Reading between the lines: Do textual characteristics and social skills influence reading

comprehension performance in individuals with autism spectrum disorder?

by

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CHAPTER I

INTRODUCTION

Reading comprehension is one of the most important skills necessary for academic, daily living and career success and therefore has been a major area of instruction for most individuals in their formative years of education (Chiang, 2007). Moreover, effective reading comprehension facilitates access to all areas across school curriculum and functional, non-academic activities across the lifespan (e.g. reading letters, contracts, product labels, etc.). Most typically developing individuals gradually develop these abilities without extensive instruction beyond what is offered by schools, and by adulthood, reading and comprehending text is considered to be almost automatic for most people. However, individuals with autism spectrum disorder (ASD), a neurodevelopmental disorder characterized by marked impairment in social communication and interaction accompanied by restricted interests and repetitive behaviors (American Psychiatric Association, 2013) often have considerable difficulties with reading comprehension (Ricketts et al, 2013; Wahlberg, 2004). These difficulties are thought to result from inherent deficits in structural language comprehension (Boucher, 2012) and pragmatic language (Ricketts Jones, Happe & Charman, 2013). The latter may potentially constrain abilities to comprehend *narrative* text (Graesser, 1994). Therefore, in this study, I will explore how the components of oral language comprehension work synergistically in reading comprehension and whether individuals with ASD experience difficulty comprehending narrative text. Throughout this study, the focus was on individuals with high-functioning autism, defined as having a full-scale IQ of 70 or above as these people are likely to learn to read, albeit with a number of

potential limitations (e.g., Garrote, Dessemontet & Opitz, 2017). I begin with a general discussion of the contribution of language comprehension in typical development and proceed to discuss these abilities in individuals with ASD.

Language Comprehension and Reading Comprehension in Typical Development

Language. In this section I will be discussing the areas of language that are germane to reading comprehension. Oral language comprehension is indispensable to reading comprehension such that an impairment in one or more components of oral language may adversely affect performance in decoding and/or reading comprehension and consequently form the basis of problems in reading comprehension. *Phonology* is defined as the sound structure of language. For example, the word "boat" includes three phonemes: "b" "o" and "t." Because English text mirrors phonology, this aspect of language plays a critical role in decoding or reading text and translates to the decoding skill of "phonological awareness" (see, for example, Gillon, 2017) *Morphology* is the study of the smallest units of meaning. It captures how changing a part of a word can change the meaning of a linguistic structure (e.g. the meaning of "The boy walk*ed;*" as compared to "The boy walk*s*"), and along with syntax, it contributes to grammar (see Gottardo et al. 2018). Closely related, *semantics* is the study of meaning. This aspect of language explores the effect that word knowledge has on the meaning of a linguistic structure and is directly related to vocabulary development in oral language and in reading (e.g., Suggate et al 2018). *Syntax* refers to the order of words in a linguistic structure and how this order affects meaning (e.g. The boy kicked the dog. The dog kicked the boy.) (see Gottardo et al. 2018). *Pragmatics* refers to the social use of language and includes narrative conventions, which is also a crucial contributor to reading comprehension (see Hoover & Tunmer, 2017). All of these components of language are explored below with an emphasis on the contribution to reading and comprehension. As a

general note, individuals with language impairment are quite heterogeneous (see Leonard, 2014 for a review). There are large variations on how these impairments impact reading comprehension and academic functioning (Conti-Ramsden & Botting, 1999; Cabell et al., 2010). Each of these language domains will be described in more detail below with an emphasis on how they contribute to decoding and reading comprehension.

Phonology. Phonological skills have a well-established role in the development of reading. In fact, phonics and phonemic awareness were designated as two of the five major components of reading by the National Reading Panel (NICHHD, 2000), a group of expert scientists and educators chosen to evaluate reading research from the last half century. Unsurprisingly, since phonics is the study of sound to letter correspondence and phonemic awareness refers to the knowledge and ability to manipulate sounds, a person who is adept at these skills has the foundation for successful reading. According to a recent meta-analytic review of 235 studies, even when verbal short-term memory was controlled, phonemic awareness was the strongest correlate of individual differences in word reading ability (Melby-Lervåg, Lyster, & Hulme, 2012). In fact, this holds true for languages other than English that have more transparent orthographies (Landerl et al 2018; Vaessen, et al., 2010; Ziegler et al., 2010). Moreover, we have long known that good and poor readers differ in their rate of developing phonological processing abilities (Gillon, 2018; Mann, Cowin, & Schoenheimer, 1989). However, although phonological skills contribute to successful decoding, a host of additional skills must be employed for successful comprehension (Stanley, Petscher & Catts, 2018). Therefore, phonology only contributes to comprehension to the extent that it contributes to decoding, which ultimately, but indirectly affects comprehension.

Morphology. Morphological knowledge has the potential to affect literacy in two ways, decoding and comprehension. Since morphological knowledge refers to the knowledge of the smallest units of meaning, it is critical to a reader's ability to decode and understand text. However, morphological knowledge is not a unitary entity as reading and comprehension are derived from an interrelated knowledge of the components of language. For instance, when decoding, morphemic boundaries affect the pronunciation of letter sequences (Bowers, Kirby & Deacon, 2012). For example, the phoneme "ea" is pronounced as one phoneme in *peach* but two phonemes in *react*. This simply shows how phonological and morphological knowledge are used together to decode, which ultimately facilitates comprehension. However, more globally, it helps readers understand the meanings or syntactic roles of unknown words (Carlisle, 2003). For example, morphological knowledge enables a reader to realize that the words, *read, reader, and readable* represent a verb, noun and adjective, respectively and if the affix *read* was known, the other two words would be easier to discern based on their placement (syntax) in a sentence.

However, somewhat paradoxically, the relationship between morphological knowledge and word reading has been shown to be independent of other factors (e.g. phonological awareness, phonics, etc.; Deacon & Kirby, 2004; Roman et al., 2009). To illustrate this point, we have compelling evidence in Nagy, Berninger and Abbot's (2006) study of the contributions of morphological awareness to reading comprehension, reading vocabulary, spelling and decoding in 607 students across fourth to ninth grade. The authors administered a suffix choice task (morphological knowledge), a nonword repetition task (phonological knowledge) and multiple literacy measures (e.g. reading comprehension, vocabulary, decoding, etc.) to determine the relationship between constructs. They found that morphological awareness made significant unique contributions to each area (mixed

results with decoding) in each grade. Most surprisingly, morphological awareness also made a significant contribution to reading comprehension above and beyond that of reading vocabulary. Taken together, these studies show that whether in isolation or in conjunction with other components, knowledge of morphology plays an indispensable role in decoding and comprehension. Similarly, semantic knowledge is usually used in conjunction with other systems (i.e. phonological) for the goal of reading with comprehension.

Semantics. We can look to Plaut, McClelland, Seidenberg, and Patterson's (1996) model of reading to illustrate the role of semantics in decoding and comprehension. They describe this relationship as a "division of labor" between a phonological process, which handles mappings between orthographic and phonological representations, and an interacting semantic process, which deals with mappings between semantic, phonological, and orthographic representations. In their model, in beginning reading, phonological processes dominate decoding and comprehension, but as decoding proficiency is gained, semantic processes play an increasing role in both areas. This happens because readers gradually depend less on sound to letter correspondence for decoding words, especially low-frequency words that do not follow generalized decoding rules, as words are more economically processed using semantic input. Moreover, to better understand the effect of semantics on comprehension, we can look at the homograph *wind*. Comprehension of this word goes beyond simple decoding using conventional rules. Rather, a competent reader must use semantic knowledge taking contextual information into account in order to accurately decode the word and understand how it changes the meaning of a sentence. For example, in the sentences, "*The wind blew the leaves*" and "*Wind the hand on the clock*", without semantic knowledge, a reader will have difficulty gathering the meaning of the sentence

because both of these forms have identical spelling and cannot be resolved using decoding (phonological awareness).

To provide further elucidation, Nation and Snowling (1998) investigated the nature of semantics in reading comprehension. They used three verbal fluency tasks that compared normal readers and poor comprehenders (i.e. Individuals with impaired comprehension despite age appropriate decoding skills) and found that poor comprehenders showed considerable semantic processing weaknesses in comparison to their linguistic competence in the phonological domain. When poor comprehenders were compared to controls, groups did not differ on phonological tasks (e.g. rhyming), however poor comprehenders performed significantly worse on semantic tasks (i.e. word association). These studies taken together suggest that the relationship between semantics skill and reading comprehension might at least in part be explained by the speed or efficiency of semantic access.

Another perspective regarding the contribution of semantic knowledge is the Lexical Quality Hypothesis (Perfetti & Hart, 2002). "Lexical quality" refers to the extent to which the reader's knowledge of a given word represents the word's actual form and meaning. Therefore, a reader's vocabulary includes words of varying lexical quality—from rare to well-known. Due to reading experience, individuals differ in the quality of word representations, which includes number of words and depth of knowledge related to those words (e.g. multiple meanings, multiple word forms). As an example, a reader needs adequate knowledge of word form and meaning (i.e. flexibility) to decipher the meaning of the word, *seal* in the sentences, "Please seal the container" and "The seal trudged lightly through the snow". As with the "wind" example above, these forms are spelled identically, but unlike "wind," "seal" is also phonologically identical in both instances. In this example, the lexical quality of the word representation will likely determine its comprehension. However,

knowledge of other domains still distinguishes between high and low quality words in unambiguous phonological codes as well. For example, phonological knowledge, which leads to accurate decoding, and syntactic knowledge, which helps derive meaning from context, ultimately contribute to how a word aids in the understanding of a sentence or paragraph. Consequently, a deficit in both or either of these domains leads to a poorer lexical quality, and poorer overall comprehension. In essence, semantic knowledge works with other domains of knowledge to achieve comprehension (Perfetti, 1985; Haenggi & Perfetti, 1994; Perfetti & Hart, 2002; Nation & Snowling, 1998).

