seigneuric & Ehrlich, 2005; Seigneuric, Ehrlich, Oakhill,

& Yuill, 2000; Sesma, Mahone, Levine, Eason, & Cutting, 2009). Executive function is an umbrella term for a set of higher-level cognitive processes, including attention, planning, organization, monitoring of behavior, problem-solving, and working memory, that aid in the "management of goal-directed behaviors" (Locascio et al., 2010, p. 2). Results of these studies have found verbal working memory and the ability to plan and organize information are two components of executive functioning related to reading comprehension (Cutting et al., 2009).

Verbal working memory. Verbal working memory has been defined as the limited processing capacity necessary for an individual to hold information in memory while simultaneously reacting to that or other information (i.e., it involves both the storage and processing of information) (Baddeley, 1986). Tasks that assess verbal working memory generally require the individual to hold increasingly complex verbal information in his or her memory while responding to related questions. In a study with typically-developing children aged nine to fifteen years, performance on working memory tasks made a significant and unique contribution to the prediction of reading comprehension (Sesma et al., 2009). This relationship is thought to be linked to verbal and semantic skills deficits that prevent individuals with poor comprehension from briefly storing verbal information, resulting in poor performance on verbally mediated tests of working memory (Cain, Oakhill, & Bryant, 2004; Nation, Adams, Bowyer-Crane, & Snowling, 1999).

A longitudinal study examining the relative contribution of working memory capacity to the reading comprehension development of children in first, second, and third grades was conducted by Seigneuric and Ehrlich (2005). Results supported their

previous examination of fourth-grade students (Seigneuric et al., 2000), finding that as word recognition becomes automatized during the early elementary school years (i.e., by third grade), working memory capacity emerges as an important predictor of reading comprehension. The authors concluded that factors contributing to individual differences in reading comprehension may change with a person's age and suggested a reciprocal relationship between working memory capacity and reading comprehension (i.e., as children become better readers, reading comprehension aids in the development of working memory capacity). In another similar correlational investigation, verbal working memory independently predicted performance on reading comprehension, providing some support for a relationship between working memory and reading ability (Christopher, Miyake, Keenan, Pennington, DeFries, Wadsworth, Willcutt, & Olson, 2012).

Planning and organization. Planning/organization is another aspect of executive function that is related to reading comprehension performance (Locascio et al., 2010; Sesma et al., 2009). In research comparing children diagnosed with dyslexia to non-dyslexic children, the former group required more planning time on the Tower of London task, in which they were asked to move colored beads from a starting position to a target position shown on a card (Reiter, Tucha, & Lange, 2005). Similarly, in another project assessing planning skill, also measured by the Tower of London task, performance on this measure significantly contributed to the prediction of reading comprehension, even after taking into account individual differences in decoding, reading fluency, vocabulary, and attention (Sesma et al., 2009).

Additional evidence has been provided that supports the view that the relationship between reading comprehension and executive functioning (in the form of planning/organization) is not always mediated by those processes that underlie basic reading skills, known as phonological processing. For example, a sample of children with specific reading comprehension deficits (i.e., poor comprehenders) performed poorly on a task measuring strategic planning even when controlling for phonological processing performance (i.e., performance on measures of phonological awareness, phonological memory, and rapid naming) (Locascio et al., 2010). The researchers concluded that an "underlying inefficiency in the planning and organization needed for a particular task" exists in children with reading comprehension weaknesses, and that "these deficits may underlie the manner in which children with [specific reading comprehension deficits] navigate and organize material for comprehension" (Locascio et al., 2010, p. 11).

Planning and organization also may shift in importance based on the complexity of the reading materials used to assess comprehension. For example, in a study that examined predictors of performance on a reading comprehension measure that contained different types of text (e.g., narrative, expository, and functional) and questions (e.g., literal, inferential, etc.), planning and organization significantly contributed only to performance on more complex passages and questions (i.e., expository and inferential, respectively) (Eason et al., 2012). Based on these results, the authors surmised that planning and organization may become more important to reading comprehension during later elementary years and beyond, when texts increase in complexity (Eason et al., 2012).

Theory of mind. Theory of mind is defined as the ability to make inferences about the thoughts, beliefs, and desires of others. Many researchers have theorized that theory of mind plays a role in the comprehension of fictional texts (Mar & Oatley, 2008). Essentially, these theorists posit that the same processes employed to comprehend the mental states of people in daily life also are utilized in the understanding of fictional characters in stories or on film (Mar, 2011). As such, individuals who have deficiencies in theory of mind may have difficulties comprehending the feelings, thoughts, and perspectives of story characters, resulting in deficits in understanding narrative text. Additionally, theory of mind impairments may prevent the development of a solid foundation of social knowledge necessary for making appropriate inferences when reading socially related texts (Saldaña & Frith, 2007).

At present, there are few empirical studies that have investigated the correspondence between theory of mind and narrative story comprehension. A recent quantitative meta-analysis of neuroimaging studies examining the relationship between theory of mind and story comprehension found that a shared network exists for these two capabilities (Mar, 2011). In a related vein, some correlations have been found between exposure to fictional narrative texts and the development of social abilities (Mar, Oatley, Hirsh, dela Paz, & Peterson, 2006; Mar, Oatley, & Peterson, 2009). However, future research still is needed to understand further the relationship between theory of mind and narrative text comprehension and whether this relationship plays a significant role in the development of and/or deficits in reading comprehension (Mar, 2011).

How is reading comprehension assessed?

Another relevant issue to the examination of factors in reading comprehension is the finding that reading comprehension assessment measures are not equivalent in the skills they require. Some primarily reflect word-level skills, whereas others evaluate broader language comprehension abilities (Cutting & Scarborough, 2006; Keenan, Betjemann, & Olsen, 2008). As a result, students' comprehension performance on one instrument may not align closely with performance on other measures of comprehension, making it necessary to qualify and confirm observations of comprehension weaknesses.

Narrative vs. expository text. A further element is the type of text used to measure reading comprehension. Studies of performance in the normal population often have not differentiated between different types of passages (e.g., Keenan et al., 2008). Narrative texts tell stories in a temporal sequence using characters and a plotline; they are typically written in the past tense, include commonly used vocabulary items, and incorporate language frequently heard in oral conversation (Best, Floyd, & McNamara, 2008; Primor, Pierce, & Katzir, 2011). Likewise, narrative texts generally are fictional, with the exception of biographies written in a narrative format. In contrast, expository texts are written with the purpose of providing information to the reader on a given topic. They may not have a temporal sequence, and include more technical, as opposed to everyday, vocabulary terms (Eason et al., 2012).

Recent research suggests that children's reading achievement may depend on the type of text used (Eason et al., 2012). Children from the second to eighth grades

have been found to achieve better scores on narrative comprehension measures (Best et al., 2008; Diakidoy, Stylianou, Karefillidou, & Papageorgiou, 2005), leading to conjecture about the factors that play a role in children's greater difficulty comprehending expository text. Although it is still not clear what specifically influences individual differences in narrative and expository text comprehension, several possibilities have been hypothesized (Eason et al., 2012). In one study, word recognition most strongly predicted performance on narrative texts, while background knowledge was the strongest predictor of expository text comprehension (Best et al., 2008). Similar findings from another investigation suggested a relationship between background knowledge and expository text performance, and also revealed that use of comprehension strategies (e.g., self-monitoring) strongly predicted expository text comprehension (Samuelstuen & Braten, 2005). Background knowledge and strategy use may less often be necessary for comprehension of narrative text (Best et al., 2008; Samuelstuen & Braten, 2005).

Question type. Another dimension on which comprehension measures vary is the nature of the questions that are asked (e.g., literal vs. inferential; multiple choice vs. open-ended questions) (Eason et al., 2012). Much like text-type performance factors, a particular type of question may require the use of higher-order cognitive processing and therefore may be more difficult for individuals deficient in such skills. For example, inferential questions assess the reader's ability to make connections between aspects of the text and background knowledge, requiring the use of higher-order cognition such as planning and organization (Eason et al., 2012).

Thus, when evaluating reading comprehension performance, it is important to select measures that will allow for the exploration of performance differences related to the type of text being used and/or the types of questions that will be asked.

Theoretical bases for comprehension weaknesses in children with Autism Spectrum Disorders

Another area of research that only recently has been examined is concerned with the reading comprehension of higher-functioning children diagnosed with Autism Spectrum Disorders (ASD), a population in which a large proportion have been found to have impairments in reading comprehension (Nation, Clarke, Wright, and Williams, 2006; Nation & Norbury, 2005; Norbury & Nation, 2011). In a review of studies that were conducted in the 1980's and 1990's (O'Connor & Klein, 2004), the reading comprehension abilities of high functioning children with autism generally fell below both age expectations and decoding performance, even though continua of decoding and reading comprehension were found.

Moreover, Nation et al. (2006) found 65% of their sample of six- to fifteen-year-old children diagnosed with ASD, who had measureable reading skills, exhibited significant comprehension impairments. Why this is the case is not yet evident, particularly for participants with adequate word-level skills. Recently, in a study comparing the reading abilities of children with ASD to children with dyslexia, participants with ASD exhibited a pattern of low comprehension abilities when compared to their performance on measures of decoding (Huemer & Mann, 2010). The authors concluded that these comprehension weaknesses went "beyond the ability to recover the phonological structures transcribed by the English alphabet" (p. 491).

Undoubtedly, any of the aforementioned factors may affect reading comprehension performance in children diagnosed with ASD. However, it remains to be determined whether there is a particular factor, or factors, that play a noteworthy role for individuals in this population. Some of the characteristics that set apart children with ASD from typically-developing peers also may contribute to their reading comprehension difficulties. Among the theories that have been proposed, executive dysfunction and theory of mind (two theories that explain the social and cognitive weaknesses of children with ASD) may facilitate understanding not just of the factors associated with reading comprehension in the general population but also of the underlying reading comprehension impairments of children with ASD.

