AWARENESS OF PROSODIC CUES IN TEXT: THE MISSING LINK BETWEEN PROSODIC SENSITIVITY AND READING COMPREHENSION IN YOUNG READERS?

by

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This thesis is dedicated to my partner, Chris Bayley, for all of his love and support.

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ABSTRACT

This thesis investigated whether and how prosodic sensitivity and reading comprehension are related in the mid-elementary grades. A total of 151 students in Grades 3 to 5 were tested. Prosodic sensitivity was found to be positively related to reading comprehension after controlling for age, punctuation knowledge, word reading, phonological awareness, vocabulary, and nonverbal ability. The role of prosodic cues in text was also investigated as a possible explanation for this relation, specifically focusing on awareness of punctuation marks (Chafe, 1988; Miller & Schwanenflugel, 2006). Prosodic sensitivity was found to be indirectly related to reading comprehension through awareness of prosodic cues in text. Children in these grades may be using prosodic cues in text to guide their implicit prosody during silent reading. I integrate these findings into theory and discuss implications for research and education.

LIST OF ABBREVIATIONS USED

a	Path from X to M in mediation analysis
a*b	Indirect effect in mediation analysis
b	Path from M to Y in mediation analysis
c	Total effect in mediation analysis
c’	Direct effect in mediation analysis, path from X to Y
CAP	Concepts About Print task
CI	Confidence interval
CTOPP-2	Comprehensive Test of Phonological Processing, second edition
F	*F* test statistic
M	Mediator variable in mediation analysis
M-PPVT	Modified Peabody Picture Vocabulary Test
N	Total sample size
p	*p*-value indicating statistical probability
PPVT-3	Peabody Picture Vocabulary Test, third edition
R^2	Measure of proportion of variance explained by the independent variable
SD	Standard deviation
SE	Standard error
t	*t* test statistic
TOWRE-2	Test of Word Reading Efficiency, second edition
WASI-2	Wechsler Abbreviated Scale of Intelligence, second edition
WRMT-3	Woodcock Reading Mastery Test, third edition
X	Independent variable in mediation analysis
Y	Dependent variable in mediation analysis

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CHAPTER 1 INTRODUCTION

1.1 Reading Comprehension and Prosodic Sensitivity

Reading comprehension is one of the most important skills children learn. Reading comprehension is defined as the ability to derive meaning from connected text (Hoover & Gough, 1990). This ability involves understanding the meaning of the text as a whole, not just pronouncing individual words (Gough & Tunmer, 1986). Reading comprehension is important because difficulties in understanding what one reads have negative ramifications for academic success (Maughan, Hagell, Rutter, & Yule, 1994), employment and even later health status (Jamieson, 2006). To better support reading comprehension, it is necessary to understand the oral language skills that support it (Snow, 1991). One oral language skill which researchers have begun examining is prosodic sensitivity. This thesis will examine whether and how prosodic sensitivity and reading comprehension are related.

Prosodic sensitivity is the awareness of the rhythmic elements of speech called prosody (Holliman, Williams, Mundy, Wood, Hart, & Waldron, 2014). Prosody includes stress, timing, and intonation (Holliman, 2016) and is a component of phonology, the sound structure in spoken language (Wood, 2006). Phonology at the segmental level refers to individual sound segments such as syllables and phonemes. For example, the word *pilot* is composed of five individual phonemes: /p/, /aɪ/, /l/, /ə/, and /t/. Prosody is phonology at the suprasegmental level and refers to overarching patterns instead of individual sound segments (Holliman, Critten, Lawrence, Harrison, Wood, & Hughes, 2014). For example, prosody includes stress placement such as primary stress being

placed on the first syllable of the word *pilot* (e.g., Chan & Wade-Woolley, 2018). This example involves prosody at the word level, but prosody can also act at the phrase level. For example, the pitch contour of a declarative statement such as *she's a pilot.* would fall while the pitch contour of a question such as *she's a pilot?* would rise (Holliman, Gutierrez-Palma, Critten, Wood, Cunnane, & Pillinger, 2017).

Researchers and educators have speculated on the relation between the production of prosody and reading comprehension for some time. Reading comprehension is assumed to be demonstrated through fluent reading, which involves reading out loud with speed, accuracy, and appropriate expression (Miller & Schwanenflugel, 2006; Kuhn, Schwanenflugel, Meisinger, Levy, & Rasinski, 2010; Allington, 1983). Reading with appropriate expression, also called reading with prosody or prosodic reading, is considered the hallmark of achieving fluent reading (Schwanenflugel, Hamilton, Wisenbaker, Kuhn, & Stahl, 2004). Prosodic reading is assumed to show reading comprehension because it shows a mastery of surface-level text processing. Surface-level text involves literal wording (Frank, Koppen, Noordman, & Vonk, 2007), and it is argued that this level of text needs to be processed before deeper meaning and connected ideas can be understood (Miller & Schwanenflugel, 2006). When reading out loud, the prosody produced by fluent readers is assumed to demonstrate information about their reading comprehension. In this view, producing prosody is intertwined with reading comprehension, to an extent that it is challenging to separate them. However, producing prosody is only one side of the coin. Awareness of prosody may be a necessary first step to being able to produce appropriate prosody. This leads to the question of whether

individual differences in children's prosodic sensitivity are related to their levels of reading comprehension.

Prosody produced in the context of speech communicates information with implications for speech comprehension. This includes information about the locations of word boundaries and word type (Cutler, Dahan, & van Donselaar, 1997). For example, stress placement distinguishes the single word *butterfly* (strong-weak-weak) from the two words *butter fly* (strong-weak strong). Stress placement also distinguishes the verb *reCORD* (weak-strong), referring to the act of recording, from the noun *REcord* (strong-weak), referring to a disk carrying sound. Prosody can also communicate information on how words may be grouped into meaningful phrases (Schwanenflugel, Hamilton, Wisenbaker, Kuhn, & Stahl, 2004), what parts of speech are most important (Bolinger, 1978), and even the attitude or mental state of the speaker (Ravid & Mashraki, 2007).

Returning to prosodic sensitivity, there are individual differences in children's awareness of prosody (Holliman, Wood, & Sheehy, 2008) and accordingly, there are differences in children's ability to access the information communicated by prosody. Given the amount of information that prosody adds to speech, it is not surprising that those with high prosodic sensitivity tend to understand speech better than those with low prosodic sensitivity (see Cutler et al., 1997 for a review). What is less clear is whether and how prosodic sensitivity is linked to reading comprehension. This relation will be the focus of the current study.

1.2 Theories on the Relation between Prosodic Sensitivity and Reading Comprehension

This investigation into whether and how prosodic sensitivity relates to reading comprehension is guided in part by theories of reading comprehension. As detailed below, several theories at least implicitly point to the possibility that prosodic sensitivity is related to reading comprehension. We will also see that this relation is underspecified, which is another inspiration for this empirical inquiry.

Only one model of reading includes prosodic sensitivity explicitly. This model was originally proposed by Wood, Wade-Woolley, and Holliman (2009) and was empirically tested and modified by Holliman, Critten, Lawrence, Harrison, Wood, & Hughes (2014). The final model from Holliman, Critten, et al. (2014) was based on data from a group of English-speaking children who were 5- to 7-years-old. This model predicts that prosodic sensitivity contributes to word reading and spelling indirectly by supporting phonological awareness, vocabulary, and morphological awareness. However, the reading outcome is word reading, not reading comprehension. Reading comprehension is distinct from word reading. Word reading, or decoding, is the ability to pronounce individual words and does not require the reader to understand the meaning of the word (Gough & Tunmer, 1990). In contrast, reading comprehension is the ability to understand the meaning of text. Although theories of reading comprehension acknowledge the role of word reading in reading comprehension, theories of reading comprehension are distinct from theories of word reading.

As such, it is important to turn to theories of reading comprehension for guidance, even if such theories do not include prosodic sensitivity explicitly. That said, theories can

guide our inquiry in delineating variables thought to be involved in reading comprehension. Specifically, all theories of reading comprehension suggest that children bring the oral language skills they have learned from speech to their understanding of written language (Storch & Whitehurst, 2002; Perfetti, Landi, & Oakhill, 1999; Hoover & Gough, 1990). Two prominent theories of reading comprehension, the Simple View of Reading (Gough & Tunmer, 1986, Hoover & Gough, 1990) and the Reading Systems Framework (Perfetti & Stafura, 2014), both propose a role for oral language comprehension skills in reading comprehension. These theories will be reviewed in detail below. Given prosodic sensitivity's relation to oral language comprehension (Cutler et al., 1997), models of reading comprehension begin to point to a way for prosodic sensitivity to connect to reading comprehension.

The most highly cited theory of reading comprehension is the Simple View of Reading (Gough & Tunmer, 1986, Hoover & Gough, 1990). This Simple View of Reading states that reading comprehension is the product of decoding and linguistic comprehension (decoding x linguistic comprehension = reading comprehension). According to this theory, decoding is the ability to pronounce isolated words quickly and accurately. Decoding has also been referred to as word reading (Kirby & Savage, 2008). Linguistic comprehension, or oral language comprehension (Hoover & Gough, 1990), is the ability to interpret language at the sentence and discourse level. Reading comprehension cannot occur without some skill in both of these components. According to Gough and Tunmer, "the average 5-year old" (p. 7, 1986) has oral language comprehension skill but not word reading skill. As such, reading comprehension cannot occur. Similarly, someone could pronounce words written in an unfamiliar language but

would not be demonstrating reading comprehension without also understanding that particular oral language. Since it only describes two components, the Simple View of Reading has been criticized for being too simple. However, Kirby and Savage (2008) point to its value as an abstract framework. Kirby and Savage (2008) state that the components themselves are complex. Oral language comprehension involves all skills related to oral language comprehension (Kirby & Savage, 2008). Prosodic sensitivity is related to oral language comprehension (Cutler et al., 1997), and might be included in this category even if this is not explicitly stated in the Simple View of Reading. A role for prosodic sensitivity in reading comprehension can be envisioned through a role in oral language comprehension.

Phonology, of which prosody is a part, also fits into the Reading Systems Framework proposed by Perfetti and Stafura (2014). The Reading Systems Framework describes component subsystems that are argued to contribute to reading comprehension. One of these subsystems is the linguistic system, which includes components related to oral language comprehension. Notably, phonology is one of the components listed under the linguistic system. According to the Reading Systems Framework, knowledge of these components leads to comprehension processes. Perfetti, et al. (1999) state that components which contribute to comprehension processes apply to the understanding of both oral and written language. This suggests that knowledge about phonology, and by extension prosody, may play a role in reading comprehension because of a role in general language comprehension.

These two theories support the idea that prosodic sensitivity is related to reading comprehension because it is supports language comprehension more generally. Beyond

this, I am interested in how the relation between prosodic sensitivity and reading comprehension works, an idea little explored in theories to date. Prosody is represented in text in part through punctuation, and awareness of the link between prosody and punctuation may play a role in the relation between prosodic sensitivity and reading comprehension. Punctuation marks reflect major aspects of the prosody of written language (Chafe, 1988), particularly when punctuation marks are syntax-related (Miller & Schwanenflugel, 2006). Punctuation marks are interwoven with syntax (Fodor, 2002) and so their function is not solely prosodic. However, punctuation marks often reflect rhythm in addition to syntactic or grammatical roles. For example, during oral reading, adult readers generally decrease their pitch and pause at the end of a sentence. In text, a period marks this location. Adult readers also tend to increase their pitch at the end of a yes-no question, where a question mark is located (Miller & Schwanenflugel, 2006).