Syntax. Syntactic knowledge and awareness is generally related to reading development. Although there is a paucity of research on syntax exclusively relative to other domains, in part because of the interrelation with morphology, we know that it provides a grammatical foundation for linking forms and meanings of words (Bentin, Deutsch, & Liberman, 1990; Carlisle, 2004; Nation & Snowling, 2004). In fact, several studies have found that difficulty detecting and correcting syntactic errors have been predictive of reading comprehension difficulties (Demont & Gombert, 1996; Gottardo, Stanovich, & Siegel, 1996; Leikin, 2002) although we still have to be careful not to assume causation in the absence of stronger evidence. However, syntactic awareness has also been shown to be associated with reading fluency, providing more evidence for the general link to reading development. Mokhtari & Thompson (2006) found that syntactic awareness was significantly correlated to reading fluency ($r = .63$) and reading comprehension ($r = .82$), reporting that those with better syntactic awareness read more fluently and performed better on reading comprehension tasks. However, other research has shown that poor comprehenders who have difficulty in the syntactic domain often have general language processing problems that extend to other language skills beyond syntax alone (Nation & Snowling, 2000; 2004).

Taken together, the bulk of the evidence suggests that individuals with difficulty in reading comprehension likely have difficulties that encompass, but not exclusively result from syntactic deficits.

Pragmatics. Pragmatic language refers to the social use of communication and has rarely been studied in the context of reading comprehension. Social use of communication is broadly defined as the verbal and nonverbal expression or interpretation of communicative acts (Gallagher & Prutting, 1983; Turkstra et al. 2017). This may include oral communication (e.g. conventions of conversation in social interactions [i.e. turn taking, topic maintenance, greetings and salutations, etc.]) as well as gestural or nonverbal communication (i.e. producing and interpreting facial expressions and other communicative body movements) (Prutting & Kirshner, 2017) . The fields of speech-language pathology and education have traditionally studied pragmatics in the context of social interaction due to the inherent social nature of pragmatics, but have rarely investigated the comprehension or interpretation of social behavior as it is represented in text. Therefore, one of the goals of this study was to determine whether there is a relationship between pragmatic language and the reading comprehension performance of individuals with autism.

Decoding. Decoding ability is one of the most important components of successful reading comprehension. The simple view of reading (SVR- Gough & Tunmer, 1986) describes reading comprehension as the product of decoding and listening comprehension. Naturally, comprehension is virtually impossible if a reader cannot decode the words that encode the message. The general consensus is that automaticity in decoding reduces the cognitive resources needed to comprehend text (Frederiksen & Warren, 1987; Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003; Just & Carpenter, 1987; Lauterbach, Park, & Lombardino, 2017; Perfetti, 1985; Walczyk, 2000) and the converse is also believed to be

true (Lauterbach, Park, & Lombardino, 2017). Notably, however, researchers have shown that the amount of variance accounted for in reading comprehension may be influenced by how each of the constructs are measured (Cutting & Scarborough, 2006; Keenan, Betjemann, & Olson, 2008). Additionally, we know that decoding generally develops commensurately with comprehension skills (Mirenda, 2003; Nation & Norbury, 2005), however, it has less influence on comprehension over the course of development such that by the mid to late elementary grades, language comprehension skills (in conjunction with other cognitive abilities) contribute more to reading comprehension than does decoding(Gillon, 2018; Stanley, Petscher, & Catts, 2017).

Garcia and Cain (2013) conducted a meta-analysis that best illustrates this relationship. They reviewed 110 studies that covered 42,916 participants from 145 samples and found that the average corrected correlation between decoding and reading comprehension was, r = .74, however, readers age and listening comprehension level were two factors that were significant modifiers of the relationship. Moreover, decoding accuracy of real words was more predictive than measures of decoding speed or pseudoword reading. This finding is also corroborated by other investigators (Florit & Cain, 2011; Johnston & Kirby, 2006; Protopapas, Simos, Sideridis, & Mouzaki, 2012; Savage, 2001, 2006) and challenges the notion that decoding speed (as a proxy for efficiency) reduces cognitive load leading to better comprehension. However, it implicated the role of semantic knowledge such that an argument may be made that the combination of semantic and phonological knowledge (as measured by real word decoding) is more predictive than measurement by pseudowords alone, which arguably only measures phonological knowledge. This obviously has implications for assessment methods, but that is beyond the scope of this paper. Interestingly, decoding was more strongly correlated to narrative text or narrative and

expository combinations than to expository text alone. Best, Floyd and McNamara (2008) also found this to be true, citing that for expository text, word knowledge was a far better predictor of comprehension skill than decoding skill. Furthermore, this result wasn't explained by the age of the participants because they were all in the third grade, and thus still relatively early in reading development.

Social Communication, Language Comprehension and Reading Comprehension in Autism

Decoding. Although typically developing children generally develop reading comprehension skills commensurately with their decoding skills, children with ASD often develop reading comprehension skills that are poor relative to their decoding skills (Minshew, Goldstein, Taylor & Siegel, 1994; Nation et. al. 2006; Wahlberg & Magliano, 2004; Nation & Norbury, 2005). This means that the decoding acumen demonstrated by individuals with ASD may overestimate functional reading comprehension abilities. In fact, in extreme cases of this phenomenon, known as hyperlexia, wherein advanced word recognition co-occurs with impaired comprehension, individuals have shown word recognition skills that were several grade levels above expectation (Nation, 1999). This discrepancy between decoding and comprehension has critical educational implications as teachers and other professionals may overlook struggling comprehenders or overestimate their abilities if they are able to decode (Ricketts, 2011). This ultimately leads to individuals experiencing increased frustration, decreased motivation to read and poor academic performance.

Structural Language. Despite considerable heterogeneity in the structural language skills exhibited by individuals with autism, there are some common threads. In a review paper, Boucher (2012) reported on the structural communication skills of individuals with

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ASD. Although individuals with ASD commonly exhibit delayed and atypical language skills in early childhood, there are some who are clinically normal and high functioning. These individuals commonly demonstrate primarily sub-clinical language and social-communicative impairments. However, group studies show that among those delayed, although articulation and grammar impairments appear to varying degrees, impaired comprehension is pervasive, especially when individuals lack semantic and/or interpersonal knowledge (Boucher, 2012; Brown, Oram-Cardy, Johnson, 2013). By school age, the common profile that emerges shows articulation and syntactic abilities least affected, and semantic and comprehension most affected. In fact, even those with clinically normal language often have poor comprehension compared to their expressive language skills. Furthermore, individuals with autism who present as clinically normal seem to perform simple academic tests (e.g. vocabulary) as well as well-matched controls but perform significantly poorer on tests that assess higher order language processing (i.e. semantics, syntax, morphology, e.g. reading comprehension) (Minshew, Goldstein & Siegel, 1997; Williams, Goldstein & Minshew, 2006). Taken together, language processing impairment seems to be a highlighting characteristic across the autism spectrum.

Language Comprehension.   Norbury and Nation (2011) investigated reading comprehension performance in individuals with ASD to obtain a better understanding of the effect of structural language impairment. The participants included 27 individuals with ASD (13 adolescents with language impairment [ALI], 14 without language impairment [ALN]) and a comparison group of 19 typically developing individuals (TD) matched for age and nonverbal ability. Individuals with ASD where recruited because of their participation in a previous study (See Nation, 2005), at which time diagnoses of ASD were made by a multidisciplinary team using the DSM-IV(1994). At the time of the Norbury and Nation

(2011) study, diagnoses were confirmed using the Autism Diagnostic Observation Schedule (ADOS-G; Lord et al. 2000)) and the Social Communication Questionnaire (SCQ; Rutter, Bailey & Lord, 2003). Placement into the ALI group was based on a history of language delay, diagnosis of language impairment from an SLP and a score of at least -1.25 SD on the Recalling Sentences subtest of the Clinical Evaluation of Language Fundamentals- 4th Ed. (CELF-4; Semel, Wiig & Secord, 2006). After using multiple regression to determine the contribution of oral language comprehension to reading comprehension performance, they found that oral language was indeed a significant predictor of reading comprehension in the ASD groups, although they did not investigate whether there was differential performance relative to text type.

Differential performance on text types. In general, reading materials are characterized as narrative or expository/informational; both of which have different characteristics and may yield different levels of comprehension in individuals with ASD. According to Best, Floyd and McNamara (2008), *expository* texts are primarily written to present information for the purpose of persuasion, analysis, comparison or simply sharing or teaching information. Ideas and concepts are usually presented in topic-oriented passages organized in a logical way, which requires considerable integration of content knowledge for successful comprehension. In contrast, *narrative* texts serve mainly to entertain the reader and often have a story grammar or script. They are usually presented as stories, novels or poems and require more of an understanding of social relationships than expository text. In fact, the reader is often expected to make inferences about characters' goals, motives, feelings and morals based on their social understanding. As a result of these differences in text characteristics, readers have to draw on different skills sets to be successful comprehenders. Because individuals with ASD often demonstrate an inherent difficulty in understanding

social relationships, it is possible that they would have more difficulty on narrative as compared to expository/informational texts, making it more difficult to achieve deep comprehension.

