Exploring the Role of Prosody in Passage Reading of Experienced and Early Readers

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Copyright Statement

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Relevant Definitions

Prosody: The rhythmic and melodic elements of language, including cues of stress, phrasing, and intonation.

Prosodic competence: A sensitivity to, and awareness of, the prosodic elements of language.

Prosodic passage reading: Reading aloud with appropriate prosody (e.g. expressively, at an appropriate pace, with correct intonation).

Presentations and Publications from Thesis

Chapters 2, 5:

The literature review discussed in chapters 2 and 5 informed the following publication:

Wade-Woolley, L., Wood, C., Chan, J., & Weidman, S.K. (2021). Prosodic Competence as the Missing Component of Reading Processes Across Languages: Theory, Evidence and Future Research. *Scientific Studies of Reading*, 1-17. https://doi.org/10.1080/10888438.2021.1995390

Chapter 6:

The study reported in chapter 6 informed the following oral conference presentations:

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Weidman, S.K., Wood C., Harrison E., & Williams, G.J (2019, March). *It's more than words: Exploring the importance of prosody in speech & reading comprehension*. NTU School of Social Sciences Research Conference. Talk in session ‘Brain Behaviours and Cognition Panel.’ Nottingham, UK.

The study reported in chapter 6 also informed the following conference poster:

Weidman, S.K., Wood, C., Harrison E., & Williams, G.J. (2019, March) *It's More than words: Exploring the Importance of Prosody in Speech and Reading Comprehension*. [Poster] NTU School of Social Sciences Research Conference. Nottingham, UK.

Chapters 7, 8

The studies reported in chapters 7 and 8 informed the following conference poster:

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Abstract

Previous research has consistently demonstrated that individual differences in prosodic competence (i.e., an individual's sensitivity to and awareness of prosodic cues) are positively associated with reading comprehension (e.g., Chung & Bidelman, 2021; Holliman, Williams, et al., 2014; Lochrin et al., 2015; Veenendaal et al., 2014). It is less clear, however, whether this relationship between prosodic competence and reading comprehension is simply due to the role of prosody in the many lower level skills involved in efficient word reading, or, whether well-developed prosodic competence facilitates reading comprehension at a higher level. Accordingly, one of the hypotheses proposed in this thesis is that prosodic competence facilitates reading comprehension at the passage level by allowing for prosodic passage reading (i.e., the ability to read a passage with appropriate prosody).

This thesis describes three empirical studies designed to examine the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension in two samples of participants: experienced readers (adults) and early readers (children ages 7- to 11-years-old). Specifically, analyses were used to investigate (a) whether performance on prosodic competence tasks explained unique variance in passage reading (prosodic reading and comprehension) after accounting for word-level reading skills (e.g., vocabulary, segmental PA, and single word reading), (b) whether prosodic passage reading ability explained unique variance in reading comprehension, after accounting for word-level reading skills, and (c) whether prosodic passage reading ability explained the contribution of prosodic competence to reading comprehension.

Results demonstrated that prosodic competence did not account for additional variance in reading comprehension, after controlling for word-level reading skills in either sample of readers. Consequently, there was no evidence that prosodic passage reading mediated the relationship between prosodic competence and reading comprehension. However, results did reveal that the role of prosody in relation to passage reading was markedly different between experienced and early readers. To illustrate, prosodic competence accounted for unique variance in prosodic passage reading (after accounting for all word-level reading skills), but exclusively in the samples of experienced readers—suggesting that prosodic competence likely facilitates prosodic passage reading, but only after a certain level of reading efficiency has been achieved. On the other hand, prosodic passage reading accounted for unique variance in reading comprehension (after accounting for all word-level reading skills), exclusively in the sample of early readers—suggesting that prosodic passage reading likely acts as a comprehension tool, but only during reading development. Accordingly, I argue that prosody should be integrated into future frameworks of reading comprehension, but that a developmental approach, which considers the changing role of prosody, is necessary. I also maintain that these results support the incorporation of prosodic passage reading in early literacy curricula.

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1. Introduction

Phonology is a branch of linguistics that is concerned with how speech sounds are stored, perceived, and produced (Nathan, 2019). This includes not only segmental phonology, which refers to the elements of language that can be considered individual segments (including words, syllables, and phonemes), but also prosody, which refers to the rhythmic and melodic elements of language (including cues of stress, phrasing, and intonation). This thesis examines the role of the latter, prosody, in relation to passage reading. I will refer to both *prosodic competence* and *prosodic passage reading*. Whereas prosodic competence refers to an individual's understanding of prosody within language in general (e.g., an awareness of the small differences in the intonational cues of spoken language), prosodic passage reading refers to an individual's ability to read a text aloud with appropriate prosody (e.g., reading with expression and with correct intonation). In this thesis, I argue that it is necessary to assess these two skillsets separately in order to (a) understand the theoretical role of prosody in passage reading and (b) identify how prosody should be incorporated into literacy education.

Phonological awareness (segmental PA), the ability to conceptualise phonology, is widely recognised as a crucial component of experienced reading (Bus & Van IJzendoorn, 1999). However, an overwhelming majority of the empirical work exploring the role of phonological awareness in relation to reading has focused only on the *segmental* aspects. The role of prosody in relation to reading, on the other hand, only started to receive empirical attention relatively recently (see Wade-Woolley & Heggie, 2016 for review). Nevertheless, prosodic passage reading is widely recognised by educators as an important reading skill. For example, the UK National Curriculum alludes to the importance of reading with prosody, stating "*Reading, re-reading, and rehearsing poems and plays for presentation and performance give pupils opportunities to discuss language, including vocabulary, extending their interest in the meaning and origin of words. Pupils should be encouraged to use drama approaches to understand how to perform plays and poems to support their understanding of the meaning.* ***These activities also provide them with an incentive to find out what expression is required, so feeding into comprehension*** [emphasis added]*."* (Department for Education, 2014).

Previous research examining the importance of prosodic competence in relation to reading, however, has largely focused on single word reading ability (Critten et al., 2021, Enderby et al., 2021; Holliman et al., 2017)—investigating how an awareness of prosodic cues may facilitate decoding and recognition of individual words. On the other hand, much less empirical work has explored how prosodic competence is related to higher level reading outputs, such as oral passage reading and comprehension.

Researchers who have investigated the contribution of prosodic competence to passage comprehension have reported mixed findings; some studies have indicated that prosodic competence predicts reading comprehension independently of word and sub-word level reading skills (Chung & Bidelman 2021; Groen et al., 2019; Veenendaal et al., 2014; Whalley & Hansen, 2006), while others have indicated that the relationship between prosodic competence and reading comprehension is completely accounted for by differences in these lower level skills (Chan & Wade-Woolley, 2018; Deacon et al., 2018; Holliman et al., 2010a). Interestingly, very few studies have explored whether the contribution of prosodic competence to reading comprehension may be related to individual differences in prosodic passage reading ability (Groen et al., 2019; Holliman et al., 2010a; Veenendaal et al., 2014). Moreover, no studies, to my knowledge, have explored whether the contribution of prosodic competence to prosodic passage reading is independent of word-level reading skills. To put it another way, there is not yet sufficient empirical research demonstrating that an understanding of prosodic cues in language is related to the ability to read a passage with appropriate prosody, after accounting for individual differences in single word reading ability. This knowledge gap is particularly notable given emerging evidence that prosodic passage reading may actually facilitate reading comprehension (Kim et al., 2021; Lai et al., 2014; Paige et al., 2017; Veenendaal et al., 2016)—thereby suggesting that the role of prosodic competence in relation to reading comprehension could be that that it underpins prosodic passage reading.

It is also important to note that the role of prosodic competence in relation to reading likely changes over the course of development. According to the Simple View of Reading (SVR; Hoover & Gough, 1990; Gough et al., 1996), the relative importance of decoding skills to reading comprehension decreases as readers become more skilled, while the relative importance of language comprehension skills increases. Given that prosodic competence appears to be implicated in both decoding processes (e.g., segmental PA, single word reading) and language comprehension processes (e.g., vocabulary, syntactic processing), it follows that an understanding of prosody may be important for both early readers and experienced readers. However, very few studies have explored the extent to which individual differences in prosodic competence relates to reading comprehension in experienced adult readers (Chan & Wade-Wooley, 2018; Kitzen, 2001; Williams & Wood, 2012) and no published studies, to my knowledge, have considered the relationship between prosodic competence and prosodic passage reading in this population. Consequently, our current understanding as to how prosodic competence is implicated in passage reading is limited. This thesis, therefore, empirically evaluates the concurrent relationships between the ability to conceptualise prosodic cues in language (i.e., prosodic competence), the ability to read aloud with appropriate prosody (i.e., prosodic passage reading), and the ability to comprehend written passages (i.e., reading comprehension) in order to better understand how researchers and educators should consider the role of prosody in passage reading.

1.1. Original Contribution to Knowledge

Theoretical contributions:

The empirical research described in this thesis contains some of the very few studies to assess prosodic competence and prosodic passage reading as separate constructs. Moreover, this thesis describes the first set of studies to (a) assess how these two individual constructs (prosodic competence and prosodic passage reading) relate to reading comprehension, after controlling for differences in word-level reading skills and (b) examine these relationships in parallel studies of experienced readers (i.e., adults) and early readers (i.e., children ages 7- to 11-years-old). Accordingly, this thesis makes an original contribution to knowledge by demonstrating that the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension are markedly different across phases of reading development. In turn, these findings have both theoretical and empirical implications as to how we understand the role of prosody in relation to passage reading.

Methodological contributions:

This thesis also introduces multiple novel methodologies. Most notably, this includes (a) the first hand-scored prosodic passage reading rubric designed to be appropriate for use with experienced adult readers and (b) a set of novel prosodic competence tasks (for both children and adults) that can be administered online and asynchronously.

1.2. Outline of Thesis

In the next chapter of this thesis (Chapter Two), I provide an overview of our current understanding as to the theoretical role of prosody in relation to reading. I use the Reading Systems Framework to structure a discussion of the many ways that prosodic competence is implicated in reading—including its role in the orthographic system, the linguistic system, the lexicon, and comprehension processes.

Chapter Three consists of three sections. In the first section, I provide a systematic review of empirical research that has explored the contribution of prosodic competence to different reading-related outcomes. Specifically, I discuss studies that have examined the relationship between prosodic competence and other metalinguistic reading skills (including segmental PA and morphological awareness), single word reading, and passage reading (including reading efficiency, prosodic reading, and reading comprehension). I argue that there is a theoretical and empirical basis to suggest that prosodic competence is implicated in the process of reading comprehension above word-level reading processes. In the second section I reflect on the possibility that prosodic passage reading may explain the relationship between prosodic competence and reading comprehension. I argue that this hypothesis involves the assumption that prosodic passage reading facilitates reading comprehension (as opposed to reading comprehension facilitating prosodic passage reading). I therefore discuss previous empirical research that critically explores this assumption—highlighting both the strengths and weaknesses of this account. In the final section I reflect on the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension through the lens of reading development. I present developmental theories of single word reading, prosodic passage reading, and reading comprehension, in order to discuss the theoretical changing contribution of prosody related skills to reading. I argue that the role of prosodic competence in relation to prosodic passage reading and comprehension may be different in early readers and experienced readers. Specifically, I suggest that whereas the primary role of prosodic competence in relation to passage comprehension in early readers may be facilitating decoding related processes, in experienced readers, this role may switch to facilitating syntactic and semantic passage level processes, such as prosodic passage reading.

In Chapter Four, I draw attention to what we know and what we don't know about the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension. These knowledge gaps are then used to develop four specific research questions concerning (a) whether performance on prosodic competence tasks explains unique variance in prosodic passage reading and reading comprehension ability, after accounting for word-level reading skills (vocabulary, segmental PA, and single word reading) (b) whether prosodic passage reading ability explains unique variance in reading comprehension, after accounting for word-level reading skills (c) if prosodic competence accounts for unique variance in reading comprehension, whether prosodic passage reading explains this relationship and (d) whether these observed relationships are different in samples of experienced and early readers.

In Chapter Five, I discuss the impact of the Covid-19 pandemic on data collection for the three empirical studies, and present the need for online data collection. Then, I review some of the measures previously used by researchers to quantify the variables of interest: prosodic competence, oral passage reading fluency, and reading comprehension. Finally, I motivate the choice of the measures used in the current thesis, reflecting on (a) the importance of reliable and valid assessments and (b) taking into account the face-to-face restrictions on data collection put in place due to the Covid-19 pandemic.

In Chapters Six and Seven I present the methodology and results of study one and Study Two: both empirical studies exploring the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension in experienced adult readers. This includes an overview of the participant samples, the measures administered, and analyses conducted. Finally, I discuss the findings of these studies in detail. These findings demonstrate that prosodic competence is robustly associated with prosodic passage reading independently of all lower level reading skills. Moreover, they also demonstrate that the contribution of both prosodic competence and prosodic passage reading to reading comprehension is completely accounted for by word-level reading skills, and consequently, suggest a lack of evidence for the posited hypothesis prosodic passage reading mediates the relationship between prosodic competence and reading comprehension in experienced readers.

In Chapter Eight, I review the methodology and results of Study Three, which explores the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension in children ages 7- to 11-years-old. Once again, this includes an overview of the participant sample, the measures administered, and analyses conducted. I discuss in detail the findings of this study which demonstrate that, similar to the samples of experienced readers, the contribution of prosodic competence to reading comprehension is completely accounted for by word-level reading skills. However, these results also demonstrate that, unlike in the samples of experienced readers, (a) the contribution of prosodic competence to prosodic passage reading was explained by lower level reading skills and (b) prosodic passage reading accounted for unique variance in reading comprehension, independently of all other assessed reading skills.

In Chapters Nine and Ten, I reflect on the findings of all three studies. Specifically, I draw attention to the markedly different pattern of results between the samples of adults and sample of children. Consequently, I discuss the implications of these findings in relation to theory, future research, and educational policy. I argue that the results suggest that (a) the contribution of prosodic competence to prosodic passage reading is likely dependent on the development of other lower level foundational skills, and (b) the contribution of prosodic passage reading to reading comprehension appears to be most robust in early readers who use oral reading as a comprehension tool. I argue that more longitudinal work is necessary in order to understand these changing relationships. I also posit that prosody should be incorporated into future frameworks of reading, but that developmental approaches are necessary. Furthermore, I suggest that while children's interventions which focus on prosodic competence may be beneficial for word reading, educators looking to aid children's reading comprehension should instead focus on the incorporation of prosodic passage reading activities into literacy curricula.

2. Theoretical Overview of Prosody and Reading

Reading comprehension—the ability to draw meaning from a written text—is widely recognized as the end goal of reading. This is a complex and multifaceted phenomenon requiring an amalgamation of different processes. As a result, there are numerous extant models of reading comprehension. In a review and evaluation of seven of the most prominent models of reading comprehension, McNamara and Magliano (2009) suggest that the reason so many different models exist is that researchers have chosen to focus on different facets of comprehension. In other words, models of reading comprehension are different depending on the type of text being read (e.g., a narrative text vs. an expository text), the motivation for reading (e.g., reading for fun vs. reading to learn), and the individual who is reading (e.g., experienced reader vs. early reader). Nevertheless, a common driving force behind many of these models is the concept of building a "situation model" (van Dijk & Kintsch, 1983). This is the idea that, rather than representing the exact text, a reader creates a complex mental representation of the situation described by the text. Take the following text as an example:

Text Example 1:

"Sally woke up late on Saturday morning to find her brother already up and in the kitchen. The room was a mess. Her new pots and pans were spread around the countertop, and the entire room smelled like bacon. Sally hated bacon."

A situation model of this text would include information such as spatial and temporal context (e.g. brother is in the kitchen, takes place in the morning, etc.), the individual entities in the text (e.g. Sally, pots and pans, brother, etc.), the structural relations the text (e.g. Sally's brother is the kitchen, pots and pans on the countertop, etc.), and the ownership relations in the text (e.g. the pots and pans are Sally's). This situation model also involves generating inferences that give the reader a deeper understanding of the text—one that incorporates background knowledge and takes into account the implied situations rather than only the explicitly stated situations (e.g. her brother was the one who spread around the pots and pans, her brother was making breakfast, etc.) (McNamara & Magliano, 2009).

2.1. Reading Systems Framework: An Overview

In this thesis, I use the Reading Systems Framework to orient my discussion of the processes involved in reading comprehension. The Reading Systems Framework (RSF; Perfetti, 1999;

Perfetti et al., 2005; Perfetti & Stafura, 2014) is a general framework that provides an overview of the processes involved in reading comprehension which help a reader build this situation model. This framework is particularly clear, in that it identifies three sources of knowledge that are crucial for successful reading comprehension: orthographic knowledge, linguistic knowledge, and general knowledge. Linguistic knowledge includes an understanding of phonology, morphology, and syntax. Orthographic knowledge includes an understanding of the writing system. General knowledge includes an understanding of the world, and also includes an understanding of text form and genre. As demonstrated in Figure 1, each of these knowledge sources interact in order to create and update the situation model.

Figure removed for copyright

Figure 1. The Reading Systems Framework (Perfetti & Stafura, 2014, pg. 24)

It is notable that while phonology is included in this framework, prosody is not explicitly mentioned. The absence of prosody from the RSF is most likely because (a) an understanding of prosody is often grouped together with an understanding of phonology—which is included in both the linguistic and orthographic systems of the RSF and (b) the specific role of prosody (outside of segmental phonology) in relation to reading has only garnered the interest of researchers relatively recently, within the last twenty-five years (Wood & Terrell, 1998).

The difference between segmental phonology and prosody is perhaps best described with an example. Let us take the word *suspect*. This word has segmental phonological properties: it can be broken down into segments: two syllables: sus/ pect and seven sounds: s/u/s/p/e/c/t.

However, this word also has prosodic properties: depending on the stress placement it may have different meanings: SUSpect (e.g. “the suspect is here)” or susPECT (e.g.“I suspect he is here”). Furthermore, once this word is placed in a sentence, the meaning of the sentence may change depending on the imbued prosody of the entire phrase: an appropriate answer to “WHERE do you suspect he is?” would be “I suspect he is HERE,” while an appropriate answer to “do you KNOW he is here?” would be “I SUSPECT he is here.” Much research has demonstrated that the ability to conceptualise phonology (i.e., phonological awareness) is a robust predictor of reading comprehension (e.g., Shanahan & Lonigan, 2010). However, when defining or assessing phonological awareness, it is extremely common for both educators and researchers to only consider the segmental phonological awareness; prosodic competence is rarely taken into account (Sodoro et al., 2002). In this chapter I will argue that, although prosody is not explicitly included in the RSF, it is implicated in almost every component of the framework.

2.2. Note on Languages

Before further discussing the role of prosody within the Reading Systems Framework, it is important to note that the development of skilled reading also invariably depends on the language and writing system being used. English has an alphabetic writing system in which each individual orthographic symbol represents an individual phoneme (i.e. a spoken letter sound). Other languages have writing systems which are non-alphabetic; some examples are syllabic systems in which each individual symbol represents a syllable (e.g. Japanese) and logographic systems (sometimes referred to as morphophonetic systems) in which each symbol represents both a meaning and a sound (e.g. Mandarin). Even languages which have alphabetic writing systems differ in critical ways; some alphabetic languages have a deep orthography with inconsistent letter-sound relationships (also known as phoneme-grapheme relationships) (e.g. English), while others have a relatively shallow orthography with consistent letter-sound relationships (e.g. Italian). Accordingly, while many universal principles apply across languages (Verhoeven & Perfetti, 2021), the relative importance of the individual systems in the RSF may depend on these differences.

Likewise, while all languages have a structure of prosody and speech rhythm, they differ in how this rhythm is divided within the language. Early research on speech rhythm identified different isochronous rhythmic patterns across languages (i.e. different rhythmic division of time into equal portions): stress-timed languages (e.g. English, German) are languages characterized by feet (i.e. intervals between two stressed syllables) of equal duration, and syllable-timed languages (e.g. French, Spanish) are languages characterized by syllables of equal duration, and mora-timed languages (e.g. Japanese, Slovak) are languages characterized by moras (i.e. units of syllable weight) of equal duration (Abercrombie, 1967; Bloch, 1950; Pike, 1945). However, more recent research has suggested that typifying languages as perfectly isochronous is not realistic; in reality it is more appropriate to characterise languages as falling on a continuum between these different rhythmic patterns (see Low, 2006 for review). Although this section largely concerns the interaction between prosody and the English language, I will also discuss the contribution of prosody to reading in the context of other languages.

2.3. Prosodic Competence: Note on Terminology

Prosody refers to the rhythmic and melodic elements of language (Nooteboom, 1997). Prosody is central to processing speech; cues of stress, phrasing, and intonation help us to comprehend spoken language (Cutler et al., 1997). As noted earlier, in this thesis I use the term prosodic competence (Wade-Woolley et al., 2021) to refer to a sensitivity to, and awareness of, all the prosodic elements of language. Within the academic literature, prosodic competence is referred to under several names including *prosodic awareness* (Holliman et al., 2017; Wade-Woolley, 2016), *prosodic sensitivity* (Clin et al., 2009; Whalley & Hanse, 2006), *suprasegmental phonology development* (Calet et al., 2015; Deng & Tong, 2021) or *speech rhythm sensitivity* (Harrison et al., 2018; Holliman et al., 2010a; Holliman et al., 2010b). These terms often refer to the same concept. However, it is important to make distinctions between them. To illustrate, although an *awareness* of prosody and a *sensitivity* to prosody might be used interchangeably, an individual may demonstrate sensitivity to prosodic cues without necessarily being aware of these cues. For example, a child may be able to distinguish between two segments of speech that differ only in prosody, yet they may not be able to explain what the difference is. As Wade-Woolley and Heggie (2016) point out, the relationship between prosodic awareness and prosodic sensitivity is analogous with the distinction between phonological awareness and phonological sensitivity; whereas phonological sensitivity tasks require only discrimination of speech sounds, phonological awareness tasks require a conscious explicit manipulation of speech. Because both prosodic sensitivity and prosodic awareness involve the overarching ability to attend to the prosodic cues of language, I use prosodic competence to refer to the sensitivity to prosodic cues and the ability to recognize, think about, and manipulate prosodic cues.

2.4. Prosody in the Orthographic and Linguistic Systems

Reading involves the processes of mapping orthographic units (e.g. the letters "oo") to phonologic units (e.g. the sound *uː*). Although prosody, on the other hand, is not explicitly placed in either system within the RSF, it is still very much present.

2.4.1. Prosody and Orthography

Perhaps the most apparent contribution of prosody within the orthographic system is the role it plays in languages that contain orthographic markers of prosody. In Greek, for example, which marks linguistic stress with diacritics, the word for "nobody" is "κανείς". In order to read this word one needs to map the phonological units (e.g. [in English] the sounds *k-a-n-ee-s*) to the orthographical units (k-α-ν-ε-ί-ς.). In isolation, the vowel (ί) is no different with and without a stress marker (ι). Within the context of a word, however, both the phonological and semantic representation depend on the reader having a level of prosodic competence; whereas the correct phonological representation is "kanEEs" represented by the stressed ί, an incorrect phonological representation is "kAnis" (e.g. κάνεις) meaning "you do?". Accordingly, these markers are used by the readers to interpret the meaning correctly. In this case, prosody plays a very similar role to that of segmental phonology in that both are clearly represented within the orthography.

In languages without such diacritic markers, the role of prosody within the orthographic system is still very much present. In English, for example, unstressed vowels are often reduced. To illustrate, the schwa phoneme /ə/ (e.g. the sound u in bus) often takes the place of a variety of different vowels; Take the sentence "*The pres**e**nt w**a**s a penc**i**l.*" Although the bolded vowels are different ("e", "a", and "i"), they are all reduced and represent the same schwa phoneme (e.g. "*The pres/**ə**/nt w/**ə**/s a penc/**ə**/l*). A reader with reasonable prosodic competence is able to correctly interpret the phonological representation of these vowels through an understanding of speech rhythm in the English language. This role of prosody is particularly apparent when reading multisyllabic words, and will be discussed further in relation to morphemes.

2.4.2. Prosody and Morphology

Morphemes are the smallest possible unit of language with a meaning (Anderson, 2015). For example, in the word “removing” there are three morphemes: re- [prefix] -move- [root] -ing [suffix]). Due to the nature of morphemes, spoken words are sometimes prosodically altered based on the addition or removal of a morpheme. To illustrate, when adding the morpheme ‘-ian’ to the word "MAgic,” the stress is moved from the first to the second syllable (rather than “MAgician” the word is pronounced “maGIcian”). This interaction between prosody and morphemes is known as morphophonology.

The importance of morphophonology is perhaps especially visible in English where the language has consistent relationships between spellings and meanings, but less consistent meanings between spellings and sounds. To illustrate, in the previous example, the addition of the morpheme ‘-ian’ not only moves the stress from the first to the second syllable (“MAgic” to “maGIcian), it also changes the sound of the phoneme “a”: whereas the sound of “a” in magic is short (as in “cat”), the sound of “a” in magician is reduced to a schwa (Treiman & Bourassa, 2000; Castles et al., 2018). If a reader is familiar with the word “magic” but not the word “magician”, an understanding of prosody aids a correct pronunciation (reducing the vowel and shifting the stress). Likewise, prosodic competence helps a reader correctly pronounce the pseudo-words “thamic” and “thamician” (thAmik and thumIshun).

2.4.3. Prosody, Segmental Phonology, and Vocabulary

Prosody is also implicated in the orthographic and linguistic system through a close relationship with segmental phonological awareness. Wood et al. (2009) proposed three theoretical paths between prosodic competence and segmental PA: two direct pathways and one indirect pathway (represented in Figure 2). The first potential direct contribution of prosodic competence to segmental PA is that a sensitivity to prosody may allow for an increased awareness of vowel stress. Given that vowel sounds are associated with peaks of loudness, also referred to as an amplitude envelope (Goswami et al., 2002), this is perceived as an auditory beat (e.g, in a reading of “the cAt in the hAt” the beats fall on the vowels). Therefore, an individual sensitive to these beats should also be more sensitive to the location of onset and rime boundaries. Accordingly, this should aid both rime awareness, a well-known component of segmental PA (pathway A; Figure 2) and phonemic awareness (pathway B; Figure 2). For example, perceiving the onset and rime boundaries in “the cat and the hat” allows a reader to recognise the onset /c/ and rime /at/.

The final potential indirect pathway between prosodic competence and PA is that prosodic competence contributes to vocabulary acquisition which then aids segmental PA (pathway C, D; Figure 2). Cutler and Mehler (1993) suggested that the pathway between prosodic competence and vocabulary can be traced back to infancy, where a periodicity bias—or understanding of linguistic rhythm (i.e. sensitivity to prosody)—helps infants to segment fluent speech into words. Given that a large majority of words in English begin with a strong syllable (Cutler & Carter, 1987), a sensitivity to strong and weak syllables should help children process streams of speech. The theory that an awareness of prosody allows children to bootstrap their way to recognizing spoken words, and therefore efficiently acquire vocabulary, is known as the prosodic bootstrapping hypothesis (Bedore & Leonard, 1995; Christophe et al., 2003). The consequent pathway between vocabulary and segmental PA (pathway D; Figure 2) can be attributed to the lexical restructuring hypothesis (LRH; Metsala & Walley, 1998). According to the LRH, vocabulary enters the lexicon of young children as holistic representations, however, as more words are added to this lexicon—particularly words that are phonologically similar to many other words, otherwise known as residing in a dense neighborhood (e.g. cat, hat, sat)— children eventually have to create more fine-grained representations of the words (e.g. cat and hat differ because “c” and “h” are unique phonemes). Therefore, gaining vocabulary leads to an increased segmental phonological awareness.

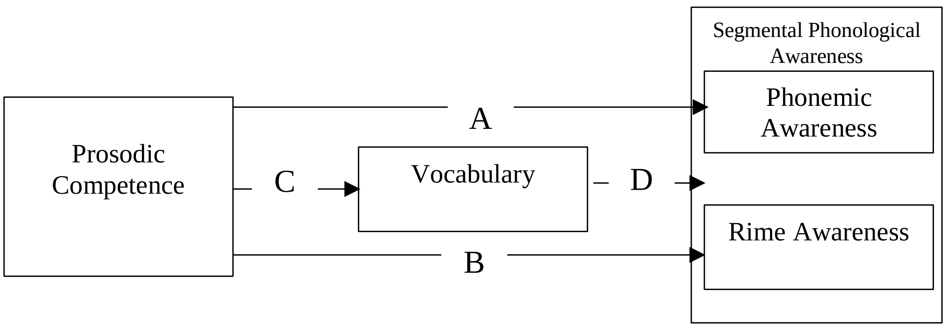

Figure 2. Theoretical Pathways between Prosodic Competence and Segmental PA proposed by Wood et al., (2009)

These three theoretical pathways have been the subject of numerous empirical studies which have, by and large, reported strong concurrent relationships between prosodic competence and segmental PA (Beattie & Manis, 2014; Cardillo, 2008; Goodman et al., 2010; Wood, 2006). These studies will be discussed further in Chapter Three.

2.5. Prosody in the Lexicon and Comprehension Processes

Prosody is also implicated in the process of language comprehension, represented in the RSF by the lexicon and comprehension processes. Language comprehension is multifaceted; an understanding of language involves not only an understanding of word meaning (involving knowledge of vocabulary and morphology which have already been discussed), it also involves knowledge of syntax and semantics (Tumner & Chapman, 2012). Knowledge of syntax refers to an understanding of the rules that determine the structure of a sentence (often referred to as grammar). Knowledge of semantics refers to an understanding of word meanings in addition to the relationship between words and how we draw meaning from them together. Prosody has a close relationship with word meaning, syntax and semantics—perhaps best described as "critically interwoven" with these aspects of language (Whalley & Hansen, 2006, pp. 298). In this section I will discuss the role of prosody in relation to the comprehension of words, syntax, and semantics.

2.5.1. Prosody and the Lexicon

The mental lexicon refers to our ability to represent individual lexical units—including phonological, orthographic and semantic information (Emmorey & Fromkin, 1988; Jackendoff, 2002); it is important that we cannot only decode words (i.e. sound out the word *p-r-e-s-e-n-t)* but that we can also represent the word and it's meaning as a unit (i.e. the word *present* refers to something given as a gift). Although prosody is not explicitly recognized as an aspect of the lexicon in the RSF (at least separately from segmental phonology), it is key; prosody is also implicated in the semantic meaning of words. For example, the lexical unit *PREsent* (with prosodic stress on the first syllable) refers to something given as a gift whereas the lexical unit *preSENT* (with prosodic stress on the second syllable) refers to a formal delivery of something. Consequently, prosody is represented in our lexicon.

Another example of prosody within the lexicon is its role in disambiguating compound nouns from adjective-noun pairs. To demonstrate, the sentence "John walked passed the green-house" may be referring to a building for plants if the adjective is emphasized (i.e. "John walked passed the GREEN-house"), or, it may be referring to a house that is green if the noun is emphasized (i.e. "John walked passed the green-HOUSE"). In the context of reading, therefore, one needs to use spelling and context clues to make an accurate interpretation of which lexical unit should be recalled.

2.5.2. Prosody, Syntax & Semantics

The current thesis concerns the role of prosody above word-level skills. Accordingly, above the level of the lexicon, prosody also serves to assign syntactic roles to words in a sentence (Chafe, 1988) and to provide appropriate syntactic structure for sentences with multiple semantic meanings. To illustrate, the sentence "pet the puppy with the glove" has multiple potential interpretations. The prosodic interpretation [pet the puppy] [with the glove] would suggest petting the puppy *while wearing the glove.* On the other hand, [pet] [the puppy with the glove] would suggest petting the puppy *who is holding the glove.* A solid empirical example of the importance of prosody in relation to sentence processing was demonstrated in a simple study in which participants were asked to recall nonsense syllables with and without syntactically appropriate morphology and prosody (Epstein, 1961). The researchers found no difference in recall ability when participants listened to nonsense syllables with and without syntactically appropriate morphology when prosody was removed (i.e. "meev gup keep gomp" or "meeving gups keeped gompily"). However, participants were significantly better at recall after adding appropriate prosody ("MEEving gups KEEped GOMpily). It follows that children who can therefore read a passage with appropriate prosody at the word level, but do not add syntactically appropriate prosody at the sentence level (e.g. "THE, FLUffy, CHIPmunk, RAN, Away.") should demonstrate poorer comprehension than children who are able to use correct prosody at both the word and sentence level (e.g. "the FLUffy CHIPmunk ran aWAY!"). This is consistent with research demonstrating that children who read with appropriate prosody demonstrate better reading comprehension (Wolters et al., 2022) and will be further discussed in the following chapter.