Fodor's (2002) Implicit Prosody Hypothesis provides some insight into why punctuation marks are important during silent reading as well as oral reading. The Implicit Prosody Hypothesis states that readers project a prosodic contour onto a text during silent reading. This hypothesis has been supported by eye-tracking research which found that word stress impacts silent reading time. Words with more strongly stressed syllables, which are typically longer in duration than weakly stressed syllables, take longer to read (Ashby & Clifton, 2005). If children are generating their own internal prosody during silent reading, as they do externally during oral reading and during speech (Miller & Schwanenflugel, 2006), awareness of this prosody may assist reading comprehension. Prosody supports oral language comprehension by adding information to speech (e.g., Schwanenflugel et al., 2004; Cutler, Dahan, & van Donselaar, 1997), and

implicit prosody generated during silent reading may add information to text in a similar way. Those with high prosodic sensitivity may be more aware of the information communicated by this prosody and may have higher reading comprehension. Furthermore, punctuation marks could be cues helping to guide readers' implicit prosody during silent reading. Readers who are more aware of the connection between prosodic cues in text such as punctuation and prosody may understand what they are reading better. This awareness of how prosodic cues in text reflect prosody in speech will be referred to as awareness of prosodic cues in text.

As an example of punctuation and implicit prosody supporting meaning, Fodor (2002) notes that readers can use the implicit prosodic contour they generate to help resolve syntactic ambiguity in garden path sentences. The beginnings of garden path sentences mislead readers into parsing a certain way, often leading to confusion or a dead end. For example, in the sentence, *While Mary was mending the sock fell off her lap*, readers are likely to treat "was mending the sock" as belonging to the same phrase. Fodor states that this ambiguity could be avoided by placing a comma after "was mending". This would cue readers to pause after "was mending" and would help resolve which parts of the sentence belong to which clause and make the sentence easier to understand. Like Fodor (2002), Chafe (1988) also saw punctuation as a guide (albeit an imperfect one) for implicit prosody, which he called "covert prosody". Prosody is present in all normal speech (Cutler et al., 1997), and Fodor's (2002) and Chafe's (1988) theories on implicit prosody suggest that prosody is also present in mental representations of all text. Prosody, and therefore awareness of prosody, cannot be ignored in either domain. Moreover, these theories suggest that punctuation marks help to guide prosody during

reading and so awareness of how punctuation marks reflect prosody needs to be considered.

To my knowledge, the role of prosodic cues in text such as punctuation has not yet been addressed explicitly by any theory of reading comprehension in English. However, in a conference poster, Gutierrez-Palma, Defior, and Calet (2010) proposed a model which added use of "prosodic marks" or punctuation to the prosodic sensitivity model by Wood et al. (2009). In their model developed for Spanish readers in the mid-elementary grades, Gutierrez-Palma et al. (2010) proposed that prosodic sensitivity plays a role in reading comprehension through use of prosodic cues in text including punctuation. In Spanish, prosody is marked at the word level through a stress mark, e.g. cajón (drawer). Prosody is also marked at the phrase level through punctuation marks. Gutierrez-Palma et al. (2010) suggested that the punctuation marks at the phrase level help readers understand syntax and thus support reading comprehension.

To summarize, the Simple View of Reading (Gough & Tunmer, 1986, Hoover & Gough, 1990) and the Reading Systems Framework (Perfetti & Stafura, 2014) suggest that prosodic sensitivity may support reading comprehension because of a role in general language comprehension. The first goal of this thesis is to test the theoretically based prediction that prosodic sensitivity and reading comprehension are related. Previous work has found that prosodic sensitivity is related to oral language comprehension (Cutler et al., 1997). Certainly, prosodic sensitivity may be related to reading comprehension because prosody supports language comprehension in both oral and written domains. As further explanation for this relation, the Implicit Prosody Hypothesis (Fodor, 2002) suggests that prosody is present in mental representations of text. This implicit prosody is

guided by prosodic cues in text including punctuation marks (Fodor, 2002, Chafe, 1988). Awareness of prosodic cues in text has yet to be integrated into theories on the relation between prosodic sensitivity and reading comprehension in English. This second goal of this thesis is to explore whether this should be the case by investigating the role of awareness of prosodic cues in text in the relation prosodic sensitivity and reading comprehension.

1.3 Empirical Research on the Relation between Prosodic Sensitivity and Reading Comprehension

Prosodic sensitivity and reading comprehension. Turning to empirical research, the few studies to date investigating the relation between prosodic sensitivity and reading comprehension have found mixed results. To our knowledge there are six studies examining prosodic sensitivity and reading comprehension in English-speaking children, each with different age ranges and with different control variables. Three of these studies report a positive relation between prosodic sensitivity and reading comprehension while three studies found no relation.

Three studies have found a positive relation between prosodic sensitivity and reading comprehension in the elementary school years. Holliman, Williams et al. (2014) found that prosodic sensitivity, as measured by a task examining awareness of stress, intonation, and timing, was significantly correlated with reading comprehension in English-speaking 5- to 7-year-olds after controlling for vocabulary and nonverbal ability. Clin, Wade-Woolley, and Heggie (2009) found that prosodic sensitivity, as measured by two tasks examining awareness of stress, was related to reading ability in English-speaking 8- to 13-year-olds. Reading ability was measured with a combined score across

reading comprehension, word reading, reading rate, and reading accuracy. This relation remained after controlling for age, nonverbal ability, general language ability, working memory, phonological awareness, and morphological awareness. This result supports the existence of a statistically significant relation between prosodic sensitivity and reading outcomes, but given the use of a combined score, the relation of prosodic sensitivity to reading comprehension alone is unknown. Thirdly, Whalley and Hansen (2006) conducted a study with English-speaking 8- to 10-year-olds where reading comprehension was the outcome variable. Prosodic sensitivity was assessed using two tasks examining awareness of stress. Prosodic sensitivity predicted individual differences in reading comprehension after controlling for word reading, phonological awareness, and general rhythm sensitivity. As such, there is some evidence to suggest that prosodic sensitivity and reading comprehension are related in the elementary school years.

However, three additional studies did not find a relation between prosodic sensitivity and reading comprehension at similar ages. In a study with English-speaking 5- to 7-year-olds, Deacon, Holliman, Dobson, and Harrison (2018) assessed prosodic sensitivity using a task which included items on stress, intonation, and timing. Reading comprehension as well as word reading and passage reading accuracy was assessed two years later. Prosodic sensitivity was not found to contribute to reading comprehension after controlling for word reading, vocabulary, phonological awareness, and morphological awareness. In a study with English-speaking 5- to 8-year-olds, Holliman, Wood, and Sheehy (2010) assessed prosodic sensitivity using a task examining awareness of word stress and assessed reading comprehension one year later. Prosodic sensitivity was not found to significantly contribute to reading comprehension after controlling for

age, vocabulary, and phonological awareness although the authors note that this contribution was approaching statistical significance at $p = .057$. These two studies contradict the findings of Holliman, Williams et al. (2014) who tested children at a very similar age (5- to 7-years-old). Turning to slightly older children, a pilot study with English-speaking students in Grade 3 and Grade 8 (Wade-Woolley & Heggie, 2018) found that prosodic sensitivity was not correlated with reading comprehension in either grade. This contradicts the findings of Clin et al. (2009) who tested children in Grade 3 and Grade 7 and Whalley and Hansen (2006) who tested children in Grade 4. However, because Wade-Woolley and Heggie (2018) had a relatively small sample size only correlations were possible and no additional variables were included as controls. Overall, there is some evidence for a relation between prosodic sensitivity and reading comprehension and some evidence for no relation between prosodic sensitivity and reading comprehension.

When evaluating the research to date, it is important to consider whether word reading was included as a control. Word reading, or decoding, is one of the components of reading comprehension according to the Simple View of Reading (Gough & Tunmer, 1986, Hoover & Gough, 1990) and substantial empirical research has shown a relation between word reading and reading comprehension (e.g., Perfetti & Stafura, 2014; Perfetti & Hogaboam, 1975). Word reading has also been found to be related to prosodic sensitivity (e.g., Holliman, Critten, et al., (2014); Chan & Wade-Woolley, 2018). Building on this work, word reading is an important control variable in any study attempting to determine whether prosodic sensitivity and reading comprehension are directly related.

Only two of the studies described above controlled for word reading when examining the relation between prosodic sensitivity and reading comprehension: Whalley and Hansen (2006), and Deacon et al. (2018). These studies had conflicting results with Whalley and Hansen (2006) finding a positive relation between prosodic sensitivity reading comprehension and Deacon et al. (2018) not finding a relation between prosodic sensitivity and reading comprehension. Both studies controlled for word reading and assessed prosodic sensitivity using a measure which included word and phrase level prosody. However, there were also some differences between the studies which may provide insight into the conflicting results. The participants in Deacon et al. (2018) were 5- to 7-years of age while the participants in Whalley and Hansen (2006) were 8- to 10-years of age. It is possible that prosodic sensitivity and reading comprehension are only related (or are more strongly related) later in development. It should not be assumed that the relation between prosodic sensitivity and reading comprehension is consistent across development. Alternatively, Deacon et al. (2018) and Whalley and Hansen (2006) included different control variables and it is possible that prosodic sensitivity simply does not contribute to reading comprehension after the effects of certain additional controls. For instance, Deacon et al. (2018) controlled for vocabulary which other studies have also found to be related to prosodic sensitivity in the same age group (Holliman, Critten, et al., 2014). Given the limited amount of research thus far it is difficult to determine which variables are most important to control for in addition to word reading. Ultimately, since only one study found a relation between prosodic sensitivity and reading comprehension after controlling for word reading, this is not enough evidence to conclude that a relation exists. Additional research with rigorous controls would be

valuable to help determine whether there is in fact a relation between prosodic sensitivity and reading comprehension.

Awareness of prosodic cues in text. Turning to the second area of focus, a wide net was cast for research on the role of awareness of prosodic cues in text in the relation between prosodic sensitivity and reading comprehension. Only two studies to my knowledge have examined relations between all three of prosodic sensitivity, reading comprehension, and awareness of prosodic cues in text. In the face of little research to date on this potentially indirect relation, I also discuss the available studies on specific aspects of this relation.

The first study assessing relations between all three of prosodic sensitivity, reading comprehension, and awareness of prosodic cues in text is Wade-Woolley and Heggie (2018). This was a pilot study with 50 English-speaking students in Grade 3 and Grade 8. Participants were asked to add punctuation to passages from which the original punctuation marks had been removed. This was a method originally suggested by Chafe (1988) to investigate implicit prosody. This task assessed participants' ability to apply punctuation which Heggie and Wade-Woolley (2018) referred to as punctuation ability. Punctuation ability is a measure of awareness of prosodic cues in text because punctuating a passage requires readers to add prosodic cues in text to a passage. Heggie and Wade-Woolley (2018) and Chafe (1988) hypothesized that participants would impose prosody onto the passage to help guide their decisions about where to place punctuation. They expected that the punctuation marks participants chose to add would reflect their ability to represent their implicit prosody through explicit punctuation marks. Application of prosodic cues would therefore be guided by awareness of prosodic cues.

Punctuation ability was found to be correlated with reading comprehension at both Grade 3 and Grade 8. Prosodic sensitivity, assessed using a measure of awareness of word stress, was correlated with punctuation ability at Grade 8 but not at Grade 3. Grade differences in the relation between prosodic sensitivity and punctuation ability suggests that these relations may not be consistent across development. Prosodic sensitivity was not found to be correlated with reading comprehension at either grade.

A second study assessing relations between prosodic sensitivity, reading comprehension, and awareness of prosodic cues in text was conducted with Spanish-speaking children. Gutierrez-Palma et al. (2010) asked Spanish-speaking children in Grades 4 and 6 to complete three measures of prosodic sensitivity examining awareness of word and phrase level stress. Similar to Wade-Woolley and Heggie (2018), punctuation ability was assessed by asking children to add punctuation marks to sentences. Prosodic sensitivity, punctuation ability, and reading comprehension were all significantly correlated. Additionally, prosodic sensitivity predicted punctuation ability after controlling for grade, working memory, phonological awareness, and non-speech rhythm but did not predict reading comprehension after the same controls. The finding that prosodic sensitivity did not predict reading comprehension is inconsistent with the findings of Whalley and Hansen (2006). However, as in Wade-Woolley and Heggie (2018) prosodic sensitivity and reading comprehension were significantly correlated.