Framework for Comprehension. Kintsch's (1988) Construction Integration model of reading comprehension can be used to explain how individuals achieve comprehension. In this three-part model, readers use their previously stored knowledge to construct a mental representation that captures the intended meaning of the text. In fact, knowledge constrains the construction of mental representations—it is a filter through which text is perceived. Reading comprehension first begins with the reader decoding the *surface code,* or the text's exact combination of words, phrases or sentences. Second, this surface code yields a *textbase* made of propositions. Propositions are broken down into a predicate (i.e., verb, adjective or connective) and one or more arguments (i.e., nouns or embedded propositions) and carry the intended meaning of the surface code. In this stage, the reader makes small inferences, linking the network of concepts to establish text coherence. Meaning is derived from a network of concepts conjured up from the surface code and text propositions. Third, the textbase is integrated with background or world knowledge to form a *situation model*, or mental representation.

Deep comprehension. Deep comprehension is achieved when the reader uses knowledge to draw inferences from the text (Graesser, Singer and Trabasso, 1994). Therefore, to efficiently and effectively construct a situation model from a text that taps social knowledge, a reader must access and use social concepts in the general knowledge network. For example, take the following sentences (surface code):

"The racecar driver saw the race traffic director hold up the caution flag. The racecar driver's vehicle stopped, but another car rear-ended the racecar driver. In response, the racecar driver's eyes widened as he threw his hands up in the air, then violently banged them against the steering wheel."

In this example, the text base level of representation refers to the propositional construction from the explicit surface code. The first sentence, for instance, has two propositions. In the first proposition, 'saw' is the predicate and 'racecar driver' is the argument. In the second, 'hold up' is the predicate (although an argument can be made for "hold") and 'race traffic director' and 'caution flag' are the arguments. The text base alone provides a superficial representation of the text. However, in the situation model, remember that deep meaning is constructed when the reader uses background knowledge or experience to interpret the text. For example, it is likely that the reader infers that the racecar driver's *vehicle* was rear-ended instead of his *body* because prior knowledge or experience probably teaches that the term 'rear-ended' is usually used in the context of accidents between vehicles. The reader obtains a deeper understanding when the reader constructs causes and motives that explain actions and events (Graesser, et al., 1994). The reader will likely infer that the racecar driver stopped abruptly, causing the other car to rear-end his racecar, though the text never states that explicitly. Furthermore, the reader may infer that the racecar driver who was rear-ended was consequently angry. However, to draw this inference the reader has to integrate social knowledge or experience with propositions generated by this surface code to recognize the social cues that denote anger and attribute them to the racecar driver who was rear-ended.

An individual with ASD is likely to have difficulty comprehending the aforementioned example. It is not surprising that when an individual has difficulty understanding and responding to social interactions in an unstructured context, it may

reasonably be assumed that this impairment may transcend into text. In fact, Graesser (1994) contends that "The inferencing mechanisms and world knowledge structures that are tapped during the comprehension of everyday experiences are also likely to be tapped during comprehension of narratives; there is no justifiable reason to believe that readers would turn off these pervasive interpretive mechanisms during reading. (p. 372)".

Furthermore, Wahlberg and Magliano (2004) investigated whether high functioning individuals with autism were capable of drawing on prior knowledge during reading. All participants were matched with normal controls, and read ambiguous passages, half of which were preceded by informative primer passages that corresponded to the ambiguous ones. An extensive recall assessment followed the readings. The results indicated that individuals with autism were able to use cues to activate and associate information on a general level, but not able to use that knowledge to interpret and remember specific information. The authors concluded that difficulty in reading comprehension experienced by individuals with autism might stem from difficulty making use of background knowledge to interpret what they read.

Language comprehension, social communication and reading comprehension. Ricketts et al. (2013) was the only study known, to date, that exclusively investigated the relation between language comprehension, social communication and reading comprehension in autism. In their study, they obtained 100 participants with a consensus clinical ICD-10 diagnosis of ASD, using information from the ADOS-G and the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter & Le Couteur, 1994). The participants were all part of a previous study, Special Needs and Autism Project (SNAP) conducted by Baird et al (2006). Ricketts and colleagues ran a hierarchical multiple regression using the Test of Receptive Grammar (TROG; Bishop, 2005) and the Clinical Evaluation of Language Fundamentals-3rd Edition

(CELF-3 UK; Semel, Wiig & Secord, 2000) to measure oral language comprehension, the Wechsler Objective Reading Dimensions (WORD; Rust, Golombok & Trickey, 1993) to measure word recognition and reading comprehension, the composite social and communication score on the ADOS-G to measure social behavior and two cognitive tasks that measured mental state attribution: Strange Stories (Happé, 1994) and Frith-Happé animations (Abell et al. 2000) as the measure of social cognition. They found that not only did word recognition and language comprehension show unique contributions to the total reading comprehension score, but that social behavior and social cognition were predictors as well. Notably, similar to Nation and Norbury (2011), they did not investigate the relation between social communication abilities and text type.

Narrative Coherence and Pragmatic Abilities

We can look at narrative comprehension and production to gain an understanding of the pragmatic abilities of individuals with autism. Hymes (1971) defined pragmatics in the most basic sense: When to say what to whom and how much to say. Beyond this, it is understanding why an individual says something relative to the socio-communicative context. Moreover, as children age, they shift from trying to remember stories verbatim to telling a summary of the most important events that encapsulate the essential meaning of the story (Brainerd & Reyna, 1998). As such, analyses of narratives can show how an individual conceptualizes a story or social interaction because it involves understanding an event, storing the event in memory and recapping it in a way that is coherent and understandable by a communication partner.

Causal Language. The use of "causal" language affects narrative coherence, which ultimately affects social interactions. Causal language is defined as a word or words that indicate a causal relationship between more than one element or event. Diehl, Bennetto and

Young (2006) conducted an investigation of the narrative abilities of individuals with high-functioning autism that highlighted the nuanced differences in the use of causal language when compared to similarly matched typically developing individuals. Groups were matched on age, gender, language and cognitive abilities as measured by omnibus standardized instruments. They analyzed aspects of story recall and narrative coherence for 17 individuals in each group. Analyses revealed that while children with ASD did not differ from controls in story length, syntactic complexity or sensitivity to the importance of story events, they produced narratives that were significantly less coherent than the narratives of controls. *Coherence* was measured in terms of causal connections per c-unit. This is defined as the sequence of events central to the story that form the gist of the story divided by the number of independent clauses (i.e. statement containing subject and predicate and modifiers), which is a common way of measuring the coherence or connectedness of a story (See Davis, O'Neil-Pirozzi, and Coon 1997). As such, an event's relative importance to a story increases with its number of causal connections. Since individuals with ASD produced significantly less coherent narratives, their retellings were more like a recitation of isolated events than a structured narrative. Markers that linked characters to events and to one another in the story were largely absent. Consequently, this reduced the quality of social interactions, as narratives were not sufficiently adapted for the needs of the listener.

Referential Devices. Coherence is also affected by use of referential expressions or devices. Colle, Baron-Cohen, Wheelwright & van der Lely (2008) investigated the narrative abilities of 12 high-functioning individuals with autism versus 12 well-matched controls during a story retelling task. Participants were asked to produce a narrative while viewing a wordless picture book. Narratives were coded for use of referential expressions (e.g. temporal expressions, anaphoric pronouns, etc.) that require speakers to consider listeners'

mental state when producing the narratives. The results showed that the autistic group produced fewer personal pronouns, temporal expressions and referential expressions, making their narratives less coherent than controls. This is another example of the lack of narrative adaptation to suit the needs of listeners. Interestingly, in addition to the above-mentioned difficulties in narrative production, individuals with autism have also shown impairments in narrative comprehension.

Central Coherence and Reading

There is extensive literature that suggests that weak central coherence contributes significantly to narrative comprehension (Happe & Frith, 2006; Norbury & Nation; Nuske & Bavin, 2015; Senokossoff, 2016). This refers to the cognitive processing style believed to be characteristic of many individuals with autism. In Frith's (1989) central coherence theory, she described this as a preference for attending to the details of linguistic information with a marked impairment in establishing global coherence or extracting gestalt meaning. According to this theory, individuals with autism often exhibit considerable difficulty in using context to disambiguate linguistic material since this requires integration and global processing of information and abstract social knowledge.

Much of the literature on weak central coherence investigated the reading of homographs because we can look at the pronunciation of homographs to understand the role of central coherence in the reading comprehension of individuals with autism (Lee, 2005). Since homographs are words that, despite being spelled identically, have different meanings and, often different pronunciations, depending on context (e.g. wind), we may obtain insight into an individual's use of context by the pronunciation of a homograph in a sentence. Recall, in the previously used examples, "The *wind* blew the leaves" and "*Wind* the hand on the clock", correct pronunciation depended on the use of context. Although

traditional investigations of central coherence involved the use of nonverbal measures comprised of perceptual tasks (Frith, 1989), Happe (1997) conducted one of the early seminal studies of central coherence in individuals with autism using linguistic measures.