According to one theory, executive dysfunction accounts for the social and cognitive difficulties of individuals diagnosed with ASD, and may have consequences for reading comprehension (Cutting et al., 2009; Happé, 1994, Locascio et al., 2010). For example, one study found impairments in verbal working memory in a group of higher functioning adolescents and adults aged eleven to twenty-four years, compared to a gender-, age-, and verbal IQ-matched clinical sample (Bennetto, Pennington, & Rogers, 1996). Nonetheless, more research needs to be conducted to determine whether verbal working memory is an area of relative weakness in individuals with ASD.

Happé (1999) proposed that executive dysfunction accounts for the repetitive and restrictive behaviors, as well as for deficits in set shifting and planning, that characterize individuals with autism. In a recent exploratory study comparing the executive functioning of a sample of adolescents with ASD, the ASD group exhibited

greater deficits on visually mediated tasks evaluating set shifting and planning ability when compared to age- and gender-matched controls (McCrimmon, Schwean, Saklofske, Montgomery, & Brady, 2012).

In another vein, theory of mind has been used to explain the social and communication impairments typical of individuals with ASD (Frith, 2003; Happé, 1999). Individuals diagnosed with ASD who are impaired in theory of mind not only may have difficulty understanding the emotions, thoughts, and differing perspectives of people they meet in real life, but also may struggle with understanding the feelings and views of characters they encountered while reading narrative text.

If verbal working memory, planning/organization, and theory of mind are areas of deficiency for children with ASD, perhaps these difficulties play a role in the reading comprehension weaknesses observed in this population.

The prevalence of reading comprehension impairment in the general population, as well as in children diagnosed with ASD, underscores the importance of identifying which aspects of the complex processes entailed in reading comprehension are impaired. Therefore, the goal of this study was to examine some of the underlying factors posited to contribute to these comprehension difficulties.

The reading comprehension performance of a sample of typically-developing students and students diagnosed with ASD between the ages of nine and fourteen were assessed. Both narrative and expository text comprehension was measured, and students were asked literal and inferential questions about each passage they read. The study explored the following cognitive factors in regard to their relationship to reading comprehension performance: word recognition, decoding, reading fluency, receptive

vocabulary, verbal working memory, planning/organization, and theory of mind. In addition, group differences in performance on the reading comprehension measure (including differences on the different passage and question types) were explored. Lastly, predictors of reading comprehension performance on different passage types were examined. The following outcomes were predicted:

1. Factors associated with reading comprehension performance:
    a. For both groups, word recognition, decoding, fluency, receptive vocabulary, and verbal working memory would be significantly and positively correlated with overall reading comprehension, and with performance on all text and question types.
    b. For both groups, planning and organization would be significantly and positively correlated with performance on expository passages and interpretation and critical analysis/process strategies questions.
    c. For children diagnosed with ASD, theory of mind performance would be significantly and positively correlated with performance on narrative passages.
2. Group differences in reading comprehension: Despite variability in reading performance within both groups (i.e., some children would do less well on both comprehension and word-level reading tasks, while others might be impaired in one component of reading but not in the other), children diagnosed with ASD would show a greater tendency to exhibit lower scores on narrative and expository reading comprehension measures than would typically-developing children.

3. Features associated with ASD:
    a. Group differences: Children diagnosed with ASD would perform significantly lower on theory of mind, verbal working memory, and planning/organization measures than would typically-developing children.
    b. In children diagnosed with ASD, performance on the theory of mind measure would make a significant and unique contribution to comprehension performance for narrative text, while executive function (planning/organization and verbal working memory) would make significant and unique contributions to scores on comprehension of expository text for both groups.
4. Group differences on question type: Children with ASD would perform significantly less well on inferential (interpretation, critical analysis/process strategies) questions than would typically-developing children, regardless of type of text. An absence of group differences on literal (initial understanding) questions was hypothesized.

CHAPTER 3

METHODOLOGY

Participants

A total of 48 students between the ages of 9 and 14 voluntarily participated in the study. Of the participants, 11 were previously diagnosed with Autism Spectrum Disorder, and 37 were typically-developing (i.e., not diagnosed with ASD). The students were recruited from suburban and urban school districts throughout Rhode Island, an urban school district in central Massachusetts, and urban and rural school districts in northern Vermont, representing mixed socioeconomic and educational backgrounds. (Refer to the Appendix for information about ASD prevalence and demographic information in the United States.) The majority of the participants in both groups were from middle to upper-middle class families[2], suggesting a low probability for performance differences based on socioeconomic background. Participant enrollment was achieved through Internet electronic mailing lists, by word of mouth within the communities noted above, and by distributing letters of informed consent to students in four school districts from which superintendent permission was given. All but one of the students whose parents signed and returned consent forms to the investigator were included in the study and their data were used in analyses. One participant in the ASD group was excluded from data analyses because he refused to complete the entire reading comprehension measure, and thus, a valid score on this

[2] The majority of typically-developing participants were recruited from a school in which the percentage of students receiving free or reduced lunch is 12% (Retrieved from the ElementarySchools.org website: http://elementaryschools.org).

pertinent measure could not be ascertained. Therefore, 47 participants were included in the analyses, with 37 in the typically-developing group, and ten in the ASD group.

The selection criteria for participants included enrollment in the fourth through eighth grades and being between 9-0 and 14-11 years of age. Participants were excluded from participation based upon the following criteria: students whose primary language was not English; individuals with any known brain damage or neurological impairments; individuals with uncorrected vision or hearing impairments; and/or individuals with prior diagnoses of Learning Impairment/Mental Retardation/Intellectual Impairment. Aside from the child with ASD who was excluded from the study for not completing the comprehension measure, no other participants were found ineligible based on exclusionary criteria.

Table 1 provides a summary of the composition of the participants.

Table 1

Composition of Participants by Group, Grade, and Gender

	Typically-developing		ASD	
Grade	Male (*n*)	Female (*n*)	Male (*n*)	Female (*n*)
4th	4	0	0	0
5th	3	6	2	1
6th	4	1	2	0
7th	6	11	1	0
8th	1	1	3	1
Total	18	19	8	2
	n=37		*n*=10	

Measures

Word Recognition. The Word Identification subtest of the Woodcock Reading Mastery Tests – Revised (WRMT-R; Woodcock, 1998) was used to measure word recognition skills. On this task, participants are asked to read words that become increasingly complex and less frequent in written English. Testing is discontinued when six consecutive items are read incorrectly. Raw scores (i.e., the number of words read correctly) were converted to age-based standard scores (provided in the manual) that were used for data analyses. Word Identification has a medium split-half reliability coefficient of .97 (Woodcock, 1998).

Decoding. The Word Attack subtest from the WRMT-R (Woodcock, 1998) was used to measure skill in applying decoding strategies to correctly pronounce pseudowords. Test items decrease in difficulty as the complexity and length of the pseudowords increase. Testing is discontinued when six consecutive pseudowords are read incorrectly. Raw scores of the total number of items read accurately were calculated and converted into age-based standard score equivalents (provided in the manual). These standard scores were used for statistical analyses. Word Attack has a median split-half reliability coefficient of .87 (Woodcock, 1998).

Fluency. The Sight Word Efficiency Subtest of the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999) was administered to assess level of fluency (i.e., the ability to read common sight words accurately and quickly). Participants read words in a list out loud for 45 seconds. The numbers of words read correctly were converted into age-based standard scores that were used for

data analyses. Test/retest (time sampling) reliability coefficients for Sight Word Efficiency range from .83 to .96.

Receptive Vocabulary. The Peabody Picture Vocabulary Test (PPVT-4; Dunn & Dunn, 2007) was used to evaluate receptive vocabulary knowledge. This test contains 228 items divided into 19 sets of 12 items in each set. For each item, participants were asked to indicate which of a set of four pictures matched a spoken word. Testing ended when the participant made eight or more errors in a set. Raw scores (number of correct items) were calculated and converted into age-based standard scores for use in data analyses. The test-retest reliability of the PPVT-4 yields correlations between .92 and .96.

Reading Comprehension. The Comprehension subtest of the Stanford Diagnostic Reading Test – Fourth Edition (SDRT-4; Karlsen & Gardner, 1996) is a timed, 54-item multiple-choice assessment consisting of various types of text (i.e., narrative/recreational, expository/informational, and functional) and questions (i.e., initial understanding, interpretation, critical analysis, and process strategies). Two levels of the SDRT-4 were used in this study: the purple level for participants in grades 4.5 to 6.4 and the brown level for participants in grades 6.5 to 8.9. Reliability estimates for the SDRT-4 range from .91 to .93 (Eason et al., 2012).

The SDRT-4's Teacher's Manual for Interpreting (Karlsen & Gardner, 1996) provides descriptions of each passage and text type. Within the Comprehension subtest, recreational, or narrative, passages are short stories containing fictional characters and often read for enjoyment. Textual, or expository, passages include information that is encountered in grade-appropriate textbooks and other materials.

Hereafter, these types of texts will be referred to as narrative and expository passages, respectively. Functional types of text typically are encountered in day-to-day situations, and include recipes, instructions about how to make something, or posters advertising a contest.

With regard to the types of questions asked within each type of passage, initial understanding questions can be answered based on information explicitly stated in the text (e.g., According to the article, what do earthworms eat?). Interpretation questions are answered based on both explicit and implicit information contained within a given passage (e.g., Earthworms are probably most helpful to…). Critical analysis questions require the reader to use comprehension strategies such as synthesizing and evaluating explicit and implicit information contained in the passage to reach an answer. Examples of critical analysis questions include asking the reader to distinguish fact from opinion, generate hypotheses, and discern the author's purpose. Lastly, process strategies questions require the reader to consider aspects of the text and use comprehension strategies to reach the correct answer. For example, the reader may be asked to find the part of a passage that supports the main idea, or may be asked how they might gather more information on the main topic of the passage. Eason et al. (2012) determined that there are significantly fewer critical analysis and process strategies questions, and therefore, items for these two categories were combined into one question type.

Based on methods used by Eason et al. (2012), SDRT-4 overall reading comprehension raw scores (i.e., the total number of correct items) were converted to percentiles based on grade-based norms and used for data analyses. To examine

performance on each text and question type, the total number of correct items on each passage and within each question type was tallied and converted to percentage correct scores that were used for data analyses.