Prosody also serves to contextualize and organize speech (Cutler et al., 1997). A clear illustration of this is the way that prosody draws attention to new or important information. This is particularly noticeable in dialogue: the question "What is Natalie wearing?" should warrant the answer "Natalie is wearing a HAT" rather than "NATALIE is wearing a hat." Consequently, the de-accentuation (or reduced intelligibility) of a word typically indicates that it is information which has previously been shared, and therefore should be able to be recalled from a previous context (Fowler & Housum, 1987; Birch & Clifton, 2002; Dahan et al., 2002). Previous research has demonstrated that when prosodic cues during dialogue are inconsistent with semantic cues, processing times become significantly slower (Terken &

Nooteboom, 1987; Birch & Clifton, 1995). A skilled reader, therefore, also needs to have an understanding of these cues in order to correctly emphasize new information. Interestingly, researchers exploring prosodic competence in English, French, and German speaking children ages 3- to 5-years-old have reported that even these very young participants are able to understand the semantic importance of prosody focus markings (e.g., the RED hat vs. the red HAT) (Szendroi et al., 2018).

2.6. Summary

In this chapter, I introduced the RSF and used this framework to discuss the many processes involved in reading comprehension. I then used a variety of examples to demonstrate how prosody is theoretically implicated in virtually all aspect of the reading process. Notably, I drew attention to the contribution of prosody not only to the linguistic and orthographic systems, but also to the lexicon and comprehension processes. Thus, I want to make it clear that the role of prosody is distinct from phonology—and perhaps more akin to morphology and vocabulary; whereas the role of segmental PA is confined to the linguistic and writing system, both vocabulary knowledge and morphological awareness are involved not only in the linguistic and writing system, but also the lexicon and comprehension processes. To explicate, in the same way that prosodic competence is implicated in both processes of decoding and comprehension, so is morphological awareness: morphological awareness facilitates the decoding process (e.g., a familiarity with individual morphemes leads to efficient decoding of unfamiliar words containing those morphemes) and facilitates language comprehension (e.g., a familiarity of individual morphemes leads to the extraction of meaning from unfamiliar words containing those morphemes).

Whereas this section focused on the theoretical role of prosody in relation to reading, the next section will take an empirical approach. Chapter Three presents empirical research that has specifically examined the contribution of prosody to reading outcomes.

3. Empirical Overview of Prosody and Reading Development

In this chapter I will first review empirical research exploring the contribution of prosodic competence to reading-related outcomes. Next, I will consider the potential role of prosodic reading, specifically in relation to reading comprehension. Finally, I will review how the contribution of prosody to reading changes over the course of development.

3.1. Empirical Overview

This section reviews empirical studies that have examined the relationship between prosodic competence and other metalinguistic reading skills (including segmental PA and morphological awareness), single word reading, and passage reading (including reading efficiency, prosodic reading, and reading comprehension). I maintain that this empirical work demonstrates the many ways that prosodic competence is important for skilled reading. Furthermore, I argue that while there is a relatively large amount of research devoted to understanding the role of prosodic competence in relation to lower level skills (i.e., single word reading), there is comparatively little research exploring the contribution of prosodic competence to passage reading outcomes (i.e., prosodic passage reading and reading comprehension).

3.1.1. Sub-Word Level Processes

In the previous chapter, I discussed the theoretical contribution of prosodic competence to sub-word level processes such as segmental PA and morphological awareness (MA). In this section, I will provide an overview of empirical research investigating how individual differences in prosodic competence are related to these metalinguistic skills.

3.1.1.1. Segmental Phonological Awareness (PA)

The three possible pathways between prosodic competence and segmental PA proposed by Wood et al. (2009) (Figure 2; Figure 3) have been the focus of multiple empirical studies. Notably, while some of these studies found that differences in prosodic competence accounted for unique variation in segmental PA after accounting for vocabulary (pathways A and B; Cardillo, 2008; Goodman et al., 2010), others found that this relationship was completely mediated by vocabulary (pathways C and D; Beattie & Manis, 2014). Holliman, Critten et al. (2014) used structural equation modeling to test each of the theoretical pathways proposed by Wood et al., (2009) in a study of 75 children aged 5- to 7-years-old. The reseachers reported that although the original model (including both direct pathways between prosodic competence and rime/phonemic awareness and indirect pathways via vocabalary) was not a good fit, a new model (Figure 3) that no longer included a path between prosodic competence and phonemic awareness, and instead included an indirect pathway to phonemic awareness via rime awareness, was a good fit. This model also provided further support for an indirect pathway between prosodic competence and rime awareness via vocabulary (pathways C and D).

Recently, Critten et al. (2020) used a longitudinal design to further test the pathways between prosodic competence, segmental PA, and word reading with a sample of 4 to 5-year-old pre-readers. At Time One, children were assessed on measures including prosodic competence, vocabulary, and segmental PA. One year later, these same children were assessed on word reading and spelling. A path analysis revealed that the new data also fitted Holliman, Critten et al. (2014)'s model adequately, further supporting the pathways in Figure 3.

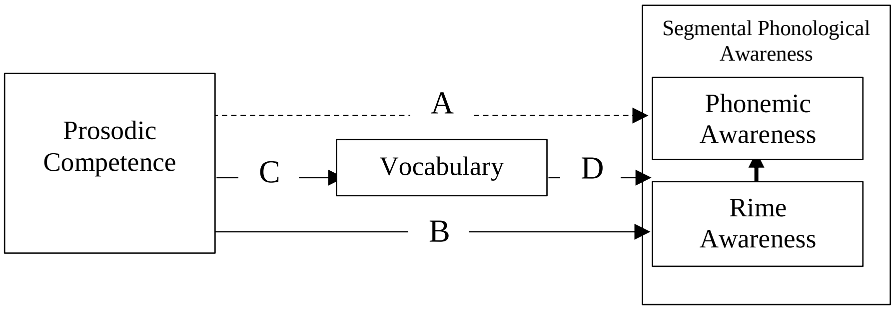

Figure 3. Empirical Contribution of Prosodic Competence to Segmental PA demonstrated by Holliman et al., (2014) and Critten et al., (2021).

Note. Dotted lines not significant, bolded lines new pathways.

It is notable, however, that all of the studies cited above assessed the relationships between prosodic competence, segemental PA, and vocabulary at one time point; even in the longitudinal study by Critten et al., (2021), vocabulary and segmental phonological awareness were not assessed at Time 2. Therefore, researchers have not been able to determine whether the relationship between prosodic competence and segmental PA is causal (i.e. does prosodic competence lead to improvements in segmental PA, or, does segmental PA lead to better prosodic competence?). In summary, although there is much concurrent empirical evidence suggesting a close relationship between prosodic competence and segmental PA, more longitudinal work is needed to provide a comprehensive account of the developmental pathways between these two metalinguisitc skills.

3.1.1.2. *Morphological Awareness (MA)*

The relationship between prosodic competence and MA was also discussed in the previous chapter; prosody and morphology are closely related in that they clearly interact with one another (e.g. adding a morpheme can shift the prosodic stress of a word). Fittingly, there is empirical evidence that prosodic competence and MA are significantly correlated in early readers (Holliman, Critten et al., 2014; Clin et al., 2009). However, the contribution of prosodic competence to MA is not entirely clear; in the Holliman, Critten et al. (2014) path analysis study, researchers reported that individual differences in prosodic competence contributed to MA, but only indirectly through vocabulary. Conversely, using structural equation modelling, Kim and Petscher (2016) found that prosodic competence directly predicted MA. It is again also notable that both of these studies explored the concurrent associations between prosodic competence and MA, as opposed to measuring prosodic competence and morphological awareness at different developmental time points. Once more, while it is evident that prosodic competence and MA are intertwined (Jarmulowicz, 2006; Jarmulowicz et al., 2007), more research is necessary to understand the developmental trajectory of this relationship.

In summary, empirical research has documented a close relationship between prosodic competence and other sub-word metalinguistic skills. Although there may not be sufficient longitudinal research to understand the exact mechanisms through which an understanding of prosody aids phonological and morphological processing, there is a growing body of evidence which suggests that prosodic competence does facilitate these skills. Therefore, while the current thesis focuses on the relationship between prosodic competence and higher-level reading outcomes, these sub-word level skills will be considered as possible pathways through which prosodic competence may contribute to passage level reading outcomes.

3.1.2. Single Word Reading

The relationship between prosodic competence and single word reading has been a focus of much empirical work. Indeed, significant positive associations between prosodic competence and word reading ability are well-documented (Choi et al., 2016; Chung & Bidelman 2021; Defior et al., 2012; Goswami et al., 2013; Goswami et al, 2010; Gutierrez-Palma et al., 2016; Holliman et al., 2017; Holliman et al., 2010a; Holliman et al., 2010b; Jarmulowicz et al., 2007; Lin et al., 2018; Wade-Woolley, 2016; Whalley, 2017). Moreover, the pathways through which prosodic competence may facilitate single word reading have been the subject of a number of empirical studies (e.g., Critten et al., 2021; Kim & Petscher, 2016; Holliman, Critten et al., 2014).

Of course, given the recognized role of segmental PA and MA in relation to word reading (Carlisle & Nomanbhoy, 1993; Kirby et al., 2008), one obvious explanation as to how prosodic competence facilitates single word reading is that an understanding of prosody aids the development of the metalinguistic skills discussed in the previous section. Another explanation is that prosodic competence facilitates word reading by supporting vocabulary acquisition. The close relationship between prosodic competence and vocabulary was reviewed in Chapter Two, but there has also been empirical work demonstrating a causal association between an understanding of prosody and vocabulary acquisition (Cristia & Seidle, 2011; Holliman, Critten, et al., 2014). A final possibility is that prosodic competence contributes to word reading directly. In other words, an understanding of prosody facilitates word reading independently of segmental PA, MA, and vocabulary,

Researchers investigating a direct contribution of prosodic competence to single word reading, independently of these other skills, have reported mixed outcomes. Whereas the results of some studies have demonstrated that individual differences in prosodic competence accounts for additional variance in single word reading above vocabulary, segmental phonological awareness and morphological awareness (Chan et al., 2019; Enderby et al., 2021; Holliman et al., 2017), others have found that an understanding of prosody does not make any additional contribution to word reading above these skills (Deacon et al., 2018; Kim & Petscher, 2016).

The two most obvious reasons for this discrepancy are (1) differences in the population being assessed and (2) differences in the measures used to assess prosodic competence. Whereas the children in the studies that found an independent contribution of prosodic competence to word reading were between the ages of 7- to 11-years-old (Chan et al., 2019; Enderby et al., 2021; Holliman et al., 2017), the children in the study by Deacon et al. (2018) and Kim and Petscher (2016) were ages 6 to 7 and 5 to 7 respectively. This suggests that while prosodic competence may not directly contribute to the word reading (above sub-lexical processing) in younger children, it does appear important for word reading above these processes in older children (ages 7- to 11-years-old). Notably, one of the most plausible reasons for this is that an understanding of prosody is naturally more important for bi-syllabic and multi-syllabic word reading (Enderby et al., 2021)—which are typically not included in assessments for very early readers. The measures used to assess prosodic competence were also different across these studies; Chan et al. (2019) and Kim and Petscher (2016) used tasks assessing prosodic competence in the context of single words, whereas Holliman et al., (2017) and Deacon et al. (2018) used tasks assessing prosodic competence in the context of phrases. These measures, and the potential reasons for different outcomes, will be discussed in more detail in Chapter Five.

Crucially, there is also longitudinal evidence that prosodic competence at Time One predicts single word reading at a later time point (Calet et al., 2015; Critten et al., 2021), including recent evidence that training prosodic competence can lead to an increase in word-reading skills (Harrison et al., 2018). In Harrison et al.'s (2018) training study, researchers placed children in one of three intervention groups: a prosodic competence training group, a segmental PA training group, and a mathematics (control) training group. The results of this study demonstrated that children in both the prosodic competence training group and the segmental PA group demonstrated an increase in word reading that was significantly larger than observed for the children in the control group. Once again, this suggests that the relationship between prosodic competence and word reading is directional—or in other words, that prosodic competence leads to improved word reading as opposed to word reading improving prosodic competence. Whether or not prosodic competence makes a direct contribution to single word reading, or an indirect contribution via segmental phonological awareness, morphological awareness and/or vocabulary, it is clear that an understanding of prosody facilitates skilled word reading.

3.1.3. Passage Reading

The contribution of prosodic competence to single word reading can help us understand its relationship to passage reading. However, an individual's performance on single word reading tasks is limited in pertinence; a great majority of reading takes place in the context of larger passages. The following sections will reflect on empirical research that has explored the role of prosodic competence in relation to both passage reading fluency and comprehension.

3.1.3.1. Reading Comprehension

Research suggests that individual differences in prosodic competence are associated with better reading comprehension (e.g., Holliman, Williams et al., 2014; Lochrin et al., 2015;

Veenendaal et al., 2014). However, the relationship between prosodic competence and reading comprehension is arguably the most complex outcome discussed thus far, because it is dependent on so many processes. To illustrate, the positive association between prosodic competence and reading comprehension may be explained by the role of prosody in relation to segmental phonological awareness, morphological awareness, vocabulary, and single-word reading.

However, it is also possible that prosodic competence facilitates passage reading (fluency and comprehension) directly, or in other words, independently of word reading. A handful of previous studies have supported this direct relationship (Breen et al., 2016; Choi et al., 2016; Veenendaal et al., 2014; Groen et al., 2019). In a sample of Cantonese Chinese-speaking 5 to 7-year-old children learning English as a second language, Choi et al. (2016) assessed Cantonese-specific prosodic competence (Cantonese lexical tone sensitivity), English-specific prosodic competence (English lexical stress sensitivity), non-speech specific auditory sensitivity, Cantonese segmental PA, and English word reading at Time One, and then English reading comprehension one-year later (Time Two). Using structural equation modelling, the researchers tested whether the pathway(s) between Cantonese lexical tone sensitivity and English reading comprehension were indirect (via English word reading) or direct—reporting that a model in which English stress sensitivity directly predicted English reading comprehension was a good fit for the data. These findings are consistent with research exploring the direct relationship between prosodic competence and reading comprehension using another method: assessing prosodic competence in populations of specifically poor comprehenders. Markedly, this research has demonstrated that individuals with age appropriate decoding skills (i.e., word reading), but who struggle with reading comprehension specifically, demonstrate significantly lower prosodic competence than age-matched counterparts (Groen et al., 2019; Breen et al., 2016).

One possibility as to how prosodic competence directly facilitates reading comprehension is by supporting language comprehension—the ability to understand and make sense of spoken language. As demonstrated by the Simple View of Reading (SVR; Hoover & Gough, 1990), language comprehension is a central component of reading comprehension. The SVR posits that reading comprehension (RC) is the product of two skill sets: word decoding (D; discussed in the previous section) and language comprehension (LC): RC = D x LC. Although there is a large body of research that highlights the role of prosody in relation to language processing (Chafe, 1988; Kintsch 1998; Snedeker & Truswell, 2003), fewer studies have specifically examined whether individual differences in prosodic competence are associated with performance on language comprehension tasks (the exception to this is research on the relationship between prosodic competence and word-level comprehension—e.g., vocabulary). Notably, however, the studies that have explored this relationship have used measures that assess a variety of different facets of language comprehension.

For example, Kim and Petscher (2016) specifically explored the relative contributions of prosodic competence, language comprehension, and single word reading to reading comprehension in English speaking children ages 6- to 7-years-old. In this study, language comprehension was assessed using two measures: the Listening Comprehension Scale of the Oral and Written Language Scales (OWLS-2; Carrow-Woolfolk, 2011) and the Oral Comprehension Subtest of the Woodcock Johnson-III (WJ-III; Woodcock et al., 2001). In the Listening Comprehension Scale of the OWLS-2, children listen to a sentence and choose a picture that best describes the semantic meaning. In the Oral Comprehension Subtest of the WJ-III, children listen to the beginning of a sentence and orally complete it. In this study, the researchers tested two models which potentially explain the relationship between prosodic competence and reading comprehension. In the first model, word reading and listening comprehension completely mediated the relationship between prosodic competence and reading comprehension. In the second model, there was still a direct path from prosodic competence to reading comprehension (even after accounting for word reading and listening comprehension). The results demonstrated that prosodic competence was significantly related to listening comprehension (r = .20), and moreover, that the first model in which single word reading and listening comprehension completely mediated the relationship between prosodic competence and reading comprehension was the best fit. On the other hand, in a study by Clin et al., (2009), researchers administered the Test for Reception of Grammar (TROG; Bishop, 1989) in addition to measures of prosodic competence to a sample of 8 to 13-year-olds. As part of the TROG, children listen to a sentence and use knowledge of grammar and syntax to select an appropriate picture. Results of the study demonstrated significant concurrent relationships between performance on this measure and on measures of prosodic competence (r = .43). Because this study did not aim to specifically assess the relative contribution of prosodic competence to performance on the TROG, they did not explore whether other skillsets may have explained this relationship. They did, nevertheless, report that performance on both the TROG and prosodic competence tasks contributed unique variance to reading ability above age, memory, and vocabulary—suggesting that the contribution of prosodic competence to reading comprehension was at least partly independent from this measure of language comprehension. However, as the measure of reading ability was a composite of multiple reading tasks (reading comprehension, passage reading efficiency, and single-word reading), it was not clear the relative contribution of these tasks to reading comprehension.

Notably, although Kim and Petscher (2016) and Clin et al. (2009) used different tasks (i.e, TROG, OWLS, WJ-III), both studies assessed language comprehension at the sentence level. This is noteworthy because reading comprehension also involves skills that take place above the sentence level. After all, comprehension by nature involves relating multiple pieces of information (Kintsch, 1998)—and often these pieces of information are contained across different pieces of the text; inference making (i.e. the ability to understand details not explicitly stated in the passage), comprehension monitoring (e.g. the ability to detect inconsistencies within a text), and story structure understanding (e.g. knowledge of conventional structure of text) are all important skillsets for successful comprehension (Oakhill & Cain, 2007) and take place at a level higher than the sentence.

From this perspective, Kim and Petscher's (2016) results suggest that the role of prosodic competence in relation to reading comprehension is completely explained by word reading and sentence level listening comprehension, whereas Clin et al.'s (2009) results suggest that the role of prosodic competence in relation to reading comprehension likely goes beyond sentence level language comprehension. Once again, however, it is important to consider the methodological differences between these studies—perhaps most notably a difference in reading level of the participants: Kim and Petscher (2016) explored these relationships in earlier readers (6 to 7-year-olds) while Clin et al. (2009) assessed relatively more advanced readers (8 to 13-year-olds). This suggests that the role of prosodic competence may shift to support different processes as readers become more skilled. Additionally, these studies used different measures of prosodic competence; Kim and Petscher (2016) assessed children's ability to identify stress in individual words (see Stress Identification Tasks, Chapter Five), whereas Clin et al. (2009) assessed children's ability to match phrases based on prosodic cues (see DEEdee Matching Tasks and Low-Pass Filter Matching Tasks, Chapter Five). Accordingly, it is possible that these measures may also have led to different results. Further discussion of these assessments will be in Chapter Five.

Notably, there is a lack of empirical research exploring the relationship between prosodic competence and language comprehension above the sentence level. As previously discussed in Chapter Two, the close relationship between prosody, syntax, and semantics clearly exhibits how prosodic competence may facilitate these higher-level comprehension processes; researchers have demonstrated that prosody can draw attention to important information (Birch & Clifton, 2002) and organise speech into an appropriate structure (Cutler et al., 1997). For example, prosody allows for chunking, or what Nomvete and Easterbrooks (2019) refer to as supralexical utilisation—the process of using prosodic phrasing to store multiple words in short term memory as a single unit (i.e., a chunk) to retrieve later. Furthermore, prosodic competence may be important for text-specific language comprehension. An important distinction between spoken language and written text is that written text typically uses different syntactic constructions than spoken language (Oakhill & Cain, 2007) and lacks much of the prosodic information present in spoken language (Whalley, 2017). Therefore, in order to understand the role of prosodic competence in relation to reading comprehension in may be necessary to use written, rather than oral, assessments of comprehension.

Accordingly, researchers have also explored the contribution of prosodic competence to text-specific language comprehension by assessing individual's ability to use and understand punctuation. In a sample of English-speaking adults, Heggie and Wade-Woolley (2018) examined the relationship between prosodic competence and the ability to use punctuation correctly. The researchers found that prosodic competence predicted punctuation ability even after accounting for differences in working memory and punctuation knowledge (i.e. basic knowledge of punctuation marks). These findings were further supported by Ryken (2019), who assessed English-speaking children ages 8- to 11-years-old, reporting that children's prosodic competence was significantly associated with children's awareness of prosodic cues in text.

To some extent, punctuation is a set of instructions for the reader as to how to read with appropriate phrasing and expression (Heggie & Wade-Woolley, 2018; Scholes, & Willis, 1990) —or in other words, how to read with appropriate prosody. It therefore follows that another mechanism by which prosodic competence facilitates reading comprehension is by aiding reading fluency (Kim & Petscher, 2016). The notion that prosodic competence contributes to reading comprehension by facilitating prosodic passage reading is one of the hypotheses posited in the current thesis. The next section, however, will first discuss empirical research that has specifically examined the relationship between prosodic competence and 'general' reading fluency.

3.1.3.2. Reading Fluency

When we think of reading fluency, we think of oral reading. This is, by nature, specific to reading aloud. Accordingly, reading fluency is not included in the Reading Systems Framework or the any of the prominent models of reading comprehension reviewed by McNamara and Magliano (2009). However, the close relationship between silent reading fluency, oral reading fluency, and reading comprehension has been increasingly evidenced in the literature. This research suggests that fluency is an important aspect of text comprehension (Kim et al., 2014; Klauda & Guthrie, 2008; Hudson et al., 2008; NRP, 2000; Veenendaal et al., 2016). Moreover, studies have demonstrated that the ability to read fluently predicts variance in reading comprehension above word reading and language comprehension (Jenkins et al., 2003; Kim & Wagner, 2015). Interestingly, society's view on the importance of oral reading fluency has shifted quite dramatically over the years; whereas reading instruction in the 1800s was largely geared toward the ability to read aloud—and specifically the ability to read aloud with appropriate prosody, this changed during the 1900s when silent reading and comprehension became the focus of instruction (as reading became more widespread and individual reading materials were more prevalent) (see Rupley et al., 2020 for review). Only relatively recently, partly encouraged by the focus on fluency by the National Reading Panel (NRP; 2000), has reading fluency begun to come back to the forefront. Perhaps it is unsurprising, then, that very little research has explored the relationship between prosodic competence and reading fluency—consequently a focus of the current thesis. Moreover, there is a split in the literature in relation to how reading fluency is defined. The National Reading Panel defines reading fluency as the ability to read with "accuracy, speed, and proper expression" (NRP, 2000, p.18). However, much of the empirical research that has investigated the contribution of prosodic competence to reading fluency has defined fluency as simply the ability to read with accuracy and speed, here referred to as *passage reading efficiency*, rather than the ability to read with proper expression, here referred to as *prosodic passage reading.*

It is important to differentiate between these two definitions of reading fluency because they are measured in distinct ways: fluency as reading efficiency refers to reading rate and accuracy, while fluency as prosodic reading refers to using appropriate expression and intonation during reading. Moreover, research suggests that these two skills are, at least somewhat, independent. Notably, in a study of 8 to10-year-old English speaking children, Cowie et al. (2002) found that although prosodic passage reading was almost always associated with passage reading efficiency, passage reading efficiency regularly occurs without prosodic passage reading. Similar results were reported in a sample of Turkish speaking 9- to 10-year-olds; Yildiz et al., (2008) assessed passage reading in a random sample of 70 children from a state school in Turkey, reporting that while students demonstrated age appropriate reading efficiency, up to 40% of students struggled with prosodic passage reading. Most recently, Schwanenflugel et al., (2015) assessed passage reading in a sample of 120 English Speaking 8 to 9-year old children, reporting a significant directional pathway between reading efficiency and multiple components of prosodic passage reading (change pitch, intrasentenial pausing). This is perhaps best explained by automaticity theories, which posit that the cognitive resources involved in higher level reading skills (such as prosodic passage reading) are only freed after lower level reading skills (such as efficient word reading) become automatic (Hudson et al., 2008). This section will discuss empirical research that has investigated the potential role of prosodic competence in relation to both measures of fluency.

Note on Implicit Prosody

Although it has only been mentioned briefly up to this point, it is of course notable that reading does not always take place aloud. In fact, most reading, after a certain level of fluency is achieved—typically around 7- to 11-years-old (Prior & Welling, 2001; Rasinski, 2012), occurs silently. This raises the question: is prosody important for silent reading? The short answer is yes. Whether reading aloud or silently it falls upon the reader to infer their own prosodic representation of a text. As already noted, unlike spoken language, prosodic cues in text are limited—typically existing only in the form of certain grammatical punctuation (an exception to this rule is a small number of stress-related diacritic marks in some languages, but this is not the case in English). This silent prosodic representation of a text is known as implicit prosody. According to the implicit prosody hypothesis (IPH; Fodor, 2002), readers generate their own representations of phrasing, stress, rhythm, and intonation during the silent reading process to aid their comprehension of a text. Of course, measuring an individual's implicit prosodic representation of a text is much more challenging than measuring a spoken prosodic representation of a text. Nevertheless, researchers have been able to provide evidence for the IPH by examining online sentence processing using techniques such as eye tracking and Electroencephalogram (EEG) measurements (see Breen 2014 for review). In line with this thesis, however, this review will focus on oral reading fluency.

Passage Reading Efficiency

Previous research has established that prosodic competence is positively associated with reading accuracy and/or rate, at least to some extent (Holliman, Williams, et al., 2014; Holliman et al., 2010a; Kitzen, 2001; Mundy & Carroll, 2012; Whalley & Hansen, 2006). However, some of these studies have reported that prosodic competence correlates with reading accuracy, but not reading rate (Whalley & Hansen, 2006; Kitzen, 2001). For example, Whalley and Hansen (2006) used the Neale Analysis of Reading Ability (NARA; Neale, 1999) to calculate reading accuracy, rate, and comprehension in a sample of 81 grade 4 children. Results of this study demonstrated that reading accuracy, but not reading rate, was positively associated with comprehension. However, as pointed out by the researchers, the NARA reading rate does not take into account self-corrections wherein children may originally read a wrong word and then correct themselves on their own accord (marked as accurate on the NARA). It is therefore possible that prosodic competence drives reading efficiency by aiding these corrections. It is also important to note that increases in reading rate are limited by the power law (e.g. reading rate can only increase to a certain point before it become unnatural). Consequently, especially with an adult sample, such as the study by Kitzen (2001) cited above, reading rate may simply be a weaker measure of reading efficiency than reading accuracy.

Of course, one explanation for a positive correlation between prosodic competence and the ability to read a passage quickly and accurately is that an understanding of prosody simply facilitates single word reading—therefore leading to efficient passage reading. Accordingly, studies have also explored whether prosodic competence makes a contribution to passage reading efficiency independently of word reading. In a sample of 5 to 7-year-old children, Deacon et al. (2018) did not find any evidence that prosodic competence contributed unique variance above word reading to passage reading speed or accuracy. Mundy and Carroll (2012) reported the same findings in a sample of adults with and without dyslexia, reporting that, after accounting for word reading, prosodic competence did not contribute any additional variance in nonsense passage reading speed. Conversely, in a similar sample of adults with and without reading difficulties, Kitzen (2001) found that while prosodic competence did not predict passage-reading speed independently of word reading, it did predict passage reading accuracy.

One possible reason for the discrepancies in the studies above is that Mundy and Carroll (2012) used a nonsense passage reading measure (a passage containing both real words and non-words) whereas Kitzen (2001) used a word reading measure. According to the dual route model of reading (Coltheart et al. 2001), two separate cognitive routes are involved in the process of reading aloud: a lexical route and non-lexical route. Whereas the lexical route involves the process of word recognition of familiar words, the non-lexical route involves the process of decoding unfamiliar or nonwords. This would suggest that the contribution of prosodic competence may partly be (a) via the lexical route and/or (b) related to semantics (a component of language that is not present in nonsense passages). It is evident, however, that more research is needed to fully understand the contribution of prosodic competence to reading efficiency in both children and adults. This will also be addressed in the current thesis.

Prosodic Passage Reading

Even fewer studies have explored the relationship between prosodic competence and prosodic passage reading. A lack of research in this area is notable for multiple reasons. Firstly, there is a body of research which suggests that reading comprehension is predicted by prosodic passage reading independently from passage reading efficiency (Arcand et al., 2014; Benjamin & Schwanenflugel, 2010; Turkyılmaz et al., 2014; Rasinksi et al., 2014; Veenendaal et al., 2015; Kocaarslan, 2019)—therefore suggesting that understanding the skills involved in prosodic passage reading may be crucial to our understanding reading comprehension. Secondly, it is logical that an understanding of the concept of prosody (i.e., prosodic competence) would precede the ability to apply prosody when reading (i.e., prosodic passage reading)—perhaps in the same way that an understanding of segmental phonological awareness precedes the ability to learn phonics and decoding (Olson & Griffith, 1993). However, the relationship between prosodic competence and prosodic passage reading has only been empirically demonstrated a handful of times.

One of the only studies to specifically explore the relationship between prosodic competence and prosodic passage reading was a longitudinal project by Holliman et al. (2010a). In this study, researchers assessed prosodic competence and prosodic passage reading of English-speaking children ages 5- to 8-years-old. Prosodic competence was assessed at Time One, using a receptive prosody task in which children were instructed to identify words with incorrect lexical stress (see Revised Mispronunciations Task, Five Seven). Prosodic passage reading (in addition to single word reading and reading comprehension) was assessed one year later, using a hand-scored fluency rubric called the Multi-Dimensional Fluency Scale (MDFS; Rasinski, 2004), in which participants are given a rating of 1 through 4 on multiple subscales. The researchers quantified prosodic passage reading as ratings of phrasing, smoothness, and pacing (see Table 2, Chapter Five). Their results indicated that performance on the prosodic competence measure at Time One significantly predicted children's scores on all subscales of the MDFS at Time Two. Notably, however, when the researchers controlled for individual differences in vocabulary and segmental PA (also assessed at Time One), prosodic competence only predicted unique variance in the phrasing subscale of the prosodic passage reading measure. On the other hand, variance in smoothness and pacing was completely accounted for by differences in segmental PA. Accordingly, this study demonstrates that, in a sample of early readers, the relationship between prosodic competence and prosodic passage reading appears to be at least partly dependent on word-level reading skills and partly independent of such skills.

Two additional studies by Veenendaal et al. (2014) and Groen et al. (2019) also have reported significant correlations between prosodic competence and prosodic passage reading in early readers. Although neither of these studies specifically aimed to explore the relationship between these prosodic skills, the researchers separately measured and reported performance on prosodic competence and prosodic passage reading. Veenendaal et al. (2014) assessed Dutch-speaking 9 to 10-year-old children's ability to use appropriate prosody during an oral story-telling task (see Story Telling Tasks, Chapter Five) and prosodic passage reading. Similar to Holliman et al. (2010a), these prosodic skills were both assessed using the MDFS (Rasinski, 2004). In this study, researchers reported that children's ability to use prosody during story-telling (i.e., prosodic competence) and during prosodic passage reading was positively significantly correlated across all dimensions (e.g., use of phrasing during story telling was correlated with use of phrasing during reading), with the exception of smoothness. Notably, the researchers also assessed participants' performance on a measure of decoding skills, reporting that, while all four of the dimensions of prosodic passage reading were significantly associated with decoding skills, the strongest correlation was with the dimension of passage reading smoothness (r =.58). This suggests that, relative to the other dimensions of prosodic passage reading, the ability to read a passage smoothly may be most reliant on decoding skills. This is also consistent with the results of Holliman et al. (2010a).