Happe (1997) investigated the pronunciation of homographs in 16 high-functioning individuals with autism and 13 typically developing individuals. Participants were asked to read 20 sentences, which consisted of four main types related to the target homograph: (a) rare pronunciation and target word before sentence context; (b) rare pronunciation and target word after sentence context; (c) frequent pronunciation and target word before sentence context; (d) frequent pronunciation and target word after sentence context. The dependent variable was number of context-appropriate pronunciations. Happe conducted a two-way ANOVA with frequency and context as within-subject factors. Though several results were reported, the most striking finding was that participants with autism made significantly less use of context in pronouncing the homographs than did the typically developing group, signaling reduced integration of information. Since then, several studies have corroborated this finding using a variety of linguistic measures.

Text Type and Cohesion

For clarity, I will define the difference between *cohesion* and *coherence*. According to Van Dijk (1983), cohesion is determined by lexically and grammatically conspicuous intra and inter-sentential relationships that link information, whereas coherence is determined by semantic relationships found across text that are formed, in part, by a reader's background knowledge. Therefore, a passage can be cohesive without being coherent although coherence seems to improve as the number of cohesive devices increase.

The quantity and types of cohesive devices found in text usually signal the text type (i.e. Narrative or Expository) and the amount of inference necessary for text coherence

(Lehman & Schraw, 2002; Linderholm et al., 2000; McNamara, 2001; McNamara, Kintsch, Songer, & Kintsch, 1996). Narrative texts tend to have a high level of cohesion because they contain referential, causal, temporal and structural cohesive devices that usually signal a series of chronological or thematically related events, which help to form a coherent representation of the text (Graesser, Singer & Trabasso, 1994). In contrast, expository text has less causal cohesive devices, placing a greater burden on the reader to generate bridging inferences to achieve text coherence (Best, Floyd & McNamara, 2008; VanDijk & Kintsch, 1983). Consequently, expository text is considered more difficult to comprehend because of its dearth of cohesive devices and demand for inference generation.

Referential and Deep (causal) Cohesion. Referential and deep cohesion bring the most coherence to a text. Referential cohesion is comprised of five types of cohesive devices that link the elements of a passage locally (e.g. Within the paragraph [i.e. phrases, clauses, and sentences]) and globally (i.e. Across paragraphs). These types include ellipsis, substitution, conjunctive, referencing and lexical devices. Similarly, deep cohesion links sentences or events in a passage by causation. As such, two or more events are linked because (a) one or more events signal the cause of another event or mental state (e.g. "George got a promotion because he finished his dissertation"); or (b) one or more events introduce evidence for a conclusion (e.g. "We can tell that George is happy because he finished his dissertation").

Given what we know about cohesion and text types, it is unclear how individuals with autism will perform on reading comprehension tasks wherein these factors vary. Because narrative texts tend to be more referentially and causally coherent than expository text, one could hypothesize that comprehension should be easier because less inferences are necessary to achieve text coherence. On the other hand, narrative text calls for more inferences that rely on the integration of social knowledge to achieve deep comprehension.

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Consequently, narrative text may be more difficult to comprehend than expository text, which relies less on social knowledge and more on content knowledge.

Therefore, the primary goal of this study was to examine the effects of cohesion and text type on the reading comprehension of individuals with autism. This important gap in the literature has implications for how we approach intervention. For example, perhaps we may need to provide more scaffolding by activating the memory of prior social experiences to bridge inferences that rely on the integration of social information. Alternatively, we may modify the cohesive devices in a text to make it more comprehendible. Furthermore, although oral language comprehension has been well established as a predictor of reading comprehension, its predictive value is unclear when the contributions of cohesion and text type are taken into account. Therefore, a secondary goal was to measure the predictive relationship of each variable to reading comprehension.

Research Questions

1) Do individuals with high functioning ASD perform better on narrative than expository texts?

2) What is the relationship between pragmatic language and performance on narrative texts for children with high functioning ASD?

   b) What is the relationship between pragmatic language and performance on expository texts for children with high functioning ASD?

3) Do individuals with high functioning ASD perform more poorly on narrative text than do typically developing children?

   b) Does degree of narrativity predict performance on reading comprehension tests better than text cohesion for children with high functioning ASD?

4) Do individuals with high functioning ASD perform better on high cohesion texts than typically developing children?

        b) Do individuals with high functioning ASD perform better on high cohesion texts than low cohesion texts?

5) What is the relationship between text cohesion (causal and referential) and reading comprehension performance in children with high functioning ASD and typically developing children?

CHAPTER II

Methods

Participants

Seventeen individuals with autism spectrum disorder and 20 typically developing middle school students (4:1 male to female ratio) were recruited from the participant pools at Vanderbilt Kennedy Center, Vanderbilt Bill Wilkerson Center, Metro-Nashville Public Schools, Los Angeles Speech Therapy Center, and New York City areas through flyers and letters to parents. The 4 to 1 m/f ratio was employed to reflect population characteristics of individuals with autism spectrum disorder.

Inclusionary and Exclusionary Criteria

Typically developing students were recruited from diverse racial backgrounds and were between the ages of 10-14. They must not have had any history of co-morbid or other developmental (e.g., ADHD, Down Syndrome) or learning disabilities that may affect educational performance. All participants achieved at least a fourth grade reading proficiency level and spoke English as their primary language. Additionally, participants had normal vision or wore corrective eyewear if previously diagnosed with vision problems.

Individuals with ASD had the same demographic characteristics as the TD comparison group. Each of them had previously been diagnosed with autism spectrum disorder by a licensed psychologist or medical doctor in an educational or clinical setting. Similar to the TD group, they had no history of co-morbid developmental disability beyond ASD and had achieved at least a fourth grade reading proficiency.

Parents of the participants received a full summary of all measures administered and $75 for the participant as compensation for their participation. One typically developing student was lost to attrition. Her data was not used in the analysis.

Materials and Procedure

Standardized measures of performance IQ, reading and language were administered according to manual instructions (See Table 1). Data were collected in no more than five, but usually three testing sessions within a month for each person.

Performance IQ

The Test of Nonverbal Intelligence (TONI-4; Brown, Sherbenou & Johnsen, 2010) provided a measure of nonverbal IQ. The benefit of using this measure is that it assessed common elements of intelligence (e.g. abstract reasoning, problem solving) without the confounding effect of verbal language ability. The test has one set of questions with no subtests. In each question stem, participants saw a sequence of abstract figures containing one missing figure in the sequence. Participants subsequently saw a set of answer choices and were asked to point to the missing figure in the sequence. Each sequence assessed at least one of eight attributes: size, position, direction, rotation, contiguity, shading, size, and movement and increased in difficulty as the test progressed. According to the testing manual, the TONI-4 was normed on individuals aged 6 years to 89 and is suitable for use on populations with intellectual, language or hearing impairment.

Oral Language Comprehension

Test of Auditory Comprehension of Language

The *Vocabulary* subtest of the Test of Auditory Comprehension of Language-Third Edition (TACL-3; Carrow-Woolfolk, 1999) was used to measure students' ability to understand the literal and most common meanings of word classes such as nouns, verbs,

adjectives and adverbs. This test does not measure the student's ability to use prior information, contextual cues or the suprasegmental aspects of language, nor did it measure figurative language or connotative meaning. Rather, students were required to point to a color illustration from a field of three that represents the word, phrase or sentence spoken by the examiner.

The *Grammatical Morphemes* subtest of the TACL-4 was used to measure students' understanding of grammatical morphemes when used in the context of a simple sentence. It assessed morphological knowledge related to parts of speech, tense and noun-verb agreement. Students pointed to the picture corresponding to the word, phrase or sentence spoken by the examiner.

The *Elaborated Phrases and Sentences* subtest of the TACL-4 was used to measure students' understanding of syntactically based word relations and elaborated phrase and sentence constructions. This included a variety of sentence types (i.e. interrogative, active, passive, embedded, etc.). Similar to the other subtests, students pointed to picture representative of the phrase or sentence spoken by the examiner.

Psychometric measures of the TACL-4 are appropriate for this research. It is a widely used standardized test normed on the 2000 census profiles and four major geographic regions of the United States. In terms of reliability, Cronbach's coefficient alpha for each subtest through all age ranges was above .8. The TACL-4 also showed high concurrent validity with the Comprehensive Receptive and Expressive Vocabulary Test (CREVT; Wallace & Hammill, 1994).

Clinical Evaluation of Language Fundamentals

The *Following Directions* subtest from the Clinical Evaluation of Language Fundamentals-Fifth Edition (CELF-5; Semel, Wiig & Secord, 2013) was used to measure

students' ability to interpret spoken directions of increasing length and complexity. Students were required to demonstrate an understanding of logical operations, remember names, characteristics and order of mention of objects and identify pictured objects within a field. To accomplish these tasks, students pointed to objects in response to oral directions.

The *Semantic Relationships* subtest from the CELF-5 was used to measure students' ability to interpret sentences that: (a) made comparisons, (b) identified locations or directions, (c) specified time relationships, (d) included serial order, or (e) were expressed in passive voice. After listening to a sentence, each student selected two correct choices from four visually presented options.

Psychometric measures of the CELF-5 are also appropriate for this research. It is a widely used standardized test, normed on the 2010 US census profiles. Sensitivity and specificity of the CELF-5 were above .9. Test-retest reliability scores for composite and index scores ranged from .83 -.90. Additionally, the CELF-5 showed concurrent validity with the Oral and Written Language Scales-2nd Edition (OWLS-2; Carrow-Woolfolk, 2011), Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk,1999), the Test of Language Development-Primary, 4th Edition (TOLD-P:4; Newcomer & Hammill, 2008), and the Test of Language Development-Intermediate. 4th Edition (TOLD-I:4; Hammill & Newcomer, 2008)

Comprehensive Assessment of Spoken Language

The *Paragraph Comprehension of Syntax* subtest of the CASL was used to measure students' ability to understand passages of increasing syntactic complexity. The student listened to eight paragraphs being read by an examiner. After each paragraph, the examiner asked the student five to seven questions. After each question, the student responded by

pointing to one of four colored pictures that best illustrated the correct answer to the question.