Theory of Mind. To assess theory of mind (i.e., the ability to "represent and attribute mental states," Happé, 1994, p. 130), Happé's Strange Stories Test was administered to each participant. Participants were presented with twenty-four short vignettes about simple day-to-day situations in which characters say things that are not to be interpreted literally. Each vignette is followed by two test questions: the comprehension question asked, "Was it true, what X said?" and the justification question asked "Why did X say that?" The types of stories are classified as: Lie, White Lie, Joke, Pretend, Misunderstanding, Persuade, Appearance/Reality, Figure of Speech, Sarcasm, Forget, Double Bluff, and Contrary Emotions (Happé, 1994). To measure performance on this task, the total number of correct mental state responses (out of twenty-four) was calculated.

Executive Functioning. Two measures of executive functioning were administered to each participant. The first, a nonverbal task, was the Tower Test of the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001) that is intended to assess planning and organization ability. Participants are asked to construct towers of discs onto a set of pegs that correspond to models depicted in a stimulus book. Testing is discontinued after three consecutive raw scores of zero. Raw scores were calculated to obtain a total achievement scale score for data analyses, reflecting skill in using the fewest possible moves to correctly build each administered

tower. According to the manual, test-retest reliability of the Tower Test has been reported as .51 (Delis et al., 2001).

Second, an experimenter-developed research tool, the Sentence Span Test (Futransky, 1992), was administered to measure the processing and storage components of verbal working memory. Participants listened to sets of sentences, ranging in length from five to seven words that previously had been recorded on a digital recorder to ensure consistency in administration. There were a total of twelve sets of sentences, with three sets of two sentences, three sets of three sentences, three sets of four sentences, and three sets of five sentences. After hearing each sentence, a three-second interval occurred, at which time the participant had to say whether the sentence was true or false (the processing component of the task). Three seconds after the last sentence of the set, a tone sounded, and the participant was asked to recall the final word of each sentence in the set (the storage component of the task). Participants were told in advance how many sentences would be in a set. Sentence span, or the total number of words correctly recalled, was calculated. Strong positive correlations have been found in a number of studies between this type of measure and reading comprehension (Daneman & Carpenter, 1980; Gathercole & Baddeley, 1993).

Procedures

Each participant was assessed across two sessions by this researcher. The time between sessions ranged from one day to one week, and for each participant, instruments were administered in the same order. During Session 1, lasting approximately one hour, the word recognition, decoding, fluency, receptive vocabulary, theory of mind, and executive functioning measures were individually

administered. Session 2 consisted of the administration of the SDRT-4 Comprehension subtest and likewise took approximately one hour to conduct. Depending upon when and where the children were assessed, some participants were administered the Comprehension subtest individually, and others were given the measure in a group format. All procedures followed a protocol previously approved by the Institutional Review Board of the University of Rhode Island.

Data Analyses

To evaluate the profiles of reading skills in the typically-developing and ASD groups, raw and standard scores were calculated for each reading measure. Descriptive analyses, including means, standard deviations, skewness and kurtosis, were conducted on all measures and on the grades and ages of the participants. Preliminary analyses were performed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity.

The relationships between the different reading measures, and among the reading measures, receptive vocabulary, theory of mind, and executive function were investigated using Spearman rank order correlation tests for each group. To explore group differences on reading comprehension, Mann-Whitney U Tests were conducted. In addition, the Friedman test was used to examine within-group differences among question types within each text type. Refer to Table 2 for the number and proportion of question types within each type of passage in the Brown and Purple levels of the SDRT-4. Lastly, although the sample size of typically-developing participants was modest, exploratory hierarchical regression analyses were conducted to examine

predictors of overall reading comprehension, and performance on narrative, expository, and functional text types.

Table 2

Number and Proportion of Question Types Within Passage Types by SDRT-4 Test Level

Question Type	Purple level			Brown level		
	Narr.	Expos.	Func.	Narr.	Expos.	Func.
Initial Understanding	5 (28%)	9 (50%)	4 (22%)	3 (17%)	4 (22%)	11 (61%)
Interpretation	11 (61%)	5 (28%)	9 (50%)	13 (72%)	9 (50%)	3 (17%)
Critical Analysis/Process Strategies	2 (11%)	4 (22%)	5 (28%)	2 (11%)	5 (28%)	4 (22%)

Note. Narr = narrative; Expos = expository; Func = functional. Adapted from Eason et al. (2012).

CHAPTER 4

FINDINGS

Descriptive Analyses

Descriptive analyses were conducted on all reading and vocabulary measures using standard scores, on the DKEFS Tower task using scaled scores, on the Sentence Span task and Happé's Strange Stories using raw scores, and on the SDRT-4 Comprehension subtest using percentiles for overall reading comprehension and percentage correct (using decimal proportions) for performance on each passage and question type. Tables 3 and 4 present descriptive data for each group.

Table 3

Descriptive Data for Independent Measures by Group

	Typically-developing $n = 37$		Autism Spectrum Disorder $n = 10$	
	M	*SD*	*M*	*SD*
Word Identification	109.65	12.37	101.40	15.63
Word Attack	110.57	9.61	111.30	20.70
TOWRE	106.97	10.60	92.00	11.03
PPVT-4	118.08	15.61	107.70	22.41
Strange Stories	23.51	1.19	17.20	9.18
Sentence Span	29.05	6.06	21.30	12.46
DKEFS Tower Test	10.05	2.13	7.20	2.35

Note. Word Identification and Word Attack subtests are from the Woodcock Reading Master Test – Revised; TOWRE = Test of Word Reading Efficiency; PPVT-4 = Peabody Picture Vocabulary Test (4^{th} ed.)

Table 4

Descriptive Data for SDRT-4 Comprehension Test Results by Group

	Typically-developing *n*=37		Autism Spectrum Disorder *n*=10	
	M	*SD*	*M*	*SD*
Overall Comprehension	66.89	23.20	33.60	29.08
Narrative Text	.86	.13	.61	.25
Expository Text	.84	.14	.64	.29
Functional Text	.86	.13	.61	.27
Initial Understanding Questions	.85	.13	.65	.24
Interpretation Questions	.88	.13	.63	.30
Critical Analysis/Process Strategies Questions	.82	.14	.53	.28

Note. Overall Comprehension scores are percentiles; performance on each text and question type are calculated as the proportion of items correctly answered (e.g., .86 is 86% items correctly answered).

Analyses to check whether there were violations of statistical assumptions revealed that the levels of skewness and kurtosis for a number of variables within the typically-developing group were not within acceptable limits (i.e., their skewness absolute values were greater than one, and their kurtosis absolute values were greater than two) (Harlow, 2005). The following typically-developing variables had a skewness greater than one: theory of mind, overall reading comprehension, performance on narrative and expository texts, and scores on initial understanding and interpretation questions. Additionally, receptive vocabulary, theory of mind, narrative and expository text performance, and scores on initial understanding and interpretation

questions had kurtosis values greater than two. Lastly, within the ASD group, the skewness absolute value of word recognition also was greater than one.

In addition, normality of the variables within each group was checked using the Shapiro-Wilk test that is recommended for samples with fewer than fifty participants (Rovai, Baker, & Ponton, 2013). For the typically-developing group results showed that theory of mind, overall reading comprehension, and scores on each text and question type were not normally distributed. Within the ASD group, performance on expository texts and interpretation questions were not normally distributed. Due to violations of these assumptions, nonparametric tests were used to conduct correlational analyses among variables, to examine group differences on the independent and dependent measures, and to explore whether there were differences among question types within each text type.

Relationships Among Predictor Variables and Between Predictors and Dependent Variables

Within each group, the relationships among the predictor variables (word recognition, decoding, reading fluency, receptive vocabulary, theory of mind, and executive function) and between the predictor variables and reading comprehension performance on the different text and question types were investigated. Spearman rank order correlation tests were used for both groups. Matrices displaying the correlations between the measures are presented in Table 5 for the typically-developing group and in Table 6 for the ASD group.

Table 5

Summary of Intercorrelations For Predictor Variables, Text Types, and Question Types for the Typically-Developing Group

Variable	1	2	3	4	5	6	7	8
1. Age	---							
2. W-ID	-.17	---						
3. W-Att	-.20	.81***	---					
4. TOWRE	-.07	.56***	.45**	---				
5. PPVT-4	-.004	.44**	.30	.64***	---			
6. ToM	-.01	-.03	-.01	.10	.15	---		
7. V-WM	.27	.26	.28	.48**	.38*	-.01	---	
8. DKEFS	-.19	.28	.49**	.05	-.06	-.08	.09	---
Overall	.14	.25	.16	.47**	.38*	.13	.36*	.03
Narr.	-.10	.28	.17	.46**	.29	.26	.19	.10
Expos.	-.01	.22	-.02	.25	.16	.09	.05	-.01
Func.	.20	.15	.08	.37*	.32	.10	.41**	-.04
IU	.11	.29	.21	.52***	.46**	.35*	.37*	.02
IN	.07	.01	-.06	.30	.11	.09	.15	-.06
CAPS	.05	.28	-.001	.17	.10	-.11	.13	.03

Note. W-ID = Word Identification; W-Att = Word Attack; TOWRE = Test of Word Reading Efficiency; PPVT-4 = Peabody Picture Vocabulary Test (4th ed.); ToM = Happé's Strange Stories; V-WM = Sentence Span; DKEFS = DKEFS Tower Test; Overall = Overall text comprehension; Narr. = Narrative text comprehension; Expos. = Expository text comprehension; Func. = Functional text comprehension; IU = initial understanding questions; IN = interpretation questions; CAPS = critical analysis/process strategies questions

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$

For the typically-developing group, Spearman rank order tests analyzing the relationships among predictor variables yielded significant correlations between the basic reading measures and between the reading and vocabulary measures, as expected. Thus, word recognition was strongly associated with decoding, $r_s(35)=.81$, $p<.001$, and reading fluency, $r_s(35)=.56$, $p<.001$, and moderately correlated with receptive vocabulary, $r_s(35)=.44$, $p=.01$. Likewise, significant correlations were found

between decoding and reading fluency, $r_s(35)=.45$, $p=.01$, and between reading fluency and receptive vocabulary, $r_s(35)=.64$, $p<.001$.