In the most recent study by Groen et al. (2019), researchers used the MDFS to compare prosodic passage reading and prosodic competence in three samples of Dutch-speaking 9 to 10-year-old children: one group of poor comprehenders, one group of younger comprehension-level matched controls, and one group of chronological age matched controls. In this study, the researchers assessed prosodic competence using the same story telling task, in addition to five additional measures of the Profiling Elements of Prosody in Speech-Communication (see PEPS-C; Chapter Five). When data from all three groups was combined, researchers reported that prosodic passage reading was again positively significantly associated prosodic competence as quantified by the oral story telling task (a sum of all four sub-scales) in addition to three of the five additional PEPS-C tasks: a receptive stress placement task, an expressive stress placement task, and a receptive word boundaries task. Notably, the researchers also reported that the children identified as poor comprehenders demonstrated significantly lower scores on both the prosodic competence and prosodic passage reading tasks than their age-matched controls (i.e., children with the same level of decoding skills but higher comprehension skills). This suggests that both of these measures are, to some extent, independent from word-level reading skills.

Overall, these studies provide an emerging, but incomplete, picture as to the relationship between prosodic competence and prosodic passage reading. All three studies reported significant positive correlations between children's ability to understand prosody outside the context of reading, and the ability to appropriately use prosody during passage reading. The results of both Holliman et al. (2010a) and Groen et al. (2019) further suggest that the contribution of prosodic competence to prosodic passage reading is, at least partly, independent of word-level reading skills. However, both of these studies also reported that this was the case for some, but not all, measures of prosodic competence. Moreover, none of the studies explicitly investigated whether the contribution of prosodic competence to prosodic passage reading was accounted for by differences in single word reading. Nor have any of these studies explored the contribution of prosodic competence to prosodic passage reading in adult readers. Accordingly, this gap in knowledge will be addressed in the current thesis.

3.2. The Role of Prosodic Passage Reading

In the previous section, I provided an overview of empirical research that has examined the contribution of prosodic competence to reading related skills. I first discussed studies that have established a close relationship between prosodic competence and metalinguistic skills, such as segmental PA and MA. I then described concurrent and longitudinal research demonstrating that prosodic competence predicts single word reading ability. I also reviewed research showing that individual differences in prosodic competence are positively associated with reading comprehension and passage reading efficiency. Finally, I focused on a handful of studies assessing the contribution of prosodic competence to prosodic passage reading. The following section reflects on the posited hypothesis that another potential mechanism by which prosodic competence facilitates reading comprehension is by aiding prosodic passage reading.

To read a passage aloud with appropriate prosody, one must have both sufficient decoding skills and semantic processing skills (Wolters et al., 2022); decoding skills allow the reader to efficiently read and string together single words, while semantic processing skills allow the reader to interpret meaning and imbue the text with appropriate prosodic cues. Notably, semantic processing involves both word-level and higher order processing (at the sentence, phrase, and passage level). In this thesis, I propose that prosodic competence is one such important skill that facilitates decoding, syntactic, and semantic processing.

Given evidence that prosodic competence is positively associated with reading comprehension (e.g., Holliman, Williams, et al., 2014; Lochrin et al., 2015; Veenendaal et al., 2014), I suggest that the contribution of prosodic competence to reading comprehension may be through prosodic passage reading. In other words, prosodic competence may facilitate successful reading comprehension by enabling the reader to imbue a passage with appropriate expression and intonation—thereby improving comprehension processes. This is consistent with the theory that reading fluency acts as a 'bridge' between word reading and reading comprehension (Kim et al., 2014; Kuhn et al., 2010; Pikulski & Chard, 2005; Rasinski, 2012). According to Pikulski and Chard (2012), fluency as a deep construct is *"[a] part of a developmental process of building decoding skills that will form a bridge to reading comprehension and that will have a reciprocal, causal relationship with reading comprehension"* (pg. 511). Although this metaphor does not specifically address the role of prosodic passage reading, in an expansion of the 'bridge' theory of fluency, Rasinski (2012) suggests that while automaticity (here described as passage reading efficiency) is the bridge between word recognition and overall reading fluency, prosody (here described as prosodic passage reading) is the bridge between overall reading fluency and reading comprehension (Figure 4).

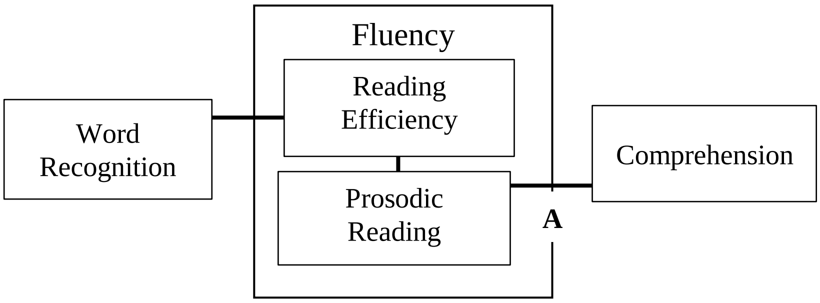

Figure 4. Adapted from "A Critical Bridge in Reading" (Rasinksi 2012, pg. 518)

Notably, this model is largely illustrative; it is a suggested theoretical framework rather than empirically derived. Moreover, this framework relies on a critical assumption: that prosodic passage reading facilitates reading comprehension (as opposed to reading comprehension facilitating prosodic passage reading) (Figure 4; path A). However, recent empirical research has provided evidence for such a framework. The following section discusses this relationship in greater detail, identifying the strengths and weakness of this account.

3.2.1. Directional Relationships between Prosodic Passage Reading and Reading Comprehension

The relationship between prosodic passage reading and reading comprehension has been a growing point of interest for educators and researchers alike. In a recent meta-analysis, Wolters et al., (2022) reviewed 35 studies that explored the association between prosodic passage reading and reading comprehension, reporting that, overall, there was a moderate correlation (r = .51) between the two reading outcomes. Notably, the researchers also commented on the difference in correlation between the measures used to assess prosodic reading. This will be addressed further in the chapter on existing methodology (see Chapter Five).

Veenendaal et al. (2016) identified three possible theoretical models to explain the relationship between prosodic passage reading and reading comprehension: (1) prosodic passage reading as a reflection of reading comprehension, (2) prosodic passage reading as a facilitator of reading comprehension and (3) prosodic passage reading and reading comprehension as bidirectional (Figure 5).

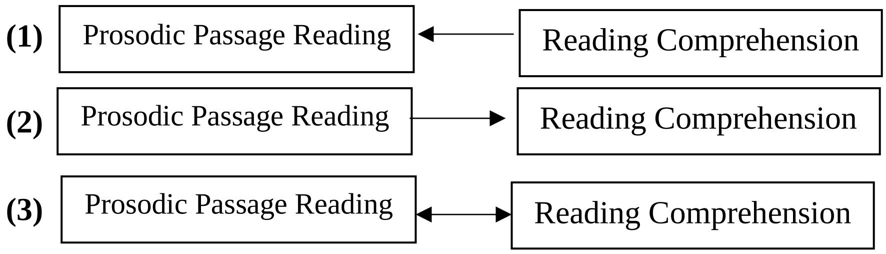

Figure 5. Theoretical Relationships between Prosodic Passage Reading and Reading Comprehension

If model 1 is a good fit, then there is little reason to include prosodic passage reading in models of reading comprehension. Rather, there is reason to include reading comprehension in models of prosodic reading; this model suggests that prosodic passage reading is simply an indicator of solid comprehension. If models 2 or 3 are a good fit, however, then prosodic reading should be considered a possible pathway between prosodic competence and reading comprehension.

3.2.1.1. Prosodic Passage Reading as a Reflection of Comprehension

The theory that prosodic passage reading is simply an indicator of successful comprehension is based on the argument that reading with appropriate prosody first requires a certain level of text comprehension. To explicate, we can again consider Text Example 1.

Text Example 1:

"Sally woke up late on Saturday morning to find her brother already up and in the kitchen. The room was a mess. Her new pots and pans were spread around the countertop, and the entire room smelled like bacon. Sally hated bacon."

A basic understanding of this text would lead the reader to the conclusion that Sally is frustrated, or at least not particularly happy, about the situation at hand. Accordingly, a reader with strong comprehension skills should imbue the text with an expression such as disgust or anger, both typically denoted by more obvious breaks between words and downward directed pitch (Cao et al., 2014). Similarly, this reader should also be able to rely on knowledge of syntactic structures to insert appropriate pauses. For example, the interpretation [pots and pans] [were spread around] would be more appropriate than [pots] [and pans were spread around].

Empirical research supporting this view includes longitudinal studies that have reported no significant relationship between prosodic passage reading and Time One and reading comprehension at Time Two. Lopes et al. (2015) assessed 98 Portuguese-speaking children on prosodic passage reading and reading comprehension, in addition to passage reading efficiency, at four time points: middle of second grade, end of second grade, middle of third grade, and end of third grade. Although results of the study demonstrated that prosodic passage reading (specifically phrasing and expressiveness) predicted reading comprehension at every time point, the researchers also reported that when passage reading efficiency was accounted for, the contribution of prosodic passage reading to reading comprehension was minimal. Accordingly, the researchers concluded that there was no evidence prosodic passage reading aided children's comprehension development above reading efficiency.

In a similar study, Fernandes et al (2018) assessed prosodic passage reading and reading comprehension, in addition to non-verbal reasoning, word reading fluency, and pseudo-word reading fluency, at two time points in two separate cohorts of Portuguese-speaking children. These included cohort 1, of 80 children in Grade 2 and then Grade 3, and cohort 2, of 75 children in Grade 4 and then Grade 5. In this study, researchers again reported robust concurrent relationships between prosodic passage reading and reading comprehension at all time points, however, they also found that after accounting for autoregressive effects (i.e. the effect of reading comprehension at Time One on reading comprehension at Time Two), prosodic passage reading only predicted later reading comprehension in the younger cohort. Moreover, after also accounting for both word and pseudo-word reading fluency, there was no evidence such effect in either cohort. Therefore, whereas prosodic passage reading may have aided comprehension development in this younger cohort, it appeared to be explained by word-level reading skills.

Neither of these studies, however, provide an obvious explanation as to why early readers exhibit improved reading comprehension when reading aloud, as opposed to reading silently (see Frazier et al., 2006). Moreover, it is notable that these results have not been reported in similar longitudinal projects. The alternative view will therefore be considered.

3.2.1.2. Prosodic Passage Reading as a Facilitator of Comprehension

There are a number of arguments as to why prosodic passage reading should facilitate reading comprehension. Dowhower (1991) suggests that reading with prosody helps the reader segment the text and group words into syntactically appropriate phrases. Kuhn et al. (2010) further suggests that prosodic passage reading serves to create an auditory sequence of information in working memory, which then can be later accessed for deeper semantic understanding. Support for both of these hypotheses is demonstrated by empirical research showing that, for early readers, prosodic passage reading appears to lead to greater comprehension than silent reading (Frazier et al., 2006; Miller & Smith, 1990)—thereby suggesting that during the reading process children utilize speech prosody to make meaning of text. Other support for this view comes from studies demonstrating that oral reading fluency accounts for variance in reading comprehension above language comprehension (and word reading) (Jenkins et al., 2003; Kim & Wagner, 2015). Furthermore, there is evidence that children who take part in reading fluency curricula and/or interventions (which involve prosodic passage reading skills) demonstrate improved comprehension (see Hudson et al., 2020 and Stevens et al., 2017 for review).

The theoretical basis for this relationship can also be exemplified by linguistic research on the interplay between prosody, syntax, and semantics; prosodic passage reading should support both syntactic processing (e.g., assigning syntactic roles) and semantic processing (e.g., highlighting new or important information). To illustrate, in relation to Text Example 1, well-developed prosodic passage reading skills should lead the reader to emphasize the new information in the final sentence [Sally hated bacon]; both *Sally* and *bacon* were previously referenced in the text, whereas *hated* is a new piece of information. Therefore "Sally HATED bacon" (as opposed to "SALLY hated bacon" or "Sally hated BACON") leads to an emphasis of new and important information (e.g., Sally's feelings towards the situation). This also fits with hypothesis put forward by Kuhn et al. (2010)—that a reader can deepen their semantic understanding by accessing auditory information from prosodic reading. Accordingly, in this case, whereas the pieces of information that were emphasized may not be completely integrated into the situation model in real time, prosodic passage reading allows for such information to be recalled from working memory for longer.

Other empirical research supporting this theory includes longitudinal studies. Lai et al. (2014) assessed reading fluency (both prosodic passage reading and reading efficiency) and comprehension in a sample of 154 (English-speaking) children aged 6- to 8-years-old, at three different time points over a school year. Using structural equation modelling, the researchers tested whether model 2 or model 3 was a better fit for the data, finding that a bidirectional relationship between fluency and comprehension (model 3) was no better than a unidirectional relationship of fluency on comprehension (model 2)—even after accounting for autoregressive effects. In a recent study by Kim et al., (2021), researchers used structural equation modelling (SEM) to specifically explore the directionality between prosodic passage reading and reading comprehension, in addition to word reading and listening comprehension, in a large sample of English speaking 6 to 8-year-olds. In this study, researchers tested competing mediation models, here referred to as model 1 (prosodic passage reading as an outcome of reading comprehension—specifically prosodic passage reading as a mediator between word reading/ listening comprehension and reading comprehension) and model 2 (prosodic passage reading as facilitator of reading comprehension—specifically reading comprehension as a mediator between word reading/listening comprehension and prosodic passage reading). Notably, in both models, word reading and listening comprehension at Time 1 (fall of Grade 1 or 2) was used as the predictor variable. In model 1, reading comprehension at Time 2 (spring of Grade 1 or 2) was used as the mediator, and prosodic passage reading at Time 3 (fall of Grade 2 or 3) as the outcome. In model 2, prosodic passage reading at Time 2 (spring of Grade 1 or 2) was used as the mediator, and reading comprehension at Time 3 (fall of Grade 2 or 3) as the outcome. Model fit statistics for these models demonstrated that the data best fit model 2—thereby demonstrating that prosodic passage reading was not simply an outcome of good comprehension, it was a predictor. To date, this is perhaps one of the strongest pieces of evidence suggesting that prosodic passage reading does indeed facilitate comprehension in early readers.

3.2.1.3. Prosodic Passage Reading and Reading Comprehension as Bidirectional

The final possibility is that both prosodic passage reading and reading comprehension serve to facilitate the other. In fact, taking a closer look at all of the theoretical examples thus far, it becomes clear that both processes are very much intertwined. To illustrate, while reading comprehension skills likely facilitate appropriate syntactic parsing during passage reading, the use of this parsing in turn should assist comprehension processing. Moreover, this model is also largely supported by further longitudinal studies.

Klauda and Guthrie (2008) assessed prosodic passage reading and reading comprehension, in addition to word reading and sentence reading efficiency, in a sample of 278 English-speaking children in Grade 5 at three different time points. In this study, the researchers found evidence that prosodic passage reading predicted reading comprehension at later time points (and visa-versa). More recently, Veenendaal et al. (2016) also measured prosodic passage reading and reading comprehension in a sample of 99 (Dutch-speaking) children at three time points: in Grade 4, Grade 5, and Grade 6. Once again, the researchers used structural equation modelling, this time demonstrating that the best fit was a bidirectional model (model 3) in which prosodic passage reading and reading comprehension were predictive of each other at later time points, even after accounting for autoregressive effects and reading efficiency.

Taken together, the theoretical and empirical work is not completely conclusive—however, I argue that there are strong grounds to infer that prosodic passage reading does, in part, facilitate reading comprehension, even if the relationship is likely reciprocal.

3.2.2. Prosodic Competence, Prosodic Passage Reading, and Reading Comprehension

The work reviewed concerns the relationship between prosodic passage reading and reading comprehension (pathway A; Figure 6). In this thesis, however, I also add prosodic competence to the conversation; if prosodic passage reading facilitates reading comprehension, could this explain the contribution of prosodic competence to reading comprehension? Below I illustrate this hypothesis by introducing prosodic competence to Rasinksi's (2012) framework of 'Fluency as Bridge.' Notably, the research questions consider whether the contribution of prosodic competence to prosodic passage reading goes beyond word recognition (pathway B; Figure 6).

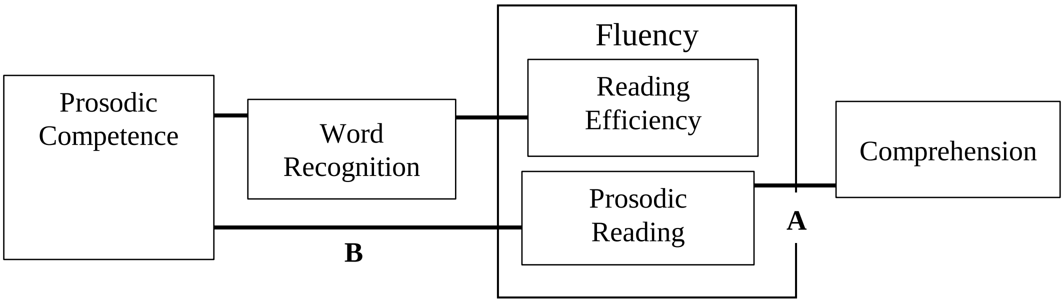

Figure 6. Expanding Rasinski's (2012) framework: Prosodic Reading as a Bridge Between Prosodic Competence and Reading Comprehension

3.3. Considering Reading Development

In the previous section I discussed the plausible directional relationships between prosodic passage reading and reading comprehension. I argued that, in view of the literature discussed, prosodic passage reading is likely a reflection of good reading comprehension to some extent, but, that this is not the entire story. Rather, an increasing amount of research suggests that prosodic passage reading plays a facilitating role in reading comprehension. Consequently, I suggest that this supports the view of reading fluency as a 'bridge' between word reading and comprehension. Moreover, I introduce the hypothesis that the contribution of prosodic competence to reading comprehension may be explained by differences in prosodic passage reading. In this section I consider whether the concurrent relationships between these skillsets may change depending on reading experience.

According to Chall (1983), children progress through a series of stages of reading development. In earlier stages (stages 0-2; ages 0- to 8-years-old), individuals largely focus on decoding the text at hand and developing fluency, whereas in later stages they are able to start to learning from the text and reflecting on the content (stages 3-6; 8+ years old). The difference between these two stages is often characterised as 'learning to read' vs. 'reading to learn.' One of the hypotheses presented in the current thesis is that the role of prosodic competence will be different depending on reading experience: the contribution of prosodic competence to passage reading for early readers who are primarily 'learning to read' will be at a lower level, facilitating decoding related skills, whereas the contribution of prosodic competence to passage reading for experienced readers who are primarily 'reading to learn' will be at a higher-level, likely facilitating syntactic and semantic processing. This chapter takes a closer look at theories of development in relation to word reading, reading comprehension and prosodic passage reading in order to reflect on the potentially changing contribution of prosodic competence.

3.3.1. Development of Word Reading

The development of word reading has also been mapped out in both "stages" (Gough & Hillinger, 1980; Frith 1985) and "phases" (Ehri, 1995; Ziegler & Goswami, 2005). Whereas theories that outline reading development in "stages" suggest that all readers pass through a set of distinct sequences, theories that outline "phases" suggest a more flexible account of the progression of reading. Here I will describe the most contemporary account of the phases proposed by Ehri (1995; 2002; 2005). These include the following:

Pre-alphabetic: In the pre-alphabetic phase, an individual "reads" words by memorizing relevant visual features or making an educated guess from context (e.g. reading the *McDonalds* sign above a restaurant from its recognizable logo). In this stage, an individual is aware of words but does not yet grasp the alphabetic principle.

Partial Alphabetic: In the partial alphabetic phase, an individual recognizes some letters and can use these (with context) to remember words by sight (e.g. reading simple familiar words which appear in familiar contexts). In this stage, an individual starts to develop phonological awareness and begins to understand the alphabetic principle.

Full alphabetic: In the full alphabetic phase, an individual uses grapheme-phoneme relationships to decode and read unfamiliar words, in addition to the familiar words already stored in their memory (e.g. reading a simple book and sounding out unfamiliar words when they appear). In this stage, an individual has grasped the principle and has developed an awareness of phonemes and rimes.

Consolidated Alphabetic: In the consolidated alphabetic phase, an individual uses their well-developed knowledge of grapheme-phoneme relationships to interpret larger units of graphemes (e.g. reading a book with unfamiliar words efficiently). In this stage the alphabetic principle is fully developed, and the individual is able to think about and manipulate parts of language.

There is a substantial amount of research that supports the progress of word reading according to these general phases (see Beech, 2005). Fittingly, the development of segmental PA and the alphabetic principle is a cornerstone of many early literacy interventions and curricula (see Teale et al., 2020). Although prosody is not explicitly referenced within this framework, the previous chapters have outlined some of the ways that prosodic competence theoretically contributes to single word reading. The following section considers whether this contribution may be different during different phases.

3.3.1.1. Prosodic Competence and Development of Word Reading

As discussed in Chapters Two and Three, researchers have demonstrated multiple pathways through which prosodic competence facilitates word reading (Wood, 2006; Holliman, Critten et al., 2014; Critten et al. 2020). This includes aiding rime awareness, aiding phonemic awareness, encouraging vocabulary growth, and directly facilitating decoding. In the earliest phases of word reading, however, not all these pathways are sensible; decoding skills are not yet developed and therefore a direct contribution of prosodic competence to word decoding is unrealistic. On the other hand, these early phases correspond to rapid vocabulary growth (Jersild et al., 1983)—an important reading skill, particularly for the pre-alphabetic phase in which children largely depend on context clues, and the development of segmental PA—a marker of the progression into the partial-alphabetic phase. It follows, therefore, that the role of prosodic competence in the pre-alphabetic and partial alphabetic is likely facilitating vocabulary growth and the development of segmental PA.

As readers progress into the full and consolidated alphabetic phases, however, their understanding of the alphabetic principle and ability to think about and manipulate parts of language (e.g., segmental PA) is much more developed (Ehri, 2005)—suggesting that any facilitating role of prosodic competence in relation to developing these skills may no longer be as necessary. Yet, one of the processes that is not addressed by Ehri's phases of word reading is how readers are able to advance from decoding mono-syllabic words to multi-syllabic words; reading an unfamiliar multi-syllabic word requires the reader to not only have a solid understanding of grapheme-phoneme relationships, but also an understanding of syllable stress (i.e., prosodic competence). In fact, the importance of prosodic competence (above segmental PA) in relation to reading multi-syllabic words in particular was recently empirically demonstrated in a sample of seventy 7 to 10-year old children (Enderby et al., 2021). Accordingly, I suggest that the role of prosodic competence during the full and consolidated alphabetic phases is likely to be different from the earlier phases; rather than facilitating the development of segmental PA and vocabulary, it directly facilitates decoding.

In summary, and in line with research demonstrating significant positive relationships between prosodic competence and single word reading across reading development (e.g., in samples of early readers and samples of experienced adult readers) (Chan & Wade-Woolley, 2018; Kim & Petscher, 2016), I maintain that prosodic competence continues to facilitate word reading over the course of reading development. However, I argue that the nature of this relationship is dependent on reading level—and that as readers become efficient decoders some of the earlier roles of prosodic competence (e.g., supporting segmental PA) become less important.

3.3.2. Development of Reading Comprehension

The development of reading comprehension is arguably more complex than the development of word reading—perhaps best characterised as a process of an ongoing continuity and change (van den Broek & Kendeou, 2017). According to the Simple View of Reading (SVR) (Hoover & Gough, 1990), skilled comprehension involves the ability to both efficiently decode words and understand language. However, unlike word decoding, language comprehension is an extremely multi-faceted process that begins to develop as soon as infants are introduced to language, and continues into adulthood (Chall, 1983; Loban, 1976).

The SVR also posits, however, that the relative contribution of single word reading and language comprehension to reading comprehension changes over the course of reading development (Gough et al., 1996); whereas decoding is the stronger predictor of reading comprehension in early readers, language comprehension emerges as the stronger predictor of comprehension in more advanced readers (i.e., after word reading becomes automatized) (García & Cain, 2014; Hogan et al., 2014).

In the previous section, I discussed how the facilitating role of prosodic competence in relation to word reading changes likely over the course of word reading development. In the same vein, prosodic competence has a multi-layered relationship with the development of reading comprehension. Previous research has established that an understanding of prosodic competence is associated with reading comprehension in both children and adults (e.g., Chan & Wade-Woolley, 2018; Holliman, Williams et al., 2014; Kitzen, 2001; Lochrin et al., 2015; Veenendaal et al., 2014; Williams & Wood, 2012). The next section will therefore consider the potential changing relationships between prosodic competence and reading comprehension over the course of reading development.

3.3.2.1. Prosodic Competence and Development of Reading Comprehension

Considering the cognitive processes involved in reading comprehension, there are two main categories: (1) lower level processes (e.g., mapping graphemes and phonemes—the linguistic and writing system in the RSF) and (2) higher level processes (e.g., creating relations between pieces of the text—the comprehension processes in the RSF) (Kendeou et al., 2014). These can also be roughly be mapped onto the processes of decoding and language comprehension in the SVR. As discussed in earlier chapters, prosodic competence is theoretically involved in both these lower level and higher-level processes. However, taking into account the developmental perspective of the SVR (i.e., that the relative contribution of decoding to reading comprehension is more robust during early reading development and less robust during later reading development—and visa versa for language comprehension), it is plausible that the role of prosodic competence in relation to reading comprehension also follows this trajectory. In other words, when reading comprehension is most restricted by decoding processes, the main contribution of prosodic competence is facilitating lower level decoding processes. On the other hand, after readers have reached a certain level of reading efficiency, prosodic competence is no longer as important for decoding and therefore switches to support language comprehension.

There is substantial empirical evidence that prosodic competence facilitates lower level reading processes (e.g., segmental, PA, word decoding) in early readers. Accordingly, this likely explains much of the relationship between prosodic competence and reading comprehension. However, this is not to claim that language comprehension is not involved in early reading comprehension. On the contrary, language comprehension is also important for successful reading comprehension from a very young age. Researchers interested in the development of comprehension have demonstrated that language comprehension of 4 to 5-year-olds (measured using a listening comprehension task) involves both lower level skills (e.g., vocabulary, working memory), in addition to higher-level skills (e.g., the ability to use linguistic context) (Florit et al., 2013). In fact, even at the earliest stages of reading development (children ages 4- to 6-years-old), higher-level skills, such as the ability to make inferences, predict later reading comprehension (Silva & Cain, 2015). The prosodic bootstrapping hypothesis (Bedore & Leonard, 1995; Christophe et al., 2003) also asserts that prosodic competence allows for language comprehension by enabling infants to segment fluent speech into words. Consequently, the role of prosodic competence in relation to reading comprehension is likely aiding both decoding and language comprehension in early readers.

In more experienced readers, however, the role of language comprehension should emerge as an even stronger predictor of reading comprehension, relative to decoding processes (Gough et al., 1996). After all, according to automaticity theories, these readers do not need to devote as much cognitive attention to the process of decoding words after achieving sufficient reading automaticity. The role of prosodic competence in relation to reading comprehension, therefore, should primarily be aiding language comprehension. Accordingly, the contribution of prosodic competence to reading comprehension may shift to almost exclusively aiding be syntactic and semantic processing in experienced readers.

3.3.3. Development of Prosodic Passage Reading

Fluent oral reading inevitably involves a certain level of skilled word reading. Naturally, the development of passage reading efficiency is therefore closely related to the development of word reading. The development of prosodic passage reading, on the other hand, requires not only efficient word reading, but also an in depth understanding of syntax and semantics.

In a recent paper mapping out the development of prosodic passage reading, Godde et al., (2020) used empirical literature to present four overlapping 'landmarks' that describe the progression of becoming a prosodic reader. These include: (1) an acquisition of fluency, (2) the planning of appropriate pauses, (3) the correct choice of intonation contours, and (4) the development of expressivity.

Here, acquisition of fluency refers to the ability to read a passage accurately and quickly—in other words, passage reading efficiency. Accordingly, the first landmark requires that readers have reached the full or consolidated phase of word reading. This progression of first acquiring reading efficiency, before prosodic passage reading, is notably consistent with other accounts of fluency development (Cowie et al., 2002; Kuhn & Stahl, 2003; Miller & Schwanenflugel, 2006). In relation to the second landmark, the ability to plan appropriate pauses, the authors identify three distinct types of pauses: hesitation pauses (pauses arising from planning or decoding issues), breath pauses (to allow the reader to take in air), and syntactic pauses (pauses between syntactic units) (Godde et al., 2020; Godde et al., 2021; Lalain et al., 2016). Notably, through a review of existing literature on prosodic reading (Álvarez-Cañizo et al., 2015; Miller & Schwanenflugel, 2008; Schwanenflugel et al., 2015), the authors suggest that pausal intrusions within words and syntactic units (i.e., hesitation or breath pauses) appear to decrease between 6-years-old and 9-years-old, while the length of syntactic pauses decreases as readers move into adulthood (Figure 7).

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Figure 7. Hypothesised Development of Prosodic Passage Reading (Godde et al. 2020, pg. 8)

Godde et al. (2020) also suggest that appropriate use of pitch and intensity during reading (the final landmarks of prosodic passage reading) demonstrate general patterns of acquisition. For example, the ability to use final rise as an interrogative (the rise in pitch at the end of a question) develops between 8- and 11-years-old. On the other hand, the use of final lengthening (the lengthening of a rhyme before a syntactic boundary) and variation in speech intensity (associated with expressive reading) doesn't typically develop until 11-years-old (Figure 7). This was further supported in another recent study by Álvarez-Canzino et al. (2020), in which researchers found significant differences in declarative final pitch declination between Spanish-speaking high-schoolers in their first year (12- to 13-years-old) and second year (13- to 14-years-old).

Surprisingly, there is little research exploring the role of prosodic competence in relation to the development of these landmark skills. However, as previously argued, it is logical that an understanding of prosody would be a precursor to the development of prosodic passage reading. Accordingly, the next section will discuss how prosodic competence may support the prosodic passage reading over the course of development.

3.3.3.1. Prosodic Competence and Development of Prosodic Passage Reading

Of course, another pre-requisite for prosodic passage reading is the ability to produce prosodic cues—also an aspect of prosodic competence. Research has demonstrated that the development of prosody production differs depending on language (Chen, 2018; Szendroi et al., 2018). According to Chen's (2018) cross-linguistic theory of the acquisition of prosodic focus marking, the rate and route of prosody production skills depend on typological differences across languages. However, across almost all languages, Chen (2018) suggests that children have largely acquired prosodic focus marking by age 4- or 5-years-old. Interestingly, in a recent study exploring the production of prosody in French-speaking pre-schoolers ages 4- to 5-years-old, researchers found that even when children were not able to consistently produce prosodic cues to mark focus during, they used head gestures to mark important information. This suggests that, at this age, children can still comprehend the importance of prosodic cues, and further, that these gestures may play a role in the development of prosodic production (Esteve-Gibert et al., 2021).

After acquisition of speech prosody, however, prosodic competence should also be implicated in every ‘landmark’ of Godde et al.’s (2020) theorised development of prosodic passage reading; acquisition of fluency, planning of pauses, appropriate intonation, and use of expression all theoretically rely on a basic understanding of prosody. However, whereas the first landmark—an acquisition of fluency (here described as reading efficiency, or in other words, the ability to read quickly and accurately) is largely dependent on word reading ability, the later landmarks are largely based on comprehension skills. In other words, reading a passage quickly and accurately can be achieved by someone with strong word reading skills and minimal language comprehension, however, the ability to read with appropriate pauses, intonation, and expression involves not only word reading skills, but also an understanding of syntax and semantics. This echoes the developmental perspective of the SVR: whereas early comprehension and emergent prosodic reading are closely related to decoding skills, skilled comprehension and prosodic reading are dependent on high-order comprehension skills.