Social Functioning

The *Pragmatic Judgment* subtest of the CASL was used to measure students' awareness and use of appropriate language in response to everyday situations. The examiner read a series of common scenarios to each student. After hearing each scenario, each student judged the appropriateness of the language used by a character in response to each scenario. If the student decided that the language used was inappropriate, the student will modified that language to an appropriate model.

Psychometric measures of the CASL are appropriate to conduct this research. The test-retest reliability coefficients for composite scores ranged from .92-.93 for all age groups test. The CASL showed concurrent validity with several other tests, however, the *Pragmatic Judgment* subtest was not included in that analysis.

The *Problem Solving* subtest of the Test of Problem Solving-Elementary Third Edition (TOPS-E 3; Bowers, Huisingh & LoGiudice, 2005) measured the students' language-based thinking, reasoning and problem solving abilities needed for social competence. Students were shown a picture stimuli book from which they evaluated several scenarios presented in a conversation-like manner. Each scenario measured the student's ability to: a) recognize a problem; b) evaluate options; c) state an appropriate solution to a problem and think of alternative solutions; and/or d) avoid specific problems. The test-retest reliability for the whole test was .84. The coefficient for the *Problem Solving* subtest was unstated. Validity was established by observing t-values of contrasting normal and language -impaired populations, which were found to be significantly different from each other.

Test of Pragmatic Language

The Test of Pragmatic Language, Second Edition (TOPL-2; Phelps-Terasaki & Phelps-Gunn, 2007) was used to obtain a comprehensive measure of students' pragmatic skills. Students' social communication were assessed in six core areas: a) Environmental setting, b) Communication partner(s) involved, c) Topic of conversation, d) Purpose of speech acts, e) Visual-gestural cues, and f) Abstraction. To accomplish this task, an examiner read a series of short narratives related to everyday social situations, which were accompanied by large colored illustrations. In response to each narrative, each student answered a series of questions related to one of the six core areas.

Psychometric measures of this assessment are appropriate to conduct this research. Split-half reliability coefficients for the ages of interest were all over .8. To measure concurrent validity, the TOPL-2 was correlated to teachers' rating of a small sample of students with a mean age of 6.7 years. The correlation coefficient of .82 provides evidence of acceptable validity, though not optimal.

Children's Communication Checklist

The Children's Communication Checklist (CCC-2; Bishop, 2003) was used to obtain a measure of each student's pragmatic language abilities based on caregiver report. The caregiver was given a form containing 70 items that were divided into 10 scales, each with seven items. The first four scales measured each child's language and communication skills in terms of form and content. The following four scales assessed the child's pragmatic language abilities. The last two scales measured behaviors that are usually found to be impaired in individuals with ASD. To complete each scale, the caregiver rated the frequency of the communication behavior described in each item by assigning a score of 0 (i.e. occurs

less than once a week) to 3 (i.e. occurs several times a day). After calculating each score, interpretation was based on the Social Interaction Difference Index.

The CCC is an appropriate measure for conducting research. It reports a sensitivity value of .89 and a specificity value of .97 for identifying children with ASD symptomatology and pragmatic social impairment (Bishop, 2006). It shows concurrent validity with the TOPL and the Autism Diagnostic Interview-Revised (ADI-R; Rutter, 2003).

Word Recognition

The *Sight Word Efficiency (SWE)* and *Phonemic Decoding Efficiency (PDE)* subtests of the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner & Rashotte, 1999) measured students' overall reading ability. This was primarily used to rule out the presence of decoding difficulty and was not a main focus of analysis. If decoding difficulty (i.e. Decoding performance lower than a fourth grade level) was detected, the participant's data was not used. The SWE subtest measured each student's ability to read a vertical list of real words within 45 seconds. Likewise, the PDE subtest measured the number of non-words, that is, words that are not real but are orthographically similar to real words (i.e. "gike", "gake") a student can read within 45 seconds.

The TOWRE is a widely used, reliable measure of single word recognition that is appropriate for use in research. It was normed on individuals ages 6 -24 years. Test-retest reliability coefficients through the age range averaged over .90. It has also shown strong concurrent validity with the Woodcock Reading Mastery Test-Revised (WRMT-R; Woodcook, 1998).

Reading Comprehension

The Gates-MacGinitie Reading Comprehension Test-Fourth Edition (GMRT; MacGinitie, MacGinitie, Mara, Dreyer & Hughes, 2000) was used to measure reading

comprehension. This test was chosen because it features narrative and expository texts, draws heavily on subjects' inference abilities and can be administered to multiple students simultaneously. Each student was required to read several short passages and answer questions that measure comprehension.

The psychometrics of the GMRT show that it is appropriate to conduct this research. It was normed on individuals from each quadrant of the United States and multiple SES levels. It has reported a test-retest reliability coefficient of .92 through the age range and has demonstrated concurrent validity with the Comprehensive Test of Basic Skills (McGraw, 1981)

The Group Reading Assessment and Diagnostic Evaluation (GRADE; Williams, 2001) also measured reading comprehension. This untimed test has two sections. In the Sentence Comprehension section, when given an incomplete sentence, participants were required to select the vocabulary word that appropriately completed each sentence. In the Passage Comprehension section, participants read medium-length narrative and expository texts and answered questions that measured comprehension. This test was chosen particularly because it provided an untimed measure of comprehension, which controls the effect of reading speed on the score. It also had longer reading passages as compared to the GMRT. Only the Passage Comprehension section of the test was used for analysis.

Coh-Metrix

Coh-Metrix (Graesser, McNamara, Louwerse & Cai, 2004) is a computational tool that was used to produce indices of the linguistic and discourse characteristics of texts used for reading comprehension measurement (i.e. GMRT, GRADE). It was specially designed to investigate the cohesion of the explicit text and the coherence of the mental

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representation of the text. This results in 108 indices that represent 11 categories or information.

Indices from the "Text Easability Principal Component Scores" were used since each score represents the amalgamation of information on key areas. I used three scores: Narrativity, deep cohesion, and referential cohesion. First, I measured the narrativity of the text, that is, the degree to which a text exhibited features of narrative text, using the "Text Easability PC Narrativity percentile" score, which is found under the "Text Easability Principal Component Scores" category. This score is derived from textual relations to the real world, including word familiarity and the degree to which the linguistic structures are typically used during everyday social interaction. Generally, texts that closely mirror everyday conversation receive a higher narrativity score than texts that are less familiar or obscure.

Second, deep cohesion was measured through the use of the "Text Easability PC Deep cohesion percentile" score. This score is derived from indices that reflect the degree to which the text contains causal and logical connective devices (e.g. conjunctive adverbs, [i.e. Consequently, therefore]) to signify causal relationships. These devices make text more coherent. Consequently, texts that contain more of these devices have greater deep cohesion scores than texts with fewer devices.

Third, referential cohesion was measured through the use of the "Text Easability PC Referential cohesion percentile". This score is derived from indices that reflect how frequently ideas overlap in adjacent or successive sentences (e.g. content word, argument or stem overlaps), as well as throughout the text globally. Referential devices connect the ideas in a text and make it more coherent. Thus, texts that contain a greater number of these devices will receive a greater referential cohesion score than texts fewer devices.

Data Analysis

For the purpose of this analysis, continuous text variables were converted into dichotomous variables for ease of calculation. First, a median split procedure was used to divide the narrativity variable into two groups (i.e. narrative vs expository). Paragraphs were evaluated using Coh-Metrix (Graesser, McNamara, Louwerse & Cai, 2004). Using the *Narrativity* percentile score, paragraphs obtaining a value greater than the 60th percentile were treated as narrative text, while paragraphs obtaining a value lower than the 40th percentile were treated as expository text. This effectively dichotomized the text types with minimal overlap (excluding the middle 20% of types). That is, performance on paragraphs that fell within the range of the 40th-60th percentiles were discarded and not evaluated in this study in order to establish a true dichotomy. Second, the same split procedure was used to establish high and low Deep Cohesion and Referential Cohesion variables using the *Text Easability Deep Cohesion* and *Text Easability Referential Cohesion* percentile values.

Next, underlying assumptions were tested, and data were converted for ease of calculation. Prior to conducting analyses, data were observed to determine whether arcsine transformation was necessary. Because the data were evenly distributed and did not aggregate at the extreme ends of the distribution, it was determined that data could be analyzed without transformation. In regard to the comparison of means, samples met assumptions of normality and homogeneity of variance by using Shapiro-Wilk Test of Normality and Bartlett Test of Homogeneity of Variances before comparisons were analyzed. In regard to multiple regression analyses, models satisfied assumptions for skewness, kurtosis and homoskedasticity before running the regressions. All models were assessed for the presence of multicollinearity and variables were determined to be orthogonal.

CHAPTER III

Results

Research Questions

1) Do individuals with ASD perform differently on narrative versus expository texts?

2) What is the relationship between pragmatic language and performance on narrative texts for children with high functioning ASD?

    b) What is the relationship between pragmatic language and performance on expository texts for children with high functioning ASD?