Somewhat surprisingly, the basic reading measures of word identification and word attack were not significantly correlated with the Overall text comprehension score from the SDRT-4. On the other hand, Overall comprehension was moderately correlated with both reading fluency, $r_s(35)=.47$, $p=.003$, and receptive vocabulary, $r_s(35)=.38$, $p=.02$. In addition, reading fluency was moderately correlated with both narrative, $r_s(35)=.46$, $p=.004$, and functional, $r_s(35)=.37$, $p=.03$, text comprehension. In addition, performance on initial understanding questions was strongly correlated with reading fluency, $r_s(35)=.52$, $p=.001$, and moderately correlated with receptive vocabulary, $r_s(35)=.46$, $p=.004$.

The correlations between the reading instruments and the cognitive assessment measures for the typically-developing group were mixed. Verbal working memory performance was moderately correlated with reading fluency, $r_s(35)=.48$, $p=.003$, receptive vocabulary, $r_s(35)=.38$, $p=.02$, and Overall text comprehension, $r_s(35)=.36$, $p=.03$. Likewise, it correlated significantly with functional text comprehension, $r_s(35)=.41$, $p=.01$, but not with performance on narrative or expository texts. Verbal working memory also correlated significantly with performance on initial understanding questions, $r_s(35)=.37$, $p=.02$.

On the other hand, performance on the nonverbal D-KEFS Tower test assessing planning and organization did not correlate significantly with word recognition, reading fluency, the verbal working memory task or any of the

comprehension scores. The only measure that the D-KEFS test was significantly correlated with was performance on the decoding measure, $r_s(35)=.49$, $p=.002$.

Theory of mind, although not correlated with any of the basic reading measures, cognitive assessment measures, or performance on any of the text types, was moderately correlated with performance on initial understanding questions, $r_s(35)=.35$, $p=.03$.

Interestingly, for the typically-developing group, performance on expository texts was not significantly correlated with any of the independent measures.

Table 6

Summary of Intercorrelations For Predictor Variables, Text Types, and Question Types For the ASD Group

Variable	1	2	3	4	5	6	7	8
1. Age	---							
2. W-ID	.12	---						
3. W-Att	.55	.84**	---					
4. TOWRE	-.03	.60	.45	---				
5. PPVT	-.24	.52	.37	.05	---			
6. ToM	.05	.56	.37	.19	.70*	---		
7. V-WM	.30	.65*	.69*	.44	.68*	.65*	---	
8. DKEFS	-.08	.12	-.01	-.32	.74*	.73*	.44	---
Overall	-.22	.40	.26	-.06	.95***	.72*	.70*	.81**
Narr.	-.03	.55	.47	.14	.94***	.74*	.85**	.74*
Expos.	-.36	.32	.15	-.07	.86***	.66*	.58	.74*
Func.	-.06	.48	.42	-.01	.87***	.74*	.79**	.73*
IU	.02	.49	.46	.04	.87***	.75*	.84**	.72*
IN	-.23	.44	.37	.09	.94***	.46	.71*	.61
CAPS	-.12	.43	.29	.03	.82**	.88***	.71*	.77**

Note. W-ID = Word Identification; W-Att = Word Attack; TOWRE = Test of Word Reading Efficiency; PPVT = Peabody Picture Vocabulary Test (4th ed.); ToM = Happé's Strange Stories; V-WM = Sentence Span; DKEFS = DKEFS Tower Test; Overall = Overall text comprehension; Narr. = Narrative text comprehension; Expos. = Expository text comprehension; Func = Functional text comprehension; IU = initial understanding questions; IN = interpretation questions; CAPS = critical analysis/process strategies questions

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$

Upon examining the relationships within the ASD group among the basic reading measures and between these measures and receptive vocabulary, the only significant relationship observed was the strong correlation between word recognition and decoding, $r_s(8)=.84$, $p=.003$. Likewise, word recognition, decoding, and reading fluency were not significantly correlated with any of the scores obtained from the SDRT-4 Comprehension test. In contrast, receptive vocabulary was very strongly

correlated with Overall text comprehension, $r_s(8)=.95$, $p<.001$, and performance on all text and question types (ranging from $r_s=.82$ to $r_s=.94$; see Table 6).

A number of significant correlations between the reading instruments and the cognitive assessment measures were found for the ASD group. With regard to the basic reading measures and vocabulary, verbal working memory was strongly correlated with word recognition, $r_s(8)=.65$, $p=.04$, decoding, $r_s(8)=.69$, $p=.03$, and receptive vocabulary, $r_s(8)=.68$, $p=.03$, but not with reading fluency. Performance on the planning/organization measure was correlated significantly with receptive vocabulary only, $r_s(8)=.74$, $p=.01$, and this relationship was strong. Performance on the theory of mind measure was strongly correlated with receptive vocabulary, $r_s(8)=.70$, $p=.04$, verbal working memory, $r_s(8)=.65$, $p=.04$, and planning/organization, $r_s(8)=.73$, $p=.02$.

Strong correlations also were found for the ASD group between the cognitive assessment measures and the various scores on the SDRT-4. Verbal working memory was strongly correlated with Overall text comprehension, $r_s(8)=.70$, $p=.03$, narrative $r_s(8)=.85$, $p=.002$, and functional, $r_s(8)=.79$, $p=.01$, comprehension, and performance on each question type (ranging from $r_s=.71$ to $r_s=.84$; see Table 6). In a similar vein, both theory of mind and planning/organization were strongly correlated with Overall text comprehension, performance on all text types, and with scores on initial understanding and critical analysis/process strategies questions (ranging from $r_s=.66$ to $r_s=.88$; see Table 6).

Group Differences on Independent Variables and the SDRT-4

The Mann-Whitney U Test was used to determine whether the ranks of each of the independent and dependent measures were dispersed differently for the typically-developing and ASD groups. Results of Mann-Whitney U Tests showed that the groups did not differ significantly on the basic reading measures of word recognition (U=112.50, p=.06) and decoding (U=177.50, p=.85). Likewise, group differences were not observed on the measure of receptive vocabulary (U=119.00, p=.09).

On the other hand, the groups differed significantly in their reading fluency, (U=60.50, p=.001), as well as on their performance on the SDRT-4 Comprehension test. Significant group differences in mean rank were found regarding overall reading comprehension (U=66.50, p=.002), performance on narrative (U=67.00, p=.002), expository (U=103.00, p=.03), and functional (U=74.00, p=.004) passages, and on initial understanding (U=97.00, p=.02), interpretation (U=77.50, p=.01), and critical analysis/process strategies (U=60.00, p=.001) question types. Figure 1 shows the typically-developing and ASD groups' performances on each of the three SDRT-4 passages, and Figure 2 depicts the two groups' performances on each of the three SDRT-4 question types.

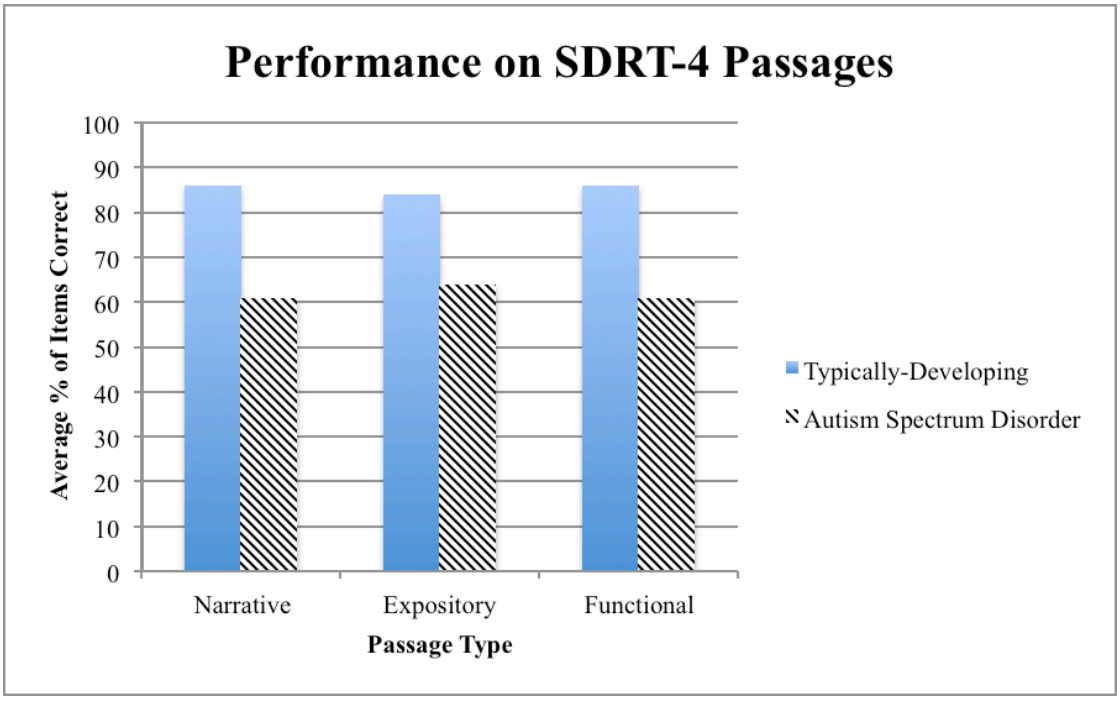

Figure 1. Typically-developing and ASD group results on SDRT-4 passages.