Empirical support for this account was demonstrated in a recent longitudinal study by Kim et al., (2021), in which researchers assessed the relative contribution of word reading and language comprehension to prosodic passage reading in a sample of English-speaking children ages 6- to 9-years-old. In this study, word reading and listening comprehension were measured at Time One, and prosodic passage reading was measured at Time Two. The researchers reported that when word reading and listening comprehension were modelled together, word reading (rather than listening comprehension) was the primary driver of prosodic passage reading. No published study has yet to assess the relative contribution of word reading and listening comprehension to prosodic passage reading in samples of more advanced readers, however, I argue that—in line with the landmarks proposed by Godde et al. (2020)—language comprehension would likely play a larger role. Accordingly, I reason that, similar to reading comprehension, the role of prosodic competence in relation to the development of prosodic passage reading may also switch from supporting word-reading efficiency during early development to supporting the use of pauses, intonation, and expression during skilled reading. This is addressed in the current thesis.

3.4. Summary

In this chapter, I reviewed empirical research that has examined the contribution of prosodic competence to reading related processes, including metalinguistic skills, single word reading, and passage reading. Specifically I focused on studies investigating the relationship between prosodic competence and prosodic passage reading. Next, I discussed the plausible directional relationships between prosodic passage reading and reading comprehension—arguing that there is empirical support that prosodic passage reading facilitates comprehension. Finally, I considered on the role of development in relation to prosody and reading. I discussed theoretical and empirical accounts of the development of word reading, reading comprehension, and prosodic passage reading and suggested that, although prosodic competence is implicated in all of these skills, the nature of its relationship likely changes during the progression from early to experienced reading. Specifically, I posit that during early reading development the role of prosodic competence is likely facilitating lower level skills involved in single word reading, while for more advanced readers, the role of prosodic competence switches to supporting higher-order passage level processes. The next chapter reflects on the literature presented thus far, and motivates the current empirical studies.

4. Current Thesis

Thus far I have established the many ways that prosodic competence is theoretically implicated in the process of passage reading. I have presented empirical evidence that prosodic competence is associated with both prosodic passage reading and reading comprehension, and discussed the potential changing relationships between prosodic competence and these reading outcomes over the course of reading development. Moreover, I have also reflected on some of the potential mechanisms by which prosodic competence may facilitate successful reading comprehension—including (a) that prosodic competence simply aids processes involved in word reading and word-level comprehension and (b) that prosodic competence aids higher level processes involved in prosodic passage reading (e.g., syntactic parsing and semantic processing). The following section reviews this literature in order to motivate the current thesis.

4.1. What We Know and What We Don't Know

Cross-sectional studies have provided substantial evidence that individual differences in prosodic competence are positively associated with single word reading ability in both children and adults (e.g., Kim & Petscher, 2016; Chan & Wade-Woolley, 2018). There is also an increasing number of studies demonstrating that individual differences in prosodic competence is positively associated with performance on reading comprehension tasks (e.g., Holliman, Williams et al., 2014; Lochrin et al., 2015; Veenendaal et al., 2014; Whalley and Hansen, 2006). However, it is not clear whether the relationship between prosodic competence and reading comprehension is completely explained by differences in word level reading skills, or, whether prosodic competence facilitates reading comprehension at a higher level.

A growing body of research indicates that prosodic passage reading is not only positively associated with reading comprehension (Wolters et al., 2022), but also a facilitator of successful comprehension (Kim et al., 2021; Klauda & Guthrie, 2008; Lai et al., 2014; Miller & Schwanenflugel, 2008; Paige et al., 2017; Veenendaal et al., 2016). It therefore follows that a possible mechanism by which prosodic competence facilitates reading comprehension is that it allows for prosodic passage reading.

A search of the literature only revealed three studies that have documented a relationship between prosodic competence and prosodic passage reading ability (Groen et al., 2019; Holliman et al., 2010a; Veenendaal et al., 2014). By and large, the aim of these studies was to understand the relationship between general prosodic skills and reading comprehension. However, all three studies also reported significant positive associations between prosodic competence and prosodic passage reading. Moreover, Holliman et al. (2010a) reported that, after controlling for differences in vocabulary and segmental PA, prosodic competence at Time One predicted unique variance in children's ability to read with appropriate phrasing one year later—but that their ability to read with smoothness and pacing was accounted for by individual differences in segmental phonological awareness and vocabulary knowledge. This indicates that the relationship between prosodic competence and prosodic passage reading potentially goes beyond word-level reading skills in children. However, because the researchers in this study did not control for single word reading, it is unknown the extent to which word reading ability may have explained this relationship.

Furthermore, no studies have explored the contribution of prosodic competence to prosodic passage reading in experienced adult readers. Therefore, it is also unclear as to whether the contribution of prosodic competence to prosodic passage reading may be more apparent in experienced readers—whose prosodic passage reading may be less limited by efficient word-level reading skills. Accordingly, the aim of the current thesis is to better understand the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension in both experienced readers (adults) and early readers (7 to 11-year old children). Results will highlight the potential mechanisms by which these prosodic skills facilitate passage reading at different time points in reading development, thereby informing (a) how prosody should be conceptualised in frameworks of reading and (b) how prosody training and assessments should be utilised in education settings and literacy curricula. The five specific research questions that will be addressed are presented below.

4.2. General Research Questions

(1) To what extent do individual differences in prosodic competence account for unique variance in prosodic passage reading?
   a. Is this relationship explained by differences in word-level reading skills (e.g., vocabulary, segmental phonological awareness, and single word reading)?
   b. Is this relationship explained by differences in passage reading efficiency?

(2) To what extent do individual differences in prosodic passage reading account for unique variance in reading comprehension?
    a. Is this relationship explained by differences in word-level reading skills (e.g., vocabulary, segmental phonological awareness, and single word reading)?
    b. Is this relationship explained by differences in passage reading efficiency?
(3) To what extent do individual differences in prosodic competence account for unique variance in reading comprehension?
    a. Is this relationship explained by differences in word-level reading skills (e.g., vocabulary, segmental phonological awareness, and single word reading)?
    b. Is this relationship explained by differences in passage reading efficiency?
(4) If prosodic competence accounts for unique variance in reading comprehension (above word-level reading skills), is this variance explained by prosodic passage reading?
(5) Are the pattern of relationships (results of RQ 1-4) the same in experienced readers (adults) and early readers (7 to 11-year old children)?

4.3. Empirical Studies

Three empirical cross-sectional studies were conducted to address these research questions. The first study specifically examined the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension in a sample of experienced readers. 105 adults (without self-reported reading disorders) completed assessments of these measures, in addition to vocabulary and passage reading efficiency. The second study investigated whether the same results could be replicated in a different sample of 86 adults. In addition to the above measures, this study also accounted for differences in segmental PA and single word reading. Furthermore, participants completed three separate passage reading tasks to account for the potential effect that instruction bias may have had on the results of study one. The final study examined the concurrent relationships between performance on these measures in a sample of 49 children aged 7- to 11-years-old. Children completed measures of vocabulary, segmental PA, single word reading, prosodic competence, passage reading efficiency, prosodic passage reading, and reading comprehension.

4.4. Hypotheses

Considering the theoretical and empirical work discussed above, I propose the following hypotheses (Figure 8):

Research Question One:

- **Hypothesis 1:** In early readers, individual differences in prosodic competence will account for variance in prosodic passage reading, but this variance will be entirely explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading)
- **Hypothesis 2:** In experienced readers, individual differences in prosodic competence will account for unique variance in prosodic passage reading ability, even after controlling for differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading) and passage reading efficiency.

Research Question Two:

- **Hypothesis 3:** In early readers, individual differences in prosodic passage reading will account for variance in reading comprehension, but this variance will be entirely explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading).
- **Hypothesis 4:** In experienced readers, individual differences in prosodic passage reading will account for unique variance in reading comprehension, even after controlling for differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading) and passage reading efficiency.

Research Question Three:

- **Hypothesis 5:** In early readers, individual differences in prosodic competence will account for variance in reading comprehension, but this variance will be entirely explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading).
- **Hypothesis 6:** In experienced readers, individual differences in prosodic competence will account for unique variance in reading comprehension, even after controlling for

differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading) and passage reading efficiency.

Research Question Four:

- **Hypothesis 7:** In early readers, word-level reading skills will account for all of the variance in reading comprehension predicted by prosodic competence.
- **Hypothesis 8:** In experienced readers, the unique contribution of prosodic competence to reading comprehension (above word-level skills) will be explained by prosodic passage reading.

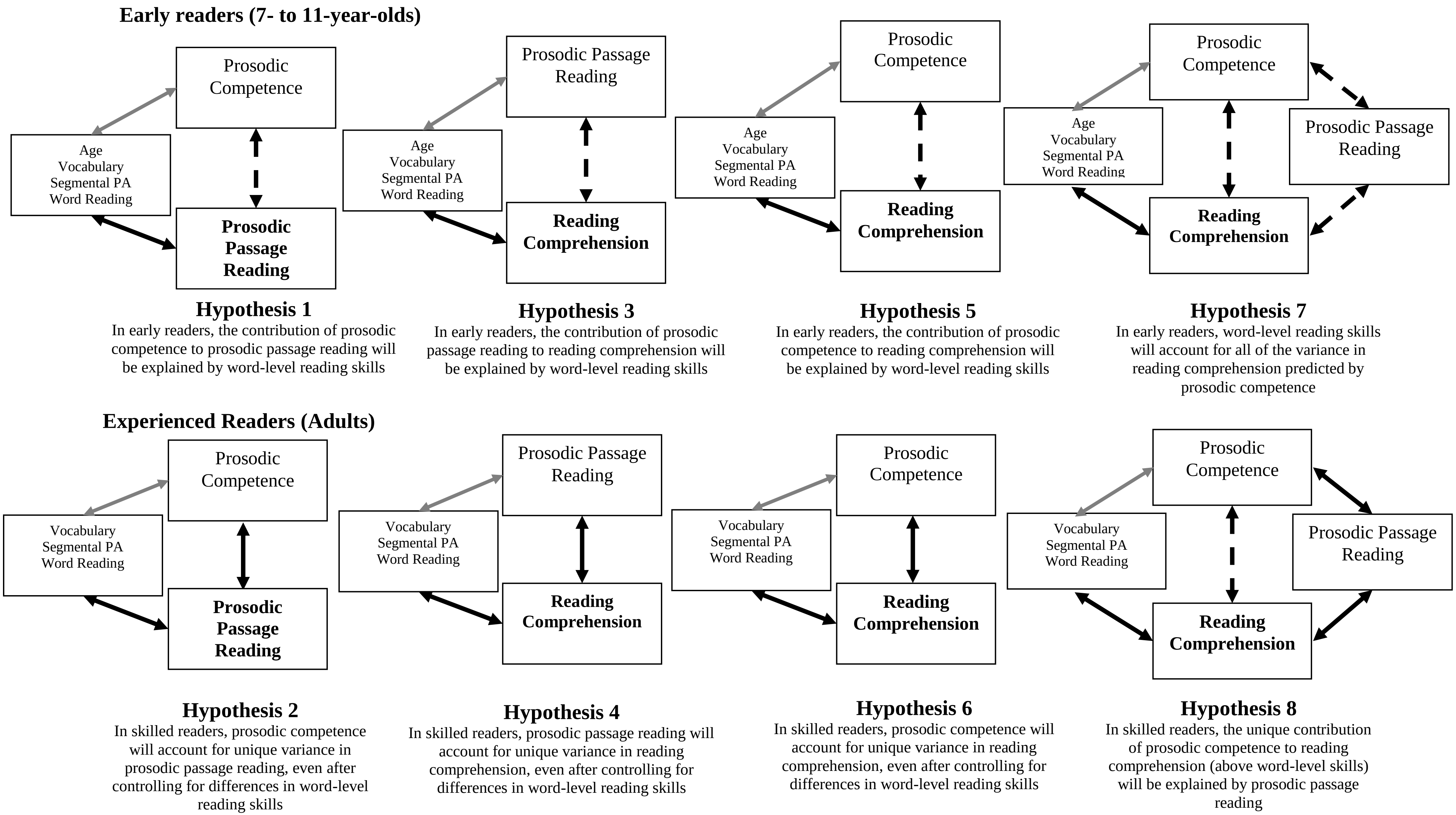


Figure 8. Hypothesised Relationships

Note. Solid arrows represent hypothesised unique variance (direct relationship); Dashed arrows represent hypothesised variance shared with word level skills (indirect relationship); Grey lines represent established relationships

4.5. Summary

In this chapter I provided a summary of the literature presented in Chapters One through Three, specifically drawing attention to our gap in knowledge around how prosodic competence facilitates reading comprehension. I then used these gaps to motivate the five research questions addressed in the current thesis, and provided a brief description of the methodology of the three empirical studies. Finally, I used the reviewed literature to motivate a series of hypotheses about the concurrent relationships prosodic competence, prosodic passage reading, and reading comprehension in samples of both experienced readers (adults) and early readers (7 to 11-year old children).

5. Existing Methodology

This chapter will review some of the existing measures which have previously been used to assess the variables of interest for this thesis. Given the relative novelty of assessing prosodic competence, this construct will be the focus of this chapter. However, I will also provide a discussion of various measures of passage reading fluency (reading efficiency and prosodic reading) and reading comprehension. This chapter also includes a reflection on which measures were most appropriate in the context of collecting data during a pandemic that restricted face-to-face contact.

5.1. The Impact of the Covid-19 Pandemic Restrictions

On March 11th, 2020 the World Health Organization characterised Covid-19 as a pandemic. On March 16th, the UK government advised against non-essential personal contact, and soon after, on March 23rd, a national lockdown was announced. At this time, in-person data collection for two studies associated with the current thesis was in progress and had to be stopped abruptly. Given the time-sensitive nature of this thesis, new online versions of these studies were designed, and data collection was started over. These new studies are reported in the current thesis (Study Two and Study Three). The original studies will be only briefly discussed in the current thesis, however, the measures used and some preliminary descriptive statistics can be found in **Appendix A.**

5.2. Prosodic Competence

In order to reflect properly on previous research examining prosodic competence, it is necessary to first recognize how this construct can be quantified. Measuring an individual's understanding of prosody is challenging for several reasons; prosodic competence is a metalinguistic skill which is both complex and abstract in nature. Consequently, many different measures have been developed to assess it. Although these measures aim to explore the same general construct, they each take a slightly different approach. In this section, I will provide an overview of some of the most common measurements used to quantify prosodic competence—including the type of response required, the populations they are typically used with, and their internal reliability (i.e., the extent to which the measures are consistent within themselves).

5.2.1. Measure: DEEdee Matching Tasks

In this task, words or phrases are replaced by the same reiterative syllable ("dee"). Although all phonemic information is removed, the prosodic information (e.g. stress, intonation, and timing) remains. Participants are asked to listen to a word or phrase and match it to a "DEEdee" word or phrase (e.g. Listen to the phrase 'The Jungle Book.' Does the rhythm of this phrase match 'deeDEEdeeDEE' or 'DEEdeeDEEdee'?).

Since the construction of this task by Kitzen (2001), many researchers have used the DEEdee paradigm to measure prosodic competence in both adult populations (Kitzen, 2001; Mundy & Carroll, 2012) and populations of children (Bhide et al., 2013; Choi et al., 2017; Clin et al, 2009; Goswami et al., 2010; Goswami et al., 2013; Holliman et al., 2012; Richards & Goswami, 2015; Ryken, 2019; Whalley & Hansen, 2006). A Mandarin version of this task has also been developed (Chung et al., 2017; Chung & Bidelman 2021). Perhaps one reason for the popularity of this measure is that it allows researchers to assess prosodic competence at both a word level (i.e. match "Tooth-fairy" to "DEEdeedee") and a phrase level (i.e. match "Twinkle Twinkle Little Star" to "DEEdeeDEEdeeDEEdeeDEE"). Unfortunately, even though this task is perhaps the most widely utilized measure of prosodic competence, it has a notably low internal reliability. As noted earlier, internal reliability refers to the extent to which a measure is consistent within itself; a reliable measure indicates that the relevant items are inter-correlated with one another, and therefore assess the same construct (Vaske et al., 2017). Cronbach's alpha is perhaps the most common measurement used to assess internal reliability, with .65 or above considered an adequate value for scales in human research (Spector, 1992; Vaske, 2017). Out of the studies cited above (which reported reliability information), the highest reliability reported with Cronbach's alpha was $\alpha = .67$ (Ryken, 2019), while the lowest was $\alpha = .37$ (Holliman et al., 2012). Goswami et al. (2013) also reported a relatively low Guttman's split-half coefficient of .52. Other reports ranged from Cronbach's alpha of $\alpha = .45$ (Goswami et al., 2010) to $\alpha = .66$ (Holliman et al., 2017).

5.2.2. Measure: Low-Pass Filter Matching Tasks

Low-pass filter matching tasks are similar to the DEEdee task—except that rather than matching a spoken phrase to a reiterative DEEdee phrase, participants are asked to match a spoken phrase to speech which has been low-pass filtered. A low-pass filter removes all auditory cues above a certain frequency. Because segmental phonological cues are carried in higher frequencies, and prosodic cues can be detected in lower frequencies, the result is speech that only carries prosodic cues—and as a result sounds ‘fuzzy’ or like it is uttered underwater.

This paradigm has also been used to explore individuals’ awareness of different components of prosody separately—including stress (match a spoken phrase to a low-pass filtered phrase based on stress cues), intonation (match a spoken phrase to a low-pass filtered phrased based on intonation cues), and timing (match a spoken phrase to a low-pass filtered phrase based on timing cues).

This type of task has primarily been used to assess prosodic competence in children between 5- and 9-years-old (Clin et al., 2009; Deacon et al., 2018; Holliman, Critten et al., 2014; Holliman, Williams et al., 2014). Researchers using this task have reported medium internal reliability, with Cronbach’s alpha ranging between α =.57 (Holliman, Williams et al., 2014) and α =.70 (Deacon et al., 2018). However, Holliman, Williams et al. (2014) also administered this task to participants at two separate time points 3 months apart, reporting relatively good test-retest reliability (r =.78).

5.2.3. Measure: Compound Noun Tasks

In this task, sometimes also referred to as the Accent Disambiguation Task, participants differentiate between two phonemically identical, but prosodically different, word strings and are asked to select a picture representing what was heard (e.g. Listen to “[light] [house]” or [lighthouse] and select from a picture of a house that is a light in colour, or a building with a light used to guide boats).

This task has been used to measure prosodic competence across both English and Spanish speaking populations, and in populations of children and adults (Calet et al., 2015; Goodman et al, 2010; Harrison et al., 2018; Kaswer, 2016; Kitzen, 2001; Holliman et al., 2012; Nash & Arciuli, 2016; Whalley & Hansen, 2006). Additionally, this task has been used to assess prosodic competence in children with Autism Spectrum Disorder (ASD) (Nash & Arciuli, 2016).

Researchers have reported this task to have good internal reliability, with Cronbach's alpha ranging between $\alpha = .71$ (Goodman et al., 2010) and $\alpha = .83$ (Holliman et al., 2012). An exception was a study by Calet et al. (2015) in which researchers measured the performance of Spanish speaking children at five different time points between 6-years-old and 9-years-old. Although the reliability of the compound noun task for young children was low at $\alpha = .50$, it was reasonably reliable for older children at $\alpha = .73$.

5.2.4. Measure: Receptive Phrasing Tasks

In these tasks, participants differentiate between two phonemically identical, but prosodically different, phrases and are asked to select a picture representing what was heard (e.g. Listen to "[red white and black shoes]" or "[red], "[white], [and black], [shoes]" and select from a picture of one pair of multi-coloured or three pairs of shoes/ Listen to "the MAN ate the cake" or "the man ate the CAKE" and select from a picture emphasizing a man or a cake).

Once again this task has been used to measure prosodic competence in samples of both children and adults (Groen et al., 2019; Kaswer, 2016; Hesling et al., 2010; Marshal et al., 2009; Nash & Arciuli, 2016). It is also included in the Profiling Elements of Prosody in Speech Communication (PEPS-C; McCann & Peppe, 2003) further discussed below.

Given that this task is often completed as part of a larger battery of tasks, there are few reported measures of internal reliability. However, Groen et al., (2019) reported a high reliability of $\alpha = .80$ in a sample of Dutch speaking 7- to 11-year-olds.

5.2.5. Measure: Stress Mispronunciation Tasks

In this task, participants listen to an audio recording with words that are pronounced with incorrect stress placement. They are then asked to select the picture of the word the speaker was trying to say (e.g. The participant hears paRROT and chooses from a picture of a panda, parrot, paper, and kayak). Researchers typically use one of two versions of this task: the original version (Wood, 2006), or a version which was revised to control for confounds in the distractor items (Holliman et al., 2010a; Holliman et al., 2010b).

The mispronunciation task has largely been used to assess prosodic competence with typically developing children between 4- and 9-years-old (Goodman et al., 2010; Holliman et al., 2008; Holliman et al., 2010a; Holliman et al., 2012; Whalley, 2017) and children with ASD between the ages of 5- and 11-years-old (Nash & Arciuli, 2016). This task has also been used to explore prosodic competence in children who are bilingual, or who have speak English as an additional language (Choi et al., 2017; Choi, et al., 2019).

Researchers have found both the original and revised version of this task to have medium to good internal reliability, reporting Cronbach's alpha between $\alpha = .60$ (Holliman et al., 2012) and $\alpha = .90$ (Choi et al., 2019). Other reports ranged from $\alpha = .70$ (Goodman et al., 2010) to $\alpha = .87$ (Holliman et al., 2012).

5.2.6. Measure: Stress Identification Tasks

In this task, also sometimes referred to as a Stress Assignment task, participants listen to a multisyllabic word and identify the syllable in the word with the strongest emphasis, or in other words, with the primary stress (e.g. Listen to "vandalism." Which syllable contains the strongest stress?). Whereas some versions of this task are completely receptive (e.g. Listen to VANdalism and vanDAlism. Are these the same or different?), other versions require the participant to clap on the stressed syllable while saying the word. Researchers using this task have asked participants to identify the location of stress in both real words (Barry et al, 2012; Calet, Gutiérrez-Palma et al., 2019; Goswami et al., 2002; Gutiérrez-Palma et al., 2016; Heggie & Wade-Woolley, 2018; Holliman et al., 2012; Kim & Petscher, 2016; Wade-Woolley et al., 2012) and pseudowords (Calet et al., 2015; Calet et al., 2017; Calet, Gutiérrez-Palma et al., 2019; González-Trujillo et al., 2014; Gutiérrez-Palma et al., 2016; Leong et al., 2011).

This task has been used to measure prosodic competence across multiple languages (including English, German, and Spanish) and age groups (including children between the ages of 4- and 11-years-old and adults). Researchers have reported that this task has a generally high internal reliability with Cronbach's alpha ranging between $\alpha = .73$ (Holliman et al., 2012) and $\alpha = .89$ (Calet et al., 2017). This task was also included in the longitudinal study of Spanish speaking children aged 6- to 9-years-old (Calet et al., 2015); although the reliability of the stress identification task for 6-year-olds was low (α = .40), at the final time point the reliability of the measure was much higher (α = .80).

5.2.7. Measure: Stress Manipulation Tasks

Unlike the tasks discussed above, this task involves participants giving an oral response (as opposed to simply selecting an answer). Therefore, whereas the previous tasks can largely be considered to measure *receptive* prosodic competence, this task measures *expressive* prosodic competence. In this task participants listen to a word and then repeat it with stress on a different—and incorrect—syllable (i.e say the word "NEcessary" with stress on the third syllable). Given the relative difficulty of this task, it is typically only used with adult participants (Chan & Wade-Woolley, 2018; Heggie & Wade-Woolley, 2018; Wade-Woolley et al., 2012).

Researchers using this task have reported good inter-rater reliability when coding expressive responses (i.e. agreement on where the participant placed stress) (Chan & Wade-Woolley, 2018; Heggie & Wade-Woolley, 2018; Wade-Woolley et al., 2012). Only one study has reported an internal reliability for this task, however this was high with a Cronbach's alpha of α = .86 (Heggie & Wade-Woolley, 2018).

5.2.8. Measure: Derived Word Production Task

This task also assesses participants expressive prosodic competence, in addition to their morphological awareness. Participants are asked to pronounce words with the correct stress placement after the addition of a suffix (e.g. add "-ful" to the end of "WONder" to make WONderful, or add "-ian" to the end of "MAgic" to make "maGIcian). A revised version of the original task (Jarmulowicz, 2006) has also been created to control for semantic transparency of the stimuli (Jarmulowicz et al., 2007).

This task has been used to measure expressive morphophonological awareness in children ages 8- to 9-years-old (Jarmulowicz, 2006; Jarmulowicz et al., 2007; Whalley, 2017). Although there are no reports of internal reliability of this measure, researchers have reported a higher inter-rater reliability when coding expressive responses (Jarmulowicz, 2006; Jarmulowicz et al., 2007).

5.2.9. Measure: Story Telling Tasks

In this task, participants use a set of pictures to make up and tell a story verbally. Accordingly, this measure quantifies expressive prosodic competence at a discourse level, as opposed the word or phrase level. Recordings of the story telling are then rated for prosody using either a subjective rating scale (e.g., a scale, often 1-4, used to rate auditory cues such as expressiveness or phrasing) or an objective auditory analysis (e.g.,. a measurement of variations in acoustic cues such as pitch and intensity).

This task was first introduced by Veenendaal et al. (2014). In this study, a sample of Dutch-speaking 9 to 10-year-old children used picture cards from the *Taaltoets Alle Kinderen* (Verhoeven & Vermeer, 2001) to tell a story which was later rated using the 4-point Multi-dimensional Fluency Scale (MDFS; Rasinski, 2004). While this story telling task had previously been used to assess children's ability to produce syntactically and semantically correct sentences (Vandewalle et al., 2012), the researchers instead assessed children's ability to tell a story with appropriate phrasing, smoothness, and pace. This task has since been used with Dutch speaking 7- to 11-year-olds (Groen et al., 2019). These studies both reported a high inter-rater reliability when coding story-telling expression (Groen, et al., 2019; Veenendaal et al., 2014). Only one study reported internal reliability, however this was high with a Cronbach's alpha of $\alpha = .85$ (Groen et al., 2019).

5.2.10. Measure: Affect Identification

In this task, participants listen to a segment of speech and identify affective characteristics, such as the speakers' emotion (e.g., excited, angry), valence (e.g., positive, negative), or intensity (e.g., intense emotion, mild emotion). Unlike some of the other measures discussed thus far, this task is often incorporated into diagnostic evaluations for individuals with neurological or psychiatric impairments (Kalathottukaren et al., 2015) which are characterised by social communicative deficits. In fact, a number of different batteries have been designed to assess affective prosody. Some of these include the Profile of Nonverbal Sensitivity (Rosenthal et al., 1979), the Florida Affect Battery (Bowers et al., 1991), the Minnesota Tests of Affective Processing (Lai et al., 1991), the Aprosodia Battery (Ross et al., 1998), Advanced Clinical Solutions (Pearson, 2009), the Diagnostic Assessment of Nonverbal Accuracy (Nowicki & Duke,

1994) and the Diagnostic Assessment of Nonverbal Accuracy Adult Prosody Scale (Baum & Nowicki, 1998). Affect identification is also included in subtests of the Profiling Elements of Prosody in Speech Communication (PEPS-C; McCann & Peppe, 2003; Peppe, 2015) further discussed below.

Given the range of different assessments, it is not surprising that this type of task has been used with varying populations, just some of which include adults with Parkinson's (Dara et al., 2008), adults with brain damage (Ross et al., 1998), and children with Attention Deficit Hyperactivity Disorder (Shapiro et al., 1993). Researchers have reported generally good internal reliability (Cronbach's alpha > .70) and test-retest reliability for a number of these different batteries (see Kalathottukaren et al., 2015 for a systematic review).

5.2.11. Battery: Profiling Elements of Prosody in Speech Communication

The PEPS-C (McCann & Peppe, 2003) is a battery of tasks, each of which measure a slightly different aspect of prosodic competence. Although the PEPS-C was originally published in 2003, a revised version was more recently introduced in 2015. This version includes 14 separate tasks, each assessesing a different aspect of prosodic competence. This includes measurements of sensitivity to turn end (i.e. was the speaker asking a question or making a statement), affect (i.e. was the speaker happy or unhappy), lexical stress (e.g. where was the stress in the word "imprint"), phrase stress (e.g. was the phrase "black bird" or "blackbird"), phrase boundaries (e.g. was the phrase "fruit, salad, and milk" or "fruit salad and milk"), and contrastive stress (e.g. was the phrase "white COW" or "WHITE cow"). All of these tasks have both a receptive and expressive version: receptive tasks involve the participant making a judgement (as in the examples above) whereas expressive tasks involve the participant to make a verbal response (i.e. child is prompted to make a verbal statement and the rater marks the expected prompt). The battery also includes measures of short and long discrimination (i.e. were these phrases the same or different) and short and long imitation (i.e. repeat these phrases).

Certain subtests from the PEPS-C have been used to assess prosodic competence with children 4-years-old up to 15-years-old, across multiple languages (there are Spanish and French adaptations of the battery), and across populations including children and adults with ASD, William's Syndrome, Developmental Language Disorder, and individuals with cochlear implants

(Calet et al., 2021; Foley et al., 2011; Gibbon & Smyth, 2013; Groen et al., 2019; Hesling et al., 2010; Kalathottukaren et al., 2014; Lochrin et al., 2015; Marshall et al., 2009; Martínez-Castilla, & Peppé, 2016).

The inter-rater reliability reports for expressive subtests of the PEPS-C are high across almost all the studies reported above. Unfortunately, however, there is a noticeable lack of reports for internal reliability for the PEPS-C; only one study mentioned above reported internal reliability for the subtests used (Groen et al., 2019). In this study, researchers reported fair internal reliability for the receptive and expressive stress placement tasks ($\alpha = .80$ and $\alpha = .76$, respectively). However, reliability for the other subtests—including long-item discrimination, long-item expression, and word boundaries—were relatively low ($\alpha = .59$, $\alpha = .69$ and $\alpha = .59$ respectively).

5.2.12. Prosodic Competence: Holistic or Atomistic

From the measures presented thus far it is clear that prosodic competence can be assessed in a variety of ways and, therefore, that administering multiple measures may be beneficial in order to achieve a robust measure of an individual's prosodic competence. However, one of the subsequent questions then becomes whether it is most appropriate to combine performance on these tasks into one composite measure of overall prosodic competence, or, whether to conceptualise each measure as representing an individual component of prosodic competence. Notably, there is a disagreement between researchers within the field of prosody and reading as to whether to view prosodic competence as holistic or atomistic (see Chen, 2018; Harrison et al., 2018; Holliman, Williams et al., 2014; Ito et al., 2018).

Some of the ways that researchers have previously broken down components of prosodic competence include defining measures as 'receptive vs. expressive', 'word level vs. phrase level', 'pragmatic vs. grammatical vs. affective,' and 'stress vs. intonation vs. timing.' Receptive vs. expressive tasks refer to differentiating the type of response required by the participant: in receptive tasks, the participant is assessed on their ability to make a judgement (e.g., Compound Noun tasks) and in expressive tasks, participants are assessed on their ability to create an oral response (e.g., Stress Manipulation tasks). Word level vs. phrase level tasks refer to differentiating what level of prosodic cues are necessary to perform the task. Word level tasks assess sensitivity to prosodic cues confined within an individual word (e.g., Stress Identification tasks) whereas phrase level tasks assess sensitivity to prosodic cues within a larger segment of speech (e.g., Receptive Phrasing tasks). Pragmatic vs. grammatical vs. affective tasks refer to the prosodic function of the task at hand. Pragmatic prosody tasks assess the participant on their ability to determine the practical function of prosody (e.g., determining question vs. statement), grammatical tasks assess the participant on their ability to determine the grammatical function of prosody (e.g., Compound Noun task), and affective tasks assess the participant on their ability to determine the emotion of a speaker (e.g., Affect Identification task). Finally, stress vs. intonation vs. timing tasks refer to the differentiation between what specific prosodic cues are needed to perform the task; stress tasks require a sensitivity to stress specifically, intonation tasks require a sensitivity to intonation specifically, and timing tasks require a sensitivity to timing specifically. The most well-known assessment of stress vs. intonation vs. timing measures include adaptations of the Low-Pass Filter task such Dina the Diver (Holliman, Williams et al., 2014) and Brenda's Animal Park (Holliman et al., 2017).