Given the limited number of studies examining relations between all three of prosodic sensitivity, reading comprehension, and awareness of prosodic cues in text, it will be useful to examine studies which look at relations between any two of these variables. Studies on prosodic sensitivity and reading comprehension have been

discussed above, but research has also been conducted on prosodic sensitivity and punctuation ability without assessing reading comprehension. Research has also been conducted on reading comprehension and a variation of prosodic reading similar to awareness of prosodic cues in text.

Heggie and Wade-Woolley (2018) examined the relation between prosodic sensitivity and punctuation ability in English-speaking adults. As in Wade-Woolley and Heggie (2018) and Gutierrez-Palma et al. (2010), participants were asked to punctuate passages or sentences to assess punctuation ability. Heggie and Wade-Woolley (2018) found that prosodic sensitivity, as measured by two tasks assessing awareness of word stress, predicted punctuation ability after controlling for baseline punctuation knowledge, working memory, and reading comprehension. The finding that prosodic sensitivity and awareness of prosodic cues in text, measured by punctuation ability, are related makes sense because awareness of prosody is a reasonable first step to being able to represent prosody in text or being aware of that representation. The inclusion of reading comprehension as a control variable also suggests that prosodic sensitivity and awareness of prosodic cues in text are related independently of reading comprehension, at least in adulthood.

Miller and Schwanenflugel (2006) and Ravid and Mashraki (2007) examined the relation between reading comprehension and a construct similar to awareness of prosodic cues in text. Both studies examined prosodic reading at specific punctuation marks (also a method originally suggested by Chafe, 1988 to investigate implicit prosody). Like studies on reading fluency, these studies required participants to read out loud. However, Miller and Schwanenflugel (2006) and Ravid and Mashraki's (2007) approach to measuring

prosodic reading reflects awareness of prosodic cues in text. While studies interested in the expression aspect of reading fluency tend to rate overall expressiveness (e.g., Allington, 1983), Miller and Schwanenflugel (2006) and Ravid and Mashraki (2007) were interested in the prosody produced at punctuation marks. For example, did readers pause at periods or raise their pitch at questions marks? To what extent did readers alter their prosody when encountering prosodic cues in text? Chafe (1988) hypothesized that examining prosody produced during oral reading would provide insight into implicit prosody. Examining prosody produced at prosodic cues in text may indicate how aware readers are of those prosodic cues in text.

Miller and Schwanenflugel (2006) conducted spectrographic analyses on the readings of children in Grade 3. Pitch changes and pause durations were measured at various punctuation marks. Children who produced larger pitch changes at the end of declarative statements and yes-no questions (pitch declines and pitch increases respectively) tended to have higher reading skill. However, reading skill was a composite of both reading comprehension and word reading and so the relation between prosodic reading and reading comprehension alone is unknown. Ravid and Mashraki's (2007) study was with Hebrew-speaking children in Grade 4. The prosody produced by children at various punctuation marks was scored according to the prosody produced by adults reading the same passage. Prosodic reading and reading comprehension were found to be correlated. Overall, these two studies provide evidence for a relation between awareness of prosodic sensitivity in text and reading comprehension.

1.4 The Current Study

Two research questions will be addressed in the current study. The first question is whether prosodic sensitivity and reading comprehension are related in the mid-elementary school grades. The second question will involve testing a possible explanation for how they may be related. Specifically, I will investigate whether prosodic sensitivity is indirectly related to reading comprehension through awareness of prosodic cues in text.

These questions will be investigated using a mediation model. A simplified version of this model without the control variables can be found in Figure 1.1. The three variables of interest are prosodic sensitivity, reading comprehension, and awareness of prosodic cues in text. Evidence of a relation between prosodic sensitivity and reading comprehension would be demonstrated by finding a significant total effect between prosodic sensitivity and reading comprehension (path c). Evidence that prosodic sensitivity is indirectly related to reading comprehension through awareness of prosodic cues in text would be demonstrated by finding a significant indirect relation from prosodic sensitivity to awareness of prosodic cues in text to reading comprehension (path a*b).

Students in Grades 3 to 5 were recruited for this study. This age was chosen because of the increased importance of reading comprehension during this time. Beginning at Grade 3 there is a shift from the *learning to read* phase of reading development to the *reading to learn* phase of reading development (Chall, 1983). In the reading to learn stage children are expected to use texts to gain new information and ideas. Children need to understand what they read to learn this new information. As children progress through school, texts become longer and more complex, making

reading comprehension more difficult and increasing the need to understand oral language skills which may be related to reading comprehension. Students were recruited from multiple grades to increase the number of participants who could be tested for this study, but analyses will also be conducted to determine whether grade moderates any of the relations in this study. There is some evidence of grade differences in the relation

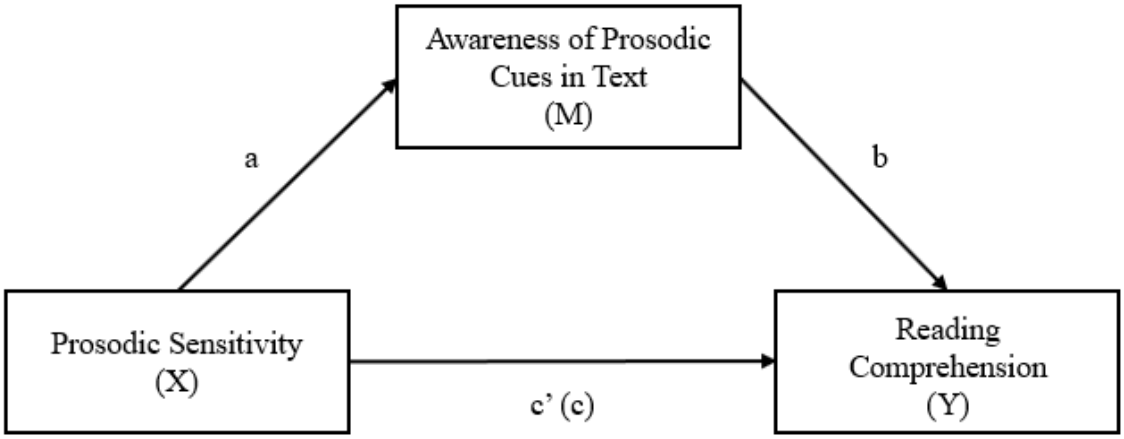

Figure 1.1. A simplified version of the proposed mediation model.

between prosodic sensitivity and awareness of prosodic cues in text, as in Wade-Woolley and Heggie (2018) who found a correlation between prosodic sensitivity and punctuation ability at Grade 8 and not at Grade 3. Findings have also been inconsistent across age groups in the relation between prosodic sensitivity and reading comprehension, as in Deacon et al. (2018) who did not find a relation in 5- to 7-year-olds and Whalley and Hansen (2006) who did find a relation in 8- to 10-year-olds. As such, it is important to evaluate whether relations are consistent across the grades examined in this study.

The DEEdee task (Whalley & Hansen, 2006) was chosen to assess prosodic sensitivity. The DEEdee task is a reiterative speech task, which is a technique where all syllables in words and short phrases are replaced with a sound. All weak syllables were replaced with "dee" and strong syllables were replaced with "DEE". Participants must identify which of two "dee-dee" options matches a clear word/phrase, e.g. "Humpty Dumpty" matches "DEEdee DEEdee" (HUMpty DUMpty), not "dee DEEdee DEE" (the LIon KING). This measure assesses prosodic sensitivity at both the word and phrase level. The DEEdee task was also chosen because it has been used with similar age groups with good reliability. For instance, Clin, et al. (2009) found that the DEEdee task had a reliability of .74 with a group of English-speaking 8- to 12-year olds.

Awareness of prosodic cues in text was assessed using two measures, each with a different approach. The first was a Punctuation Performance task (similar to the tasks used by Heggie & Wade-Woolley, 2018 and Wade-Woolley & Heggie, 2018). This task involved adding punctuation to a passage. The second task was a Listening task which involved participants listening to sentences and then adding punctuation to the sentences on a worksheet based on the prosody heard in the sentence. This was a new task created

for this study. This task differed from the Punctuation Performance task in that there were multiple grammatically correct ways of punctuating sentences in the Listening Task; participants needed to rely on the prosody present when listening to each sentence to get the correct answer. Scores from the Punctuation Performance task and the Listening task were combined to form a composite score for awareness of prosodic cues in text.

Control measures include age as well as other language skills known to be related to reading comprehension. This includes word reading (Perfetti & Hogaboam, 1975), vocabulary (Nagy, 1988), phonological awareness (Nation & Snowling, 2004), and nonverbal ability (Nation, Clarke, & Snowling, 2010). Standardized measures were used where available, including for reading comprehension. Punctuation knowledge was also included as a control variable following on Heggie and Wade-Woolley (2018) and Wade-Woolley and Heggie (2018). Since the awareness of prosodic cues in text measures require participants to use punctuation, it is important to control for participants' knowledge of the grammatical function of certain punctuation marks. It would be difficult to interpret participants' use of a question mark for example if they did not know that such a mark is used to indicate a question.

CHAPTER 2 METHODOLOGY

2.1 Participants

A total of 151 children in Grades 3, 4, and 5 were recruited for this study. All participants were enrolled in a standard English program at one of four public elementary schools in Nova Scotia, Canada. According to parental report, 132 of the children spoke English as a first language. Other first languages were Korean and Mandarin (3 each); Arabic, Bengali, and Malayalam (2 each); and Croatian, Hebrew, Hindi, Igbo, Polish, Spanish, Tagalog, Urdu, and "N/A" (1 each). One child spoke both English and Mandarin as first languages and another child spoke both English and Malayalam as first languages. Children who reported speaking English as a first language were compared to children who did not report speaking English as a first language on the measures used in this study to determine whether the groups were similar. There were no differences between the groups on reading comprehension ($t(148) = 1.20$, $p = .231$), prosodic sensitivity ($t(145) = -0.36$, $p = .721$), either measure of awareness of prosodic cues in text (punctuation performance: $t(144) = 0.69$, $p = .495$; listening task: $t(147) = -0.10$, $p = .921$), punctuation knowledge ($t(145) = 1.64$, $p = .103$), word reading ($t(145) = -0.20$, $p = .844$), phonological awareness ($t(147) = 0.76$, $p = .446$), or nonverbal ability ($t(147) = 0.78$, $p = .438$). However, children who reported speaking English as a first language had larger vocabularies ($M = 37.79$, $SD = 4.62$) than children who did not report speaking English as a first language ($M = 31.95$, $SD = 8.52$), $t(149) = 2.93$, $p = .008$. With the exception of vocabulary, these groups of children were similar. See Table 2.1 for mean scores and range of scores on measures by group. To further examine whether these groups were

Table 2.1

Mean Scores and Range of Scores on Standardized Measures for Participants who Reported English as a First Language and Participants who did not Report English as a First Language

	English Reported as a First Language					English Not Reported as a First Language				
	N	*Mean*	*(SD)*	*Min.*	*Max.*	*N*	*Mean*	*(SD)*	*Min.*	*Max*
Reading comprehension	131	20.50	(6.34)	0.00	34.00	19	18.68	(4.76)	11.00	29.00
Prosodic sensitivity	128	0.73	(0.17)	0.33	1.00	19	0.74	(0.16)	0.44	1.00
Punctuation performance	128	25.13	(14.11)	1.00	49.00	18	22.67	(15.33)	3.00	47.00
Listening task	131	15.40	(4.11)	1.00	24.00	18	15.50	(4.06)	4.00	20.00
Punctuation knowledge	128	3.41	(0.73)	0.00	4.00	19	3.11	(0.81)	2.00	4.00
Word reading	128	98.52	(21.17)	18.00	142.00	19	99.58	(27.09)	49.00	139.00
Phonological awareness	130	25.75	(5.63)	8.00	34.00	19	24.68	(6.14)	12.00	34.00
Vocabulary	132	37.79	(4.62)	22.00	49.00	19	31.95	(8.52)	7.00	44.00
Nonverbal ability	130	15.71	(4.76)	3.00	26.00	19	14.79	(5.18)	5.00	24.00

similar, correlations between all measures were compared. Correlations between measures were not significantly different between the group who reported speaking English as a first language and the group who did not report speaking English as a first language, as determined by Box's M (70.74), $F(45, 2963.06) = 1.25$, $p = .121$. As a result of these similarities, participants were combined across languages in the analyses.