3) Do individuals with ASD perform more poorly on narrative text than do typically developing children?

    b) Does degree of narrativity predict performance on reading comprehension tests better than text cohesion for children with high functioning ASD?

4) Do individuals with high functioning ASD perform better on high cohesion texts than typically developing children?

    b) Do individuals with high functioning ASD perform better on high cohesion texts than low cohesion texts?

5) What is the relationship between text cohesion (causal and referential) and reading comprehension performance in children with high functioning ASD and typically developing children?

   Welch's Two Sample t-test was used to determine whether individuals with ASD perform differently on narrative versus expository texts. It was predicted that performance would be better on expository texts, given that Brown et al. (2013) showed that individuals with ASD performed better on texts requiring limited social knowledge versus texts

requiring high degrees of social knowledge. Contrary to the hypothesis, this analysis revealed no significant differences between narrative (M = 41, SD = 23.2) and expository (M = 36.2, SD = 21.6) means, t(31.88) = .59, p < .56 and these means were relatively similar, suggesting that this is not simply the product of an underpowered analysis, especially given the relative high variance in each narrative typology.

Correlational analysis was performed to determine the relationship between pragmatic language skills and reading comprehension performance for individuals with ASD. I predicted *a priori* that there would be a significant relationship between these variables because Ricketts et al. (2013) showed that social behavior and social cognition contributed to reading comprehension performance. As hypothesized, statistical analysis revealed a strong positive relationship between pragmatic language and performance on narrative, r = .76, p < .001 and expository texts, r = .84, p < .001.

Welch's two sample t-test was used to determine whether there was a significant difference in performance on narrative text for ASD and TD groups. The dependent variable was percentage of question items correct. Because comprehension of narrative text presumably requires social knowledge, it was predicted that individuals with ASD would perform more poorly on narrative text than their TD peers. As expected, the ASD group performed significantly more poorly on narrative text (M = 41, SD = 23.2) than the TD group (M = 67.4 , SD = 13.9), t (25.57) = -4.08, p < .001.

Additionally, multiple linear regression was performed to determine whether the degree of narrativity predicted reading comprehension performance better than the degree of cohesion. Referential Cohesion, Deep Cohesion and Narrativity per passage were entered as predictor variables, while mean number correct per passage was the dependent variable. Based on previous research and the theoretical model presented in Chapter 1,

there was a strong rationale to hypothesize that both the degree of coherence and degree of narrativity could affect how individuals with ASD comprehended text based on the types and amount of inferences associated with each variable. Before performing the regression, correlational analysis was performed to detect the presence of multicollinearity. Correlational analysis revealed no significant correlations among variables (See Table 2), with most associations in the low to moderate range of magnitude. Regression analysis showed a significant model fit, $F (3, 2) = 36.4$, $p < .03$, $R^2 = .982$, Adjusted $R^2 = 95.5$). Although all three predictor variables significantly predicted reading comprehension performance, degree of narrativity did *not* predict reading comprehension to a significantly *greater* degree than either of the cohesion variables, which was not anticipated (See Table 3).

Welch's Two Sample t-test was used to determine whether individuals with ASD perform better on high cohesion texts relative to typically developing peers. It was predicted that because weak central coherence has been reported as a feature known to constrain comprehension abilities in this population, texts containing a high degree of cohesion should enable better reading comprehension performance and perhaps resulting in a relative "savant skill" for this type of text. However, it was unclear whether this expected improvement in performance would compare to that of typically developing individuals. Analysis revealed that individuals with ASD performed significantly more poorly on texts containing a high degree of referential cohesion than typically developing individuals. Similar performance was observed on texts containing a high degree of causal cohesion, with the ASD group performing significantly worse than the TD group (See Table 4).

Welch's Two Sample t-test was used to determine whether individuals with ASD perform better on high cohesion texts than low cohesion texts. As previously stated, individuals with ASD were expected to perform better on high cohesion texts. However,

contrary to *a priori* expectations, this analysis revealed that there was no difference in performance on high cohesion and low cohesion means (See Table 5). This likely accounts for the relative weakness compared to typical peers, comprehension of high cohesion text was not a "splinter skill" in this ASD sample.

Correlational analysis, which is traditionally the best metric to observe the individual relationships between text cohesion (causal and referential) and reading comprehension performance in both ASD and TD groups, showed no significant relationship. However, analysis of variance may be employed to understand this relationship more globally. One major limitation with correlational analyses, as currently constructed, is that it observes the relationship between mean reading comprehension scores per passage and degree of cohesion (causal and referential) per passage, leaving only five degrees of freedom, as the GRADE features six passages. Such degrees of freedom may obscure our ability to find a correlation if one truly exists. Another limitation is that it is difficult to extrapolate from this analysis because other variables (i.e. language skill) may be influencing reading comprehension performance.

As an alternative, post-hoc analysis of variance was used to examine the relationship between text cohesion and reading comprehension. Since degree of cohesion was expected to be generally associated with better reading comprehension performance and typically developing individuals were expected to perform better than those with ASD, then analysis of variance between these groups on deep and referential cohesion should support these assumptions. However, analysis of variance did not show this pattern of results. Repeated measures ANOVA comparing the effects of text cohesion on reading comprehension in low causal cohesion, high causal cohesion, low referential cohesion and high referential cohesion

conditions showed no difference in performance based on degree of cohesion for the ASD group.

Summary of Results

To summarize, although individuals with ASD showed no difference in performance between text types, there was a strong positive relationship between pragmatic language skills and performance on both types of text. Also, level of narrativity, referential and causal cohesion significantly predicted and accounted for almost all of the variance in performance. However, narrativity did not predict performance better than measures of cohesion. Furthermore, not only did individuals with ASD perform worse than TD individuals on narrative texts, they performed worse regardless of text type or cohesiveness of the text. Moreover, level of cohesion *did not* differentiate their performance. Lastly, there were no significant correlations between level of cohesion and reading comprehension in either group.

CHAPTER IV

Discussion

The goal of this study was to examine the effects of text type and cohesion on the reading comprehension abilities of individuals with ASD. Although researchers have investigated reading comprehension in individuals with ASD (Clarke, Snowling, Truelove & Hulme, 2010; Norbury & Nation, 2011; Randi et al., 2010), few researchers have examined the contribution of social communication (Ricketts, et al., 2013) to reading comprehension and a literature search did not yield any previous studies that have investigated the relation between social communication and text type. Therefore, this study extended the work of Ricketts et al. (2013) to address this important gap in the literature, and further evaluate whether cohesion significantly contributes to reading comprehension performance.

Results of this study suggest that although individuals with ASD perform more poorly on reading comprehension tasks than do typically developing children as one would expect, both groups have similar profiles, with respect to the effects of text type and cohesion. Interestingly, I confirmed the expectation that social communication abilities were strongly associated with reading comprehension performance in both groups, but this relationship did not manifest itself in differential performance on narrative versus expository texts in ASD. Contrary to *a priori* expectations, within group comparisons showed that neither group performed better when the text contained a high degree of cohesion.

These results support the idea that impairments inherent in ASD (i.e. difficulty integrating information, difficulty understanding social relationships, etc.) contribute to generally poor reading comprehension performance (i.e. in both text types) and that ASD is

marked by considerable heterogeneity. Although one must be cautious when interpreting "no difference" results, especially with regard to statistical power, the analyses showed similar means with considerable variability in performance for both text types, indicating that there is likely no real difference in performance and that it is unlikely that these no difference results are simply the product of underpowered analyses. Further, given the well documented variability in language skills within the ASD population, large variability in reading comprehension performance was predictable.

One possible reason why the participants did not show differential performance on text types could be that there was no true difference between narrative and expository textual characteristics. Spiro and Taylor (1987) essentially argued that the now ubiquitous genre classification system (i.e. Narrative versus Expository) is inherently flawed. The problem is that textual properties that are used to characterize one genre can be found in varying degrees in the other. For example, temporal organization is often used to help distinguish text genres, and likely affects the amount of coherence in a text, and consequently, the amount and types of inferences necessary to achieve deep comprehension as discussed previously. In the present study, there were passages that were similarly organized in terms of temporal sequences and likely called for similar cognitive processes to achieve comprehension despite being coded as separate genres (See Appendices). Therefore, if this argument is valid, similar performance is likely to be seen on both texts. Nevertheless, even with potential ambiguity between text types, the cognitive processes undertaken by participants in the current study were likely influenced by word recognition and oral language comprehension abilities.

The overall pattern of results seen in the current study was consistent with Brown, Oram-Cardy and Johnson's (2013) meta-analysis of the reading comprehension skills of

individuals with autism in which they showed that decoding skills were similar to TD peers and the variability in reading comprehension performance ranged from severe to within normal limits (i.e. -2.2 to +0.7 SD). Moreover, it is well known that many children with ASD have an affinity for decoding and this likely accounts for the relative strength in this skill. Ricketts et al. (2013) also reported considerable variability in reading comprehension performance from their sample, but noted that there was more variability in word recognition than in reading comprehension. The same patterns were observed in the present study; post-hoc analyses showed that performance on word recognition was similar between ASD and TD groups (t (30.83), = .40 p < .69). Taken together, the present study supports the well-established finding that high functioning individuals with ASD, in general, are comparable to their TD peers in terms of performance on word recognition tasks, but have significantly more difficulty with reading comprehension although performance varies widely.