Arguments for an atomistic view of prosodic competence maintain that different components of prosody may relate to reading in different ways. Therefore, in order to better understand the relationship between prosody and reading it is necessary to individually assess these components. Empirical evidence supporting this theory includes studies which have demonstrated that performance on individual prosodic competence tasks appear to load on separate factors (Holliman, Williams et al., 2014), and that some components of prosodic competence (e.g., intonation) are more closely related to passage comprehension than others (e.g., timing) (Miller and Schwanenflugel, 2006).

On the other hand, arguments for a holistic view of prosodic competence point out that, with the exception of very particular and finely manipulated measures, cues of prosody are almost always completely interconnected; features of stress, timing and intonation in language naturally co-occur (Chen, 2018; Wade-Woolley et al., 2021), and prosodic cues can function as grammatical, pragmatic, and affective markers simultaneously (Kalathottukaren et al., 2015; Ito et al., 2018). To explicate, identifying a stressed syllable in a word (e.g., Stress Identification task) does not simply require a sensitivity to stress—rather, it involves an understanding of the intonational and durational properties of strong and weak syllables (Bolinger, 1958). Strong syllables are typically denoted by a higher pitch and of a longer duration, therefore, a sensitivity to prosody in general is necessary. Likewise, sensitivity to turn end (e.g., identifying a segment of speech as a question rather than a statement) serves both a pragmatic and grammatical purpose—allowing a listener to understand the speaker's practical purpose and grammatical cues. Furthermore, sensitivity to the affect of the question allows the listener to determine if a response is warranted. Similarly, many "word-level" prosodic competence tasks actually require both word-level and phrase-level prosodic cues; identifying an item as a 'compound noun' or an 'adjective and noun' involves not only a sensitivity to the prosodic cues within the target word(s) itself, it involves processing these cues relative to the rest of the prosodic structure of the text (Frazier et al., 2006). In the current thesis—in line with some of the most recent research in the field (e.g., Critten et al., 2021; Deacon et al., 2018)—I take the 'holistic' view of prosody. Accordingly, I choose to quantify participants' prosodic competence as a composite measure (performance across all administered tasks).

5.2.13. Non-Speech Specific Tasks

Although any segment of speech or sound possesses prosodic properties, the tasks discussed so far all measure prosodic competence in relation to speech specifically. Unlike segments of speech, non-speech sound segments do not have a linguistic function (i.e. sound in a non-speech context cannot carry the intonational properties of asking a question or portraying excitement). However, given the obvious importance of auditory processing in relation to prosodic competence, researchers have questioned whether prosodic competence should be measured in a more global (non-speech specific) manner and consequently have developed tasks to address this—both within the context of musical rhythm and non-musical acoustic processing.

One of the primary differences between speech rhythm (i.e. distal prosody) and musical rhythm is timing; whereas the foundation of musical rhythm is a grid of equal time intervals which give it a recognizable beat, there is no such beat in speech rhythm (Ozernov-Palchik & Patel, 2018). Over the last 10 years, researchers have begun to develop an understanding as to the relationship between awareness of speech rhythm and musical rhythm. To do so, a variety of tasks have been created to assess awareness of musical rhythm. These measures include receptive tasks, which require participants to identify differences in metrical or rhythmic patterns, and production tasks, which require participants to copy or tap out a rhythm (Bishop-Liebler et al., 2014; Calet et al., 2015; Calet, Gutiérrez-Palma et al., 2019; Choi et al., 2016; González-Trujillo et al., 2014; Goswami et al., 2010; Holliman et al., 2010b; Kuppen et al., 2011; Myers et al., 2018; Wade-Woolley et al., 2012; Whalley & Hansen, 2006). These studies have reported a significant positive relationship between speech specific prosodic competence and non-speech specific prosodic competence (Holliman et al., 2010b; Tierney et al., 2021; Wade-Woolley et al., 2012; Whalley & Hansen, 2006). Most recently, a study by Obergfell et al. (2021) also demonstrated that musicians (individuals who played a classical instrument) performed significantly better on speech specific prosodic competence tasks than non-musicians.

Researchers have also explored the relationship between non-musical auditory processing and prosodic competence. To measure non-musical auditory processing, researchers have developed measures that assess the ability of participants to discriminate sound segments based on cues of frequency, duration, intensity, and amplitude rise time (Bishop-Liebleret al., 2014; Choi et al., 2016; Goswami, 2002; Goswami et al, 2010; Kuppen et al., 2011; Leong et al., 2011; Goswami et al., 2013; Goswami, Barnes et al., 2016; Goswami, Cumming et al., 2016). Results of these studies have likewise demonstrated that individuals who have difficulties with auditory processing also have difficulties with speech-specific prosodic competence (Goswami, 2002; Goswami et al., 2010; Goswami et al., 2013; Leong et al., 2011; Tong et al., 2018).

Nevertheless, research has also demonstrated that speech-specific prosodic competence predicts reading ability above non speech-specific auditory processing (Holliman et al., 2010b; Whalley & Hansen, 2006). Therefore, in the current thesis, I chose to utilise measures which quantify prosodic competence in relation to speech specifically.

5.2.14. Overview and Selected Measures

This section has provided a summary of some of the more popular existing tasks used to measure prosodic competence. It is apparent that while a reasonable number of measures have been developed over the last twenty years, there is not yet a specific task or battery that stands out as the most consistent and reliable measure of prosodic competence. This has some interesting ramifications as to how we interpret ongoing research exploring prosodic competence in relation to reading skills. Accordingly, the tasks used to assess prosodic competence will from now on be carefully considered when reflecting on results of previous studies.

The measures used in the three empirical studies reported in this thesis include adaptations of the Compound Noun Task, the Receptive Phrasing Task, the Mispronunciations Task, and the Stress Identification task. These tasks were selected using four criteria. Firstly, I only considered measures which assessed prosodic competence in relation to speech specifically. Secondly, I selected measures with previous reports of high internal-reliability. Thirdly, I identified the measures with the flexibility to be used with both a sample of adults and children. Lastly, I chose measures that could be administered during the pandemic-related face-to-face restrictions. It is notable that this final criterion was not originally part of the selection criteria, but was added by necessity in March of 2020 partway through data collection for two studies that could not be completed. Consequently, these original studies did include some additional measures of prosodic competence (e.g. Stress Manipulation Task and Story Telling Task) that were less feasible to measure after restrictions were put in place. These measures are not reported in the results due to insufficient sample sizes, but are noted in **Appendix A.** Finally, across all three studies I choose to quantify prosodic competence as a composite score across tasks. Markedly, this may have implications as to the specificity and precision of tasks; results speak to the overarching prosodic competence of participants rather than to performance on specific tasks. However, in line with much of the recent research, I take a holistic view of prosody that asserts prosody is best conceptualised as the ability of a participant to understand and orchestrate *all* aspects of prosody rather than individual components.

5.3. Reading Fluency

Although reading fluency could be considered a more recognizable literacy skill, at least in relation to prosodic competence, it has also been described as “the neglected reading goal” (Allington, 1983). Even the National Reading Panel (NRP, 2000) suggested that out of the five dimensions of reading included in their report—phonemic awareness, phonics, vocabulary, comprehension, and fluency—fluency was the least understood and most in need of more attention. One very plausible reason that reading fluency is often left out of the conversation is simply due to a lack of static definition (Hoffman et al., 2007; Kuhn et al., 2010; Rasinski, 2012;

Samuels, 2006; Veenendal et al., 2015; Zutell & Rasinksi, 1991) and consequently a difference in how it is quantified. In a comprehensive review of the theories and assessments surrounding fluency, Kuhn et al., (2010) identify some of these different definitions. Notably, they also pinpoint two contrasting theoretical perspectives of reading fluency which are used to differentiate between aspects of reading fluency in the current thesis: one perspective emphasizing the role of automaticity and the other emphasizing the role of prosody. The following section will discuss the common measurements of "reading fluency as automaticity," here described as passage reading efficiency and "reading fluency as prosody," here described as prosodic passage reading.

5.3.1. Passage Reading Efficiency: Reading Fluency as Automaticity

Automaticity is a well-established concept within cognitive psychology; certain skills are so deeply rooted within our brains that we are able to perform them without conscious thought or effort. Logan (1997) discusses the concept of automaticity in relation to reading by identifying four properties commonly used to define automaticity: speed, effortlessness, autonomy, and lack of conscious awareness. According to the automaticity perspective of reading fluency, therefore, a fluent reader should be able to read quickly and without effort, intention or conscious awareness. In relation to reading, it should come as no surprise that, out of these four markers, reading speed is by far the simplest to quantify. If we take the perspective that fluent reading is synonymous with automaticity, then a high reading rate should be an indicator of high fluency. Yet, it is also important to note that we would not expect an increase in fluency to be demonstrated by a continuous linear increase in reading rate. After all, there is a limit to the speed which we would expect a fluent adult to read. The notion that reaction time decreases only until "some irreducible limit is reached" is known as the "power law" (Logan 1992; 1997). As pointed out by Kuhn et al., (2010), a perfect example of the power law in the context of reading rate can be demonstrated by Hasbrouk and Tindal's (2006) report of oral reading fluency data from students in Grades 1 through 8. Whereas children in Grade 1 (at the 50th percentile) demonstrated an average weekly improvement of 1.9 correct words read per minute, children in Grade 8 (at the 50th percentile) demonstrated an average weekly improvement of 0.6 correct words read per minute. Consequently, it can be inferred that reading rate may be most useful as an indicator of automaticity for children in earlier stages of reading development.

Nevertheless, reading rate is perhaps the most widely recognized marker of reading fluency; reading fluency interventions often measure success in terms of an improvement of correct words read per minute (see Hudson et al., 2020 and Stevens et al., 2017 for a review of fluency interventions). The most common measures of passage reading efficiency include the Gray Oral Reading Test (GORT; Wiederholt & Bryant, 1992), the Neale Analysis of Reading Ability (NARA; Neale, 1999), the Qualitative Reading Inventory (QRI; Leslie & Caldwell 2001), and the Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency subtest (DIBELS; Good & Kaminski 1996). All of these assessments quantify reading fluency based on a combination of reading rate (number of seconds taken to read a story) and accuracy (number of correct words).

Yet, while measuring reading rate may provide an indication of automatic reading, this is not the entire picture. After all, when we imagine a fluent reader we do not envision a reader who reads extremely fast—we envision a reader who uses their voice expressively and appropriately to convey meaning to a listener. Accordingly, the other perspective of reading fluency identified by Kuhn et al. (2010) emphasizes the importance of reading not only with speed and accuracy, but also with appropriate phrasing and expression.

5.3.2. Prosodic Passage Reading: Reading Fluency as Prosody

Unlike passage reading efficiency, which is almost exclusively quantified by reading rate and accuracy, there is no single obvious way to quantify prosodic passage reading. As a result, multiple techniques have been developed which measure the extent to which a reader uses appropriate prosodic cues during oral reading. These can be most easily broken down into two methods: subjective measures of auditory cues (hand-scored rubrics) and objective measures of acoustic cues (acoustic analyses). The following section describes each of these techniques in further detail.

5.3.2.1. Hand-Scored Rubrics

To date, a selection of hand-scored rubrics have been designed to measure prosodic passage reading—although these have almost exclusively focused on capturing the performance of early readers. One of the first of these rubrics was a six-point scale published by Allington (1983).

This rubric, adapted from an earlier paper (Allington & Brown, 1979), places a reader into one of six categories based on their use of phrasing, stress, and expression. The National Assessment of Educational Progress (NAEP) later published a similar scale that places a reader into one of four categories depending on prosodic reading—and further classifies a rating of 1 or 2 as non-fluent and a rating of 3 or 4 as fluent (Pinnell et al., 1995). This NAEP oral reading fluency scale has since been used by researchers as a measure of reading fluency as prosody in a series of studies (e.g., Keehn, 2003; Nomvete & Easterbrooks, 2019; Valencia et al., 2010). Depictions of both of these scales are in Table 1.

Table 1 *Single Dimension Fluency Scales*

Fluency Scale (Allington, 1983) and NAEP Oral Reading Fluency Scale (2002)

Scoring	**Fluency Scale** Allington (1983)	**NAEP Oral Reading Fluency Scale** (NAEP, 2002)
1	Word by word	Reads primarily word-by-word. Occasional two-word or three-word phrases may occur—but these are infrequent and/or they do not preserve meaningful syntax. **[Non-fluent]**
2	Primarily word by word with some 2-3 word phrasing	Reads primarily in two-word phrases with some three- or four-word groupings. Some word-by-word reading may be present. Word groupings may seem awkward and unrelated to larger context of sentence or passage. **[Non-fluent]**
3	Primarily by phrases (2-3 words) by sometimes word by word: sometimes gives phrases inadequate stress in relation to syntax	Reads primarily in three- or four-word phrase groups. Some small groupings may be present. However, the majority of phrasing seems appropriate and preserves the syntax of the author. Little or no expressive interpretation is present. **[Fluent]**
4	Primarily in phrases with very little word by word reading; sometimes ignores external punctuation; generally reads in a monotone	Reads primarily in larger, meaningful phrase groups. Although some regressions, repetitions, and deviations from text may be present, these do not appear to detract from the overall structure of the story. Preservation of the author's syntax is consistent. Some or most of the story is read with expressive interpretation **[Fluent]**
5	Primarily in phrases, attending to terminal punctuation; some internal punctuation is ignored; expression is not consistently adequate	
6	In phrases, with fluency, using both terminal and internal punctuation; provide appropriate semantic and syntactic emphasis for purposes of dramatization; expression approximate normal speech	

Perhaps the most commonly used hand-scored rubric of prosodic reading is the Multi-Dimensional Fluency Scale (Zutell & Rasinski, 1991; Rasinski, 2004; Table 2). Unlike the two previously discussed rubrics, this scale measures fluency on multiple dimensions. According to Zutell and Rasinski (1991), using a unidimensional scale to assess reading fluency as prosody may create issues of reliability; one rater may give weight to a particular aspect of reading fluency (e.g. appropriate phrasing) whereas another rater may give weight to another particular aspect of reading fluency (e.g. appropriate pacing). By breaking down reading fluency as prosody into multiple dimensions, however, the MDFS reminds raters to give each dimension equal consideration (Zutell & Rasinski, 1991). This rubric, depicted in Table 2, has also been used in a variety of studies to quantify prosodic reading (e.g., Courbron, 2012; Fernandes et al., 2018; Groen et al., 2019; Paige et al., 2014; Veenendaal et al., 2016).

Notably, Zutell and Rasinksi (1991) also argue that it is important to break up prosodic reading into separate dimensions because it is possible that a reader will perform differently for separate dimensions. For example, a reader who reads relatively smoothly—struggling with only a few structures—and at a comfortable pace should score a 3 for phrasing and a 4 for pacing. Alternatively, a reader who reads relatively smoothly—struggling with only a few structures—but exceptionally slowly, should score a 3 for phrasing and a 1 for pacing. However, experienced prosodic passage reading concerns the orchestration of all of these different dimensions in order to achieve a natural and speech-like interpretation of the text.

Table 2 *Multi-dimensional Fluency Scale*

(Rasinski, 2004)

Scoring	Multi-Dimensional Fluency Scale Rasinksi (2004)			
	Expression and Volume	**Phrasing**	**Smoothness**	**Pace**
1	Reads with little expression or enthusiasm in voice. Reads words as if simply to get them out. Little sense of trying to make text sound like natural language. Tends to read in a quiet voice.	Monotonic with little sense of phrase boundaries, frequent word-by-word reading.	Frequent extended pauses, hesitations, false starts, sound-outs, repetitions, and/or multiple attempts.	Slow and laborious.
2	Some expression. Begins to use voice to make text sound like natural language in some areas of the text, but not others. Focus remains largely on saying the words. Still reads in a quiet voice.	Frequent two- and three-word phrases giving the impression of choppy reading; improper stress and intonation that fail to mark ends of sentences and clauses.	Several "rough spots" in text where extended pauses, hesitations, etc., are more frequent and disruptive.	Moderately slow.
3	Sounds like natural language throughout the better part of the passage. Occasionally slips into expressionless reading. Voice volume is generally appropriate throughout the text. Reads with good expression and enthusiasm throughout the text.	Mixture of run-ons, mid-sentence pauses for breath, and possibly some choppiness; reasonable stress/intonation.	Occasional breaks in smoothness caused by difficulties with specific words and/or structures.	Uneven mixture of fast and slow reading.
4	Sounds like natural language. The reader is able to vary expression and volume to match his/her interpretation of the passage.	Generally well phrased, mostly in clause and sentence units, with adequate attention to expression.	Generally smooth reading with some breaks, but word and structure difficulties are resolved quickly, usually through self-correction.	Consistently conversational

5.3.2.2. Acoustic Analyses

Assessing prosodic reading using an acoustic analyses involves objectively measuring the acoustic properties of speech. Typically, this includes measurements of speech frequency (measured in hertz), intensity (measured in decibels), and length/ timing (measured in time units such as seconds). In order to quantify these characteristics, researchers often use a spectrographic analysis. A spectrogram can provide a pictorial representation of frequency, amplitude, and time in one visual: time is shown on a horizontal axis, frequency is shown on a vertical axis, and amplitude is represented by colour (Figure 9). Using a spectrographic analysis, researchers can look for patterns in speech acoustics during reading. For example, prosodic reading can be quantified by the extent to which a reader demonstrates a decline in pitch at the end of sentences (also captured by measuring vowel lengthening at the end of sentences) and a rise in pitch at the end of questions (Binder et al., 2013; Miller & Schwanenflugel, 2006; Miller & Schwanenflugel, 2008). Another common measurement of prosodic reading is the presence of intrasentenial, or inappropriate pauses (i.e. pauses not dictated by punctuation), and/or pause length between sentences during reading (Álvarez-Canzino et al., 2015; Binder et al., 2013; Dowhower, 1987; Herman 1985; Miller & Schwanenflugel, 2008; Schwanenflugel et al. 2004). Acoustic analysis is increasingly being utilized by researchers to assess prosodic passage reading (Álvarez-Canzino et al., 2015; Álvarez-Canzino et al., 2020; Binder et al., 2013; Miller & Schwanenflugel, 2006; Miller & Schwanenflugel, 2008).

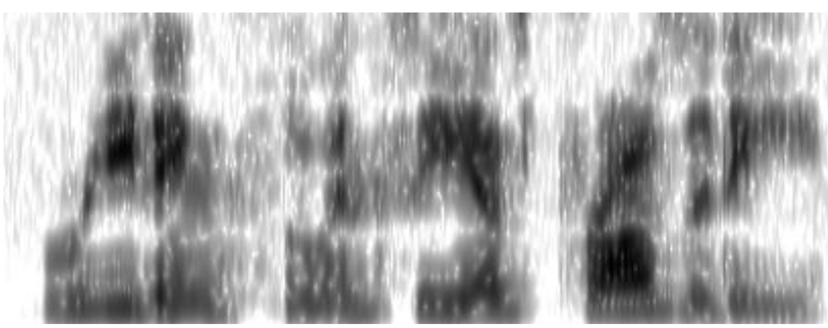


Figure 9. Spectrogram of Speech Segment

5.3.3. Overview and Selected Measures

It is also important to note that fluency tasks not only differ in relation to how fluency is quantified (e.g. as reading efficiency or prosodic reading) but also what type of text is used. For example, reading fluency can be assessed in relation to passage reading, sentence reading, word reading, or even pseudo-word reading. Expectedly, the skillsets required to complete these tasks differ; we would expect pseudo-word reading to rely heavily on low-level decoding skills (such as phonological and morphological awareness), isolated word reading to also rely on vocabulary knowledge, and passage reading to rely not only on these skills, but also knowledge of syntax and semantics.

Given the focus of the current thesis—assessing the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension—reading fluency at the level of the passage was chosen as the most appropriate measure. This is in accordance with research demonstrating that passage reading fluency predicts variance in reading comprehension above word level and sentence level reading fluency (Klauda & Guthrie, 2008). In order to quantify passage reading efficiency, the marking criteria from the Qualitative Reading Inventory (QRI; Leslie & Caldwell, 2001) was chosen because it was deemed flexible enough to use with both children and adults.

Choosing a measure of prosodic passage reading proved more difficult; as discussed in the previous sections, both hand-scored rubrics and acoustic analyses have been widely used to quantify prosodic passage reading—and neither of these techniques seems to be obviously favoured above the other. This is likely because there are some recognizable drawbacks and advantages for both.

Perhaps the most apparent disadvantage to using any sort of hand scored rubric is that they are subjective—and therefore potentially less reliable. In order to increase the reliability of using a hand-scored rubric to quantify prosodic passage reading, researchers typically use at least two raters and check the agreement between given scores (inter-rater reliability). Studies exploring the reliability of the MDFS have reported high reliability (Moser et al., 2014; Paige et al., 2014; Rasinski et al., 2009), indicating that it is a sound measure of prosodic reading. In a recent study Smith and Paige (2019) further compared the reliability and efficiency of the NAEP oral reading fluency scale and the MDFS, reporting that both were reliable, but suggesting that the MDFS should be slightly favoured due to more explicit information about each fluency dimension.

Conversely, there is little concern of reliability when using spectrographic measurements to quantify prosodic passage reading. The objectivity of an acoustic analysis is therefore an obvious advantage over hand-scored rubrics. However, the accessibility of this technique is a clear drawback; teachers looking to measure prosodic reading are able to use hand-scored rubrics easily, but rarely have the resources to carry out an acoustic analysis. Furthermore, given that prosody is multi-faceted and has countless linguistic functions, fully capturing prosodic reading using objective acoustic measurements requires a sufficiently complex analysis. Hand-scored rubrics, on the other hand, allow a rater to consider and assess most functions of prosody.

It is also important to note that since hand-scored rubrics and spectrographic measurements were first used to measure prosodic reading both methods have been evolving and improving with research. Researchers using spectrographic analyses now include a variety of different acoustic measurements grounded in previous research to quantify fluency as prosody (Kuhn et al., 2010), and more recent fluency rubrics are sufficiently complex, containing multiple dimensions of prosody (Benjamin et al., 2013; Smith & Paige 2019).

For the current thesis, a multi-dimensional hand-scored rubric (MDFS; Rasinski, 2004) was selected for three reasons. Firstly, given that the research goal was to explore the relationship between prosodic passage reading and prosodic competence, it felt appropriate to select a measure which contained dimensions of prosody easily be mapped onto the prosodic competence tasks (e.g. sensitivity to and awareness of phrasing, intonation, and timing). Secondly, given the face-to-face restrictions in place due to the pandemic, it was not possible to control for any background noise during the oral reading task. Unfortunately, this makes an acoustic analysis challenging. Lastly, given the time constraints of the research, it was more feasible to do a thorough analysis using hand-scored rubrics, rather than carrying out sufficiently complex spectrographic analysis. This should also ensure that results can be more easily replicated in classroom settings.

Notably, however, no hand-scored fluency rubric has been designed to be used with samples of experienced adult readers; the existing fluency rubrics are intended for early readers. To illustrate, the written criteria for 'smoothness' scale of the MDFS defines scoring a 1 as 'frequent extended pauses, hesitations, false starts, sound-outs, repetitions, and/or multiple attempts,' scoring a 2 as 'several "rough spots" in text where extended pauses, hesitations, etc., are more frequent and disruptive,' scoring a 3 as 'Occasional breaks in smoothness caused by difficulties with specific words and/or structures' and scoring a 4 as 'Generally smooth reading with some breaks, but word and structure difficulties are resolved quickly, usually through self-correction.' Previous research has demonstrated that passage reading fluency continues to develop past early literacy acquisition and into adulthood (Wallot et al., 2013)—thereby suggesting that adult readers should exhibit noticeable variations in fluency. However, I argue that the existing scales are not sensitive enough to the smaller differences in passage reading fluency exhibited by adult readers, inevitably leading to a negatively skewed distribution in which most readers will receive scores of 3 and 4. Therefore, for Study One and Two in the current thesis, I chose to develop an adapted measure of the Multi-Dimensional Fluency Scale (MDFS; Rasinski, 2004) that is sensitive to smaller variations in adult reading, here referred to as the Adult Multi-Dimensional Fluency Scale (AMFDS). This adapted scale will be presented in Chapter Six.

Finally, it is of note that I once again chose to approach prosodic passage reading as a holistic construct. To explicate, rather than considering participants' scores on the expression, phrasing, smoothness, and phrasing scales separately, I combine these dimensions into a global score of prosodic reading. Accordingly, this score represents participants' orchestration of all dimensions—and therefore their ability to read a passage with appropriate prosody.

5.4. Reading Comprehension

Unlike both prosodic competence and reading fluency, reading comprehension assessments are common. Some more novel approaches to assessing reading comprehension include having participants read and retell a story in their own words (see Reed & Vaughn, 2012), asking participants to create a written response to the text (see Bintz, 2000), or even asking participants to 'think aloud' and share their thoughts during the reading process (see Gunning, 1998). However, by far the most common and well-documented measurement of reading comprehension, and the one used in the current thesis, is question-based: participants are asked to read a text and then answer a series of questions about the text. This section provides an overview of some of the different types of typical reading comprehension questions.

5.4.1. Categories of Reading Comprehension Questions

Identifying categories of reading comprehension questions is crucial. This is because different questions place different demands on the reader. To illustrate, a question that is *literal* requires the reader to simply identify information that is directly stated in the text. In relation to Text Example 1, for example, a literal question would be "When did Sally wake up?" Answering this question simply requires the reader to find or recall an exact quote from the text. In contrast, a question that is *inferential* requires the reader to consider the text and make a conclusion about something that is not directly stated in the text. An example of an inferential question would be "What do you think Sally felt when she walked into the kitchen?" Unlike a literal question, this question requires the reader to generate a mental model of the text and draw relations between different adjacent sentences (e.g. [the entire room smelled like bacon] [Sally hated bacon]).

The formatting of a reading comprehension question can also impact what is required from the reader. *Open-response* questions require the participant to give an oral or written response to the question, *Multiple Choice* responses involve the participant making a selection from a set of answers, and *Yes/No (or True/False)* questions only require the participant to select from two choices. Accordingly, an open response question in relation to Text Example 1 would be *Why do you think Sally felt irritated when she walked into the kitchen?*, a multiple choice question would be *What do you think Sally felt when she walked into the kitchen? (a) excited (b) bored (c) irritated (d) sleepy* and a Yes/No question would be *Do you think Sally was excited when she walked into the kitchen? (a) Yes (b) No.*

Text Example 1:

> "Sally woke up late on Saturday morning to find her brother already up and in the kitchen. The room was a mess. Her new pots and pans were spread around the countertop, and the entire room smelled like bacon. Sally hated bacon."

The type and formatting of reading comprehension questions have implications in relation to both educational and research goals. In relation to teaching reading comprehension, for example, it might be more appropriate to ask open-ended inferential questions which require the student to exercise critical thinking skills. In relation to research goals, reading comprehension measures should include questions which provide a valid assessment of all the skills involved in reading comprehension. The most commonly used measures to assess children's reading comprehension include the Gray Oral Reading Test (GORT; Wiederholt & Bryant, 1992), the Gates-MacGinitie Reading Tests (MacGinitie et al., 1989), the Neale Analysis of Reading Ability (NARA; Neale, 1999), the Wechsler Individual Achievement Test (WIAT; Wechsler, 1992), and the York Assessment of Reading for Comprehension (YARC; Snowling, 2009). There are significantly fewer measures to assess adult reading comprehension, however these include the Adult Reading Test (ART; Brooks et al., 2004) and the Woodcock Reading Mastery Test (Woodcock, 1998).

5.4.2. Overview and Selected Measures

In the current empirical studies, reading comprehension for both experienced and early readers was measured using a combination of multiple choice and open answer questions; reading comprehension in study one was assessed using and adaption of the Adult Reading Test (ART; Brooks et al., 2004), reading comprehension in Study Two was assessed using an adaptation of the Discourse Comprehension Test (Brookshire & Nicholas, 1993), and in Study Three reading comprehension was evaluated using assessments from Rising Stars Reading Planet assessment (Rising Stars and RS Assessment, n.d.). These measures were chosen partly because they were reported to be valid measurements of reading comprehension and partly because the publishers gave permission for these texts to be adapted into an online format and used in the research project. Once again, it is notable that that this final criterion was not an original restriction of the study but was instead added partway through data collection in March of 2020 due to the pandemic restrictions. Accordingly, some data was collected using two separate measures of reading comprehension: the original version of the Adult Reading Test (ART; Brooks et al., 2004) and the York Assessment for Reading Comprehension (YARC; Snowling, 2009). These are not reported in the results due to insufficient sample sizes, but are noted in **Appendix A.**

5.5. Summary

In this chapter, I reviewed measures that have previously been used by researchers to assess prosodic competence, reading fluency, and reading comprehension. I consider the possible strengths and drawbacks of these measures in relation to the current thesis. Finally, I motivate the choice of measures for the three empirical studies, including the consideration of restrictions due to the Covid-19 pandemic.

6. Study One. Examining the Role of Prosody in Passage Reading of Experienced Readers

6.1. Introduction

An increasing number of studies suggest that individual differences in prosodic competence are positively associated with passage reading comprehension (Chan & Wade-Woolley, 2018; Deacon et al., 2018; Lochrin et al., 2015; Whalley and Hansen, 2006). One possibility as to why this may be the case is that prosodic competence facilitates skills related to single-word reading—a well-known component of successful reading comprehension. Another possibility is that prosodic competence facilitates reading comprehension at the passage-level.

This study examines both of these possibilities. Specifically, an overarching aim of the current study is to investigate whether the contribution of prosodic competence to reading comprehension is mediated by prosodic passage reading. Accordingly, the following four research questions address the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension.

Study One Research Questions:

(1) To what extent do individual differences in prosodic competence account for unique variance in prosodic passage reading in a sample of experienced adult readers?

   a) Is the contribution of prosodic competence to prosodic passage reading still significant after accounting for individual differences in vocabulary?

   b) Is the contribution of prosodic competence to prosodic passage reading still significant after also accounting for individual differences in passage reading efficiency?

(2) To what extent do individual differences in prosodic passage reading account for unique variance in reading comprehension in a sample of experienced adult readers?

   a) Is the contribution of prosodic passage reading to reading comprehension still significant after accounting for individual differences in vocabulary?

   b) Is the contribution of prosodic competence to prosodic passage reading still significant after also accounting for individual differences in passage reading efficiency?

(3) To what extent do individual differences in prosodic competence account for unique variance in reading comprehension ability in a sample of experienced adult readers?
   a) Is the contribution of prosodic competence to reading comprehension still significant after accounting for individual differences in vocabulary?
   b) Is the contribution of prosodic competence to reading comprehension still significant after accounting for individual differences in passage reading efficiency?

(4) If prosodic competence accounts for unique variance in reading comprehension (after controlling for vocabulary and passage reading efficiency), is this variance explained by prosodic passage reading?

6.2. Hypotheses

In line with the theoretical and empirical research described earlier, the hypotheses for study one are below.

- **Hypothesis 1:** In experienced adult readers, individual differences in prosodic competence will account for unique variance in prosodic passage reading ability, even after controlling for differences in vocabulary and passage reading efficiency.
- **Hypothesis 2:** In experienced adult readers, individual differences in prosodic passage reading will account for unique variance in reading comprehension, even after controlling for differences in vocabulary and passage reading efficiency.
- **Hypothesis 3:** In experienced adult readers, individual differences in prosodic competence will account for unique variance in reading comprehension, even after controlling for differences in vocabulary and passage reading efficiency.
- **Hypothesis 4:** In experienced adult readers, the unique variance in reading comprehension predicted by prosodic competence will be explained by individual differences in prosodic passage reading ability.

6.3. Participants

Prior to participant recruitment, ethical approval for the study was obtained from the Nottingham Trent University Research Ethics Committee (within the School of Business, Law and Social Sciences). Participants were recruited using (a) SONA systems, an online participant recruitment and management platform, and (b) paper flyers placed on a University campus. In return for their time, all participants were given the option of receiving either a £5 amazon voucher or academic credit. Prior to beginning the study, all participants were provided with a participant information sheet and asked to sign a consent form **(Appendix B).**

A total of 121 participants completed the study, however, participants who reported speaking English as a second language were removed from the sample due to differences in prosodic competencies associated with learning a second language (Trofimovich & Baker, 2006). Participants who reported a history of reading difficulties or disorders were also removed from the sample. Data from 105 participants (84 females, 24 males, $M = 25.2$ years, $SD = 9.1$ years) was included in the final analysis. An overrepresentation of female participants is notable, likely due to recruitment through a psychology department, however, there is no theoretical basis as to why this should influence results (Hyde, 2005).