At the time of testing, 48 of the children were in Grade 3, 49 of the children were in Grade 4, and 54 of the children were in Grade 5. See Table 2.2 for mean ages by grade and sex. Standardized scores on reading comprehension and word reading for each grade can be found in Table 2.3. All means are close to the mean standard score of 100 with standard deviations around 15, suggesting that the group as a whole were typical readers.

2.2 Measures

***Prosodic sensitivity*.** The DEEdee task (Whalley & Hansen, 2006) was used to measure prosodic sensitivity**.** The DEEdee task was adapted for administration on a laptop using E-Prime 3.0 software (Psychology Software Tools, 2016) but used the original items. This task involved listening to a recording of a story or movie name said clearly in English while a picture of the story or movie appeared on screen. For example, participants would hear "*Humpty Dumpty*". Participants then listened to two dee-dee phrases and selected which phrase matched the story or movie they had heard clearly in English. Dee-dee phrases had the same number of syllables as the story or movie name, but all syllables were replaced with the sound "dee". This eliminated phonetic information while preserving the stress pattern of the name. Participants would hear one

dee-dee phrase which matched the name of the story or movie they had heard, such as "*DEEdee DEEdee*" (which matches HUMpty DUMpty). They also heard a dee-dee

Table 2.2

Mean Age in Years by Participant Grade and Sex

	Female			Male			Total		
		Age			Age			Age	
	N	*Mean*	*(SD)*	*N*	*Mean*	*(SD)*	*N*	*Mean*	*(SD)*
Grade 3	23	8.84	(0.33)	25	8.78	(0.31)	48	8.81	(0.30)
Grade 4	27	9.80	(0.27)	22	9.78	(0.17)	49	9.79	(0.23)
Grade 5	29	10.75	(0.33)	25	10.87	(0.29)	54	10.81	(0.31)
Total	79	9.87	(0.84)	72	9.81	(0.91)	151	9.84	(0.87)

Table 2.3

Mean Age-Based Standard Scores on Reading Comprehension and Word Reading by Participant Grade

	Reading Comprehension		Word Reading: Sight Word Efficiency		Word Reading: Phonemic Decoding	
	Mean	*(SD)*	*Mean*	*(SD)*	*Mean*	*(SD)*
Grade 3	102.73	(12.91)	98.91	(14.88)	96.54	(17.70)
Grade 4	107.68	(17.49)	99.45	(11.62)	97.64	(14.26)
Grade 5	105.23	(17.54)	98.88	(13.14)	95.10	(14.73)
Total	105.27	(16.25)	99.08	(13.15)	96.38	(15.44)

Note. The mean standard score according to the manual is 100. Only data for participants included in the analyses reported in the results section are included here.

phrase which matched the name of another story or movie with the same number of syllables, such as "*dee DEEdee DEE*" (which matches the LIon KING). Participants chose which of the two dee-dee phrases matched the story or movie they had heard clearly in English by saying the number "one" to indicate that the first dee-dee phrase was the match or "two" to indicate that the second dee-dee phrase was the match. In this example, the correct response would be "one". The recordings used in this study have been used before by other researchers who administered the DEEdee task (Clin et al., 2009). Recordings were created by a trained phoneticist. There were two practice items followed by 18 test items which were all story or movie names. See Appendix A for the list of items used in this task. Scores were converted into percentage correct to account for missed items (caused by researcher error or issues with software). Two participants missed one item and two additional participants missed two items of the 18 test items (0.002% of all test items were missed). Cronbach's alpha for this task with the current sample was .67.

***Reading comprehension*.** The Passage Comprehension subtest from the Woodcock Reading Mastery Test 3 (WRMT-3; Woodcock, 2011) was used to measure reading comprehension. This test is standardized for Grades K-12, or ages 4-79. This test involved reading sentences and short paragraphs which had a blank where a word was missing. Participants demonstrate their understanding of what they read by correctly producing the word which belonged in the blank. Administration followed the standard procedure outlined in the manual. According to the manual, split-half reliabilities for Grades 3, 4, and 5 for this subtest range from .85 to .87.

Awareness of prosodic cues in text: Punctuation performance. The first of two tasks measuring awareness of prosodic cues in text was the Punctuation Performance task. The Punctuation Performance task was based on Heggie and Wade-Woolley (2018). Participants were presented with a short paragraph which had no punctuation marks. They were asked to read the paragraph silently and add in all the punctuation marks they thought were missing. To compete this task, participants had to use the implicit prosody of the paragraph to decide which punctuation marks to apply. See Appendix B for the unpunctuated practice item and paragraph used in this task.

The paragraph was created for this study. According to Flesch-Kincaid Grade Level Readability Formula and Spache Readability Formula, the paragraph was at a Grade 2 reading level (Kincaid, Fishburne, Rogers, & Chissom, 1975; Spache, 1953). The paragraph was created at a lower reading level than the grade level of participants so that difficulties reading the paragraph would not interfere with the task of applying punctuation marks. Six sentence types were included, corresponding to the sentence types in Miller and Schwanenflugel (2006). When read out loud, these sentences types tend to be read with different prosody. Using these sentence types allowed the paragraph to have varied implicit prosody as well as a variety of punctuation marks.

The paragraph was presented on a piece of paper in size 18 Arial font, was double-spaced, and included two spaces between each word to ensure that participants had enough space to add in punctuation marks. As in Heggie and Wade-Woolley (2018), all letters were lower-case so that participants could not use capital letters as cues to the beginnings and ends of sentences. Participants were given a maximum of five minutes to add punctuation marks and the task ended when participants indicated that they were

done adding punctuation marks or a when the five minutes had ended. Cronbach's alpha for this task was .96.

Awareness of prosodic cues in text: Listening task. The second task used to measure awareness of prosodic cues in text was the Listening task. The Listening task was created for this study and involved listening to recordings of sentences. Participants were presented with a corresponding list of sentences which had no punctuation marks. They were asked to listen to each sentence and add in all the punctuation marks they thought were missing. See Appendix C for the unpunctuated practice items and sentences used in this task.

There were multiple grammatically correct ways of adding punctuation marks to the written sentences in the Listening task. For example, the unpunctuated sentence *that is all mary said* could be punctuated as: 1) That is all Mary said. or 2) "That is all," Mary said. Which punctuation marks were the most appropriate to add could be determined by listening to the prosody in the recording of each sentence. The first example is a basic declarative sentence. According to data collected by Miller and Schwanenflugel (2006), adults tend to read basic declaratives with a decrease in pitch at the end. The second example is a basic quotative sentence. According to data collected by Miller and Schwanenflugel (2006), adults tend to read basic quotatives with a flat pitch and a very short pause at the comma. The prosody in the recording of the sentence matched one of these examples. To complete this task, participants had to use the explicit prosody in the recordings to decide which punctuation marks to apply. There were 14 sentences created for this task which included 7 pairs of sentences. As in the example above, two possible versions of each sentence were created. The syntactic structure of the sentences was kept

the same but individual words were changed so that the sentences would not be identical on paper. For example, to match the sentence, *That is all Mary said.*, the sentence, *"That is all," Dave said.* was also created. Recordings were created by a female speaker. Recordings were examined using Praat software (Boersma & Weenink, 2018) to confirm that the expected prosody was present. All words used in this task have a word frequency in *The Educator's Word Frequency Guide* (Zeno, Ivens, Millard, & Duvvuri, 1995) at Grade 2 which is lower than the grade level of participant, increasing the likelihood that participants were familiar with the individual words in the task.

The sentences were presented on a piece of paper in size 16 Arial font with two spaces between each word to ensure that participants had enough space to add punctuation marks. As in Heggie and Wade-Woolley (2018) and in the Punctuation Performance task, all letters were lower-case so that participants could not use capital letters as cues. Sentences were presented in a pseudo-random order. Each member of a pair was in a different half of the task (either first half or second half), but the order of sentences within each half was determined by a random number generator. This was done in an effort to separate sentence pairs without introducing a pattern which would be noticeable to participants. To further reduce the risk that participants would be influenced by sentence pairs, sentences were covered with an opaque piece of paper after participants were finished adding punctuation marks. Cronbach's alpha for this task was .80.

A composite score of awareness of prosodic cues in text was created from scores on the Punctuation Performance task and the Listening task. For each of the Punctuation Performance task and the Listening task, the number of correct punctuation marks added

was totaled. Scores were then converted into standard scores and averaged to form the composite score of awareness of prosodic cues in text for each participant.

Punctuation knowledge. The punctuation knowledge task was based on Clay's (1989) Concepts About Print (CAP) task. In this task, the researcher read a shortened version of the short picture book, *What's in the Pot* (Alonzo, Warren, & Western, 2016), to participants and asked them questions about various elements of print. Four of Clay's (1989) original items, items 8-11, assessed punctuation knowledge and so these four items were given to participants in this study. After reading the book, the researcher turned back to the first page and pointed at a question mark, quotation marks, comma, and period in turn, asking "What's this for?". Responses were open-ended and were scored as correct if they appeared on Clay's (1989) list of acceptable responses (in Appendix D). Other responses were aggregated and scored for correctness by two independent raters. One rater was the author and the other rater was a Ph.D. candidate with experience in language research. Agreement was 94%. Any disagreements were discussed by the two raters to reach a final scoring decision.

Word reading. The subtest from the Test of Word Reading Efficiency 2 (TOWRE-2; Torgesen, Wagner, & Rashotte, 2012) was used to measure word reading. This test is standardized for Grade 1-12, or ages 6-24. This test contains two subtests. For the first subtest, sight word efficiency, participants were asked to read words out loud from a list of real English words of increasing difficulty (e.g. *cat*, *book*, *people*) and had 45 seconds to read as many words as possible. For the second subtest, phonemic decoding, participants were asked to read nonwords out loud from a list of pronounceable nonwords of increasing difficulty (e.g., *baf*, *dess*, *shlee*) and had 45 seconds to read as

many nonwords as possible. Administration followed the standard procedure outlined in the manual. According to the manual, test-retest reliabilities for the sight word efficiency subtest for ages 8 to 10 years range from .89-.94 and test-retest reliabilities for the phonemic decoding subtest for ages 8 to 10 years range from .90-.94.

Phonological awareness. The Elision subtest of the Comprehensive Test of Phonological Processing 2 (CTOPP-2; Wagner, Torgesen, Rashotte, & Pearson, 2013) was used to measure phonological awareness. This test is standardized for Grades K-9, or ages 4-24. Participants were asked to repeat words said by the researcher, and to then say that word again without a specific sound. For example, "Say *stale*. Now say *stale* without saying /t/". Administration followed the standard procedure outlined in the manual. According to the manual, coefficient alpha reliabilities for this subtest for ages 8-10 years range from .87-.93.