Relations between Pragmatic Language, Text Type and Reading Comprehension

One of the most compelling questions of this study was the relationship between pragmatic language skills and reading comprehension in individuals with ASD. Results of this study suggest that children who have better social skills are generally better comprehending *both* narrative and expository texts. The prevalent assumption was that individuals with ASD would perform well on expository text because of their ability to memorize facts, strength in comprehending literal language, penchant for details, and preference for non-social stimuli. Conversely, the perceived lack of social understanding should have precluded them from performing well on narrative text because of its inherently social nature. However, analysis revealed a strong positive correlation between pragmatic language skills and reading comprehension performance on narrative and expository texts.

It should also be noted that post-hoc correlational analyses of the oral language comprehension skills of individuals with ASD were strongly correlated with performance on narrative, r = .80, p < .001 and expository text, r = .82, p < .001 separately, and oral language comprehension and reading comprehension composite scores were also strongly correlated, r = .83, p < .001. These results are complimentary because both oral language and reading are communicative in nature and more precisely, rely upon social-pragmatic knowledge. Therefore, it stands to reason that greater social awareness and generalized language ability will lead to greater comprehension and interactions in oral communication, as well as reading comprehension in narrative and expository domains. This lays the groundwork for further exploration in future studies investigating whether there is a causal relationship between social skills and reading comprehension.

Perhaps the least compelling question of this study, although needed for internal validity and study integrity, was whether individuals with ASD perform more poorly on narrative text than typically developing individuals. Indeed, it has been well documented that, in general, individuals with ASD perform more poorly on reading comprehension measures. However, few studies focused on the performance of these populations on narrative text alone. This study confirmed that individuals with ASD perform more poorly on reading comprehension broadly, and narrative comprehension, specifically. Historically, similar performance can be seen in a study by Minshew et al. (1994) where high functioning individuals with ASD performed significantly more poorly on reading comprehension than an IQ matched control group. Frith and Snowling (1983) also saw the same profile when individuals with ASD were matched by reading age with Dyslexic and TD groups. More recently, investigators have continued to replicate the poor reading comprehension performance of individuals with ASD (Brown, Oram-Cardy & Johnson, 2013; Davidson &

Ellis-Weismer, 2014; Huemer & Mann, 2010, Nation et al., 2006; Nation et al. 2006; Norbury & Nation, 2011; Ricketts, 2011). There is consensus that this poor performance can be largely attributed to poor oral language skills. However, it is less clear as to how the degree of cohesion or text type (measured by degree of narrativity) contribute to performance.

In this study, cohesion and text type significantly predicted reading comprehension performance. This finding was not particularly surprising given what we know about the effects of cohesion, particularly with typically developing individuals. However, since individuals with ASD often have difficulty integrating background knowledge to construct mental representations of text, and texts with high degrees of cohesion allow for easier integration of background knowledge into the situation model, leading to deeper comprehension, I wanted to determine whether degree of cohesion would be more predictive than text type. Recall that in contrast to highly cohesive texts, expository texts require more bridging inferences to achieve comprehension. However, they generally require less use of social knowledge, potentially making it easier for individuals with ASD to comprehend text.

The findings of this study show that text type was not more predictive than degree of referential or causal cohesion. One reason for this occurrence may have been because the number of cohesive devices located in the text actually influence comprehension more than the text's narrativity, which takes into account elements beyond cohesion, such as the frequency with which words are used in everyday life and the amount of world knowledge required for comprehension. It could also be argued that there was a negligible difference between the predictive value of both constructs and both are equally important for

comprehension. In fact, it is likely that cohesion and narrativity are measuring underlying features of the text that ultimately lead to coherence.

In the current study, the textual properties associated with referential cohesion were also associated with narrativity in that they allowed for inferences to be made more easily by increasing local coherence. There was a moderate correlation between these variables, $r = .44$, though it was nonsignificant likely due to being underpowered. Admittedly, I expected to see a stronger relationship between causal cohesion and narrativity since narrative texts are generally thought to be more causally linked than expository text. However, referential cohesion disambiguates text and lessens cognitive load. This is particularly important for individuals with ASD because they have been documented to have difficulty making use of pronouns and other referents. As a text becomes more referentially cohesive, the reader does not have to produce as much mental effort to construct an understanding, which consequently frees mental resources for deeper processing. Similarly, common features of narrative text (i.e. familiar words, story structure) enable readers to construct an understanding and allow for easier inferences.

Despite the perceived increase in the ability to comprehend highly cohesive texts (as per the TD literature), individuals with ASD still did not show differential performance on high versus low cohesion texts nor did they perform better than typically developing individuals when texts were highly cohesive. This supports the idea that cohesion does not account for enough variance in reading comprehension that it supersedes the contribution of other variables to the point that it makes a greater practical difference in comprehension than other variables. In fact, it implies that reading comprehension is driven by myriad variables and, as a result, cannot be predicted by cohesion alone. Put in a different way, perhaps the influence of cohesion has been overestimated. From the list of potentially

contributing factors, one tangentially related variable which was not considered in this study was the contribution of background knowledge.

Level of background knowledge could have played a significant role in the achievement of comprehension. McNamara et al. (1996) found that when individuals have low knowledge they benefit from high coherence texts, but when they have high knowledge they benefit from *low* coherence texts. They concluded that texts with low coherence actually encourage high knowledge readers to engage in more mental effort, resulting in the establishment of richer mental representations than if they had not worked as hard. These mental representations are a product of the interaction between active inferencing and background knowledge, leading to deeper comprehension. In the present study, it is unclear how much topic-specific background knowledge the participants possessed, and it is possible that it may have obscured some of the benefits that may have come from high cohesion texts. Furthermore, the fact that individuals with ASD have been shown to access and use background knowledge differently than TD individuals (Wahlberg & Magliano, 2004) adds to the complexity of the issue.

The results of this study suggest that ASD and TD groups may, in fact, respond to cohesion differently. We saw a strong negative relationship between deep cohesion and reading comprehension performance in TD individuals, $r = -.69$, but only a weak negative relationship in ASD individuals, $r = -.28$. The results were not significant because of the way the analysis was run. The deep cohesion score from each passage of the GRADE constituted the Deep Cohesion variable and mean number correct per passage constituted the reading comprehension variable, providing only six observations per variable for the analysis. Therefore, although a strong correlation was found, it was not significant because of the number of observations in the analysis (See Table 6). Nevertheless, the observed

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relationship between deep cohesion and reading comprehension lends some support to the idea that when passages are less causally cohesive (i.e. Expository text), TD participants use their background knowledge to help them draw inferences to achieve comprehension to a greater degree than their ASD counterparts. Of course, we cannot draw premature conclusions based on this level of evidence, however, these results raise the possibility that individuals with ASD do not process text in the same way as do TD individuals.

Summary of Conclusions

The results of this study confirm established theories of how reading comprehension is accomplished and may offer some new insights on the differences between ASD and TD groups. Not surprisingly, the TD group outperformed the ASD group on narrative and expository texts, but were relatively the same in terms of word recognition. More importantly, however, is that it seems as though the TD group responded to cohesion differently than the ASD group. Results may suggest that the TD group was able to use their background knowledge to fill in gaps in causal cohesion whereas the ASD group was not. However, this result should be interpreted with caution, since background knowledge was not assessed and there were a limited number of observations.

There are several possible reasons for this observed result. First, the ASD group could have performed more poorly because they had less background knowledge than the TD group. Second, it is possible that the groups did not differ on background knowledge, but the ASD group was less adept at accessing and using their background knowledge to comprehend text. Third, unlike TD groups previously studied in the literature, high knowledge individuals with ASD do not use background knowledge to fill in gaps when a passage lacks cohesion. Rather, a different mechanism may influence when and how background knowledge is used. Fourth, dearth of linguistic knowledge or other relevant

traits precluded the ASD group from making appropriate inferences. Fifth, it is also possible

that regardless of being underpowered, this result truly does not rise to the level of

significance and there is no real relationship between the variables.

Limitations and Future Directions

There are several important limitations to this project that should influence

interpretations. First, since participant groups were relatively small, we cannot generalize the

performance of these groups to the general population. Rather, this project serves as a

foundation for more critical thought regarding the nature of reading comprehension and the

degree to which textual characteristics influence overall performance in individuals who are

typically developing and those with autism spectrum disorder. From a statistical standpoint,

being underpowered limited the ability to observe a significant association between causal

cohesion and reading comprehension performance in the TD group. If this association is

indeed significant and these findings are replicated, it could have important implications for

how we think about the impact of causal cohesion, and equally important, how individuals

with autism may differ in their processing of text.

Second, following accepted convention, and for the purpose of this study, I drew an

artificial dichotomy between text types. In reality, texts exist on a continuum of narrativity

which is determined by the quality and number of textual features contained within it.

Although I implemented a split procedure that eliminated from consideration performance

on texts that fell between 40 to 60 percent narrativity, texts within a given domain (i.e.

narrative or expository) may still differ significantly from each other in terms of their textual

features, and consequently, the types of cognitive processes necessary to comprehend them.

Therefore, treating all texts from a given domain the same may obscure important

differences between the texts and ultimately limit the conclusions that could be drawn.

Third, comprehension monitoring abilities—which was not a focus of this study—may have influenced the performance of the participants. It is a well-established belief that due to social understanding, central coherence and executive functioning abilities, individuals with ASD have marked difficulty with comprehension monitoring and related abilities (Brock, Norbury, Einav & Nation, 2008; Cronin, 2008; Frith, 1989, O'Connor & Klein, 2004; Randi et al. 2010; Snowling & Frith, 1986). Therefore, it is difficult to distinguish the degree to which the observed performance was due to textual features or individual cognitive differences.