6.4. Measures

The following section provides a summary of the measures used in study one.

6.4.1. Vocabulary

A 10-item vocabulary task was developed for this study. All items were taken from open-source online resources associated with the Scholastic Aptitude Test (SAT) and Graduate Record Examination (GRE). Both the SAT and GRE are standardized assessments widely used by University admissions in the USA; the SAT by undergraduate admissions and the GRE by graduate school admissions.

This task was administered on a computer. Participants were asked to read a sentence containing an underlined word. They were also shown a list of five single-word options, from which they clicked on the one which they believe best represented the underlined word (Figure 10). Prior to starting the task, one practice item was presented. Items were presented to all participants in the same order **(Appendix C).** See Figure 10 for example item.

Vocabulary score was quantified as number of correct items out of 10. A follow up study (see Original Study with Adults, **Appendix A)** demonstrated that performance on this task was significantly moderately correlated at $r = .62$ ($p < .001$) with the vocabulary subtest of the

Wechsler Adult Intelligence Scale fourth edition (WAIS-IV; Wechsler 2008), suggesting reasonable validity. Internal reliability was only moderately acceptable (Cronbach's alpha = 0.47).

Daniel was visibly frustrated after the <u>deferment</u> of his school's field trip.

(a) cancellation

(b) termination

(c) announcement

(d) commencement

(e) postponement

Correct response is: [E]

Figure 10. Item Example of Study One Vocabulary Task

6.4.2. Prosodic Competence

Prosodic competence was assessed using two computer-based picture tasks: an accent disambiguation (compound noun) task and a receptive phrasing (subject-object focus) task.

6.4.2.1. Picture-Based Tasks: Accent Disambiguation

The Accent Disambiguation task, also known as a Compound Noun task, was an adaptation of the measure introduced by Landi et al., (2018), revised to accommodate British dialect speakers (see **Appendix D**). In this task, participants sat at a computer and listened to a series of 14 sentences recorded by a female native British English speaker with a Received Pronunciation (RP) accent. Each sentence contained an ambiguous target word—in this case a word that could either be *a compound noun* or *an adjective and a noun* depending on prosodic interpretation. In half of the sentences, the target word was spoken with prosody suggesting an adjective noun interpretation (e.g., Luke parked his car outside of the <u>green-HOUSE</u>). In the other half of the sentences, the target word was spoken with prosody suggesting a compound noun interpretation (e.g., Luke parked his car outside of the GREEN-house). After each sentence, participants were presented with two images on a second screen depicting the possible target words (e.g. a green-HOUSE [a house painted green] and a GREEN-house [a house used to store plants]). The instructions given to the participants were as follows: "*In this task you will hear a sentence followed by two images. Your task is to click on the image which you think best fits the sentence.*" Prior to starting the task, two practice items were presented with feedback. Prosodic competence was quantified as number of correct items. Internal reliability for this task was only moderately acceptable (Cronbach's alpha = 0.47). Consequently, two items were removed from final analysis to improve reliability. The final internal reliability was acceptable (Cronbach's alpha = 0.57). A list of all final (and removed) items can be found in **Appendix D.** See Figure 11 for example item..

AUDIO: "**Luke parked his car outside of the *GREEN-house.***"

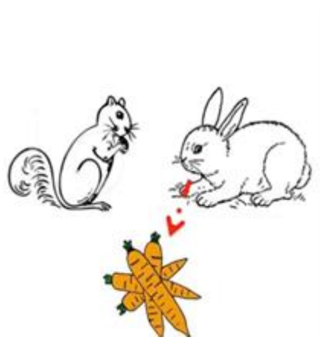
Correct response is: [A]

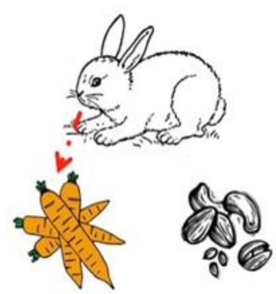
Figure 11. Item Example of Study One Accent Disambiguation Task

6.4.2.2. Picture-Based Task: Subject-Object

The Subject-Object task was an adaptation of the Subject Focus vs. Object Focus Task (Landi et al., 2018). This receptive phrasing task was revised to accommodate British dialect speakers (see **Appendix D**). In this task participants sat at a computer and listened to a series of 14 sentences (recorded by a female native British English speaker with an RP accent). Each sentence was spoken as to prosodically emphasize either the subject of the sentence (e.g. the RABBIT was eating carrots) or the object of the sentence (e.g. the rabbit was eating CARROTS*)*. After each sentence, the participants were presented with two pictures on a following screen depicting these conditions (e.g. one picture emphasizing a rabbit and one picture emphasizing the carrots) in addition to the questions that should prompt the target answer (e.g. “Who will eat carrots?” or “What will the rabbit eat?”). The instructions given to the participant were as follows: “*In this task you will hear a sentence followed by two images. Your task is to click on the image which you think best fits the sentence.”* Prior to starting the task, two practice items were presented with feedback. Prosodic competence was quantified as number of correct items. Internal reliability for this task was only moderately acceptable (Cronbach’s alpha = 0.49). Consequently, two items were removed from final analysis to improve reliability. The final internal reliability was acceptable (Cronbach’s alpha = 0.62). A list of all final (and removed) items can be found in **Appendix D.** See Figure 12 for example item.

AUDIO: “**The *RABBIT* will eat carrots*.”***





Who will eat carrots? ***What will the rabbit eat?***

Correct response is: [A]

Figure 12. Item Example of Study One Subject-Object Task

6.4.3. Reading Comprehension

Reading comprehension was assessed using an computer-based adaptation of the Adult Reading Test (ART; Brooks et al., 2004). Before starting the task, all participants were trained by the researcher on how to use a digital voice recorder to record their reading. In this task, participants were instructed that they would see a text on a screen and that they should do their best to read aloud *"both fluently and expressively"* and then to answer the following comprehension questions. After reading the text, participants were presented with nine multiple-choice comprehension questions on following screens. Prior to starting the task, a practice text and two practice items were presented with feedback. Reading comprehension score was quantified as number of correct items. Reliability for the comprehension task was moderately acceptable (Cronbach's alpha = 0.56). The text and accompanying multiple-choice questions are presented in **Appendix E.** See Figure 13 for example item.

According to the text, what do you think would happen if the gases were mixed at minus 100 degrees Celsius?

(a) Explosive (dangerous) combustion.
(b) Some combustion.
(c) No reaction.
(d) Not enough information in the text.

Correct response is: [C]

Figure 13. Item Example of Study One Reading Comprehension Task

6.4.4. Passage Reading Fluency

6.4.4.1. Passage Reading Efficiency

In order to quantify passage reading efficiency, recordings of participants' oral reading of the comprehension text (taken from the digital voice recorder) was marked for average number of correct words read per minute (WCPM). WCPM was defined as the number of correct words read aloud from the passage divided by the number of seconds taken to read the passage, then multiplied by 60 ((correct words/ total time)*60). Word errors were scored according to the

Qualitative Reading Inventory (QRI) Error Score Criteria (Leslie & Caldwell, 2001; Table 3). Total number of errors ranged between 0-24 ($M = 6.9$, $SD = 4.5$)

Table 3 *Qualitative Reading Inventory (QRI) Error Score Criteria (Leslie & Caldwell, 2001)*

Addition	If reader adds words to the passage or adds a letter to the end of a word, count as an error.
Omissions	If reader omits entire word, count as an error.
Self-Corrections	If reader says a word wrong and then corrects him or herself, count one error and one correct.
Repetitions	If reader says a word correctly then rereads correctly, count only the first reading as correct and each repetition of the word as an error.
Mispronunciation	If reader mispronounced a word, count as an error each time it is read *except* when mispronunciation is a plausible pronunciation of a proper noun, which is then counted as correct (make allowance for common dialects).

6.4.4.2. *Prosodic Passage Reading*

In order to quantify prosodic passage reading, recordings of participants' oral reading of the comprehension text were rated using a hand-scored marking rubric. This rubric was based on the Multi-Dimensional Fluency Scale (MDFS; Rasinski, 2004), however, it was adapted to be more sensitive to small variations in adult reading. This adaptation was made because, to my knowledge, a prosodic reading rubric for adult readers has yet to be developed. This adapted scale is referred to as the Adult Multidimensional Fluency Scale (AMDFS; Table 4). Using the AMDFS participants were given a rating of 1-4 on the same dimensions as the original scale: phrasing, expression, smoothness, and pacing. Total prosodic reading score was quantified as the sum of all four dimensions. All recordings were rated according to the AMDFS by two independent raters. Total prosodic score matched between raters for 66% of participants, however, total prosodic score matched within +/-1pt for 91% of participants. Final ratings for participants who did not receive a matching score was later agreed upon between raters. The given total prosodic scores ranged between 6-16 (*M* = 12.9, *SD* = 2.5)

Table 4 *Adult Multi-Dimensional Fluency Scale (AMDFS)*

(Adapted from Rasinski, 2004)

Scoring	Expression	Phrasing	Smoothness	Pace
1	Reader reads words as if simply to get them out. Little to no expression or enthusiasm in voice.	Reader reads with a lack of appropriate phrasing. Reading marked by run-ons, mid-sentence pauses for breath, and little to no adherence to punctuation.	Reader is consistently broken in rhythm (i.e. false starts, hesitations, repetitions, and self-correction, etc.)	Reader reads either in a great rush or extremely slowly.
2	Reader reads with expression in a few places but is mostly expressionless.	Reader reads with some appropriate phrasing but largely does not adhere to phrasal cues.	Reader has a number of "rough spots" caused by difficulties with specific words and/or structures that cause breaks in rhythm. Reader may struggle to recover.	Reader reads at a variable pace, or a pace which may be uncomfortable for the listener.
3	Reader uses expression throughout the better part of the passage. Occasionally slips into expressionless reading.	Reader generally uses appropriate phrasing, adequate attention to punctuation, and appropriate intonation.	Reader is generally smooth with some breaks, but reader is able to recover from these breaks.	Reader is slightly rushed or slow in some spots, but generally at a comfortable pace.
4	Reader uses good expression and enthusiasm throughout the text. The reader is able to vary expression and volume to match their interpretation of the passage.	Reader uses appropriate phrasing throughout the text. Uses intonation to denote ends and beginnings of phrases. Breathes at appropriate times.	Reader is smooth. Few to no breaks in rhythm.	Reader reads at a comfortable, conversational pace throughout.

6.5. Results

This section presents the results of study one. Sections 8.5.1 and 8.5.2 provide a descriptive summary of participants' performance on the administered measures, and correlations between these measures. Sections 8.5.3 – 8.5.6 address Research Questions 1 through 4.

6.5.1. Data Preparation

Before addressing the research questions, the assumptions for running a multiple linear regression were checked. The two outcomes of interest, reading comprehension and prosodic passage reading, were considered as dependent variables. It is notable that regressions are most commonly utilized in relation to continuous or interval numerical data. In this case, whereas both dependent variables were quantified numerically, the measures of reading comprehension and prosodic reading were discrete data (i.e. number of correct responses) and ordered categorical data (i.e. ordered value between 4 and 16), respectively. However, the use of such parametric statistics for this purpose is not only widespread in the current field (e.g., Holliman et al., 2010a; Veenendaal et al., 2014; Whalley & Hansen, 2006), but across fields. Markedly, it is often argued that the use of parametric statistics in relation to ordered categorical data consistently leads to robust analyses (Norman, 2010). Nevertheless, results should be interpreted with this in consideration (Kuzon et al., 1996).

Regressions predicting reading comprehension

Data from 105 participants (84 females, 24 males, *M* = 25.2 years, *SD* = 9.1 years) was included in the final analysis (see section 8.3 for details about removed participants). Firstly, an analysis of standard residuals demonstrated that all z-scores were within +/- 3.29, indicating no outliers (Field 2018) (*Std. Residual Min* = -3.07, *Std. Residual Max* = 2.16). Secondly, the assumption of collinearity was checked. VIF and Tolerance scores were all within a reasonable limits (VIF < 10; Tolerance > .10; Tabachnick & Fidell, 2001), indicating that multi-collinearity was not a concern (Vocabulary, *Tolerance* = .76, *VIF* = 1.3; Prosodic Competence, *Tolerance* = .78, *VIF* = 1.3; Passage Reading Efficiency, *Tolerance* = .83, *VIF* = 1.2; Prosodic Passage Reading, *Tolerance* = .69, *VIF* = 1.5). The data also met the assumption of independent errors (*Durbin-Watson value* = 1.67) and non-zero variances (Vocabulary, *Variance* = 2.7; Prosodic

Competence, *Variance* = 11.7; Passage Reading Efficiency, *Variance* = 380.7; Prosodic Passage Reading, *Variance* = 5.8; Reading Comprehension, *Variance* = 1.57). Histograms and scatter plots were used to check assumptions of homoscedasticity, linearity, and random normally distributed errors. A histogram of standardised residuals for reading comprehension score demonstrated that errors were approximately normally distributed. A P-P plot of standardised residuals suggested that the data met assumptions of homogeneity of variance and linearity (points close to the line).

Regressions predicting total prosodic passage reading

An analysis of standard residuals indicated that five participants demonstrated potentially unusual z-scores values (+/- 2.58), however, these participants were not removed from analysis as it was determined that they represented natural individual variation in performance (Aguinis et al., 2013). A Durbin-Watson test indicated that the data met the assumption of independent errors (*Durbin-Watson value* = 1.44). Histograms and scatter plots were used to check assumptions of homoscedasticity, linearity, and random normally distributed errors. A histogram of standardised residuals for total prosodic passage reading score demonstrated that errors were approximately normally distributed. A P-P plot of standardised residuals demonstrated that the data met assumptions of homogeneity of variance and linearity (points close to the line).

6.5.2. Descriptive Statistics

Descriptive statistics for all measures are in Table 5. A series of zero-order correlations were run in order to better understand the relationship between participants' performance on each of the administered measures (Table 6). Notably, performance on all measures was moderately significantly correlated—with the exception of reading comprehension and passage reading efficiency (r = .37, p = .09). Further zero-order correlations were also carried out to explore the relationship between the two measures of prosodic competence. The results of this study demonstrated that performance on these tasks was moderately significantly correlated at r = .47 (p < .001). In line with the holistic approach to prosody (Chapter Five), these measures were combined to create a composite measure of prosodic competence.

Table 5. *Study One: Means and Standard Deviations for all Measures (n = 105)*

	Min	Max	Mean	SD
Vocabulary (max = 10)	2	10.	7.8	1.6
Passage Reading Efficiency (WCPM)	93.6	205.4	149.3	19.5
Prosodic Competence (max = 24)	8	24	20.0	3.4
AD Picture Task (max = 12)	3	12	9.4	2.0
SO Picture Task (max = 12)	3	12	9.9	2.0
Prosodic Passage Reading (max = 16)	6	16	12.9	2.4
Phrasing (max = 4)	2	4	3.4	0.7
Expression (max = 4)	1	4	3.1	0.7
Smoothness (max = 4)	1	4	2.8	0.9
Pacing (max = 4)	1	4	3.4	0.7
Reading Comprehension (max = 9)	4	9	6.9	1.3

Note. WCPM = average correct words read per minute, AD = Accent Disambiguation, SO = Subject-Object

Table 6. *Study One: Correlations (n=105)*

	Passage Reading Efficiency (WCPM)	**Prosodic Competence**	**Prosodic Passage Reading**	**Reading Comprehension**
Vocabulary	.27**	.34**	.45**	.45**
Passage Reading Efficiency	-	.32**	.36**	.09
Prosodic Competence	-	-	.42**	.20*
Prosodic Passage Reading	-	-	-	.31**

Note. **p < .01, * p < .05, WCPM = average correct words read per minute

6.5.3. Contribution of Prosodic Competence to Prosodic Passage Reading

This section will address Research Question 1 *(To what extent do individual differences in prosodic competence account for unique variance in prosodic passage reading in a sample of adult readers?).* In order to answer this question, a series of regressions were performed. As demonstrated in Table 6, prosodic competence was significantly moderately correlated with total prosodic passage reading (r = .42). A linear regression demonstrated that prosodic competence accounted for 18% of variation in prosodic passage reading score $F(1,103) = 21.83$, $p < .001$ (Table 7).

Table 7. *Study One: LR Accounting for Variance in Prosodic Passage Reading from Prosodic Competence (n= 105)*

Prosodic Passage Reading	R	R^2	β	*t*	B
	.42	.18			
Prosodic Competence			.42	4.67**	.28

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

A hierarchical multiple linear regression was performed to explore whether this contribution was still significant after accounting for individual differences in vocabulary. At step one, vocabulary contributed significantly to the regression model, $F(1,103) = 26.71$, $p< .001$ and accounted for 21% of the variation in prosodic passage reading. At step two, prosodic competence accounted for an additional 7% of unique variance, and this change in R^2 was significant, $F(2,102) = 20.20$, $p < .001$ (Table 8).

Table 8. *Study One: HMLR Accounting for Variance in Prosodic Passage Reading from Vocabulary and Prosodic Competence (n = 105)*

Prosodic Passage Reading	R	R^2	ΔR^2	β	*t*	B
Step 1	.45	.21	.21			
Vocabulary				.45	5.17**	.68
Step 2	.53	.28	.07			
Vocabulary				.35	3.93**	.47
Prosodic Competence				.30	3.33**	.17

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

A final hierarchical multiple linear regression was performed to explore whether this contribution was still significant after accounting for individual differences in passage reading efficiency. At step two, passage reading efficiency contributed an additional 6% of variance in prosodic reading $F(2,102) = 18.65$, $p<.001$. At step three, prosodic competence accounted for another 5% of variance in prosodic passage reading, and this change in R^2 was significant $F(3,101) = 15.67$, $p < .001$ (Table 9).

Table 9. *Study One: HMLR Accounting for Variance in Prosodic Passage Reading from Vocabulary, Passage Reading Efficiency, and Prosodic Competence (n = 105)*

Prosodic Passage Reading	R	R^2	ΔR^2	β	*t*	B
Step 1	.45	.21	.21			
Vocabulary				.45	5.17**	.68
Step 2	.52	.27	.06			
Vocabulary				.39	4.38**	.57
Passage Reading Efficiency				.26	2.93**	.03
Step 3	.57	.32	.05			
Vocabulary				.32	3.56**	.47
Passage Reading Efficiency				.20	2.25*	.02
Prosodic Competence				.25	2.73**	.17

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

6.5.4. Contribution of Prosodic Passage Reading to Reading Comprehension

This section will address Research Question 2 *(To what extent do individual differences in prosodic passage reading account for unique variance in reading comprehension in a sample of adult readers?).* In order to answer this question, a series of regressions were performed. As demonstrated in Table 6, prosodic passage reading was significantly moderately correlated with total reading comprehension (r = .31). A linear regression demonstrated that prosodic passage reading accounted for 10% of variation in total reading comprehension $F(1,103) = 11.11$, p =. 001 (Table 10).

Table 10. *Study One: LR Accounting for Variance in Reading Comprehension from Prosodic Passage Reading (n= 105)*

Reading Comprehension	R	R^2	β	*t*	B
	.31	.10			
Prosodic Passage Reading			.31	3.33**	.16

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

A hierarchical multiple linear regression was performed to explore whether this contribution was still significant after accounting for individual differences in vocabulary. At step one, vocabulary contributed significantly to the regression model, $F(1,103) = 25.62$, p<.001 and accounted for 20% of variance in reading comprehension. At step two the model was still significant, $F(2,102) = 13.91$, p<.001, however, prosodic passage did not account for any significant change in R^2 (Table 11).

Table 11. *Study One: HMLR Accounting for Variance in Reading Comprehnesion from Vocabulary and Prosodic Passage Reading (n = 105)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.45	.20	.20			
Vocabulary				.45	5.06**	.35
Step 2	.46	.21	.01			
Vocabulary				.38	3.89**	.30
Prosodic Passage Reading				.13	3.40	.01

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

A final hierarchical multiple linear regression was performed to explore the relative contribution of passage reading efficiency to reading comprehension. Although the model was significant, at steps two and three neither passage reading efficiency nor prosodic passage reading accounted for additional variance in reading comprehension $F(3,101) = 9.43$, $p< .000$ (Table 12).

Table 12. *Study One: HMLR Accounting for Reading Comprehension from Prosodic Competence, Vocabulary, Passage Reading Efficiency, and Prosodic Passage Reading (n = 105)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.45	.20	.20			
Vocabulary				.45	5.06**	.35
Step 2						
Vocabulary	.45	.20	.00	.46	4.95**	.35
Passage Reading Efficiency				-.03	-0.36	-.00
Step 2	.47	.22	.02			
Vocabulary				.39	3.96**	.30
Passage Reading Efficiency				-.08	-0.78	-.01
Prosodic Passage Reading				.16	1.56	.08

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

6.5.5. Contribution of Prosodic Competence to Reading Comprehension

This section will address Research Question 3 (*To what extent are individual differences in prosodic competence associated with reading comprehension in a sample of experienced readers?).* In order to answer this question, a series of linear regressions were performed.

A linear regression demonstrated that prosodic competence accounted for 4% of the variance in reading comprehension $F(1,103) = 4.21$, $p = .043$ (Table 13).

Table 13. *Study One: LR Accounting for Variance in Reading Comprehension from Prosodic Competence (n = 105)*

Reading Comprehension	R	R^2	β	*t*	B
	.20	.04			
Prosodic Competence			.20	2.05*	.07

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

A hierarchical multiple linear regression was performed to explore the contribution of prosodic competence to participants' reading comprehension after accounting for vocabulary. At step two the model was still significant, $F(2,102) = 12.87$, $p < .001$, however, prosodic competence did not account for did not account for any significant change in R^2 (Table 14).

Table 14. *Study One: HMLR Accounting for Variance in Reading Comprehension from Vocabulary and Prosodic Competence (n = 105)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.45	.20	.20			
Vocabulary				.45	5.06**	.35
Step 2	.45	.20	.00			
Vocabulary				.43	4.55**	.33
Prosodic Competence				.05	0.54	.02

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

6.5.6. Role of Prosodic Passage Reading

This section will address Research Question 4 *(If prosodic competence accounts for unique variance in reading comprehension (after controllong for word-level reading skills), is this variance explained by prosodic passage reading?).* The results of this study demonstrated that prosodic competence did not account for any additional variance in reading comprehension after controlling for vocabulary. Therefore, no further analyses were conducted.

6.6. Discussion

The aim of study one was to answer four research questions*: (1) To what extent do individual differences in prosodic competence account for unique variance in prosodic passage reading in a sample of experienced adult readers? (2) To what extent do individual differences in prosodic passage reading account for unique variance in reading comprehension in a sample of experienced adult readers? (3) To what extent do individual differences in prosodic competence account for unique variance in reading comprehension ability in a sample of experienced adult readers? (4) If prosodic competence accounts for unique variance in reading comprehension (after controlling for word-level reading skills), is this variance explained by prosodic passage reading?*

Initial hypotheses predicted that: (a) individual differences in prosodic competence would account for variance in prosodic passage reading and reading comprehension, even after controlling for differences in vocabulary and passage reading efficiency (b) individual differences in prosodic passage reading would account for variance in reading comprehension, even after controlling for differences in vocabulary and passage reading efficiency and (c) the unique variance in reading comprehension accounted for by prosodic competence would be explained by differences in prosodic passage reading. These predictions were only partially supported.

As expected, the results demonstrated a strong positive relationship between prosodic competence and prosodic passage reading, which was still significant even after accounting for differences in vocabulary and passage reading efficiency. However, although results verified that prosodic competence, prosodic passage reading, and reading comprehension were all significantly positively associated with each other, neither of the prosodic skills accounted for unique variance in reading comprehension after controlling for vocabulary. In this section, I first reflect on the results of this study in relation to previous research, and then discuss potential limitations.

6.6.1. Concurrent Relationships between Prosodic Competence and Prosodic Passage Reading

The expected relationship between prosodic competence and prosodic passage reading was clearly supported by the results. Not only did participants' performance on the prosodic competence tasks predict 18% of variance in prosodic passage reading task, 5% of this variance was completely independent of vocabulary and passage reading efficiency (Figure 14).

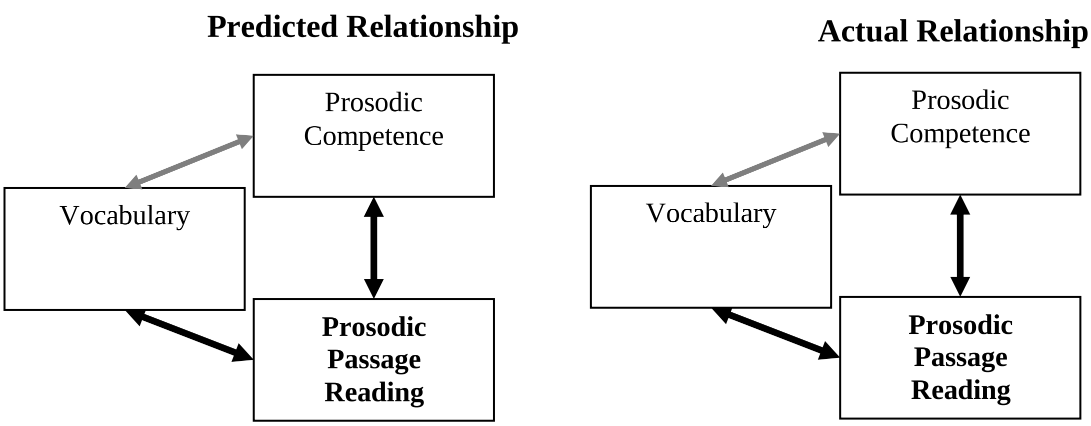


Figure 14. Study One: Predicted and Actual Relationships between Prosodic Competence and Prosodic Passage Reading

Note. Solid arrows represent unique variance (direct relationship); Grey lines represent previously established relationships

Although it is often presumed that prosodic competence is closely related to prosodic passage reading (Wade-Woolley et al., 2021) empirical evidence establishing this is minimal. Therefore, these results support just a small number of studies illustrating this relationship (Holliman et al., 2010a; Veenendaal et al., 2014; Veenendaal et al., 2016). To my knowledge, however, this is the first study to empirically determine a statistically significant positive association between prosodic competence and prosodic passage reading in a sample of adults—and further to evidence that the relationship between these skills survives even after accounting for other reading related skills. It is particularly notable that this relationship was still significant after controlling for passage reading efficiency; if the association between prosodic competence and prosodic passage reading was explained by passage reading efficiency, it would indicate that the role of prosodic competence could simply be facilitating the many lower level reading skills involved in accurate and efficient word reading. However, results instead suggest that prosodic competence is specifically implicated in *prosodic* passage reading. Accordingly, these results support the assertion that an understanding and awareness of prosody within language underpins the ability to imbue written text with appropriate prosodic cues.

Notably, 11% of the variance in prosodic passage reading explained by prosodic competence was shared with vocabulary. This shared variance was expected; empirical research has consistently demonstrated significant positive correlations between prosodic competence and vocabulary (Beattie & Manis, 2014; Wood, 2006). Theoretically, according to the prosodic bootstrapping hypothesis (Bedore & Leonard, 1995) and the theory of periocity bias (Cutler & Mehler, 1993), prosodic competence is implicated in the development of vocabulary from a young age. This may partly explain the relationship. However, this shared variance also makes sense given that both the prosodic competence task and the prosodic passage reading task involved vocabulary knowledge; in the prosodic competence task participants needed to comprehend the compound nouns and adjectives used in the tasks, and in the prosodic passage reading task participants used vocabulary knowledge to create a coherent interpretation of the passage. Additionally, the nature of the vocabulary task may also have contributed to this shared variance. As in the current study, synonym vocabulary assessments are typically used to assess word-level comprehension (e.g., Kieffer et al., 2016; Warrington et al., 1998). However, it is also possible that participants may have used sentence-level comprehension to facilitate performance (e.g., top-down processing of the sentence, using contextual clues). Therefore, although language comprehension above the word-level was not directly assessed, there is a possibility that the shared contribution of prosodic competence and vocabulary (in relation to prosodic passage reading) was partly because they both facilitate phrase level comprehension.

This robust association between prosodic competence and prosodic reading is also noteworthy because the prosodic competence tasks used in the present study were entirely independent of reading. To explicate, both the Compound Noun task and Subject-Object prosodic competence tasks measured participants' sensitivity to prosodic cues using only speech and pictures. Therefore, it is unlikely that decoding related skills would drive the relationship. Nevertheless, it is possible that other metalinguistic skills, such as segmental phonological awareness or morphological awareness—both of which are closely related to prosodic competence (see Chapter Three)—may have played a role. This will be further discussed in the limitations section.

6.6.2. Concurrent Relationships between Prosodic Passage Reading and Reading Comprehension

Counter to hypotheses, the relationship between prosodic passage reading and reading comprehension was not independent of vocabulary (Figure 15). Rather, the 10% of variance in reading comprehension explained by prosodic passage reading was entirely accounted for by differences in performance on the vocabulary task.

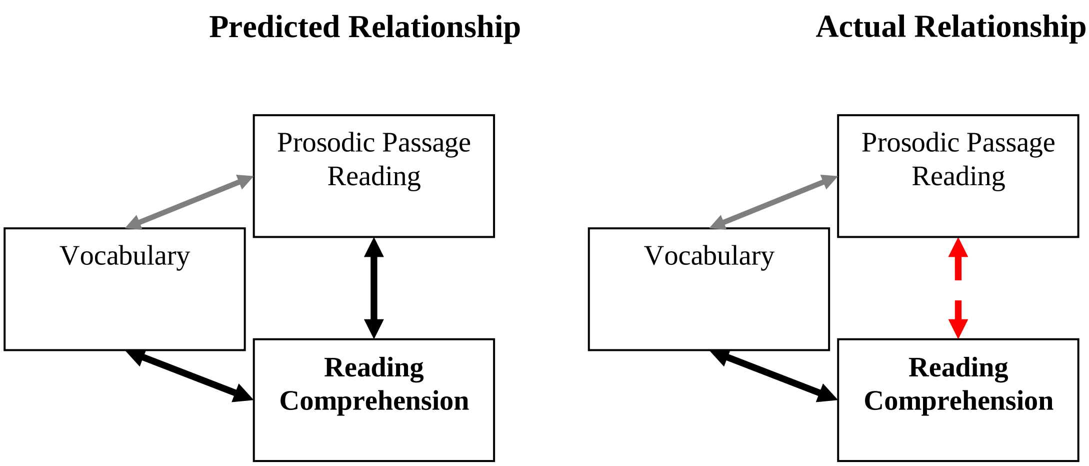


Figure 15. Study One: Predicted and Actual Relationships between Prosodic Passage Reading and Reading Comprehension

Note. Solid arrows represent unique variance (direct relationship); Dashed arrows represent variance shared with vocabulary (indirect relationships); Grey lines represent previously established relationships; Red lines indicate unexpected results

The original hypothesis predicted that, for experienced adult readers, the facilitating role of prosodic passage reading in relation to reading comprehension would be at the syntactic and semantic level. Or, at least, that the higher order semantic processing involved in prosodic passage reading would be reflected in reading comprehension. However, these results instead suggested that any facilitating role of prosodic passage reading in relation to reading comprehension was confined to the word level (e.g., accounted for by the vocabulary measure).

As previously discussed, the relationship between prosodic passage reading and reading comprehension has received a decent amount of attention by previous researchers—albeit almost exclusively within samples of early readers, rather than experienced adults. A meta-analysis of 35 studies (that included children between the ages of 6- and 15-years-old) reported that prosodic passage reading and reading comprehension were, on average, moderately correlated (r = .51) (Wolters et al., 2022). The results of the current study demonstrated a comparable relationship, although weaker, relationship (r = .31). In relation to the three theoretical models presented in Chapter Three (prosodic reading as a reflection of reading comprehension, prosodic reading as a facilitator of reading comprehension and prosodic reading and reading comprehension as bidirectional), this suggests that prosodic passage reading in experienced adult readers is (a) relatively less important for successful comprehension and/or (b) relatively less indicative of successful comprehension.