Vocabulary. Vocabulary was measured using the Peabody Picture Vocabulary Test, Third Edition (PPVT-3; Dunn & Dunn, 1997) in a modified form (M-PPVT; Sparks & Deacon, 2015). This version included every fourth item from the original PPVT-III to reduce testing time while maintaining the progression of difficulty found in the full version. This modified version has been used successfully in past research and has been found to have similar split-half reliabilities to the split-half reliabilities reported in the manual for the full version: .84 for the modified version (Sparks & Deacon, 2015) versus .92 for the full version at Grade 3 (Dunn & Dunn, 1997). Otherwise, administration followed the standard procedure. Participants listened to a series of words spoken by the researcher and indicated which of four printed pictures best matched that word.

***Nonverbal ability*.** The Matrix Reasoning subtest from the Wechsler Abbreviated Scale of Intelligence 2 (WASI-2; Wechsler, 2011) was used to measure nonverbal ability. This test is standardized for Grades K-12, or ages 6-90. Participants were presented with incomplete patterns and were asked to select which of five pictures completed the pattern. Administration followed the standard procedure outlined in the manual. According to the manual, split-half reliabilities for this subtest for ages 8 to 10 years ranged from .85-.88.

2.3 Procedure

This data was collected as part of a larger study on oral language skills and reading comprehension. Ethical approval was obtained from the Dalhousie University Social Sciences and Humanities Research Ethics Board and from the Halifax Regional Centre for Education Research Committee prior to testing. All measures were administered in the spring, near the end of the participant's academic year. Each participant was tested individually by a trained researcher during school hours in a quiet area of the participant's school. All measures were administered in the same order for each participant and took about 90 minutes to complete. Of the measures reported here, the vocabulary measure was administered first, followed by the Listening task, nonverbal ability, the Punctuation Performance task, phonological awareness, prosodic sensitivity, reading comprehension, punctuation knowledge, and word reading. Testing was divided into shorter sessions based on the school's bell schedule and the participant's interest and energy level. Participants received a small token of appreciation (a notebook or pencil and eraser) as thanks for their participation.

CHAPTER 3 RESULTS

3.1 Preliminary Analyses

Data for six participants were removed prior to analysis since these children did not complete all measures. This conservative approach was used instead of an alternate method such as mean imputation because of the amount of missing data for each participant. Of the six participants who did not complete all measures, one did not complete 8/9 measures, two did not complete 5/9 measures, and one did not complete 4/9 measures. Two of the participants did not complete only 2/9 measures; however, the measures they did not complete were the two awareness of prosodic cues in text measures which was a key variable of interest. As such, analyses are reported with data only for participants who completed all measures.

The raw data was examined for univariate and multivariate outliers. One univariate outlier was identified, defined as a score outside three times the interquartile range for a variable. This univariate outlier had an unusually low vocabulary score. Two multivariate outliers were identified after calculating the Mahalanobis distance for each participant (Mahalanobis, 1936). One of these multivariate outliers was the participant who had the univariate outlier score. The main analysis is reported without these two outliers.

Mean performance on measures and correlations between measures were also calculated. Mean performance on measures by grade can be found in Table 3.1. Mean performance was similar with and without the outliers. Performance without the outliers is reported since these participants were included in the main analysis. Correlations between measures can be found in Table 3.2. The pattern of the correlations was similar

Table 3.1

Mean Performance on Measures by Grade

Measure (max.)	Grade 3		Grade 4		Grade 5		Total	
	Mean	*(SD)*	*Mean*	*(SD)*	*Mean*	*(SD)*	*Mean*	*(SD)*
Prosodic sensitivity (1)[a]	0.68	(0.16)	0.75	(0.17)	0.77	(0.16)	0.74	(0.17)
Reading comprehension (38)	17.32	(3.73)	21.32	(5.39)	22.90	(5.84)	20.66	(5.60)
Prosodic cues in text	-0.53	(0.77)	0.12	(0.92)	0.35	(0.73)	0.00	(0.88)
Punctuation performance (57)	17.05	(12.28)	26.79	(14.25)	29.50	(13.30)	24.78	(14.29)
Listening task (25)	13.23	(4.17)	15.75	(4.25)	16.94	(3.29)	15.43	(4.16)
Punctuation knowledge (4)	3.23	(0.74)	3.57	(0.62)	3.44	(0.64)	3.42	(0.68)
Word reading (174)	89.55	(24.47)	100.49	(18.30)	104.69	(21.34)	98.65	(22.21)
Phonological awareness (34)	24.48	(5.83)	27.02	(4.78)	26.17	(5.12)	25.93	(5.31)
Vocabulary (54)	34.89	(5.03)	36.83	(4.78)	39.75	(4.02)	37.29	(4.99)
Nonverbal ability (30)	13.59	(4.75)	16.62	(4.71)	16.79	(4.09)	15.75	(4.70)

[a]Prosodic sensitivity is included as a proportion score because some test items were missed due to software or tester error. Proportions were calculated from the number of items correct out of the number of test items received by each participant. All other scores are given as raw scores.

Table 3.2

Correlations Between Measures

Measure	1	2	3	4	5	6	7	8	9
1. Prosodic sensitivity	-								
2. Reading comprehension	.458***	-							
3. Prosodic cues in text	.444***	.618***	-						
4. Punctuation performance	.439***	.622***	.879***	-					
5. Listening task	.342***	.464***	.879***	.546***	-				
6. Punctuation knowledge	.199*	.455***	.348***	.363***	.248**	-			
7. Word reading	.320***	.570***	.511***	.616***	.282**	.348***	-		
8. Phonological awareness	.344***	.446***	.363***	.418***	.220**	.220**	.571***	-	
9. Vocabulary	.241**	.432***	.271**	.261**	.215**	.237**	.288***	.185*	-
10. Nonverbal ability	.458***	.514***	.584***	.539***	.487***	.324***	.417***	.383***	.346***

Note. *$p < .05$, **$p < .01$, ***$p < .001$. Prosodic Cues in Text is the composite of Punctuation Performance and the Listening Task.

with and without outliers. Again, correlations without the outliers is reported since these participants were included in the main analysis. Scores on all measures are significantly related based on $p < .05$. However, after correcting for the 45 correlations which were conducted, only correlations of $p < .001$ remain statistically significant (denoted by *** in Table 3.2). The variables most highly related to prosodic sensitivity are reading comprehension, awareness of prosodic cues in text, and nonverbal ability. Similarly, the variables most highly related to reading comprehension are awareness of prosodic cues in text and the Punctuation Performance task. Correlations show that all other measures are also related to reading comprehension which supports their relevance as control variables.

3.2 Testing Direct and Indirect Effects

Main Analysis. A mediation analysis was conducted to determine whether prosodic sensitivity and reading comprehension are related and whether prosodic sensitivity is indirectly related to reading comprehension through awareness of prosodic cues in text. Age, punctuation knowledge, word reading, phonological awareness, vocabulary, and nonverbal ability were included as covariates. Outliers were not included. This analysis was conducted using model 4 of the PROCESS macro in SPSS version 25.0 (Hayes, 2017; IBM Corp., 2017). Variables were standardized prior to analysis to make the coefficients comparable (Hayes, 2017). The results can be found in Table 3.3 and Figure 3.1. The model accounted for a sizable portion of the variance in reading comprehension, $R^2 = .586$.

Prosodic sensitivity was positively related to reading comprehension after controlling for awareness of prosodic cues in text (direct effect; $c' = .138$, $p = .038$) and independent of awareness of prosodic cues in text (total effect; $c = .179$, $p = .008$).

Table 3.3

Standardized Regression Coefficients for the Mediation Model

		Consequent						
		Awareness of Prosodic Cues in Text (*M*)				Reading Comprehension (*Y*)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Constant		-.005	.061	.933		-.014	.056	.807
Covariates								
Age		.230	.068	.001***		.108	.065	.100
Punctuation Knowledge		.133	.073	.072		.213	.068	.002**
Word Reading		.238	.081	.004**		.181	.076	.019*
Phonological Awareness		.011	.079	.890		.111	.072	.127
Vocabulary		-.089	.079	.263		.171	.073	.020*
Nonverbal Ability		.344	.076	<.001***		.049	.075	.514
Variables of Interest								
Prosodic Sensitivity (*X*)	*a*	.168	.071	.019*	*c'*	.139	.066	.038*
Awareness of Prosodic Cues in Text (*M*)		-	-	-	*b*	.248	.079	.002**
		$R^2 = .502$				$R^2 = .586$		
		$F(7, 135) = 19.45, p < .001$***				$F(8, 134) = 23.68, p < .001$***		

Note. *$p < .05$, **$p < .01$, ***$p < .001$.

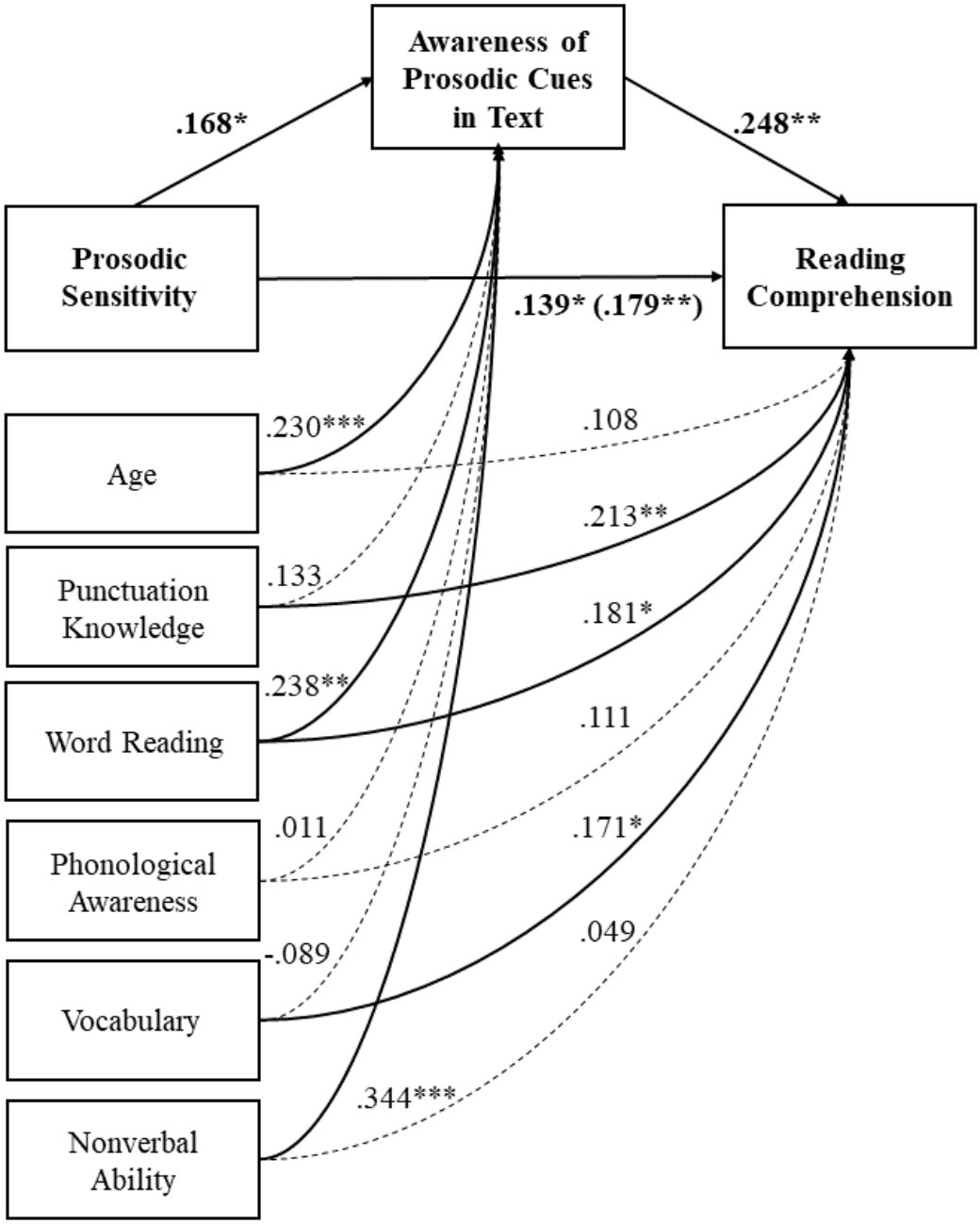

Figure 3.1. Mediation model with standardized regression coefficients. *$p < .05$, **$p < .01$, ***$p < .001$.