Nevertheless, this study adds two important pieces of evidence to the literature which should be investigated further. First, it supports the notion that pragmatic language abilities are associated with the reading comprehension performance of individuals with autism spectrum disorder. Future studies should investigate whether there is a causal relationship between these variables and whether specific pragmatic abilities serve as a limiting factor. Second, we observed a strong negative relationship between causal cohesion and reading comprehension performance in the TD group, but not in the ASD group though it was not significant because of the way it was analyzed. Future studies should replicate this effort with a larger sample to verify the true magnitude and direction of the relationship between these variables. Relatedly, since background knowledge has been shown to influence the amount and type of inferences that are draw in the TD population. Further studies should investigate the role of background knowledge as it relates to text cohesion with the ASD population.

Lastly, this study sought to observe the impact of textual features on the reading comprehension performance of individuals with autism spectrum disorder. However, to do so, I looked at a very small segment of the ASD population, those 10 to 14 years of age.

Since significant cognitive changes occur throughout the lifespan, and content as well as social knowledge continues to grow over time and continued exposure, it is entirely possible that we may see different results if this study is replicated with a different age group. Therefore, this study merely scratches the surface with respect to the true nature of reading comprehension abilities in this population as a whole. There is much work to do. Reading comprehension is important to all individuals—typically developing or otherwise—throughout the lifespan. Helping individuals with ASD read and comprehend better will be mutually beneficial to everyone.

TABLES

Table 1

Standardized measures

Measure	Construct
Test of Nonverbal Intelligence- 4th Ed.	Nonverbal IQ
Clinical Evaluation of Language Fundamentals- 5th Ed.	
Following Directions	Oral Language Comprehension
Semantic Relationships	Oral Language Comprehension
Test of Auditory Comprehension of Language	
Vocabulary	Oral Language Comprehension
Grammatical Morphemes	Oral Language Comprehension
Elaborated Phrases and Sentences	Oral Language Comprehension
Comprehensive Assessment of Spoken Language	
Pragmatic Judgment	Pragmatic Language
Paragraph Comprehension of Syntax	Oral Language Comprehension
Test of Problem Solving- Elementary	
Problem Solving	Pragmatic Language
Test of Pragmatic Language	Pragmatic Language
Children's Communication Checklist	Pragmatic Language
Group Reading Assessment and Diagnostic Evaluation	Reading Comprehension
Gates-MacGinitie Reading Test	Reading Comprehension
Test of Word Reading Efficiency	
Sight Word Efficiency	Word Recognition
Phonemic Decoding Efficiency	Word Recognition

Table 2

Intercorrelations for ASD Referential Cohesion, Deep Cohesion,

Narrativity Ratings

Variable	1	2	3
1. Referential Cohesion	--		
2. Deep Cohesion	-.64	--	
3. Narrativity	.44	-.06.	--

Table 3

Multiple Regression Analysis Summary for Variables Predicting Reading Comprehension

Predictor Variable	B	t	p
Referential Cohesion	-.02	-9.93	.01**
Deep Cohesion	-.02	-8.86	.01*
Narrativity	.01.	6.38	.02*

*p < .05. ** p < .01

Note. R^2 = .98 (Adj. R^2 = .96), p < .013

Table 4

<u>Group Differences in Performance on Reading Comprehension Texts Containing High</u>

<u>Referential Cohesion and High Causal Cohesion</u>

	High referential cohesion			High causal cohesion		
Group	<u>M</u>	<u>SD</u>	<u>t</u>(24.91)	<u>M</u>	<u>SD</u>	<u>t</u>(26.02)
ASD	36.94	23.11		38.74	24.77	
TD	67.1	13.27		55.83	15.23	
			-4.73***			-2.46*

<u>Note</u>: *p < .05. ***p < .001.

Table 5

Performance on Reading Comprehension Texts by Individuals with Autism Based on

Degree of Cohesion

	Referential cohesion			Causal cohesion		
Degree of Cohesion	M	SD	t(31.79)	M	SD	t(31.13)
High	36.94	23.11		38.74	24.77	
Low	39.46	25.09		37.48	20.93	
			-.30			.16

Table 6

<u>Correlations for Mean Number of Reading Comprehension Items Correct</u>

<u>and Degree of Cohesion for Individuals with Autism and those who are Typically</u>

<u>Developing</u>

Group	Referential cohesion	Causal cohesion
Autism		
Mean number correct	-.39	-.28
Typically Developing		
Mean number correct	.25	-.69

APPENDIX A

Gates-MacGinite Reading Test Example 1 - Level 7/9

A Native American remembers the old ways.

We had no matches so we had to make our fires by striking white flint or by filling a piece of buckskin with dry, rotten wood or tree-canker-touchwood-and then rubbing it up and down a sinew bow-string until it got hot and started an ember in the touchwood. We had a professional "fire-man" with the tribe, a man whose business it was to carry fire with him from camp to camp and sell it to the members of the tribe when they got ready to make their fires. He carried the fire in a hollow birch log about 2 feet long. He would start an ember and then put in a lot of touchwood and strap the log to his horse and carry it for a day or so without having to bother about it again. We youngsters used to like to see him open it; it looked like a quiet, glowing little furnace.

Coh-Metrix Ratings

Narrativity- 93

Referential Cohesion- 92

Deep Cohesion- 99

*Note: Coded as narrative text

Gates-MacGinite Reading Test Example 2 - Level 7/9

Jean Henri Fabre, a French naturalist, noticed that pine processionary caterpillars always filed out of their nest in a line, each one following the silken trail laid down by the caterpillar in front of it.

One day he watched a file of caterpillars crawl up the side of a large wooden plant tub. The leader started around the rim and the others followed. When the rim was crowded with a complete circle of caterpillars, Fabre broke the silken trail that led to the rim and removed it. He watched to see what the caterpillars would do.

Round and round the rim they went, each one blindly following the caterpillar ahead, each one adding its silk to the circular trail. None would venture away from the path, which had always before led them back to their nest.

They circled the rim for nearly eight days. At last on famished individual blazed a new trail down the outside of the tub, and the others followed. Finally they were back in familiar territory.

Coh-Metrix Ratings

Narrativity- 41

Referential Cohesion- 42

Deep Cohesion- 19

*Note: This was not used for analysis because the narrativity ratings fell between the 40-60th percentiles.

Gates-MacGinite Reading Test Example 3 - Level 7/9

In the northernmost wastes of the northern hemisphere continents the coniferous forests give way to bleak icy plains. These are covered with snow and ice in the gloomy winter, but during the brief summer they thaw out. However, the soil at depth remains frozen, and the meltwater from the surface cannot drain away, a condition known as permafrost. The result is a treeless summer landscape of lakes and marshes. The annual freezing and thawing heaves the topsoil around producing polygonal patterns and soil-covered mounds of ice called pingoes. This kind of terrain is called Tundra.

<u>Coh-Metrix Ratings</u>

Narrativity- 4

Referential Cohesion- 8

Deep Cohesion- 16

*Note: Coded as expository text.

Group Reading Assessment and Diagnostic Evaluation (GRADE) Example 1

I wasn't thrilled about going snorkeling in the ocean. First of all, I'm not a great swimmer. Plus, I hate deep water-especially if it has things with teeth and stingers living in it. And, I knew I'd get stuck having to help my pesky little brother. So you can understand why I was cranky that morning as my family headed out to the coral reef.

The guide's reassurance that the water there was "only 17 feet deep" wasn't helping. The guide showed us how to adjust our goggles so they were watertight. We also learned the proper way to breathe through the curved snorkel tube. I was still nervous, though, when we hopped into the water. I spent a few minutes paddling around (and only got one mouthful of salty water). Saltwater buoys you up, so it's easy to stay afloat. I soon found that I could keep my face underwater for minutes at a time.

There was so much to see I didn't even want to blink! The delicate choral shapes were filled with an underwater community. Tropical fish in brilliance blues, greens, and reds darted everywhere. Stingrays and see urchins and a hundred other forms of life went about their business.

<u>Coh-Metrix Ratings</u>

Narrativity- 79

Referential Cohesion- 4

Deep Cohesion- 86

*Note: Coded as narrative text.

APPENDIX E

Group Reading Assessment and Diagnostic Evaluation (GRADE) Example 2

In the early 1700s, most people in Europe lived on farms. Families were largely self-sufficient. They raised their own food, gather their own fuel to heat their homes, and even made their own cloths. Women and children spun wool for thread, and men wove it into material for clothes.

All of this changed during a period in history known as the Industrial Revolution. The Industrial Revolution lasted from about 1750 to 1850. During this time there was an explosion of inventions and economic changes that eventually would transform the world.

Machinery revolutionized the way many people lived their lives. Spinning machines and great looms meant that factories could mass-produce cloth and sell it. Steam power was harnessed, and newer, stronger metals were produced. Improved plows and livestock breeding made farming more productive. Better bridges could be built, and railroads came into being. Trains and better roads made travel easier and quicker for the ordinary person. Raw materials and manufactured goods could be moved more efficiently, too.

Farm workers moved to the cities to work in the new factories, raising the population of the cities. At the same time, overcrowded and cheap housing for the factory workers led to unhealthy, unsafe living conditions. Children as young as five years old worked 12 to 15 hours a day in underground mines or windowless factories.

Coh-Metrix Ratings

Narrativity- 13

Referential Cohesion- 2

Deep Cohesion- 86

*Note: Coded as expository text.

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