However, these results differ from a similar recent study that also explored the concurrent relationships between prosodic passage reading (referred to by the authors as ‘phrase reading’) and reading comprehension—but in a sample of adolescent readers (Nomvete & Easterbrooks, 2019). In this study, researchers assessed 70 adolescents ages 13- to 21-years-old on word reading, passage reading efficiency (reading rate), prosodic passage reading (NAEP oral reading fluency scale), syntactic awareness, and reading comprehension. Similar to the present study, researchers reported a significant correlation between prosodic passage reading and reading comprehension (r = .57). On the other hand, the researchers also reported that after accounting for passage reading efficiency and syntactic awareness, prosodic passage reading still accounted for 6% of unique variance in reading comprehension. Notably, however, this study did not account for differences in vocabulary. Therefore, in light of the current results, I suggest that word-level knowledge—central to both prosodic reading and comprehension—may explain this relationship. Nevertheless, this also suggests that for adolescents, the sample of Nomvete and Easterbrooks (2019) study, prosodic passage reading may be more central to reading comprehension. Moreover, as pointed out by the researchers, many of the participants were identified as ‘struggling’ readers (largely due to the nature of data collection in alternative education settings). Taken together, this study and the current findings indicate that prosodic passage reading is likely more important for comprehension for less skilled readers. This is consistent with the findings of Miller and Smith (1990), who demonstrated that, in a sample of 83 English speaking 8 to 10-year-olds, reading aloud was associated with higher comprehension in poor readers, but not in average or good readers.

In view of that, one of the most plausible explanations for such results, and consequently consistent with the current findings, is that prosodic passage reading only facilitates reading comprehension for readers who utilise oral passage reading as a tool; more experienced readers may not need to rely on a tool such as prosodic passage reading to help with text segmentation and semantic processing. Accordingly, this will be explored further in the following studies.

6.6.3. Concurrent Relationships between Prosodic Competence and Reading Comprehension

The final two hypotheses suggested: (a) that prosodic competence would account for unique variance in reading comprehension (after controlling for vocabulary and passage reading efficiency) and, conditionally, (b) that this unique variance would be accounted for by individual differences prosodic passage reading. However, the results did not support this first prediction: the contribution of prosodic competence to reading comprehension was completely accounted for by individual differences in performance on the vocabulary measure (Figure 16).

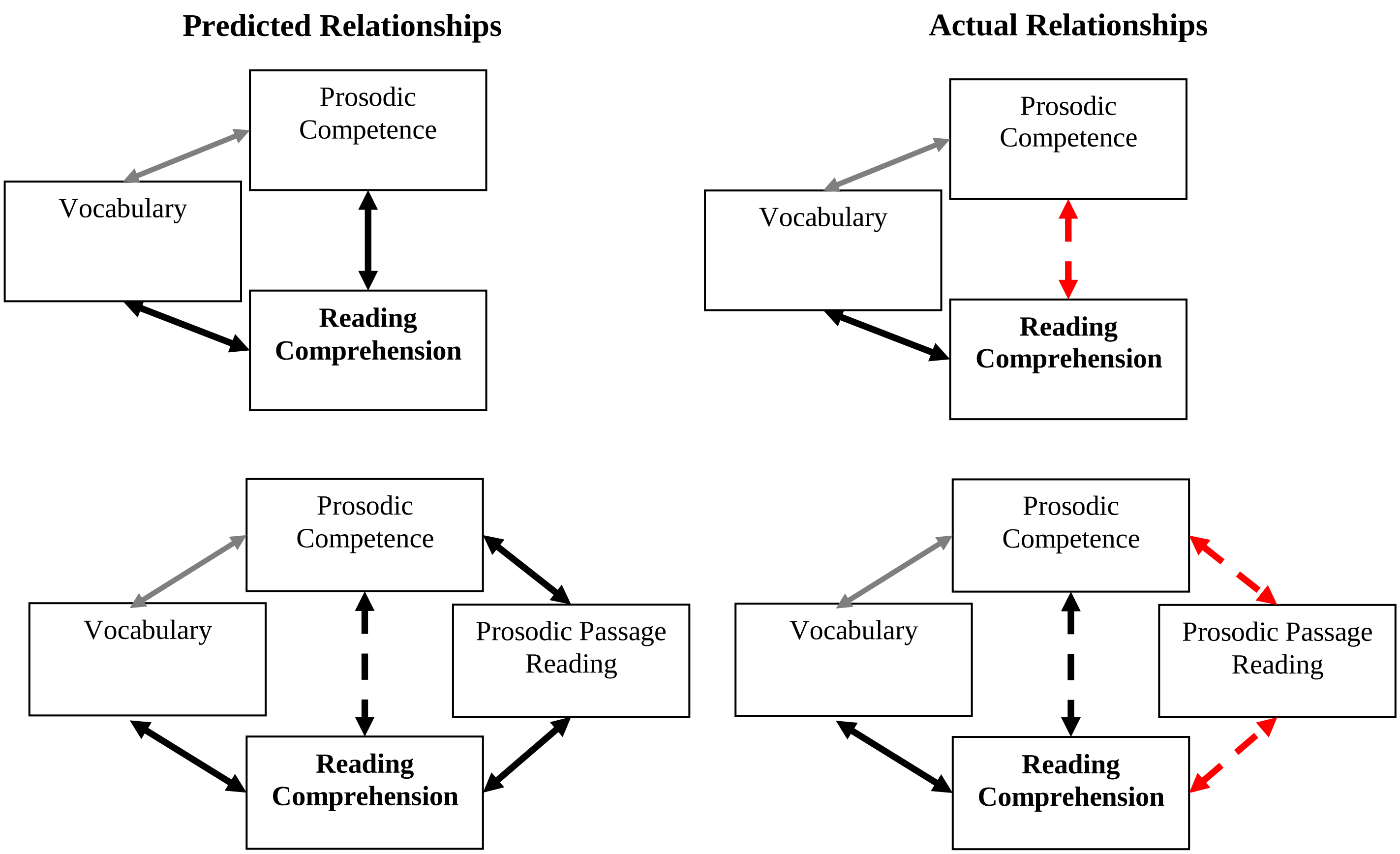


Figure 16. Study One: Predicted and Actual Relationships between Prosodic Competence and Reading Comprehension

Note. Solid arrows represent unique variance (direct relationship); Dashed arrows represent variance shared with vocabulary (indirect relationships); Grey lines represent previously established relationships; Red lines indicate unexpected results

Notably, the results did show that performance on the prosodic competence tasks was significantly correlated, although weakly ($r = .20$), with performance on the reading comprehension task. This is consistent with other previous studies exploring the relationship between prosodic competence and reading comprehension in samples of adults and young adults (Breen et al., 2016; Chan & Wade-Woolley, 2018; Kitzen, 2001; Williams & Wood, 2012). The hypothesis that this relationship would survive controlling for vocabulary was largely motivated by the results of Kitzen's (2001) study, which demonstrated that prosodic competence predicted unique variance in reading comprehension, even after accounting for vocabulary and other lower level reading-related skills. In this study, Kitzen assessed 60 adults (30 with histories of reading difficulty and 30 without) on prosodic competence (using the DEEdee and Compound Noun tasks), reading comprehension, and vocabulary—in addition to segmental phonological awareness, morphological awareness, rapid naming speed (RAN), and single word reading. A multiple regression established that, in a model including all of these measures (vocabulary, PA, MA, RAN, and prosodic competence), both measures of prosodic competence contributed unique variance to reading comprehension.

There are multiple potential explanations as to why the current results are not consistent with these findings. Firstly, although in both studies the participant sample was adults, half of the total sample (30 participants) in the study by Kitzen (2001) reported histories of reading difficulties. Accordingly, the contribution of prosodic competence to reading comprehension may be more evident in less able readers—who potentially rely more on their understanding of prosody to facilitate syntactic and semantic processing when comprehending a passage. Secondly, it is always important to note that because passage reading is text dependent (Amendum et al., 2018), this may explain the disparity. In other words, it is possible that the passages used by Kitzen (2001) may have required more prosodic skills (e.g., more syntactically complex phrases) than the passage in the current study. It is also possible that selected passage in the current study (the most difficult passage of the ART) contained more advanced vocabulary, and therefore that vocabulary knowledge accounted for relatively more variance in comprehension (above prosodic skills).

Nevertheless, the current results are consistent with other previous work. Chan and Wade-Woolley (2018) also assessed prosodic competence (using a stress identification and stress manipulation task), vocabulary, and reading comprehension in addition to executive function, segmental PA, word reading, and non-verbal IQ in a sample of 103 adults. Although researchers reported that prosodic competence contributed significantly to single word reading after accounting for these other measures, it did not contribute unique variance to reading comprehension. Results of this study also indicated that, out of these reading related measures (including prosodic competence), vocabulary was the strongest predictor of reading comprehension. In another study by Williams and Wood (2012), researchers used an experimental design to assess the contribution of different aspects of prosodic competence (using a matching paradigm of the stress identification task) to reading outcomes. Once again, researchers reported that, in a sample of 64 adults, vocabulary accounted for all unique variation in reading comprehension, even after accounting for prosodic competence. The findings of these two studies are wholly in line with the present results. Therefore, I argue that the most appropriate interpretation of the current results is that the contribution of prosodic competence to reading comprehension is facilitating word-level comprehension. Notably, the lack of relationship between passage reading efficiency and reading comprehension in the current study was surprising, suggesting that word-level decoding skills did not play a notable role in adult reading comprehension. Although this is somewhat consistent with the developmental view of the SVR (Gough et al., 1996)—which posits that language comprehension, rather than word recognition, is relatively more important for skilled reading comprehension—I also suggest that this may be partly due to the demanding reading instructions used in the current study (participants were told to read quickly, accurately, with expression, and for comprehension). Therefore, this will be addressed in the following studies.

In summary, the present study demonstrated that the contribution of prosodic competence to reading comprehension in adult readers is largely—or else, completely—accounted for by individual differences in vocabulary. This supports a small number of previous studies with experienced adult readers (Chan & Wade-Woolley, 2018; Williams & Wood, 2012). Consequently, for experienced readers, the contribution of prosodic competence to reading comprehension appears to be language comprehension at the word-level, rather than higher-order syntactic or semantic processing. Nevertheless, the measures of both prosodic competence and passage reading are of consequence in drawing this conclusion. Accordingly, limitations of the current study are addressed below.

6.6.4. Limitations

Perhaps the most notable limitation of this study was the exclusion of other known measures of reading-related skills. The inclusion of a vocabulary measure allowed for a basic understanding as to the shared variance between prosodic competence and word-level semantic processing. The inclusion of a measure of passage reading efficiency allowed for an understanding as to shared variance between prosodic competence and general word reading skills. However, it would be inappropriate to generalise performance on the passage reading efficiency task as a true measure of word decoding and/or recognition—particularly as this task was not exclusively a measure of quick and efficient word reading. To explicate, because passage reading efficiency was assessed simultaneously with prosodic passage reading and comprehension, readers likely were focusing on more than simply efficient word reading. Furthermore, other metalinguistic skills, namely segmental phonological awareness, may have been driving some of the observed relationships. Therefore, including additional measures would have allowed for a more detailed understanding as to the role of these prosodic skills in relation to passage reading. Accordingly, Study Two includes these additional measures.

Another limitation of the current study was the low internal reliability of some included measures. Of course, the construct of prosodic competence is notably difficult to measure reliably. For that reason, measures for this study were partly chosen because of reasonable reports of sufficient reliability (Groen et al., 2019; Holliman et al., 2012). However, both the Accent Disambiguation and Subject-Object prosodic competence measures still demonstrated relatively low reliability (Cronbach's alpha = 0.57 and Cronbach's alpha = 0.62 respectively). Furthermore, the reading comprehension task and vocabulary task also demonstrated relatively low reliability (Cronbach's alpha = 0.56 and Cronbach's alpha = 0.47). The reason for this is likely due to the low number of items included in each of these measures; the Cronbach's alpha statistic is notably sensitive to the number of items in the scale (Nunnally & Bernstein, 1994). In final analysis, the prosodic competence measures included 14 items, the vocabulary measure included 10 items, and the reading comprehension measure included 9 items. While it can been argued that these low values should not devalue the findings (Knapp & Brown, 1995), the importance of valid and reliable measures should not be understated. Therefore, Study Two will aim to replicate these results using the same measures, but including a larger number of items to increase the likelihood of robust internal reliability.

Finally, it is important to consider the passage reading assessments used in the study. Both oral reading fluency and reading comprehension are naturally text-specific skills (Amendum et al., 2018)—meaning that a reader may demonstrate high fluency and comprehension for one text, but not another text. In this study, the text used was a 307-word long passage taken from the Adult Reading Test (ART; Brooks et al., 2004). As indicated by a Flesch Reading Ease score of 44.8, this text was relatively difficult to read; the Flesch Reading Ease scale is on a scale of 0-100, with 70-100 indicating an easy text, 60-70 indicating a standard text, and 30-50 indicating a difficult text, and 0-30 indicating a very difficult text (Flesch, 1948). Given that vocabulary accounted for a majority of the variance in reading comprehension (relative to the other measures), it is possible that reading comprehension was too dependent the reader having high vocabulary knowledge, and therefore, that the role of syntactic and semantic processing were unobservable. Moreover, the questions used to assess reading comprehension also should be considered. In the current study, the comprehension items were formatted as multiple-choice items, and were largely literal, rather than inferential, questions (**Appendix E**). Therefore, although the findings suggest that neither prosodic competence nor prosodic passage reading account for additional variance in reading comprehension after controlling for vocabulary, it is possible that the measure was not sensitive enough to demonstrate the role of prosody facilitating inferential comprehension. This would also be consistent with a recent study by Keskin et al. (2019), in which researchers evaluated the importance of prosodic reading in relation to listening comprehension. In this study, Turkish-speaking children in Grade 3 listened to prosodic and non-prosodic reading of texts and answered both literal and inferential comprehension questions. Whereas there was no difference in score of literal questions between groups, students in the prosodic groups performed better on the inferential questions. Thus, both the level of the text and content of the comprehension questions will be considered in the design of Study Two.

Another minor limitation of this study was that participants were not formally asked to report any histories of reading difficulties or disorders (although data from participants who did voluntarily report reading difficulties were not included in the final sample). As highlighted by the study by Kitzen (2001), the inclusion of participants who did not share this information may have affected results. Of course, understanding the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension in individuals with reading difficulties is an important next step—particularly in relation to adult remedial reading interventions. However, given that the theoretical motivation of this study was to understand these relationships in experienced readers, it would be ideal to have these populations assessed separately.

Lastly, whereas children’s reading comprehension is typically measured hand in hand with oral reading fluency (e.g., MacGinitie et al., 1989; Snowling, 2009; Wechsler, 1992), this may not be appropriate in the context of experienced readers who are typically silent readers. Consequently, if we are assessing experienced readers on reading efficiency and prosodic passage reading, then it may be most appropriate to provide instructions which allow participants to consciously perform the tasks to the best of their ability. In the current study, instructions were given to participants to "*read the text both fluently and expressively and then do your best to answer the following comprehension questions.*" However, given that these instructions ask the reader to demonstrate three (arguably distinct) reading skills: passage reading efficiency, prosodic passage reading, and reading comprehension, the oral reading fluency task may have been partly assessing which of these three skills the participant chose to focus on. Therefore, it may be most appropriate to provide readers with explicit instructions as to which reading outcome is being assessed. Theoretically, this should then lead to a more valid assessment of participants' true ability to perform these passage-reading skills. The methodology of Study Two will also address this accordingly.

6.7. Conclusion

Results of this study only partially supported the original hypotheses. Individual differences in experienced adult readers' performance on the prosodic competence tasks was associated with their ability to read a passage with appropriate prosody. Moreover, this relationship survived a control for individual differences in both vocabulary and passage reading efficiency. This suggests that prosodic competence likely facilitates prosodic passage reading, or, at least, that an understanding of prosody is related to prosodic passage reading independently of these skills.

On the other hand, results also demonstrated that the contribution of both prosodic competence and prosodic passage reading to reading comprehension was minimal, and completely accounted for by individual differences in vocabulary. This was not consistent with the original hypothesis, which predicted that (a) both prosodic skills would account for unique variance in reading comprehension and (b) prosodic passage reading would emerge as a mediator between prosodic competence and reading comprehension. Rather, these results suggest that, in experienced readers, prosodic competence may be important for oral passage reading, but not directly related to passage comprehension.

Although the concurrent nature of the study means that the direction of the relationships between these skillsets cannot be determined, these results have implications in relation to how we conceptualise the role of prosodic in frameworks of skilled reading, future research, and educational policy. These implications will be discussed in Chapter Nine.

7. Study Two. Further Examining Prosody in Experienced Passage Reading

7.1. Introduction

Study one aimed to better understand the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension in a sample of experienced adult readers. Specifically, this study explored the hypothesis that the contribution of prosodic competence to reading comprehension is that it facilitates prosodic passage reading (as opposed to by facilitating word-level reading skills). However, the results demonstrated that, in this population, neither prosodic competence nor prosodic passage reading accounted for unique variance in reading comprehension controlling for vocabulary and passage reading efficiency. On the other hand, results did demonstrate that prosodic competence accounted for unique variance in prosodic passage reading, independently of these measures.

The purpose of Study Two was to (a) assess whether prosodic competence accounts for unique variance in prosodic passage reading, after also controlling for differences in segmental phonological awareness and single word reading (b) explore the effect of reading instructions on the relationships demonstrated in study one and (c) address the other identified limitations of study one, while testing whether the findings could be replicated in a second independent sample of experienced adult readers. Finally, Study Two also assessed the feasibility of conducting this study using online asynchronous administration.

Study Two Research Questions

(1) To what extent do individual differences in prosodic competence account for unique variance in prosodic passage reading ability in a second sample of experienced adult readers?
   a) Is the contribution of prosodic competence to prosodic passage reading ability still significant after accounting for individual differences in vocabulary, segmental phonological awareness and single word reading?
   b) Is the contribution of prosodic competence to prosodic passage reading ability still significant after accounting for individual differences in passage reading efficiency?

c) Are these results consistent with study one?

(2) To what extent do individual differences in prosodic passage reading ability account for unique variance in reading comprehension in a second sample of experienced adult readers?

a) Is the contribution of prosodic passage reading ability to reading comprehension still significant after accounting for individual differences in vocabulary, segmental phonological awareness and single word reading?

b) Is the contribution of prosodic competence to prosodic passage reading ability still significant after also accounting for individual differences in passage reading efficiency?

c) Are these results consistent with study one?

(3) To what extent do individual differences in prosodic competence account for unique variance in reading comprehension ability in a second sample of experienced adult readers?

a) Is the contribution of prosodic competence to reading comprehension still significant after accounting for individual differences in vocabulary, segmental phonological awareness and single word reading?

b) Is the contribution of prosodic competence to reading comprehension still significant after accounting for individual differences in passage reading efficiency?

c) Are these results consistent with study one?

(4) If prosodic competence accounts for unique variance in reading comprehension (after controlling for word-level reading skills), is this variance explained by prosodic passage reading ability?

7.2. Hypotheses

Considering the findings of study one, the hypotheses were adapted so that predictions were consistent with the results of the previous study. Accordingly, the following were the hypotheses for Study Two:

- **Hypothesis 1:** In experienced adult readers, individual differences in prosodic competence will account for unique variance in prosodic passage reading ability, even after controlling for differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading) and passage reading efficiency.
- **Hypothesis 2** (**adapted**): In experienced adult readers, individual differences in prosodic passage reading will account for variance in prosodic passage reading, but this variance

will be entirely explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading)

- **Hypothesis 3** (**adapted**): In experienced adult readers, individual differences in prosodic competence will account for variance in prosodic passage reading, but this variance will be entirely explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading)
- **Hypothesis 4 (adapted)**: In experienced readers, variance in reading comprehension will be explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading).

7.3. Change in Methodology as a Result of Covid-19

Originally, this study was intended to be administered in person, and measures were chosen primarily because they were standardized and/or reliable assessments of the constructs of interest. This included the vocabulary sub-test of the Wechsler Adult Intelligence Scale fourth edition (WAIS-IV; Wechsler, 2008), the standard version of the Adult Reading Test (ART; Brooks et al., 2004), the Elision sub-test of the Comprehensive Test of Phonological Processing (CTOPP-2; Wagner et al., 1999), and two additional measures of prosodic competence: the Story Telling Task (adapted from Veenendaal et al., 2014) and the Stress Manipulation Task (Wade-Woolley et al., 2012). This original study also aimed to explore the relative importance of expressive vs. receptive prosodic competence. Unfortunately, partway through data collection, a restriction on face-to-face data collection (due to the Covid-19 pandemic) was put in place, and the study had to be discontinued. Given the time-sensitive nature of this study, a new online version of Study Two was designed. The expressive measures of prosodic competence, the Story Telling Task and Stress Manipulation Task, were also deemed unsuitable for online adaptation due to the interactive nature of these measures. The WAIS-III, CTOPP-2, and ART were unable to be moved to an online platform because of copyright rules from the publishers of these assessments. Therefore, the measures included in this new version of the study were partly chosen due to the feasibility of administering them in an asynchronous online format. A further description of the measures and data collected before this restriction are in **Appendix A.**

7.4. Participants

Prior to participant recruitment, ethical approval for the study was obtained from the Nottingham Trent University Research Ethics Committee (within the School of Business, Law and Social Sciences). After data collection for the original version of this study was paused (due to the face-to-face restrictions brought on by the pandemic), an amendment in methodology was submitted and approved by the chair of the ethics committee. Participants for the current version were then recruited online via social media and the participant recruitment website Prolific (www.prolific.co) [June 2020]. Prior to beginning the study, all participants were presented with an online information sheet and asked to sign a virtual consent form. This consent form also included questions about demographics and reading habits. The information sheet and consent form are in **Appendix F.** The demographic questions are in **Appendix G.**

A total of 125 participants completed the study between June and August 2020. Data from 18 participants was removed due to (a) errors with audio recording and/or (b) lack of engagement with the study (no attempt to answer open text items, no attempt to read aloud, or unrealistic response times). Data from an additional 13 participants who reported that English was their second language was also removed due to differences in prosodic competencies associated with learning a second language (Trofimovich & Baker, 2006). Data from 3 participants were removed due to previous participation in study one. Data from 5 participants was removed because they reported a history of reading difficulties or disorders. Data from 86 participants (52 females, 31 males, and 3 who identified as non-binary or another gender, mean age = 35.2, *SD* = 12.29) were included in the final analysis. Of these native English speakers, 57 participants reported speaking British dialect, 20 participants reported speaking American dialect and 9 reported speaking another dialect of English (Australian, Scottish, Irish, or Jamaican).

7.5. Measures

Due to Covid-19 restrictions, this study was adapted to be an entirely self-administered online experiment hosted on the experiment platform LabVanced (Finger et al., 2017). This section provides a summary of all tasks.

7.5.1. Vocabulary

The vocabulary task consisted of the original 10-item multiple-choice questions from study one, plus an additional 10 items that were also taken from online resources associated with the Scholastic Aptitude Test (SAT) and Graduate Record Examinations (GRE). Participants were asked to read a sentence from the screen and choose the word that best fit the underlined item from a list of five options. Prior to starting the task, a practice item was presented. Inter-item reliability for this task was notably higher than in study one (Cronbach's alpha = 0.80). A list of all additional vocabulary are in **Appendix C.**

7.5.2. Segmental Phonological Awareness

Segmental PA was assessed using three novel computerised tasks. Phoneme and rime awareness were measured using a sound-deletion task and a sound-identification task. Syllable awareness was assessed using a syllable-identification task. All three tasks involved participants listening to items recorded by a female native British English speaker with a Received Pronunciation (RP) accent. An independent samples t-test was run to check for differences between the self-reported dialects of participants for these tasks. There were no significant differences in performance between British dialect speakers and non-British dialect speakers for the sound deletion task (British: M = 16.0, SD = 4.8, Non-British: M = 16.1, SD = 4.4; t(84) = .46, p = .92), the sound identification task (British: M = 12.9, SD = 4.8, Non-British: M = 11.4, SD = 4.2; t(84) = 1.4, p = .15), or the syllable identification task (British: M = 20.6, SD = 5.0, Non-British: M = 21.0, SD = 5.4; t(84) =.35, p = .73).

7.5.2.1. Sound Deletion

A multiple-choice task was developed to explore participants' understanding of word and sound manipulation. This task was modelled on the Elision subtest of the Comprehensive Test of Phonological Processing CTOPP; Wagner et al., 1999), however, it was adapted so that participants would not need to provide an oral response, thereby making online administration suitable. Participants were given the following instructions: "*In this task you will hear an original word and a new word. Your task is to identify what sound has been removed from the original word to make the new word. Sounds may be removed from the beginning of words, the* *end of words, or in the middle of words."* Prior to the practice items, participants were also given an example ("*You might hear the original word:* ***snowman*** *and the new word:* ***snow.*** *The sound that was removed was "man").* Participants were instructed to answer as accurately and as quickly as possible. Two practice items and correct/ incorrect feedback were provided. The task consisted of 20 trials: 5 with sound deleted at the beginning, 5 with sound deleted at the end, and 10 with sound deleted in the middle. Unlike the CTOPP, participants completed all items regardless of previous performance. All words were taken from The English Lexicon Project database (Balota et al., 2007), and selected based on frequency. Inter-item reliability was high for this task (Cronbach's alpha = 0.82). For a list of all words and relevant lexical properties, see **Appendix H.** See Figure 17 for example item.

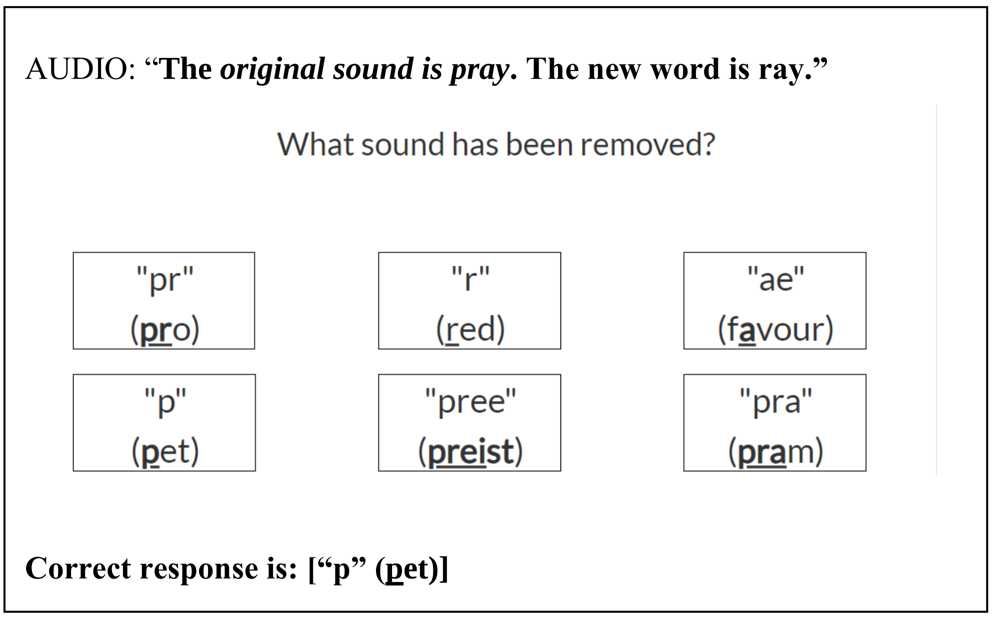


Figure 17. Item Example of Study Two Sound Deletion Task

7.5.2.2. Sound Identification

A multiple-choice task was developed to assess participants' phonemic awareness. Participants were given the following instructions: "*In this task you will hear a word and be asked to identify individual sounds in that word. For example, "hive" has 3 sounds: "h" (as in* ***h****it) / "ie" (as in t****ie****)/ "v" (as in* ***v****an). In this round you will be asked to identify the [FIRST, THIRD, or FIFTH] sound in the word.*" In the first section of the task participants had to identify the first phoneme (speech sound) of the word. In the second section of the task participants had to identify the third speech sound of the word. In the final section of the task participants had to identify the fifth speech sound of the word. Participants were instructed to answer as accurately and as quickly as possible. Prior to starting the task, two practice items and correct/ incorrect feedback were provided.

The task consisted of 24 trials: 8 trials required the participant to identify the 1st speech sound, 8 trials required the participant to identify the 3rd speech sound, and 8 trials required the participant to identify the 5th speech sound. All words were taken from The English Lexicon Project database (Balota et al., 2007) and were of similar frequency, according to the Hyperspace Analogue to Language (HAL) corpus (Lund & Burgess, 1996). Inter-item reliability was high for this task (Cronbach's alpha = 0.83). For a list of all words and relevant lexical properties, see **Appendix H.** See Figure 18 for example item.

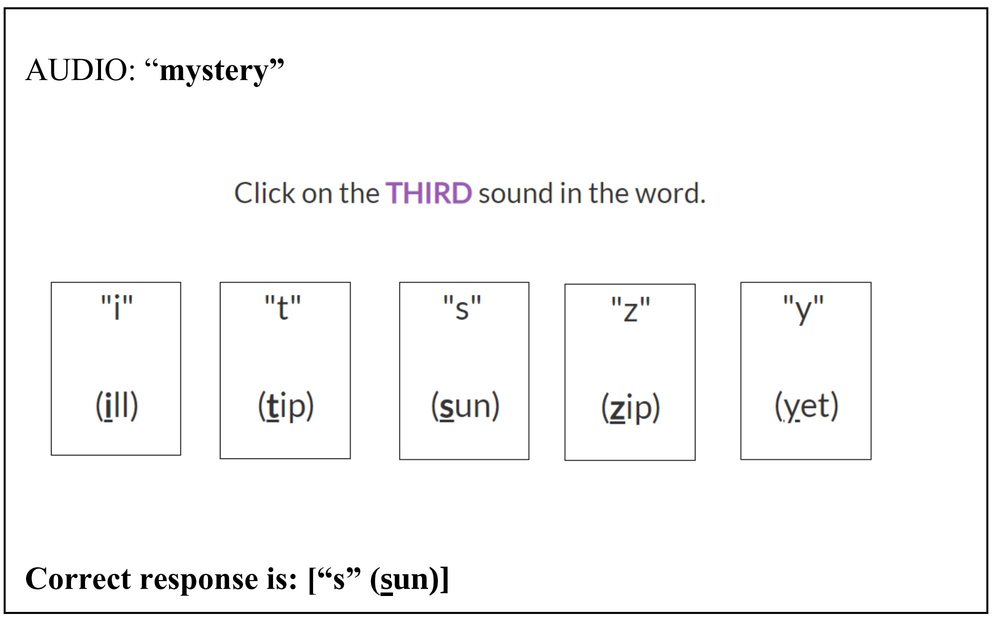


Figure 18. Item Example of Study Two Sound Identification Task

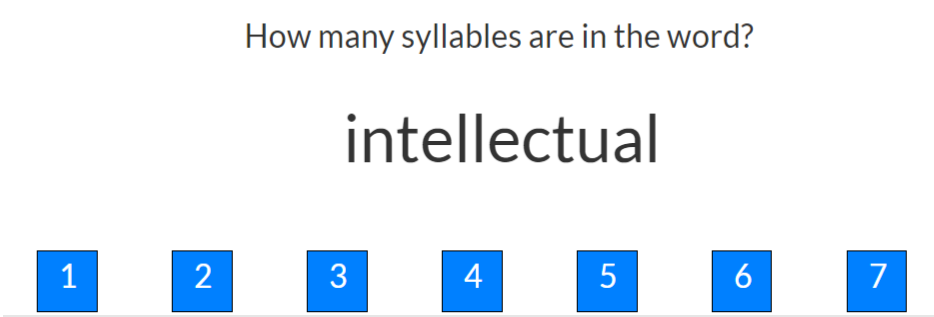
7.5.2.3. Syllable Identification

A multiple-choice task was developed to assess participants' awareness of syllables. Participants were given the following instructions: *In this task you will be presented with a word. Your task is to identify how many syllables make up that word."* Prior to the practice items participants were also given an example (*"Syllables are the rhythmic building blocks of language. For example: The word lantern has two syllables: lan-tern. The word digestive has three syllables: di-ges-*

tive".) Participants were instructed to answer as accurately and as quickly as possible. Prior to starting the task, two practice items and correct/ incorrect feedback were provided.