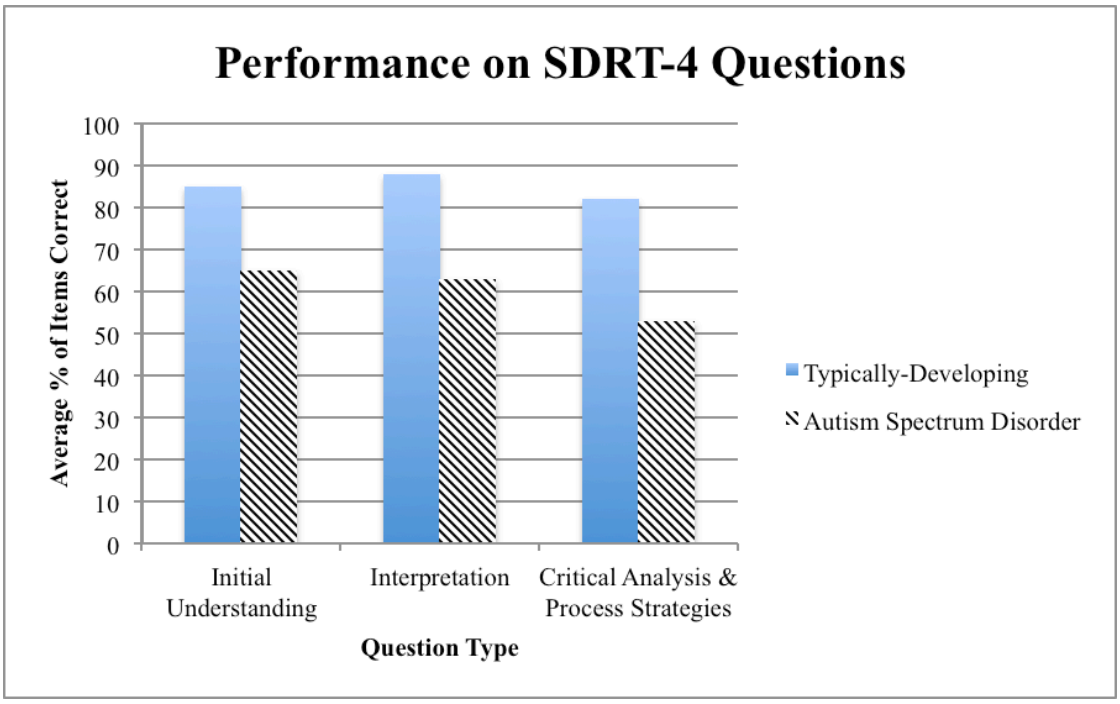

Figure 2. Typically-developing and ASD group results on SDRT-4 questions.

Moreover, the two groups differed significantly in their performance on the question types in response to the different passages. For example, they differed in their accuracy on initial understanding questions within narrative (U=82.00, p<.001), expository (U=98.50, p=.02), and functional passages (U=101.00, p=.02). Likewise, performance differences were observed with regard to interpretation questions in response to narrative (U=91.50, p=.01) and functional (U=74.50, p=.002) passages. In addition, group differences were found in response to critical analysis/process strategies questions pertaining to narrative (U=67.00, p=.001), expository (U=107.50, p=.04), and functional (U=111.50, p=.04) passages. There were no significant differences in performance on interpretation questions within expository passages (U=113.50, p=.17).

Lastly, the two groups also differed in performance on each of the cognitive assessment measures: theory of mind (U=93.00, p=.004), verbal working memory (U=110.00, p=.05), and planning/organization (U=66.00, p=.002).

Within Group Differences Among Text and Question Types

Assumptions of independence of observations and continuous distributions were checked and met, allowing the use of the Friedman test (a nonparametric alternative to a repeated measures ANOVA). The purpose of the Friedman tests was to assess whether there were differences within each group for the mean ranks of each passage type and for those of each question type. Separate Friedman tests were conducted for each group, and results indicate that there were no statistically significant differences for either group for any of the three passage.

On the other hand, statistically significant differences were observed for both groups with regard to question type. For the typically-developing group, $\chi^2(2, N=37)=6.34$, $p=.04$, three orthogonal contrasts performed using Wilcoxin tests with the Bonferroni correction (*comparison-wise alpha*=.02) identified pairwise differences. The contrasts between performance on initial understanding and interpretation questions ($Z=-2.40$, $p=.02$, $r=-.39$), and between interpretation questions and critical analysis/process strategies questions ($Z=-2.44$, $p=.02$, $r=-.40$) were statistically significant. In both cases, the statistically significant contrasts revealed that initial understanding questions ($M=.85$, $SD=.13$) yielded significantly more accurate responses than interpretation questions ($M=.88$, $SD=.13$), and that interpretation questions resulted in significantly more correct items than critical analysis/process strategies questions ($M=.82$, $SD=.14$).

Similar results were obtained for the ASD group, $\chi^2(2, N=10)=7.40$, $p=.03$; three orthogonal contrasts conducted with Wilcoxin tests (Bonferroni correction *comparison-wise alpha*=.02) revealed pairwise differences. The contrast between initial understanding questions and critical analysis/process strategies questions ($Z=-2.71$, $p=.01$, $r=-.86$) was statistically significant. For ASD students, critical analysis/process strategies questions ($M=.53$, $SD=.28$) yielded significantly fewer accurate responses than did initial understanding questions ($M=.65$, $SD=.24$). According to Cohen (1988), this constitutes a large effect size, as indicated by an r value greater than .60.

Within Group Differences Among Question Types For Each Text Type

Friedman tests also were conducted to assess whether there were differences within each group among the mean ranks of each question type for each type of passage. Mean scores for each text-question combination by group membership are presented in Table 7. A statistically significant difference was found for the typically-developing group, $\chi^2(8, N=37)=34.75$, $p<.001$, indicating that for these students there were differences in performance levels among the nine text-question combinations.

Table 7

Descriptive Data for SDRT-4 Comprehension Test Results by Group for Each Text-Question Combination

	Typically-developing n=37		Autism Spectrum Disorder n=10	
	M	*SD*	*M*	*SD*
Narrative Text Questions				
Initial Understanding	.98	.08	.63	.41
Interpretation	.84	.14	.59	.30
Critical Analysis/Process Strategies	.75	.30	.30	.35
Expository Text Questions				
Initial Understanding	.85	.16	.61	.29
Interpretation	.87	.17	.70	.30
Critical Analysis/Process Strategies	.81	.21	.60	.34
Functional Text Questions				
Initial Understanding	.87	.15	.62	.31
Interpretation	.88	.16	.63	.25
Critical Analysis/Process Strategies	.84	.19	.62	.32

Note. Performance on each text-question combination are calculated as the proportion of items correctly answered (e.g., .86 is 86% items correctly answered).

Next, nine orthogonal contrasts were performed using Wilcoxin tests with the Bonferroni correction (*comparison-wise alpha*=.005) to identify pairwise differences. Within narrative texts only, the contrasts between performance on interpretation

questions and initial understanding questions (Z=-4.71, p<.001, r=-.77), and between critical analysis/process strategies questions and initial understanding questions (Z=-3.78, p<.001, r=-.62) were statistically significant. In both cases, the statistically significant contrasts indicated that for narrative texts initial understanding questions yielded significantly more accurate responses (M=.98, SD=.08) than interpretation (M=.84, SD=.14) and critical analysis/process strategies questions (M=.75, SD=.30). These results constitute large effect sizes (Cohen, 1988).

A Friedman test also was conducted for the ASD group to determine whether there were statistically significant differences in the performance levels of question types for each passage type. According to this test, there were no differences in accuracy of responses among the nine text-question combinations. However, although not significant, the stark difference between this group's performance on critical analysis/process strategies questions within narrative texts, as compared with performance on the rest of the text-question combinations, is important to note. Figure 3 depicts the percentage of items correctly answered in both groups as a function of text and question type. The figure illustrates that fewer accurate responses were obtained from the critical/analyses items in narrative texts only.

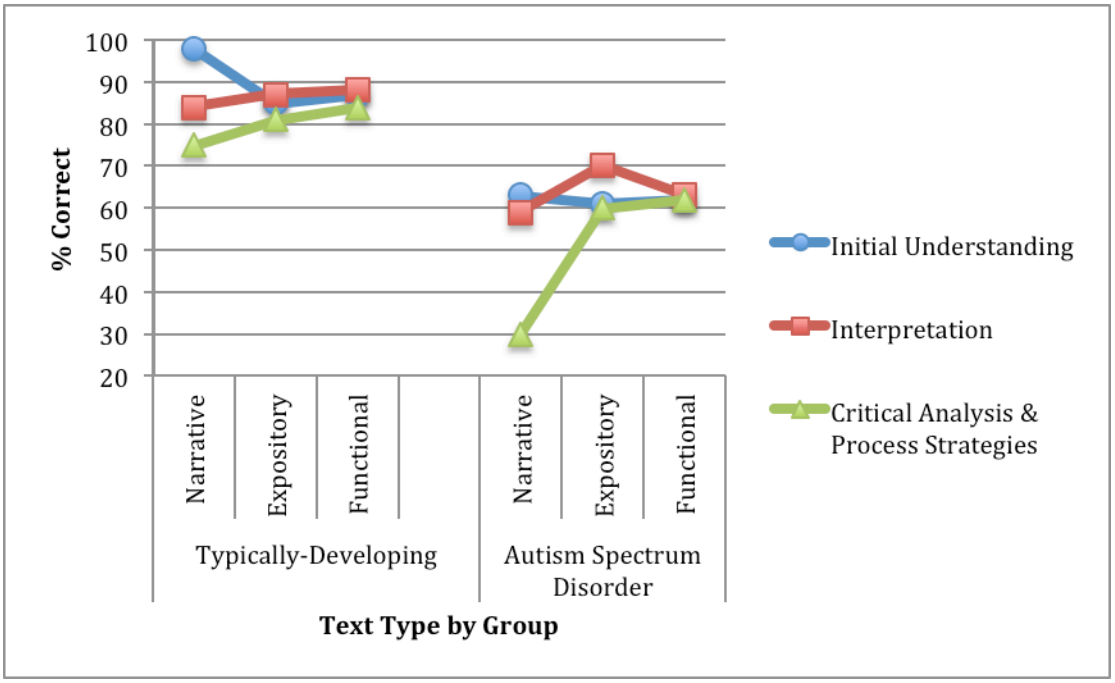

Figure 3. Percentage of items answered correctly in the typically-developing and ASD groups as a function of text type and question type.