Prosodic sensitivity was positively related to awareness of prosodic cues in text (a = .168, p = .019). Awareness of prosodic cues in text was positively related to reading comprehension after controlling for prosodic sensitivity (b = .248, p = .002). A bias-corrected bootstrap confidence interval for the indirect effect (ab = .042) based on 5000 bootstrap samples was entirely above zero (.006 to .094). This suggests an indirect relation between prosodic sensitivity and reading comprehension through awareness of prosodic cues in text.

Analysis with outliers included. Outliers were not included in the main analysis reported above. However, the pattern of results would have been the same if outliers had been included. To further investigate the results found, the main analysis was conducted again with the outliers included. The model still accounted for a sizeable portion of the variance in reading comprehension, R^2 = .580. When outliers included, prosodic sensitivity was positively related to reading comprehension after controlling for awareness of prosodic cues in text (direct effect; c' = .135, p = .043) and independent of awareness of prosodic cues in text (total effect; c = .177, p = .009). Prosodic sensitivity was positively related to awareness of prosodic cues in text (a = .166, p = .019). Awareness of prosodic cues in text was positively related to reading comprehension after controlling for prosodic sensitivity (b = .256, p = .002). A bias-corrected bootstrap confidence interval for the indirect effect (ab = .042) based on 5000 bootstrap samples was entirely above zero (.006 to .092). A direct relation between prosodic sensitivity and reading comprehension and an indirect relation between prosodic sensitivity and reading comprehension through awareness of prosodic cues in text was therefore found with and without the outliers.

Analysis without covariates. The main analysis was also conducted without the covariates to confirm that the pattern of results does not depend on the presence of the covariates and is not due to suppressor effects. This is considered good practice when testing multivariate models and is recommended by Simmons, Nelson, and Simonsohn (2011). As in the main analysis, outliers were not included. The pattern of results was the same when covariates were not included and the model still accounted for a sizeable portion of the variance in reading comprehension, $R^2 = .424$. Prosodic sensitivity was positively related to reading comprehension after controlling for awareness of prosodic cues in text (direct effect; $c' = .229$, $p = .002$) and independent of awareness of prosodic cues in text (total effect; $c = .459$, $p < .001$). Prosodic sensitivity was positively related to awareness of prosodic cues in text ($a = .447$, $p < .001$). Awareness of prosodic cues in text was positively related to reading comprehension after controlling for prosodic sensitivity ($b = .515$, $p < .001$). A bias-corrected bootstrap confidence interval for the indirect effect ($ab = .230$) based on 5000 bootstrap samples was entirely above zero (.152 to .325). A direct relation between prosodic sensitivity and reading comprehension and an indirect relation between prosodic sensitivity and reading comprehension through awareness of prosodic cues in text was therefore found with and without the covariates. This suggests that the results found do not depend on the presence of the covariates.

3.3 Exploring Grade as a Moderator

Since the participants in this study spanned three grades, a second exploratory mediation analysis was conducted with grade as a moderator to determine whether grade moderates, 1) the relation between prosodic sensitivity and awareness of prosodic cues in text, 2) prosodic sensitivity and reading comprehension, or 3) awareness of prosodic cues

in text and reading comprehension. This model corresponded to model 59 of the PROCESS macro in SPSS version 25.0 (Hayes, 2017; IBM Corp., 2017), which was used to conduct the analysis. Data was re-examined for multivariate outliers in each individual grade. None were identified so all participants who completed all measures were included in this analysis. The results can be found in Table 3.4. Grade did not significantly moderate the relation between prosodic sensitivity and awareness of prosodic cues in text ($i_1 = .091$, $p = .231$), the relation between prosodic sensitivity and reading comprehension ($i_2 = .128$, $p = .073$), or the relation between awareness of prosodic cues in text and reading comprehension ($i_3 = .153$, $p = .055$). A key finding here is that the relation between prosodic sensitivity and reading comprehension is not affected by grade, although with the addition of grade as a control prosodic sensitivity was no longer related to reading comprehension after controlling for awareness of prosodic cues in text (direct effect; $c' = .116$, $p = .077$).

Pairwise contrasts suggested some grade differences in the overall indirect relation of prosodic sensitivity and reading comprehension through awareness of prosodic cues in text (path a*b). See Table 3.5 for the pairwise contrasts. There was a significant difference between the size of the indirect effect at Grade 3 versus Grade 4 as well as between the size of the indirect effect at Grade 3 versus Grade 5. Both bias-corrected bootstrap confidence intervals were entirely above zero. There were no significant differences between the size of the indirect effect at Grade 4 versus Grade 5 as the bias-corrected bootstrap confidence interval included zero. Examining the indirect effect at each grade suggests that the size of the indirect effect becomes larger as grade increases and is only statistically significant at Grade 4 and Grade 5. The indirect effect at each

Table 3.4

Standardized Regression Coefficients for the Moderated Mediation Model

		Consequent						
		Awareness of Prosodic Cues in Text (*M*)				Reading Comprehension (*Y*)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Constant		-.015	.061	.803		-.071	.060	.237
Covariates								
Age		.104	.190	.585		-.025	.171	.883
Punctuation Knowledge		.113	.068	.100		.174	.062	.006
Word Reading		.248	.081	.003**		.220	.075	.004**
Phonological Awareness		-.003	.077	.971		.058	.071	.415
Vocabulary		-.099	.070	.158		.134	.063	.037*
Nonverbal Ability		.348	.074	<.001***		.095	.073	.193
Grade		.176	.234	.452		.205	.211	.334
Variables of Interest								
Prosodic Sensitivity (*X*)	*a*	.158	.071	.027*	*c'*	.116	.065	.077
Awareness of Prosodic Cues in Text (*M*)		-	-	-	*b*	.243	.078	.002**
Interactions								
Grade x Prosodic Sensitivity		.091	.076	.231		-	-	-
Grade x Prosodic Sensitivity		-	-	-		.128	.071	.073
Grade x Awareness of Prosodic Cues in Text		-	-	-		.153	.079	.055
		$R^2 = .509$				$R^2 = .609$		
		$F(9, 135) = 15.55, p < .001$***				$F(11, 133) = 18.82, p < .001$***		

Note. *$p < .05$, **$p < .01$, ***$p < .001$.

Table 3.5

*Pairwise Contrasts Between the Conditional Indirect Effect (a*b) at Each Grade*

Grades	Contrast	Bootstrapped *SE*	Bootstrapped CI
Grade 4 vs. 3	.031	.017	[.002, .070]
Grade 5 vs. 3	.090	.046	[.008, .192]
Grade 5 vs. 4	.059	.033	[<.000, .131]

grade can be found in Table 3.6. Although the relation between prosodic sensitivity and reading comprehension is consistent across grades, prosodic sensitivity appears to only indirectly affect reading comprehension through awareness of prosodic cues in text at Grade 4 and 5 and not at Grade 3.

Table 3.6

*The Conditional Indirect Effect (path a*b) at Each Grade*

Grade	Effect	Bootstrapped *SE*	Bootstrapped CI
Grade 3	.005	.016	[-.024, .044]
Grade 4	.036	.021	[.003, .083]
Grade 5	.095	.018	[.018, .194]

CHAPTER 4 DISCUSSION

4.1 Conclusions

Prosody produced in the context of fluent oral reading is thought to demonstrate reading comprehension (Miller & Schwanenflugel, 2006; Kuhn, et al., 2010). However, less attention has been paid to prosodic sensitivity. Prosodic sensitivity has been found to relate to speech comprehension (Cutler et al., 1997) but whether prosodic sensitivity is also related to reading comprehension is less clear. Therefore, the first goal of this thesis was to determine *whether* prosodic sensitivity is related to reading comprehension in English-speaking children in the mid-elementary grades. Prosodic sensitivity and reading comprehension were found to be positively related in Grades 3-5 after controlling for age, punctuation knowledge, word reading, phonological awareness, vocabulary, and nonverbal ability. The second goal of this thesis was to determine *how* prosodic sensitivity and reading comprehension are related. Punctuation marks represent prosodic cues in text, and the possibility that prosodic sensitivity is indirectly related to reading comprehension through awareness of these prosodic cues in text was tested. Prosodic sensitivity was found to be indirectly related to reading comprehension through awareness of prosodic cues in text after controlling for age, punctuation knowledge, word reading, phonological awareness, vocabulary, and nonverbal ability. Awareness of prosodic cues in text did not fully explain the relation between prosodic sensitivity and reading comprehension, but a partial indirect effect provides evidence that these constructs are separate and that awareness of prosodic cues in text has a distinct role in the relation between prosodic sensitivity and reading comprehension.

An exploratory analysis was also conducted to determine whether these results were consistent across Grades 3-5. This analysis was considered exploratory primarily because of low power. Fritz and MacKinnon (2007) ran a simulation study on sample sizes needed to achieve .80 power in mediation models. These simulations did not include covariates but examining their recommendations can give an approximate idea of whether there was sufficient power in this analysis. Based on the type of mediation used and the sizes of paths a and b in this study, Fritz and MacKinnon (2007) recommend a minimum sample size of 53 participants. While the full sample of participants in this study far exceeded this number, the number of participants per grade was 45 in Grade 3, 47 in Grade 4, and 53 in Grade 5.[1] These numbers, particularly at Grade 3 and 4, fall slightly short of recommendations. When the mediation model was run with grade as a moderator, awareness of prosodic cues in text appeared to play an indirect role in the relation between prosodic sensitivity and reading comprehension at Grades 4 and 5 but not at Grade 3. Grade did not moderate the relationship between prosodic sensitivity and reading comprehension or between awareness of prosodic cues in text and reading comprehension, but these relations were trending towards significance (p = .073 and p = .055 respectively). Although concerns with low power limit the amount of confidence we can have in these results, they do raise the possibility that the role of awareness of prosodic cues in text is not consistent across development.

Returning to the finding that prosodic sensitivity and reading comprehension are related at the mid-elementary grades, this corroborates the findings of Whalley and Hansen (2006) who found that prosodic sensitivity and reading comprehension are

[1] These numbers do not include participants who did not complete all measures since they were not included in analyses.

related at 8- to 10-years of age. In addition to word reading and phonological awareness which Whalley and Hansen (2006) controlled for, the study reported on here also controlled for age, punctuation ability, vocabulary, nonverbal ability, and awareness of prosodic cues in text. The finding that prosodic sensitivity and reading comprehension are related beyond the effects of these control variables is noteworthy. Together, these two studies provide evidence for the existence of a relation between prosodic sensitivity and reading comprehension. However, these results contradict the findings of Deacon et al. (2018), who did not find a relation between prosodic sensitivity and reading comprehension in 5- to 7-year-olds. Both the current study and Whalley and Hansen (2006) examined 8- to 10-year-olds, so it is possible that prosodic sensitivity and reading comprehension are not related or are only weakly related until mid-elementary school. This relation may take time to develop.

The relation between prosodic sensitivity and reading comprehension may develop over time because children may become increasingly aware of implicit prosody or because implicit prosody may be useful for reading the increasingly complex texts children encounter. According to the Implicit Prosody Hypothesis (Fodor, 2002), prosodic sensitivity may be related to reading comprehension because implicit prosody adds information to text the same way oral prosody adds information to speech. It is possible that younger children may not be as aware of their implicit prosody as older children and thus may not be able to use the information in implicit prosody to the same extent when reading. It is also possible that younger children are aware of their implicit prosody but that they do not yet use the information in implicit prosody because such information may be useful when attempting to understand complex texts but not simple

texts. As children progress through school they encounter increasingly complex texts. . Complex texts are more difficult to understand and include longer sentences with varying structure (Benjamin & Schwanenflugel, 2010). For example, the sentence, *The dog chased the cat.* has a simpler structure and is easier to understand than this more complex sentence: *The dog, who was brown, chased the cat.* If readers pause at the commas in the more complex sentence, their implicit prosody may aid understanding of the sentence by helping them to separate the sentence into manageable and meaningful groups of words. This is not as necessary in the simpler sentence. Benjamin and Schwanenflugel (2010) examined English-speaking Grade 2 students and found that their prosodic reading of complex texts contributed unique variance to reading comprehension, but their prosodic reading of simple texts did not. Prosodic sensitivity and reading comprehension may be more strongly linked when reading complex texts.

The finding that prosodic sensitivity is indirectly related to reading comprehension through awareness of prosodic cues in text, at least at Grades 4 and 5, also brings together findings from previous studies. Miller and Schwanenflugel (2006) and Ravid and Mashraki (2007) found that prosodic reading and reading comprehension were related at Grade 3 and Grade 4 respectively, and this is supported by the current finding that awareness of prosodic cues in text is related to reading comprehension. The pilot study by Wade-Woolley and Heggie (2018) found that prosodic sensitivity was significantly correlated with punctuation ability at Grade 8. However, Wade-Woolley and Heggie (2018) did not find a significant correlation between prosodic sensitivity and punctuation ability at Grade 3. This is in contrast to the current finding that prosodic sensitivity and awareness of prosodic cues in text are related from Grades 3-5, although the exploratory

analysis with grade as a moderator suggested that relations at Grade 3 may be different than at Grade 4 and 5. Beyond these individual relations, the current study found that prosodic sensitivity is related to reading comprehension through awareness of prosodic cues in text after controlling for age, word reading, punctuation knowledge, phonological awareness, vocabulary, and nonverbal ability. This finding helps to specify why there is a relation between prosodic sensitivity and reading comprehension.

Beyond establishing whether there is a relation between prosodic sensitivity and reading comprehension, this thesis attempted to determine how such a relation could work. Prosodic sensitivity reflects an awareness of prosody in speech, so how does that translate to reading text? We know that prosodic sensitivity is related to speech comprehension because individual differences in prosodic sensitivity mean individual differences in the ability to access information communicated by prosody (Cutler et al., 1997). Theories such as the Implicit Prosody Hypothesis (Fodor, 2002) suggest that readers project a prosodic contour onto text even when reading silently, so it is possible that implicit prosody includes similar information to prosody in speech and this information may have implications for meaning. High prosodic sensitivity may lead to more speech-like implicit prosody. Speech-like implicit prosody may be more appropriate and informative, which in turn may support reading comprehension. It is also possible that higher reading comprehension leads to the application of more appropriate implicit prosody which in turn supports prosodic sensitivity. This study took the theoretical position that prosodic sensitivity supports reading comprehension (Gough & Tunmer, 1986; Perfetti & Stafura, 2014), but the data was cross-sectional and so direction

cannot be determined. Determining the direction of the relation between prosodic sensitivity and reading comprehension remains a job for future research.

Regardless of the direction of the relation between prosodic sensitivity and reading comprehension, awareness of prosodic cues in text appears to play a role. Prosody is represented in text to some extent through punctuation. Prosodic cues in text such as punctuation marks may help to guide implicit prosody (Fodor, 2002; Chafe, 1988). Awareness of how punctuation marks reflect prosody may help readers to project implicit prosody which is more appropriate and informative. If punctuation was absent from text, it would be much more challenging to separate phrases appropriately and to determine what types of sentences were being represented (e.g. statements, questions). It is possible that high prosodic sensitivity may lead to a higher awareness of how punctuation marks can be used as a guide to separate phrases and determine sentence types. This awareness could reasonably support reading comprehension. It is also possible that higher reading comprehension supports reader's awareness of how punctuation marks separate phrases and determine sentence types. This increased awareness could lead to higher prosodic sensitivity. Either way, prosodic cues in text can act as a guide to implicit prosody and this may help to partially explain the relation between prosodic sensitivity and reading comprehension.

There may be developmental differences in the relation between prosodic sensitivity and reading comprehension, especially regarding the role of prosodic cues in text. The exploratory analysis conducted suggested that awareness of prosodic cues in text may be involved in the relation between prosodic sensitivity and reading comprehension at Grades 4 and 5 but not at Grade 3. Examining mean performance on

measures by grade (Table 3.1) reveals that participants in Grade 4 and 5 appear to score more similarly on most measures than Grade 3 and 4. It is possible that a shift occurs between Grade 3 and Grade 4. This possibility is in line with previous research. Wade-Woolley and Heggie (2018) found that prosodic sensitivity was correlated with punctuation ability at Grade 8 but not at Grade 3. Deacon et al. (2018) also found no relation between prosodic sensitivity and reading comprehension for 5- to 7-year olds while Whalley and Hansen (2006) did find a relation for 8- to 10-year-olds. It is possible that children may not be aware of how prosody is represented in text until Grade 4, though the performance of the Grade 3 children in this study on the awareness of prosodic cues in text measures suggests that this is not the case. It is perhaps more likely that children in Grade 3 are not yet using their awareness of prosodic cues in text when attempting to understand what they read. Over time there may be a shift from prosodic sensitivity being not related or only directly related to reading comprehension, to prosodic sensitivity being indirectly related to reading comprehension through awareness of prosodic cues in text.

4.2 Theoretical Implications

These results suggest that prosodic sensitivity should be explicitly incorporated into theories of reading comprehension. The Simple View of Reading (Gough & Tunmer, 1986, Hoover & Gough, 1990) as an abstract framework (Kirby & Savage, 2008) leaves room for prosodic sensitivity to play a role in reading comprehension because prosodic sensitivity is related to oral language comprehension (Cutler et al., 1997). Oral language comprehension, termed linguistic comprehension, is one of the two components of the Simple View of Reading. The fact that this study found prosodic sensitivity to relate to

reading comprehension after controlling for word reading, which is similar to the decoding component of the Simple View of Reading, further reinforces this possibility. Prosodic sensitivity is not an explicit component of the Simple View of Reading, but these findings suggest that it should be included in broader conceptualizations, particularly when the components of Simple View of Reading is conceptualized as an abstract framework. There is more to reading than being able to pronounce words on a page. To understand text, a network of oral language skills including prosodic sensitivity is also needed.

Similarly, the Reading Systems Framework (Perfetti & Stafura, 2014) includes phonology but does not explicitly include prosody or prosodic sensitivity. Prosody is a component of phonology, so the Reading Systems Framework leaves room for the possibility that prosody influences reading comprehension as phonology is theorized to influence reading comprehension. However, in my view prosody should be accounted for separately from segmental phonology. This thesis found prosodic sensitivity to contribute to reading comprehension after controlling for the effects of segmental phonological awareness, but segmental phonological awareness did not contribute to reading comprehension after controlling for prosodic sensitivity. Theories such as the Reading Systems Framework should include prosodic sensitivity separately and in addition to segmental phonology skills such as phonological awareness. Prosodic sensitivity, along with phonological awareness, may be part of the linguistic system of the Reading Systems Framework which leads to reading comprehension processes.

Moreover, these results suggest that awareness of prosodic cues in text should be incorporated into theories of reading comprehension. Letters and sounds are natural parts

of the conversation around segmental phonology and reading, and I suggest that punctuation should be part of the conversation when talking about prosody and reading. Awareness of prosodic cues in text is not included in any current theories of reading comprehension in English, although Gutierrez-Palma et al. (2010) did propose that, for Spanish readers, prosodic sensitivity may play a direct role in reading comprehension through use of punctuation marks. In English, prosodic sensitivity may play a similar role. Prosodic sensitivity may affect use of and awareness of punctuation marks, which may affect reading comprehension (or vice versa). Readers do not ignore punctuation marks, and neither should reading theories.

4.3 Educational Implications

The ultimate goal of this line of research is to inform teaching strategies and interventions which can be applied to help improve reading comprehension. Gaining a better understanding of what skills are related to naturally occurring individual differences in reading comprehension and how is a crucial first step. Though there is still much work to be done, this study has revealed possible avenues for teaching and intervention which should be explored. To determine appropriate recommendations, it is useful to first examine what children are currently being taught about punctuation, prosody, and reading comprehension.

Learning outcomes in Nova Scotia suggest that punctuation and prosody are already very important to educators, especially in the context of oral reading (Nova Scotia Department of Education and Early Childhood Development, 2015). According to the Nova Scotia learning outcomes document, children learn about punctuation, prosody, and reading comprehension in the very early grades. In primary, students are expected to be

able to identify and describe the use of punctuation marks. With regards to prosody, students should know what fluent reading sounds like. Prosody is explicitly listed as a component of reading fluency which students should be able to recognize. Students should also understand that print carries a message. By Grade 1, students are expected to be able to understand the message in very simple texts. The complexity of the texts which students are expected to understand increase each year throughout elementary school. Interestingly, when reading out loud students are expected to be able to use punctuation to guide prosody. This includes guiding appropriate pauses, intonation, and expression. By Grade 3, students should be able to use punctuation marks to convey meaning during oral reading.

Learning outcomes in Nova Scotia acknowledge the role of punctuation marks in guiding prosody during oral reading and in clarifying meaning (Nova Scotia Department of Education and Early Childhood Development, 2015). However, little focus is placed on awareness of prosody. It may be useful to discuss not only what punctuation marks are used for but also what they sound like. For example, "This is a question mark. When you hear pitch go up at the end of a sentence, it is a question. When you see a question mark when reading, your pitch should also go up at the end." Explicit instruction on the link between punctuation marks and prosody may support student's use of punctuation as a guide to prosody during silent reading as well as oral reading. During silent reading, students can be encouraged to look for periods to find where they would pause if reading out loud. Pausing at these same points during silent reading might help separate texts into more manageable chunks. Continuing to promote oral reading as children progress

through elementary school and encounter texts which are progressively more complicated may also be useful to reinforce how increasingly complex text should sound.

4.4 Limitations and Future Directions

This study had several limitations which must be taken into account when interpreting the results. The first is that the data collected for this study is cross-sectional. Although mediation analyses are often interpreted as having a causal nature, assumptions cannot be made about cause and caution is strongly advised about drawing conclusions on the direction of the reported relations. The model in this study tested the theoretical direction that prosodic sensitivity supports reading comprehension, but it is also possible that reading comprehension supports prosodic sensitivity and the results can be equally interpreted in this direction. Additionally, it is possible that this relation is bidirectional. Longitudinal data, in which both variables are tested at two or more time points, would provide insight into the temporal order of this effect since it could be determined whether one variable accounts for gains in the other (e.g. Deacon, Benere, & Castles, 2012). Likewise, the model in this study tests whether prosodic sensitivity predicts awareness of prosodic cues in text which in turn predicts reading comprehension, but longitudinal data or an intervention study would be needed to confirm the directionality of these effects as well. Future research should involve a longitudinal study or intervention study. Still, this area of study is in its infancy and in my view a first step is to delineate relations between these variables is valuable even without definitive evidence of the direction of these relations.