Predictors of Text Comprehension in Typically-Developing Participants

Stevens (1996) recommends that there should be at least fifteen participants per predictor variable in multiple regression analyses. Therefore, in the regression analyses examining predictors of reading comprehension, three predictor variables at most were selected for each of the analyses for overall text comprehension, and performance on narrative, expository, and functional texts, respectively.

According to the Spearman calculations previously reported, reading fluency, receptive vocabulary, and verbal working memory were significantly correlated with overall comprehension. Therefore, these variables were used in hierarchical multiple regression to investigate their contribution to the prediction of overall reading comprehension. The overall model explained 28% of the variance in overall text

comprehension, $F(3, 33)=5.74$, $p=.003$. Examination of the final standardized beta values (see Table 8), and squaring the partial correlation coefficients of each predictor variable, revealed that reading fluency explained the largest amount of unique variance (11%), receptive vocabulary explained 4% of the unique variance, and verbal working memory explained the least amount of variance (<1%). Reading fluency contributed significant variance to predicting overall comprehension performance regardless of the order in which the variables were entered. In contrast, receptive vocabulary contributed significant variance only when entered first (see Table 8), and verbal working memory did not contribute significant variance, whether it was entered first or last.

Table 8

Hierarchical Regression Predicting Typically-Developing Performance on Overall Text Comprehension (N=37)

Step/Model	Variable Added	ΔR^2	*p*	Final *ß*
Overall Text Comp.				
1	Reading fluency	.32	<.001***	.40
2	Receptive vocabulary	.03	.26	.21
3	Verbal working memory	.002	.75	.05
1	Receptive vocabulary	.24	.002**	.21
2	Reading fluency	.10	.03*	.40
3	Verbal working memory	.002	.75	.05
1	Verbal working memory	.09	.07	.05
2	Reading fluency	.23	.002**	.40
3	Receptive vocabulary	.03	.27	.21

Note. *$p \leq .05$ **$p \leq .01$ ***$p \leq .001$

Next, predictors of narrative text comprehension were examined with hierarchical multiple regression. Correlational analyses revealed that reading fluency was the only independent variable to be significantly related to performance on

narrative passages. However, word recognition and receptive vocabulary also were selected for the regression, because correlational analyses revealed that, of the independent variables, these measures had the highest correlations with narrative performance (p=.09). The predictive powers of theory of mind and executive function were not examined, due to low correlations with narrative text comprehension. In this case, the overall model explained 32% of the variance in narrative comprehension performance, $F(3, 33)=6.74$, p=.001. Reading fluency explained the largest amount (i.e., 19%) of unique variance, whereas word recognition and receptive vocabulary each contributed less than one percent of unique variance in predicting narrative comprehension. Reading fluency contributed significant variance regardless of the order in which the variables were presented, whereas word recognition and receptive vocabulary only contributed significant variance when entered first (see Table 9).

Table 9

Hierarchical Regression Predicting Typically-Developing Performance on Narrative Text Comprehension (N=37)

Step/Model	Variable Added	ΔR^2	p	Final β
Narrative Text Comp.				
1	Reading fluency	.37	<.001***	.54
2	Word recognition	.001	.84	.01
3	Receptive vocabulary	.006	.58	.10
1	Word recognition	.14	.03*	.01
2	Reading fluency	.24	.001***	.54
3	Receptive vocabulary	.01	.58	.10
1	Receptive vocabulary	.21	.004**	.10
2	Word recognition	.03	.28	.01
3	Reading fluency	.14	.01**	.54

Note. *$p \leq .05$ **$p \leq .01$ ***$p \leq .001$

The fact that expository text comprehension did not correlate significantly with any of the independent measures presented a challenge to deciding which predictor variables to utilize for the regression analyses. However, given that reading fluency contributed significant unique variance in the prediction of overall comprehension and performance on narrative passages, this variable was thought to be a possible predictor of expository passage comprehension. In addition, to determine whether executive function would significantly predict expository text comprehension, as hypothesized, verbal working memory and planning/organization also were entered into the regression. Results showed that the overall model was not significant, $F(3, 33)=2.52$, $p=.08$, adjusted $R^2=.11$. Given the low correlations with expository text comprehension, it is not surprising that neither of the executive function measures significantly predicted performance on these types of passages, with each variable contributing less than one percent of unique variance (see Table 10). On the other hand, reading fluency explained 16% of the unique variance, and emerged as the only significant predictor, irrespective of the order in which the variables were entered.

Table 10

Hierarchical Regression Predicting Typically-Developing Performance on Expository Text Comprehension (N=37)

Step/Model	Variable Added	ΔR^2	*p*	Final *ß*
Expository Text Comp.				
1	Reading fluency	.18	.01**	.44
2	Verbal working memory	.001	.86	-.03
3	Planning/organization	.002	.79	-.04
1	Verbal working memory	.03	.30	-.03
2	Planning/organization	.003	.74	-.04
3	Reading fluency	.152	.02*	.44
1	Planning/organization	.002	.78	-.04
2	Reading fluency	.18	.01*	.44
3	Verbal working memory	.001	.88	-.03

Note. *$p \leq .05$ **$p \leq .01$ ***$p \leq .001$

Lastly, hierarchical regression analyses examined the predictors of functional text comprehension. Performance on this type of text was significantly correlated with reading fluency and verbal working memory, according to Spearman rank order analyses. As a result, these two measures were chosen as predictors. The overall model was significant and explained 21% of the variance in functional text comprehension, $F(2, 34)=5.87$, $p=.006$. Verbal working memory and reading fluency each contributed significant variance when they were entered in that order, as indicated in Table 11. Reading fluency explained the largest proportion of unique variance (14%), whereas verbal working memory only contributed 3% of the variance when entered first.

Table 11

Hierarchical Regression Predicting Typically-Developing Performance on Functional Text Comprehension (N=37)

Step/Model	Variable Added	ΔR^2	*p*	Final *β*
Functional Text Comp.				
1	Reading fluency	.23	.003**	.40
1	Verbal working memory	.02	.30	.18
1	Verbal working memory	.13	.03*	.18
2	Reading fluency	.13	.02*	.40

Note. *$p \leq .05$ **$p \leq .01$ ***$p \leq .001$

CHAPTER 5

CONCLUSION

This study sought to examine some of the underlying factors that relate to and may predict reading comprehension performance of fourth through eighth graders on different types of passages and in response to different question types. Specifically, the relationships between reading comprehension and basic reading skills, receptive vocabulary, executive function, and theory of mind were assessed. There were two groups of participants consisting of thirty-seven typically-developing children and ten children diagnosed with ASD. Group differences on each of the independent and dependent measures were evaluated using nonparametric analytical procedures. In addition, hierarchical regression analyses using those factors that correlated significantly with narrative and expository text comprehension performance were conducted for the typically-developing group only. The SDRT-4 Comprehension subtest was selected as the dependent measure in this study because it contains three types of passages (i.e., narrative, expository, and functional) and it utilizes different types of questions (i.e., initial understanding, interpretation, and critical analysis/process strategies). In addition, this measure was used in a prior study with a normal population to assess both predictors of and differences in performance on the aforementioned text and question types (Eason et al., 2012).

Factors Associated with Reading Comprehension Performance

The first hypothesis related to factors thought to be associated with reading comprehension performance. For both groups, it was predicted that basic reading skills (word recognition, decoding, reading fluency), receptive vocabulary, and verbal working memory would be significantly and positively correlated with overall reading comprehension and performance on all text/question types. Correlational analyses revealed that for the typically-developing group reading fluency and receptive vocabulary were significantly and positively related to overall reading comprehension, comprehension of narrative, expository, and functional texts, and performance on initial understanding and interpretation questions. It has been argued that, as children improve their basic reading skills (e.g., word recognition, decoding), reading comprehension performance is less influenced by these word-level factors (Storch & Whitehurst, 2002). This may explain why, for both groups, word recognition and decoding were not significantly correlated with comprehension. Given that comprehension weaknesses have been associated with deficits in vocabulary knowledge (Catts et al., 2006; Cutting & Scarborough, 2006), it is not surprising that higher scores on the receptive vocabulary measure were associated with increased reading comprehension.

Likewise, in the ASD group, receptive vocabulary was significantly correlated with reading comprehension (i.e., overall reading comprehension and performance on all text and question types). In fact, the very high correlations (i.e., greater than .80) between receptive vocabulary and comprehension infer the large role that receptive vocabulary plays in comprehension of all types of texts. As children transition beyond

the primary grades, a greater emphasis is placed on "reading to learn" (Chall, 1983). By third grade, children are expected to have become proficient at decoding and spelling. Thus, instruction shifts to teaching comprehension strategies and texts become more challenging (Chall, 1983). As texts increase in complexity, higher order skills, such as vocabulary knowledge, increase in their relevance to comprehension ability (Catts et al., 2006; Storch & Whitehurst, 2002). In addition, the links between vocabulary knowledge and comprehension are likely to be reciprocal, with wider reading also introducing new words and concepts. The association of vocabulary knowledge with comprehension is evident for the students in this study, regardless of group membership.

Verbal working memory is another higher-level cognitive capability related to reading comprehension, whereby the ability to hold complex verbal information in memory aids in the understanding of increasingly complex texts (Cain et al., 2004; Nation et al., 1999). This is somewhat supported by the correlational results of the present study. For example, in the typically-developing group, verbal working memory was moderately correlated with performance on functional texts and initial understanding questions, although not significantly associated with reading comprehension for the other types of text and questions. In the ASD group, verbal working memory was more strongly linked with comprehension: higher levels of performance on the Sentence Span task were associated with higher levels of overall comprehension, understanding of narrative and functional texts, and performance on each question type. In a twin study exploring the etiology of the relationship between reading performance and verbal short-term memory, a moderate relationship was

found in both typically-developing and disabled readers (Wadsworth, DeFries, Fulker, Olson, & Pennington, 1995). However, the researchers highlighted the complexity of this relationship and called for additional investigation. Thus, further research with a larger sample of children (both typically-developing and diagnosed with ASD) would help to elucidate varying findings between groups, whether verbal working memory is more determinate of individual differences in passage understanding for children diagnosed with ASD, and whether it may be more crucial for the comprehension of more complex texts.