The results are specific to the age group tested (Grades 3 to 5) and cannot be generalized to students in younger or older grades. Participants in this study were also in

three different grades. A range of grades was collected primarily to increase the number of participants who could be recruited and tested. Age was a control variable in this study, however there is still a risk that developmental change was being captured, especially since the exploratory analysis found that prosodic sensitivity was indirectly related to reading comprehension through awareness of prosodic cues in text at Grades 4 and 5 but not at Grade 3. The possibly of low power when attempting to detect indirect effects by grade increases the need for future studies to determine whether there are differences between Grade 3 and Grades 4 and 5. Future research should also examine other grades to determine whether these relations exist at other points of development. It is possible that Grade 3 represents a shift in the existence or nature of the relation between prosodic sensitivity and reading comprehension. This possibility should be investigated with students in younger grades.

This study was also conducted with English-speaking participants, limiting implications to English. We cannot conclude whether the relations found extend to other languages. Other studies should be conducted to determine if these relations exist in other languages. For example, tonal languages such as Mandarin use pitch to distinguish grammatical or lexical meaning (Klein, Zatorre, Milner, & Zhao, 2001). Prosodic sensitivity may play a different and perhaps a more important role in understanding tonal languages.

Not all participants in this study spoke English as a first language or as an only language. This diversity likely made our sample more representative of the mid-elementary population as it reflects a broader reality. According to Statistics Canada, 8.14% of Nova Scotians and 41.92% of Canadians do not speak English as a first

language (2017). The percentage of children in this study who did not report speaking English as a first language was 12.58%. The current study found that students who did not report speaking English as a first language performed similarly to students who did report speaking English as a first language on standardized measures, with the exception of vocabulary. Vocabulary contributed significantly to reading comprehension but not to prosodic sensitivity, although vocabulary was significantly correlated with both variables. There were not enough participants in the current sample who spoke additional languages to examine the effects of specific additional languages on the relations between prosodic sensitivity, reading comprehension, and awareness of prosodic cues in text. This is a potential avenue for future research. Interestingly, English-speaking adults learning Mandarin, a tonal language, as an additional language have been found to have improved awareness of pitch changes after only six months of instruction (Potter, Wang, & Saffran, 2017). This suggests that experience with additional languages does impact prosodic sensitivity. Importantly, this also suggests that prosodic sensitivity can be improved, at least in adulthood.

Both prosody and punctuation marks are interwoven with syntax (Miller & Schwanenflugel, 2006; Fodor, 2002). Variations in oral prosody such as pauses and pitch changes can indicate how words are structured into meaningful and syntactically appropriate phrases (Dowhower, 1991). In text, punctuation marks often mark these locations (Miller & Schwanenflugel, 2006) and can be used by readers to resolve syntactic ambiguities (Fodor, 2002). However, syntactic awareness, the ability to reflect on and manipulate the syntactic structure of sentences (Mokhtari & Thompson, 2006), was not included as a control variable in this study. Syntactic awareness has been found

to be related to reading comprehension (e.g., Mokhtari & Thompson, 2006) but little is known about the relations between syntactic awareness, prosodic sensitivity, and awareness of prosodic cues in text. The only study to my knowledge which examined the contribution of prosodic sensitivity to reading comprehension while controlling for syntactic awareness is Clin et al. (2009). Clin et al. (2009) found that prosodic sensitivity contributed unique variance to reading ability (a combination of reading comprehension, word reading, reading rate, and reading accuracy) after controlling for general language ability, assessed using an oral measure focusing on morphological and syntactic knowledge. Although prosodic sensitivity contributed unique variance beyond a measure involving syntactic awareness in Clin et al. (2009), this is a single study and so the role of syntactic awareness cannot be dismissed.

Syntactic awareness may have played a role in the results of this study because both measures of awareness of prosodic cues in text in this study, the Listening task and the Punctuation Performance task, likely involved syntactic awareness. Pairs of sentences in the Listening task differed on prosody and punctuation marks but also on syntactic structure. In the Punctuation Performance task, participants may have been using their knowledge of sentence structure to help determine where to apply punctuation marks. Syntactic awareness may be valuable as a control variable in future studies to determine whether reading comprehension, prosodic sensitivity, and awareness of prosodic cues in text are related beyond the influence of syntactic awareness.

Another limitation is the low reliability of the prosodic sensitivity measure. The DEEdee task (Whalley & Hansen, 2006) had a Cronbach's alpha of .67 for the current sample which is slightly below the commonly recommended cut-off of .70 (Nunnally,

1978). However, others have considered reliabilities of >.65 (DeVellis, 1991) and even >.60 (Hair, Black, Babin, & Anderson, 2010) to be acceptable, particularly for measures used for research purposes (Roszkowski & Spreat, 2011). The reliability of the DEEdee task is also comparable to other prosodic sensitivity tasks. The Dina the Diver task and Brenda's Animal Park are similar tasks to the task used in this study in that all three tasks assess prosodic sensitivity at both the word and phrase level. Holliman, Williams et al. (2014) found that Dina the Diver had a Cronbach's alpha of .63 and Holliman et al. (2017) found that Brenda's Animal Park had a Cronbach's alpha of .71. The DEEdee task (Whalley & Hansen, 2006) had the advantage of including both word and phrase level prosody. However, a useful avenue for future research may be to determine whether word level and phrase level prosodic sensitivity are related to reading comprehension or other reading outcomes differently.

The DEEdee task is also limited in that it only includes items assessing awareness of stress. Although stress is the most widely studied aspect of prosody, prosody also includes intonation and timing (Holliman, 2016). The fact that this measure only assesses awareness of a single aspect of prosody limits the general conclusions which can be made about prosodic sensitivity in this study. This study suggests that awareness of stress is related to reading comprehension and to awareness of prosodic cues in the mid-elementary grades. However, these conclusions cannot be generalized to the relations between reading comprehension, awareness of prosodic cues in text, and other aspects of prosody including intonation and timing. These conclusions also cannot be generalized to prosodic sensitivity as a whole, despite the use of this broad term in this thesis. Future

studies are encouraged to develop and use reliable multidimensional measures of prosodic sensitivity.

Punctuation marks were the only prosodic cues in text examined in this study, but it is possible that punctuation marks are not the only prosodic cue available in text. Research on word reading has found that the spelling of words, particularly the ends of words, is highly predictive of stress placement (Arciuli, Monaghan, & Seva, 2010). Sparks (2018) found that English-speaking adults and children in Grades 5-6 use the stress patterns of aurally presented pseudowords to guide their spelling. For example, the ending spelling *-et* is associated with first-syllable stress while the ending spelling *-ette* is associated with second-syllable stress. Sparks (2018) found that adults and children in Grades 5-6 chose the ending spelling related to the stress pattern they heard. During reading, word ending spelling may be an additional prosodic cue in text. This type of cue was not examined in this study, but future research should investigate whether awareness of word ending spellings is related to prosodic sensitivity, reading comprehension, and the punctuation measures used to measure awareness of prosodic cues in text in the current study.

In summary, this thesis provides evidence for a relation between prosodic sensitivity and reading comprehension in Grades 3-5. The inclusion of so many control variables including age, word reading, punctuation knowledge, phonological awareness, vocabulary, and nonverbal ability, allows for greater confidence in the results. Additionally, this thesis provides initial evidence suggesting that awareness of prosodic cues in text, specifically punctuation marks, plays a role in the relation between prosodic sensitivity and reading comprehension. In my view, awareness of prosody should be

included in theories of reading comprehension. Prosody is present in speech and theories such as the Implicit Prosody Hypothesis (Fodor, 2002) suggest that prosody is also present during reading through mental representations of text. The way prosody is represented in text, through punctuation, is important to consider when examining how prosodic sensitivity relates to reading comprehension and other reading outcomes. It is my hope that the evidence presented in this thesis will allow both prosodic sensitivity and awareness of prosodic cues in text to become more prominent parts of the conversation on reading development moving forward.

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APPENDIX A List of Items from the DEEdee Task

The first line for each item lists what participants heard. The second line lists the names of stories which correspond to the stress pattern of the dee-dee phrases heard.

DEE or underlined = strongly stressed syllable

dee or not underlined = weakly stressed syllable

Practice Items

A.	Humpty Dumpty	DEEdee DEEdee Humpty Dumpty	dee DEEdee DEE The Lion King
B.	Bob the Builder	DEE dee DEEdee Bob the Builder	deeDEEdeeDEE Pinocchio

Test Items

1.	Snow White	DEE DEE Snow White	DEEdee Bambi
2.	Aladdin	dee DEE DEE The Frog Prince	deeDEEdee Aladdin
3.	Pokémon	dee DEE DEE The Snow Dogs	DEEdeeDEE Pokémon
4.	Old King Cole	DEE dee DEE Jack and Jill	DEE DEE DEE Old King Cole
5.	The Simpsons	DEEdee DEE Peter Pan	dee DEEdee The Simpsons
6.	Cinderella	DEEdeeDEEdee Cinderella	DEEdee dee DEE Winnie the Pooh
7.	Old Mother Goose	DEE DEEdee DEE Old Mother Goose	deeDEEdeeDEE Pinocchio
8.	Sesame Street	DEEdeedee DEE Sesame Street	DEE dee DEEdee Bob the Builder
9.	Thumbelina	deeDEEdeeDEE Pinocchio	DEEdeeDEEdee Thumbelina

10.	Sleeping Beauty	DEEdee DEEdee Sleeping Beauty	dee DEEdee DEE The Saddle Club
11.	The Jungle Book	dee DEEdee DEE The Jungle Book	DEEdee DEEdee Mary Poppins
12.	Pocahontas	dee DEEdee DEE The Lion King	DEEdeeDEEdee Pocahontas
13.	Stuart Little	DEEdee DEEdee Stuart Little	DEEdee DEE DEE Little Boy Blue
14.	The Ginger-bread Man	dee DEEdeedee DEE The Gingerbread Man	dee DEEdee DEEdee The Ugly Duckling
15.	The Little Mermaid	dee DEEdee DEEdee The Little Mermaid	DEEdee deeDEEdee Hairy McClary
16.	Hansel and Gretel	dee deeDEEdeeDEE The Aristocrats	DEEdee dee DEEdee Hansel and Gretel
17.	The Fox and the Hound	dee DEE dee dee DEE The Fox and the Hound	DEE DEEdee DEEdee Hey Diddle Diddle
18.	Lady and the Tramp	DEEdee dee dee DEE Lady and the Tramp	DEEdee DEE DEEdee Little Miss Muffet

APPENDIX B Practice Item and Unpunctuated Paragraph from the Punctuation Performance Task

ethan came inside annie asked is it sunny

lily and her mom went to the park they walked in and lily spotted a big brown fluffy dog mom can i pet the dog lily asked you will need to ask the dogs owner her mom replied okay said lily lily walked up to the woman holding the dogs leash can i please pet your dog lily asked sure said the woman just remember to be gentle talk softly and avoid surprising him what is his name lily asked his name is teddy said the woman hi teddy said lily bending down to pet him teddy looked up at lily and licked her with his wet pink dog tongue why did he do that asked lily the woman laughed i think he likes you she said

APPENDIX C Practice Items and Unpunctuated Sentences from the Listening Task

A. is it rainy outside

B. it is windy she said

1. that is all jacob said
2. she said she wants to go later
3. adam went to the park
4. we should play mice
5. the child wore gold
6. go get him grandma
7. she eats shoots and leaves
8. we should play cats
9. she said she wants to go today
10. that is all emma said
11. penny went to the shop
12. go get him grandpa
13. the girl wore blue
14. he eats shoots and leaves

APPENDIX D List of Items and Correct Responses for Punctuation Knowledge

From Clay's (1989) Concepts About Print

Item	*Correct Responses*
1. Question mark (?)	Said "question mark" Said "a question" Said "asks something"
2. Quotation marks (" ")	Said "that's someone talking" Said "talking" Said "speech marks"
3. Comma (,)	Said "a little stop" Said "a rest" Said "a comma"
4. Period (.)	Said "full stop" Said "period" Said "it tells you when you've said enough" Said "it's the end