Planning/organization was hypothesized to be another factor that would be significantly and positively correlated with performance on expository passages, as well as on more challenging question types (i.e., interpretation and critical analysis/process strategies questions). This hypothesis was not supported in the typically-developing group, as performance on the D-KEFS Tower test was not significantly correlated with any of the comprehension scores. Results of a previous study using the Tower test to measure planning/organization found that children with reading comprehension deficits performed the poorest on this task (Locascio et al., 2010). The present results perhaps are not consistent with that study because the individuals assessed in the current study did not have diagnosed reading disabilities (word-level deficits or poor comprehension). Although the Locascio et al. (2010) study did not conduct correlational analyses to examine the correspondence between reading comprehension and planning/organization, perhaps if they had, they may have found similar results to this study with their control (i.e., non-reading disabled) group. Further research is needed to examine the relationship between reading

comprehension and planning/organization in both typically-developing and reading disabled children.

In the ASD group, higher scores on the Tower test were strongly associated with higher overall reading comprehension, comprehension of all text types, and increased performance on initial understanding and critical analysis/process strategies text types. Critical analysis and process strategies questions have been found in previous research using the SDRT-4 to be the most difficult questions for participants because these types of questions require the reader not only to understand the passage, but also to analyze and evaluate the text, making use of reading strategies to recognize text structure (Eason et al., 2012). For students in the ASD group, the ability to simultaneously engage in these tasks in order to successfully respond to more complex question types may have been related to more effectively developed planning and organization ability. These findings are similar to studies that have been conducted with non-ASD populations (e.g., Best et al., 2008; Eason et al., 2012; Samuelstuen & Braten, 2005). Another interesting point of note is the abstract planning and organization abilities measured by the nonverbal Tower test: children are presented with different sized discs and asked to build towers on a set of pegs that correspond to models in a stimulus book. With the results of this study suggesting a relationship between nonverbal planning/organization abilities and reading comprehension, it would be fruitful to compare SDRT-4 performance with a verbally mediated planning/organization measure.

In light of research documenting the relationship between theory of mind and narrative story comprehension, it was hypothesized that, in the ASD group,

performance on the Strange Stories task would be significantly and positively correlated with comprehension of narrative text. The present results revealed a strong, positive relationship between theory of mind performance and overall reading comprehension, comprehension of all text types, and performance on initial understanding and critical analysis/process strategies question types for the ASD participants. Anecdotally, individuals in the typically-developing group tended to receive full credit on the Strange Stories test, leading to the assumption that this group was not impaired in theory of mind. One could assume, then, that for typically-developing students, theory of mind is not a major factor contributing to individual differences in reading comprehension, although the Strange Stories measure may have ceiling effects for a non-impaired group that obscure the role of this ability.

On the other hand, as anticipated, individuals in the ASD group tended to have more difficulty on the Strange Stories task, performing significantly worse than typically-developing students. In a study comparing Strange Stories performance of individuals with autism to IQ-matched controls, the participants with autism performed significantly worse (Happé, 1994). The author suggested the presence of "real underlying" discrepancies in understanding the mental states of others (i.e., theory of mind) that was unrelated to verbal IQ (Happé, 1994, p. 142). Similar results were obtained in the present study, as the typically-developing and ASD groups did not differ significantly on their receptive vocabulary performance, a measure that often serves as a proxy to IQ, but did differ on their theory of mind performance. However, the broad range of receptive vocabulary scores among the ASD participants, as demonstrated by the large standard deviation of PPVT-4 scores (see Table 3), raises

concerns regarding whether IQ may in fact significantly contribute to performance differences both on theory of mind and the comprehension measure, and calls for further research in this area. Further research with larger samples of children with ASD could help unravel the relationships among IQ, theory of mind, and comprehension.

Group Performance Differences

Considering that there were uneven sample sizes between the two groups in this study, nonparametric procedures were used to examine differences between typically-developing and ASD participants. Of course, additional research with adequate samples is necessary to test whether the significant differences found between typically-developing and ASD students are generalizable. Accordingly, the analyses contained in this section are to be considered an exploratory pilot investigation of possible differences in cognitive factors and reading comprehension between typically-developing children and those diagnosed with ASD.

A major hypothesis of this study proposed that there would be significant group differences in performance on narrative and expository texts. Results of nonparametric analyses supported this prediction: the typically-developing participants performed significantly better than the ASD group on overall reading comprehension and on each type of passage. Before discussing these comprehension-related results, it is important first to examine the basic reading skills of the two groups.

There were no group differences in performance on word recognition and decoding measures. However, the selection of students in this age range for this study also may have facilitated obtaining both typically-developing and ASD participants

with adequate basic reading skills. Nonetheless, the results support previous research comparing the decoding skills of ASD participants with typically-developing individuals. Similar to the general population, heterogeneity in decoding skills has been found in high-functioning individuals with ASD, who perform variably below, at, or above age expectations (see O'Connor & Klein, 2004, for a review of studies from the 1980s and 1990s). However, while variation in reading comprehension performance also has been documented in the ASD population, abilities in this domain tend to fall below both age expectations and decoding performance (Huemer & Mann, 2010; Nation et al., 2006; O'Connor & Klein, 2004). Correspondingly, the present results revealed similar decoding abilities for the two groups but significantly lower comprehension performance (regardless of text type) in the ASD sample. In light of the fact that children in the ASD group also tended to have lower reading fluency, that variable also may play a role in their lower comprehension performance. Cutting and Scarborough (2006) have argued that inclusion of assessment of reading fluency is necessary to adequately predict reading comprehension performance.

With regard to whether there would be performance differences based on question type, the hypothesis that no group differences would be found on initial understanding questions was not supported: typically-developing children performed significantly better on this question type. On the other hand, the prediction that there would be group differences in performance on higher order question types was confirmed. Individuals in the ASD group performed significantly less well on interpretation and critical analysis/process strategies questions than did the typically-developing children. Thus, these children with ASD not only performed less well on

comprehension, regardless of text type; they also experienced more difficulty on each question type – from simple questions that could be answered based on information found directly in the passages (i.e., initial understanding), to more complex questions that required more evaluation and analysis of the text (i.e., interpretation and critical analysis/process strategies).

A further hypothesis proposed that participants in the ASD group would perform significantly lower on independent measures of theory of mind, planning/organization, and verbal working memory. Exploration of group differences confirmed that the ASD group performed significantly less well on each of these tasks. The Strange Stories results corroborate the existence of social and communication impairments found in individuals diagnosed with ASD, particularly with regard to challenges related to understanding and making inferences about others' feelings, thoughts, and beliefs (Frith, 2003; Happé, 1999). Coupled with results documenting significantly lower overall comprehension and performance across text/question types, impairments in theory of mind may inhibit children with ASD not only from relating socially to others in real-life situations, but also may affect their ability to make inferences when reading any type of text, particularly written material involving socially-related topics (Sandaña & Frith, 2007).

The results related to verbal working memory differences are consistent with one study in which participants with ASD performed significantly less well on a similar sentence span task (Bennetto et al., 1996). Results of that study also found that participants diagnosed with autism exhibited a memory profile similar to clinical samples with frontal lobe deficits (i.e., executive dysfunction). Another investigation

examined the verbal and spatial working memory in high-functioning children, adolescents, and adults diagnosed with ASD and compared them with age- and cognitive-matched controls (Williams, Goldstein, Carpenter, & Minshew, 2005). Results documented intact verbal working memory in individuals with autism, with these participants performing similarly to control participants (Williams et al., 2005). Considering that the ASD group assessed in the present study consisted of only a small sample of individuals, further research is needed to investigate the role of verbal working memory for those diagnosed with ASD.

Predictors of Reading Comprehension

Unfortunately, the small number of participants in the ASD group prohibited further evaluation of the proportion of variance accounted for by the measures using regression analyses (Harlow, 2005). Therefore, this type of multivariate analysis was only conducted for the typically-developing group.

It also was hypothesized that, in both groups, planning/organization and verbal working memory would make significant contributions to expository passage comprehension. In the regression analyses examining the predictors of expository text comprehension for the typically-developing group, neither of the executive function measures contributed significant variance to the prediction of performance on this passage type. These results are inconsistent with previous findings in which performance on the D-KEFS Tower test was a strong predictor of performance on expository texts (Eason et al., 2012).

Current results did, however, find that verbal working memory was one of the significant predictors of typically-developing group performance on functional types

of texts, sharing much of its predictive power with reading fluency. These findings are similar to a study in which the working memory of children between the ages of nine and fifteen uniquely predicted their reading comprehension performance, even after controlling for the effects of word level skills, vocabulary, and attention (Sesma et al., 2009). While the latter study did not differentiate among the types of text that were used to measure comprehension, results of both studies provide support for the existence of a relationship between comprehension of certain text types and verbal working memory. Because functional texts in the SDRT-4 are meant to imitate real-life situations (e.g., following directions, recipes, advertisements), they may be more familiar to students. SDRT-4 functional passages also are presented in a sequential manner and are thought to be easier to navigate to correctly answer related questions (Eason et al., 2012; Geiger & Millis, 2004). Perhaps children with better-developed verbal working memory (i.e., a higher capacity to store verbal information in memory while responding to new information at the same time) are more able to store incoming information from the functional passage while simultaneously retrieving information to aid in their understanding of the text.

Overall, the hierarchical regression analyses revealed that reading fluency significantly predicted overall comprehension, and performance on each of the passage types. In fact, reading fluency explained the largest proportion of unique variance, and remained a significant predictor even after other variables were added. These results provide support to theoretical and empirically supported implications that oral reading fluency may serve as "an overall indicator of reading expertise and development" (Fuchs, Fuchs, Hosp, & Jenkins, 2001, p. 250).

Additionally, receptive vocabulary contributed significant variance in the prediction of overall reading comprehension, but only when it was the first variable entered into the regression. These results suggest that a large proportion of the variance that receptive vocabulary contributes to overall comprehension is shared with reading fluency. Similarly, both receptive vocabulary and word recognition emerged as significant predictors of narrative comprehension, but only when each was entered first. These results underscore the large proportion of variance shared among these variables and reading fluency for predicting comprehension of narrative texts. Taken together, the results highlight the importance of having a solid foundation of word-level skills (i.e., being able to recognize common sight words quickly and accurately), coupled with adequate vocabulary knowledge in order to understand the text (Catts et al., 2006; LaBerge & Samuels, 1974; Leach et al., 2003; Perfetti, 1985).

Once again, research with larger samples is needed not only to be able to generalize these results, but also to explore the role of the other independent variables in overall reading comprehension and comprehension of different types of text.

Within Group Performance Differences on the SDRT-4

As presented above, analyses were conducted within both groups to determine whether there were within-group differences among both passage types and question types. Analyses revealed that, for both typically-developing children and those diagnosed with ASD, there were no differences in performance among the three types of texts. These results are similar to those found by Eason et al. (2012) in which no performance differences between narrative and expository texts were observed. The authors provided some explanation as to why these results were obtained. Coh-Metrix

analyses of the passages that compared text features between each passage type, revealed that SDRT-4 expository passages are more cohesive than narrative texts (Eason et al., 2012). This text feature may not only help readers compensate for the less-familiar topics featured in the non-fiction passages, but may also diminish the necessity of utilizing higher-order inferencing and/or planning/organizational skills (Eason et al., 2012). Hence, in future investigations comparing difference types of text, it will be important to carefully control the characteristics of the text in order to be able to compare the cognitive demands for each.

In contrast, analyses within both groups revealed significant differences among the three question types. Critical analysis/process strategies questions emerged as the most challenging for both groups, and resulted in significantly fewer correct items than interpretation questions (for the typically-developing group) and initial understanding questions (for the ASD group). These results are expected, given the higher order thinking involved and use of comprehension strategies required to answer the more complex critical analysis/process strategies questions (Eason et al., 2012).

In order to explore whether performance on each question type varied depending on the type of passage used, analyses were conducted to determine whether there were significant differences for each group among the nine SDRT-4 text-question combinations. Significant differences were found in the typically-developing group only. Post-hoc comparisons revealed that, for narrative texts only, initial understanding questions yielded significantly more accurate responses than interpretation and critical analysis/process strategies questions. These results are consistent with findings by Eason et al. (2012), in which initial understanding

questions pertaining to narrative passages were significantly easier than interpretation questions. These authors proposed that greater familiarity with reading narrative passages that lead the reader through a timeline of sequential events, coupled with questions that ask about their understanding of what is directly located in the passage, results in a more accurate response rate (Eason et al., 2012). Moreover, initial understanding questions about narrative texts do not ask the reader to infer information from the passage. In contrast, one can argue that expository passages often assume that readers bring with them a certain amount of background knowledge that often is necessary for answering interpretation and critical analysis/process strategies questions, both of which require a deeper understanding and drawing conclusions about the main idea of the passage (Eason et al., 2012).

Overall Conclusions

Of the potential factors associated with individual differences in reading comprehension that were examined in this study, receptive vocabulary and verbal working memory emerged as significant correlates for both groups of students, particularly for individuals diagnosed with ASD. For typically-developing students, reading fluency was significantly related to and uniquely predicted overall, narrative, and functional text comprehension. Higher reading fluency scores also were significantly correlated with increased accuracy on initial understanding questions for these students. Within the ASD group, theory of mind and planning/organization abilities were associated with performance on all passage types and with easier as well as more complex questions. These results emphasize the significance of factors that are important for both of the groups studied, and those areas that seem to be related

only to one of the groups. For example, receptive vocabulary and verbal working memory was relevant for both groups, whereas theory of mind was related to comprehension performance in the ASD group only. Such findings may help educators and future researchers focus on particular skills.

Additional findings of this study revealed performance differences between typically-developing children and those diagnosed with ASD. In this sample, students in the ASD group tended to perform significantly less well on the reading comprehension measure (as indicated by significantly lower overall comprehension and performance on all text and question types), as well as on the reading fluency, executive functioning, and theory of mind measures. Although further research is necessary to generalize findings, these preliminary results could help educators be cognizant of potential comprehension differences among their students (despite having comparable word recognition and decoding skills), and point towards areas that may be in need of remediation for students with ASD.

Contributions to the Field

This study expands upon previous research in a number of ways. First, this preliminary examination of a subset of children with ASD serves as a pilot exploration of some of the cognitive factors that may be related to comprehension of different types of texts and questions for this population. Previous research has only begun to look at factors that contribute to reading comprehension for students with ASD, and few, if any, studies have looked at the specific characteristics of the measures used to assess comprehension (e.g., passage type, questions used to assess comprehension). The results of this investigation point to directions for further research with ASD

populations, such as specific reading and cognitive factors (e.g., reading fluency, receptive vocabulary, executive function, and theory of mind) that could be studied further to examine their roles in comprehension of various text types and ability to process different forms of questions. Thus far, most have looked only at basic reading skills and background knowledge. An exception is the Eason et al. (2012) study, in which a number of cognitive factors were explored with regard to their contribution to comprehension performance on different types of passages and questions, though children diagnosed with ASD were not part of the sample.

Limitations and Future Directions

A number of limitations must be mentioned for this study. First, given the relatively small percentage of individuals with ASD in the population, coupled with general difficulties associated with recruitment of school populations in general, smaller than expected ASD and typically-developing samples were assessed. This problem limits the drawing of conclusions regarding whether the independent variables were significant and/or unique predictors of comprehension of the varying text/question types. Although some emerged as significant predictors, the small sample size did not provide an adequate database for evaluating all of the variables included.

Another limitation of the study is that the participants were selected on the basis of convenience and consisted of a relatively homogeneous sample of fourth through eighth grade students. There were uneven numbers of students representing each grade, with the majority of the participants being in seventh grade. Thus, a subsequent study that assesses more randomly selected, heterogeneous groups that are

representative of the typically-developing and ASD school populations as a whole would allow for more reliable comparisons between groups and greater generalizability of the results.

In a related vein, the children making up the ASD group in this study were selected based on anecdotal reports by their teachers or parents that they were diagnosed to be on the autism spectrum. Thus, there is no way to tell how these diagnoses were made (e.g., Were appropriately standardized instruments used for diagnosis? Were sufficient behavioral observations and parent interviews conducted to reach adequate conclusions?) and whether these individuals actually do fall within the autism spectrum. In addition, given the "spectrum" of ASD, all students in this cohort varied with regard to the diagnostic features of the disorder that they exhibited (i.e., language/social interaction delays, social and communication impairments, stereotyped behaviors, etc.) (DSM-IV-TR; American Psychiatric Association, 2000).

The assessment of theory of mind used in the study is another limitation, and has to do with the complicated nature of this theoretical cognitive ability. Theory of mind, much like executive function, is an umbrella term that is viewed by theorists as "a complex and multifaceted construct that reflects the understanding of an interconnected network of mental states" (Hutchins, Prelock, & Bonazinga, 2012, p. 327). Among the many components of theory of mind that in a broader view have been termed social cognition some include: intentionality, visual perspective taking, affective recognition, counterfactual reasoning, empathy, and mental-physical distinction (Prelock, 2012). Therefore, the Strange Stories measure used in this study explores only one aspect of theory of mind, and measures like it have been criticized

for being limited in their ability to adequately assess the whole of the construct. Additionally, theory of mind measures often result in ceiling effects when these abilities are not impaired (Hutchins et al., 2012). This appeared to be the case in the present study for typically-developing students and a few individuals in the (albeit small) ASD group. In future studies, because there does not seem to be a 'gold standard' for measuring theory of mind, perhaps an additional measure should be used that encompasses more than just one element of this cognitive realm (e.g., the Theory of Mind Inventory; see Hutchins et al., 2012).

Closing Remarks

In summary, although the present study had limitations, it serves as an exploratory pilot study examining the relationships among a number of cognitive factors and their associations with reading comprehension, both for typically-developing students and those with ASD. The use of a measure of reading comprehension that encompasses some of the various ways that comprehension may be assessed in schools, particularly those used in high stakes testing within schools (Eason et al., 2012), provides information about the effects of different types of passages and questions on performance. Accordingly, the results contribute preliminary information to educators about the role certain cognitive abilities play in students' reading comprehension and highlight areas of differences in cognitive skills between typically-developing children and those diagnosed with ASD. In particular, this study revealed the associations between reading comprehension and both receptive vocabulary and verbal working memory for the two groups of students evaluated. It also documented that children with ASD exhibited lower reading fluency

and comprehension on a variety of types of texts (i.e., narrative, expository and functional). The pupils with ASD likewise had more difficulty on tasks measuring verbal working memory and organization/planning abilities, as well as those tapping theory of mind. These observations may facilitate decision-making pertaining to instruction and assessment of reading comprehension, especially for students with ASD.

APPENDIX

Prevalence of ASD and Demographic Characteristics in the United States

According to the Centers for Disease Control (CDC) Community Report from the Autism and Developmental Disabilities Monitoring Network (ADDM; 2012), the overall prevalence of ASD is 11.3 per 1,000 (or 1 in 88) individuals. Approximately five times as many boys are diagnosed with ASD as girls (1 in 54 versus 1 in 252). The prevalence of ASD is 12 per 1,000 for White, non-Hispanic children; 10.2 per 1,000 for Black, non-Hispanic children; 7.9 per 1,000 for Hispanic children; and 9.7 per 1,000 for Asian or Pacific Islander children (Centers for Disease Control, 2012). The largest prevalence increases between 2002-2008 were among Hispanic and Black children. For White, non-Hispanic children there was a 70% increase; for Black, non-Hispanic children, there was a 91% increase, and for Hispanic children, there was a 110% increase. The CDC hypothesizes that this is due, in part, to improved screening and diagnostic procedures (ADDM; 2012). It is clear that ASD affects children of all racial and ethnic backgrounds, and therefore, participants in this study were not excluded based on race, ethnicity or gender. As expected, the majority of participants in the ASD group were boys.

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