The task consisted of 16 trials: two 1 syllable words, two 2 syllable words, three 3 syllable words, three 4 syllable words, three 5 syllable words, two 6 syllable words, and one 7 syllable word. All words were taken from The English Lexicon Project database (Balota et al., 2007) and were of similar frequency according to the Hyperspace Analogue to Language (HAL) corpus (Lund & Burgess, 1996). Inter-item reliability was high for this task (Cronbach's alpha = 0.90). For a list of all words and relevant lexical properties see **Appendix H**. See Figure 19 for example item.

AUDIO: "**intellectual**"



Correct response is: [5]

Figure 19. Item Example of Study Two Syllable Identification Task

7.5.3. Prosodic Competence

Prosodic competence was assessed using six tasks: the two picture-based tasks from study one and four additional text-based tasks.

7.5.3.1. Picture-Based Tasks

Both tasks involved participants listening to items recorded by a female native British English speaker with a Received Pronunciation (RP) accent. An independent samples t-test was run to check for differences between participant dialects for these tasks. There were no significant differences between performance of British dialect speakers and non-British dialect speakers for the prosodic competence picture tasks (British: M = 38.9, SD = 7.6, Non-British: M = 38.0, SD = 7.3; t(84) =.49, p = .63).

Accent Disambiguation Task

The Accent Disambiguation Task was almost identical to study one; an adaption of the task used by Landi et al. (2018), revised to accommodate British speakers. In this task, participants listened to a series of sentences containing an ambiguous target word (i.e. a word that could either be a compound noun or an adjective and a noun, depending on prosodic interpretation) and were presented with two images depicting the two possible interpretations. For each trial, participants were asked to click on the appropriate picture. Two adaptations were made to the administration for Study Two: (1) participants heard both conditions for all items (a total of 28 items rather than 14 items), and (2) participants were instructed to answer quickly as well as accurately. Prior to starting the task, two practice items and correct/ incorrect feedback were provided. The additional items led to an improvement in inter-item reliability (Cronbach's alpha = 0.78). All items can be found in **Appendix I.**

Subject-Object Task

The Subject-Object Task was also almost identical to study one; an adaption of the task used by Landi et al. (2018). In this task, participants listened to a series that prosodically emphasized either the subject of the sentence (e.g. the RABBIT was eating carrots) or the object of the sentence (e.g. the rabbit was eating CARROTS*)*. After each sentence, the participants were presented with two pictures depicting these conditions and were asked to click on the appropriate picture. Analogous to the previous task, two adaptations were made to the administration for Study Two: (1) participants heard both conditions for all items (a total of 28 items rather than 14 items), and (2) participants were instructed to answer quickly as well as accurately. Prior to starting the task, two practice items and correct/ incorrect feedback were provided. The additional items again led to an improvement in inter-item reliability (Cronbach's alpha = 0.87). All items can be found in **Appendix I.**

7.5.3.2. Text-Based Prosody Tasks

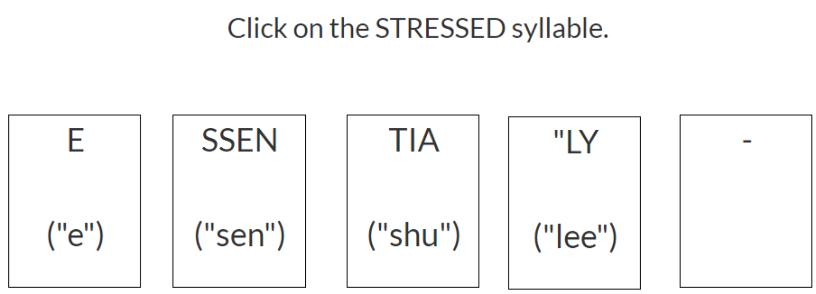
The prosodic competence text-based tasks (syllable stress and word stress) tasks were presented in two conditions: explicit and implicit. Only the explicit tasks required participants to listen to items (recorded by a female native British English speaker with an RP accent). An independent samples t-test was run to check for differences between participant dialects for these tasks. There were no significant differences between performance of British dialect speakers and non-British dialect speakers for the explicit word-level task (British: M = 14.6, SD = 4.1, Non-British: M = 15.5, SD = 4.3; t(84) = .98, p = .59) or the explicit sentence-level task (British: M = 14.0, SD = 3.9, Non-British: M = 13.5, SD = 4.8; t(84) = .49, p = .59). In the implicit task, participants did not hear a recording of a speaker and instead were required to answer based on their own understanding of how the word should be read.

Explicit Syllable Stress Task

In the explicit version of the text-based syllable stress task, participants were given the following instructions "*In this task you will hear a multisyllabic word. Your task is to click on which syllable you think was STRESSED (i.e. emphasized, loudest, most prominent).*" This task was modelled on the Stress Identification task (Chan & Wade-Woolley, 2018; Wade-Woolley et al., 2012), but adapted to be used in an online setting. Participants were instructed to answer as accurately and as quickly as possible. Prior to starting the task, two practice items and correct/ incorrect feedback were provided.

The task consisted of 20 trials: five 2-syllable words, eight 3-syllable words, five 4-syllable words, and two 5-syllable words. All words were taken from The English Lexicon Project database (Balota et al., 2007) and were of similar frequency according to the Hyperspace Analogue to Language (HAL) corpus (Lund & Burgess, 1996). Inter-item reliability was high for this task (Cronbach's alpha = 0.84). For a list of all words and relevant lexical properties, see **Appendix I.** See Figure 20 for example item.

AUDIO: “**essentially**”



Correct response is: [SSEN (“sen”)]

Figure 20. Item Example of Study Two Explicit Syllable Stress Text Task

Implicit Syllable Stress Task

In the implicit version of the text-based syllable stress task, participants were given the following instructions “*In this task you will be presented with a multisyllabic word. Your task is to click which syllable you think should be STRESSED (i.e. emphasized, loudest, most prominent) if it were spoken aloud. This time you will not hear the word, so it is up to you to decide which syllable you think should be stressed*.” Participants were instructed to answer as accurately and as quickly as possible. Prior to starting the task, two practice items and correct/ incorrect feedback were provided.

The task consisted of 20 trials: five 2-syllable words, eight 3-syllable words, five 4-syllable words, and two 5-syllable words. All words were taken from The English Lexicon Project database (Balota et al., 2007) and were of similar frequency according to the Hyperspace Analogue to Language (HAL) corpus (Lund & Burgess, 1996). Inter-item reliability was high for this task (Cronbach’s alpha = 0.89). For a list of all words and relevant lexical properties, see **Appendix I.** See Figure 21 for example item.

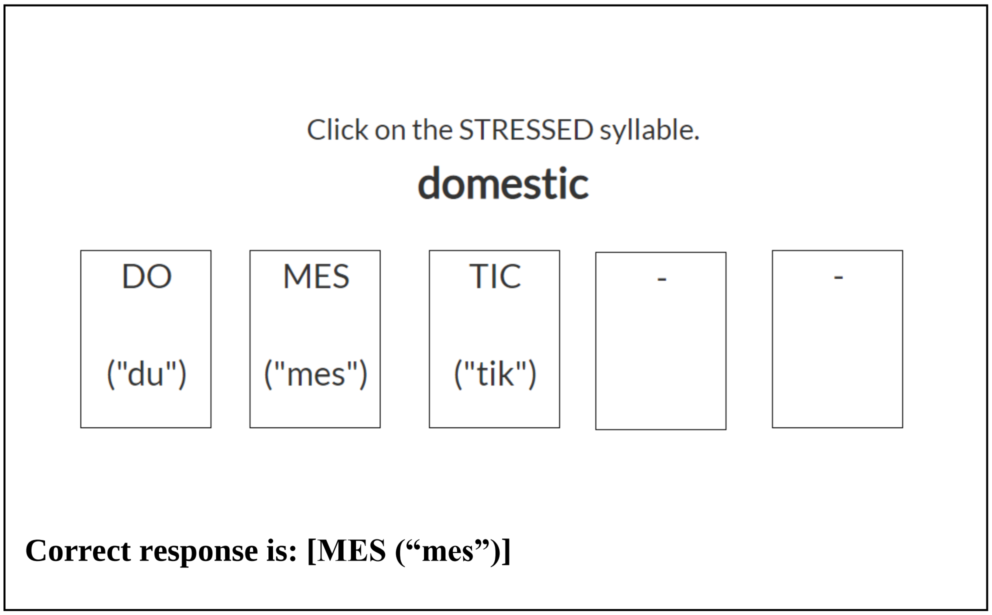


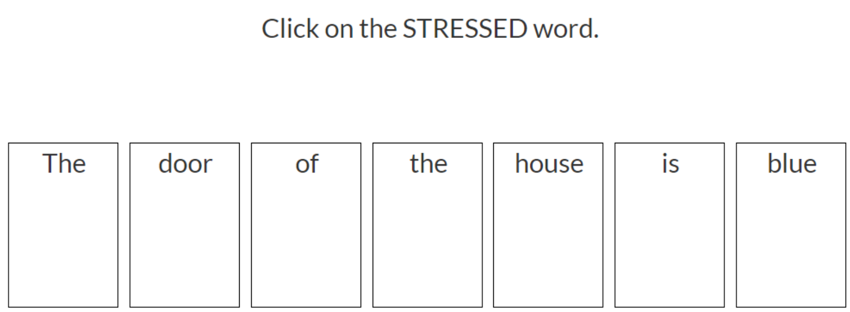
Figure 21. Item Example of Study Two Implicit Syllable Stress Text Task

Explicit Word Stress Task

In the explicit version of the text-based word stress task, participants were presented with a question and answer—and given the following instructions “*In this task you will hear a question and answer. Your task is to click on which word you think was STRESSED (i.e. emphasized, loudest, most prominent).”* Participants were instructed to answer as accurately and as quickly as possible. Prior to starting the task, two practice items and correct/ incorrect feedback were provided.

This task was a novel assessment that consisted of 16 trials. Each trial consisted of a question and answer, with one (semantically appropriate) stressed target word in the answer: 6 emphasized the noun, 5 emphasized the adjective, 3 emphasized the verb, and 2 emphasized the preposition. Inter-item reliability was high for this task (Cronbach’s alpha = 0.96). For a list of all sentences, see **Appendix I.** See Figure 22 for example item.

AUDIO: “**Is the door of the house yellow? No, the door of the house is BLUE.**”



Correct response is: [“blue”]

Figure 22. Item Example of Study Two Explicit Word Stress Text Task

Implicit Word Stress Task

In the implicit version of the text-based word stress task participants were given the following instructions “*In this task you will be presented with a question and answer*. *Your task is to select which word of the response you think SHOULD be stressed if it were read aloud (i.e. emphasized, loudest, most prominent). This time you will not hear the sentence, so it is up to you to decide which word you think should be stressed.”* Participants were instructed to answer as accurately and as quickly as possible. Prior to starting the task, two practice items and correct/ incorrect feedback were provided.

The task consisted of 16 trials: 6 emphasized the noun, 5 emphasized the adjective, 3 emphasized the verb, and 2 emphasized the preposition. Inter-item reliability was high for this task (Cronbach’s alpha = 0.89). For a list of all sentences see **Appendix I.** See Figure 23 for example item.

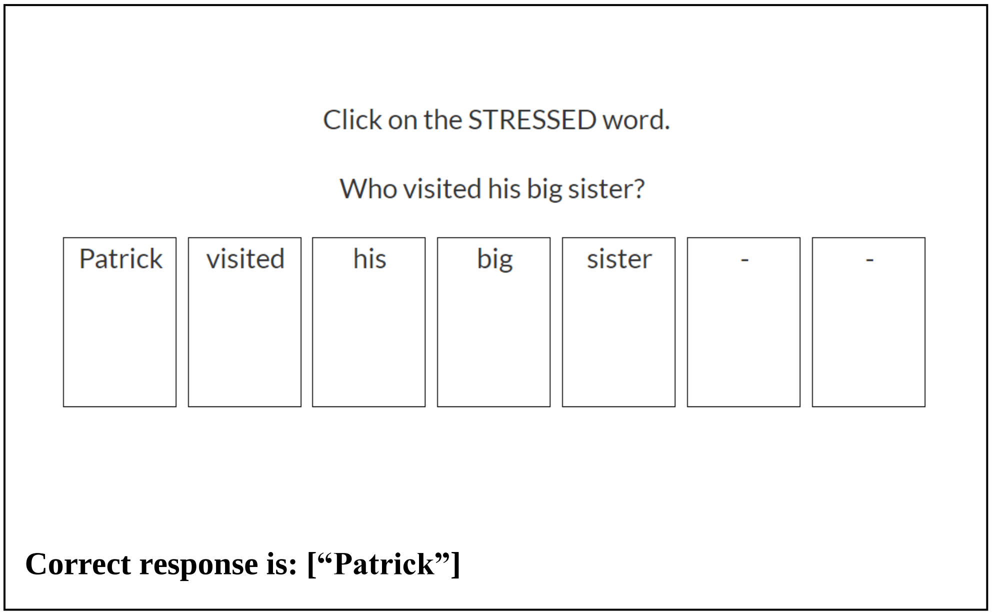


Figure 23. Item Example of Study Two Implicit Word Stress Text Task

7.5.4. Single Word Reading

The National Adult Reading Test (NART; Nelson & Willison, 1991) was used to measure participants' word reading. This test is made up of a list of 50 words with irregular spelling. The screen explained to participants that they would be recorded during the task and then provided following instructions "*Some words you may not recognize; in fact, most people will not know them. If you get to a word you do not know then you can take a guess or pass."* Each word was later scored as correct or incorrect based on the NART pronunciation key. Inter-item reliability was high for this task (Cronbach's alpha = 0.90). A list of all words and the correct pronunciations are in **Appendix J.**

7.5.5. Reading Comprehension

To measure reading comprehension, participants were presented with two texts from the Discourse Comprehension Test (DCT; Brookshire & Nicholas, 1993; **Appendix K**), followed by corresponding comprehension questions. This measure was selected because (a) it provides a reliable measure of comprehension, including texts designed to control for length, complexity, and difficulty (Brookshire & Nicholas, 1993) and (b) the publishers allowed for the task to be replicated and administered in an online format. Participants were given the following instructions before being presented with two separate texts: "*In this task, you will see a passage on the screen. Read the passage. After you have finished you will be asked some questions about the passage. There will be two passages in total. It does NOT matter how quickly you read. Do your best to understand the passage."* After reading each text the participant was presented with 12 questions: 8 multiple choice questions and 4 open answer follow up questions. Scoring criteria for open answer questions, in addition to the texts and question items, are presented in **Appendix K.** Inter-item reliability was high for this task (Cronbach's alpha = .73).

7.5.6. Passage Reading Fluency

Reading fluency was quantified using the same criteria as study one: passage reading efficiency was scored according to the Qualitative Reading Inventory (QRI) Error Score Criteria (Leslie & Caldwell, 2001; Table 3), and prosodic passage reading was quantified according to the Adult Multidimensional Fluency Scale (AMDFS; Table 4). However, to control for the potential effect of reading instructions on these fluency measures, passage reading efficiency and prosodic passage reading were marked independently from the reading comprehension text and from one another.

7.5.6.1. Passage Reading Efficiency

Passage reading efficiency was quantified using the same criteria as Study One (see Table 1; errors were given for additions, omissions, self-corrections, repetitions, and mispronunciations) However, the passage used to assess reading efficiency (DCT; **Appendix K)** had specific instructions: "*Read this passage out loud as ACCURATELY as possible, and as QUICKLY as is natural.* Total number of errors ranged between 0-11 (M = 2.7, SD = 2.8).

7.5.6.2. Prosodic Passage Reading

Prosodic passage reading was quantified using the same criteria as Study One (see Table 2; Adult Multi-Dimensional Fluency Scale). However, the passage used to assess reading efficiency (DCT; **Appendix K)** had specific instructions: "*Read this passage out loud as EXPRESSIVELY as possible; imagine reading to a group of people. It does not matter how quickly you read."* All recordings were rated according to the AMDFS by two independent raters. Total prosodic score (4-16) matched between raters for 70% of participants. Total prosodic score matched within +/-

1pt for 98% of participants. Final prosodic passage reading score for participants who did not receive a matching score was later agreed upon between raters. The given total prosodic scores ranged between 5-16 (*M* =13.3, *SD* = 2.9)

7.6. Results

This section presents the results of Study Two. Sections 9.6.1 and 9.6.2 provide a descriptive summary of participants' performance on the administered measures, and correlations between these measures. Sections 9.6.3 – 9.6.6 address Research Questions 1 through 4.

7.6.1. Data Preparation

As in Study One, the assumptions for running a multiple linear regression were checked before addressing the research questions. These are presented below. Accordingly, the same note of caution in relation to using regressions to analyse non-continuous data—including discrete data in the case of the reading comprehension measure and ordered categorical data, in the case of the prosodic passage reading measure—applies to this analysis.

Regressions predicting reading comprehension

Data from 86 participants (52 females, 31 males, and 3 who identified as non-binary or another gender, mean age = 35.2, *SD* = 12.29) were included in the final analysis (see section 9.4 for details about removed participants). Firstly, an analysis of standard residuals of reading comprehension scores demonstrated that all z-scores were within +/- 3.29, indicating no outliers (Field 2018) *(Std. Residual Min* = -3.10, *Std. Residual Max* = 2.40*).* Secondly, the assumption of collinearity was checked. VIF and Tolerance scores were all within a reasonable limits (VIF < 10; Tolerance > .10; Tabachnick & Fidell, 2001), indicating that multi-collinearity was not a concern (Vocabulary, *Tolerance* = .46, *VIF*= 2.19; Segmental PA, *Tolerance* = .35, *VIF*= 2.83, Prosodic Competence, *Tolerance* = .30, *VIF*= 3.30, Word Reading, *Tolerance* = .43, *VIF*= 2.33, Passage Reading Efficiency, *Tolerance* = .87, *VIF*= 1.16). The data also met the assumption of independent errors (*Durbin-Watson value* = 1.50) and non-zero variance (Vocabulary, *Variance* = 5.60, Segmental PA, *Variance* = 122.7, Prosodic Competence, *Variance* = 535.80, Word Reading, *Variance* = 54.24, Passage Reading Efficiency, *Variance* = 440.42, Prosodic Passage Reading, *Tolerance Variance* = 7.98). Histograms and scatter plots were used to check assumptions of homoscedasticity, linearity, and random normally distributed errors. A histogram of standardized residuals demonstrated that errors were approximately normally distributed. A P-P plot of standardized residuals demonstrated that the data met assumptions of homogeneity of variance and linearity (points close to the line).

Regression predicting total prosodic passage reading

An analysis of standard residuals of prosodic passage reading scores demonstrated that all z-scores were within +/- 3.29, indicating no outliers (Field 2018) *(Std. Residual Min* = -2.51, *Std. Residual Max* = 2.06*).* A Durbin-Watson test indicated that the data met the assumption of independent errors (*Durbin-Watson value* = 2.20). Histograms and scatter plots were used to check assumptions of homoscedasticity, linearity, and random normally distributed errors. A histogram of standardized residuals demonstrated that errors were approximately normally distributed. A P-P plot of standardised residuals demonstrated that the data met assumptions of homogeneity of variance and linearity (points close to the line).

7.6.2. Descriptive Statistics

Descriptive statistics were used to explore participants' performance on each of the administered measures (Table 15). In line with Study One, a composite measure of prosodic competence was created by totalling participants' score on all six measures. Notably, the scores of these subtasks were adjusted so that performance on each measure evenly contributed to the total composite score (e.g. the compound noun task had 24 items and was not adjusted, but the text-based syllable tasks had 20 items and therefore total score was multiplied by 1.2 so that final score was out of 24). Zero-order correlations were also run to examine the relationships between these individual measures. The results demonstrated that performance on all prosodic competence tasks were significantly correlated at $p<.001$, with moderate to strong relationships between r =.40 and r =.70 (see **Appendix L**). In line with research demonstrating that segmental phonological awareness largely represents a unidimensional construct (Stanovich et al., 1984), a composite measure of segmental PA was also created, using the same method. Zero-order correlations between these measures are in **Appendix L.**

Table 15. *Study Two: Means and Standard Deviations for all Measures (n = 86)*

	Min	Max	Mean	Std Dev
Vocabulary (max = 20)	10	20	14.3	2.7
Segmental PA* (max = 72)	16	70	49.2	11.1
Sound Identification (max = 24)	4	23	12.6	4.7
Syllable Identification (max = 16)	2	16	13.9	3.3
Sound Deletion (max = 20)	3	19	13.3	3.9
Word Reading (max = 50)	15	46	32.2	7.2
Passage Reading Efficiency (WCPM)	122.5	233.1	185.4	21.0
Prosodic Competence* (max = 144)	56	144	115.5	22.9
Picture-Based Tasks (max = 48)	22	48	38.6	7.4
AD Picture Task (max = 24)	10	24	18.7	3.7
SO Picture Task (max = 24)	7	24	19.9	4.4
Text-Based Tasks (Syllable) (max = 48)	14	48	33.7	10.6
Explicit Syllable Task (max = 20)	5	20	14.8	4.1
Implicit Syllable Task (max = 20)	5	20	13.3	5.1
Text-Based Tasks (Word) (max = 48)	11	48	43.2	9.1
Explicit Word Task (max = 16)	0	16	13.8	4.3
Implicit Word Task (max = 16)	3	16	15.0	2.3
Prosodic Passage Reading (max =16)	5	16	13.3	2.9
Phrasing (max =4)	1	4	3.4	0.9
Expression (max= 4)	1	4	3.3	0.8
Smoothness (max= 4)	1	4	3.2	0.9
Pacing (max = 4)	1	4	3.4	0.8
Reading Comprehension (max = 24)	11	24	19.5	3.1
Factual (Multiple Choice) (max = 8)	4	8	7.1	0.8
Inference (Multiple Choice) (max = 8)	4	8	6.6	1.3
Inference (Open Answer) (max = 8)	0	8	5.7	1.8

Note. *subscales adjusted to contribute evenly to total, WCPM = words read per minute, PA = phonological awareness

Zero-order correlations were run in order to better understand the relationships between participants' performance on each of the measures (Table 16). Notably, segmental PA, vocabulary, single word reading, prosodic competence, prosodic passage reading, and reading comprehension were all significantly inter-correlated. Once again, passage reading efficiency was not significantly associated with reading comprehension.

Table 16. *Study Two: Correlations (n = 86)*

	Vocab	**PA**	**WR**	**RE** (WCPM)	**Prosodic Comp**	**Prosodic Reading**	**Reading Comp**
Vocabulary	-	.51**	.70**	.22*	.55**	.50**	.27*
Segmental PA	-	-	.50**	.24**	.80**	.52**	.29**
Word Reading	-	-	-	.32**	.59**	.59**	.32**
Passage Reading Efficiency	-	-	-	-	.32**	$.21^{+}$	.17
Prosodic Competence	-	-	-	-	-	.67**	.27*
Prosodic Passage Reading	-	-	-	-	-	-	.22*

Note. ** p < .01, * p < .05, $^{+}$ p < .01, PA = phonological awareness, WR = single word reading, RE = passage reading efficiency, WCPM = average correct words read per minute

7.6.3. Contribution of Prosodic Competence to Prosodic Passage Reading

This section will address Research Question 1 *(To what extent do individual differences in prosodic competence account for unique variance in prosodic passage reading ability in a second sample of adult readers?)*. In order to answer this question, a series of regressions were performed. As demonstrated in Table 16, prosodic competence was significantly moderately correlated with total prosodic passage reading ability (r = .67). A linear regression demonstrated that prosodic competence accounted for 45% of variation total prosodic reading $F(1,84) = 67.89$, p <.001 (Table 17).

Table 17. *Study Two: LR Accounting for Variance in Prosodic Passage Reading from Prosodic Competence (n = 86)*

Prosodic Passage Reading	R	R^2	β	*t*	B
	.67	.45			
Prosodic Competence			.67	8.24**	.08

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

A hierarchical multiple linear regression was performed to explore whether this contribution was still significant after accounting for individual differences in vocabulary, segmental PA, and single word reading. At step one, these measures accounted for 42% of variance in prosodic passage reading $F(3,82) = 19.54$, $p < .001$. At step two, prosodic competence accounted for an additional 8% of unique variance, and this change in R^2 was significant $F(4,81) = 20.59$, $p < .001$ (Table 18).

Table 18. *Study Two: HMLR Accounting for Variance in Prosodic Passage Reading from Vocabulary, Segmental PA, Word Reading, and Prosodic Competence (n = 86)*

Prosodic Passage Reading	R	R^2	ΔR^2	β	*t*	B
Step 1	.65	.42	.42			
Vocabulary				.09	0.7	.10
Segmental PA				.29	2.9**	.07
Word Reading				.38	3.1**	.15
Step 2	.71	.50	.08			
Vocabulary				.05	0.47	.06
Segmental PA				-.06	-0.5	-.02
Word Reading				.26	2.3*	.10
Prosodic Competence				.53	3.8**	.07

Note. ** p < .01, * p < .05, PA = phonological awareness

A final hierarchical multiple linear regression was performed to explore whether this contribution was still significant after also accounting for individual differences in passage reading efficiency. At step two, the model was still significant—however, passage reading efficiency did not account for any additional variance in prosodic passage reading $F(4,81) = 14.48$, $p < .001$. At step three, prosodic competence once again accounted for an additional 9% of unique variance and this change in R^2 was significant $F(5,80) = 16.38$, $p < .001$. (Table 19).

Table 19. *Study Two: HMLR Accounting for Variance in Prosodic Passage Reading from Vocabulary, Segmental PA, Word Reading, Passage Reading Efficiency, and Prosodic Competence (n = 86)*

Prosodic Passage Reading	R	R^2	ΔR^2	β	*t*	B
Step 1	.65	.42	.42			
Vocabulary				.09	0.72	.10
Segmental PA				.29	2.9**	.07
Word Reading				.38	3.1**	.15
Step 2	.65	.42	.00			
Vocabulary				.09	0.7	.10
Segmental PA				.29	2.8**	.07
Word Reading				.38	3.1**	.15
Passage Reading Efficiency				.00	-0.0	-.00
Step 3	.72	.51	.09			
Vocabulary				.05	0.4	.06
Segmental PA				-.06	-.47	-.02
Word Reading				.27	2.3*	.11
Passage Reading Efficiency				-.04	-0.5	-.01
Prosodic Competence				.54	3.8**	.07

Note. ** p < .01, * p < .05, PA = phonological awareness

7.6.4. Contribution of Prosodic Passage Reading to Reading Comprehension

This section will address Research Question 2 *(To what extent do individual differences in prosodic passage reading ability account for unique variance in reading comprehension in a second sample of adult readers?)*. In order to answer this question, a series of regressions were performed. As demonstrated in Table 16, prosodic passage reading was significantly correlated with total reading comprehension ($r = .22$). A linear regression demonstrated that prosodic passage reading accounted for 5% of variation total reading comprehension *F*(1,84) = 4.12, *p* = .045 (Table 20).

Table 20. *Study Two: LR Accounting for Variance in Prosodic Passage Reading from Prosodic Competence (n = 86)*

Reading Comprehension	R	R^2	β	*t*	B
	.22	.05			
Prosodic Passage Reading			.22	2.03*	.23

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

A hierarchical multiple linear regression was performed to explore whether this contribution was still significant after accounting for individual differences in vocabulary, segmental PA, and single-word reading. Results demonstrated that, at step one, these measures accounted for 13% of variance in prosodic passage reading *F*(3,82) = 4.02, *p*= .01. At step two, although the model was still significant, *F*(4,81) = 2.99, *p* = .02, prosodic passage reading did not account for any additional variance (Table 21).

Table 21. *Study Two: HMLR Accounting for Variance in Prosodic Passage Reading from Vocabulary, Segmental PA, Word Reading, and Prosodic Competence (n = 86)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.36	.13	.13			
Vocabulary				.03	0.2	.04
Segmental PA				.17	1.4	.05
Word Reading				.22	1.5	.09
Step 2	.36	.13	.00			
Vocabulary				.04	0.2	.04
Segmental PA				.18	1.4	.05
Word Reading				.23	1.4	.09
Prosodic Passage Reading				-.03	-0.8	-.03

Note. ** p < .01, * p < .05, PA = phonological awareness

A final hierarchical multiple linear regression was performed to explore the relative contribution of passage reading efficiency to reading comprehension. Although the model was still significant, $F(5,80) = 2.41$, $p = .043$, at steps two and three neither passage reading efficiency nor prosodic passage reading accounted for additional variance in reading (Table 22).

Table 22. *Study Two: HMLR Accounting for Variance in Prosodic Passage Reading from Vocabulary, Segmental PA, Word Reading, Passage Reading Efficiency, and Prosodic Competence (n = 86)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.36	.13	.13			
Vocabulary				.03	0.2	.04
Segmental PA				.17	1.4	.05
Word Reading				.22	1.5	.09
Step 2	.36	.13	.00			
Vocabulary				.03	0.2	.04
Segmental PA				.17	1.3	.04
Word Reading				.20	1.3	.08
Passage Reading Efficiency				.06	0.5	.00
Step 3	.36	.13	.00			
Vocabulary				.04	0.2	.05
Segmental PA				.17	1.3	.05
Word Reading				.21	1.3	.09
Passage Reading Efficiency				.06	0.5	.01
Prosodic Passage Reading				-.03	-0.3	-.03

Note. ** $p < .01$, * $p < .05$, PA = phonological awareness

7.6.5. Contribution of Prosodic Competence to Reading Comprehension

This section will address Research Question 3 (*To what extent do individual differences in prosodic competence account for unique variance in reading comprehension in a second sample of adult readers?).* In order to answer this question, a series of regressions were performed. As demonstrated in Table 16, prosodic competence was only weakly correlated with reading comprehension ($r = .27$). A linear regression demonstrated that prosodic competence accounted for 7% of variation in reading comprehension scores $F(1,84) = 6.4$, $p < .05$ (Table 23).

Table 23. *Study Two: LR Accounting for Variance in Reading Comprehension from Prosodic Competence (n = 86)*

Reading Comprehension	R	R^2	β	*t*	B
	.27	.07			
Prosodic Competence			.27	2.5*	.03

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

A hierarchical multiple linear regression was performed to explore whether this contribution was still significant after accounting for individual differences in vocabulary, segmental PA, and single-word reading. At step one, vocabulary, segmental PA, and word reading contributed significantly to the regression model ($F(3,82) = 4.1$, $p = .01$) and accounted for 13% of the variation in reading comprehension. At step two the model was still significant, $F(4,81) = 3.0$, $p = .02$, however, prosodic competence did not account for any additional variance in reading comprehension (Table 24). This was consistent with the result of Study One, in which prosodic competence also did not predicted unique variance in reading comprehension after accounting for vocabulary.

Table 24. *Study Two: HMLR Accounting for Variance in Reading Comprehension from Vocabulary, Segmental PA, and Prosodic Competence (n = 86)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.36	.13	.13			
Vocabulary				.03	0.2	.04
Segmental PA				.17	1.4	.05
Word Reading				.22	1.5	.09
Step 2	.36	.13	.00			
Vocabulary				.03	0.2	.04
Segmental PA				.20	1.2	.06
Word Reading				.23	1.5	.09
Prosodic Competence				-.05	-0.3	-.01

Note. ** p < .01, * p < .05, PA = phonological awareness

7.6.6. Role of Prosodic Passage Reading

This section will address Research Question 4 *(If prosodic competence accounts for unique variance in reading comprehension (after controlling for word-level reading skills), is this variance explained by prosodic passage reading?).* The results of this study demonstrated that prosodic competence did not account for any variance in reading comprehension after controlling for vocabulary, segmental PA and single word reading. Therefore, no further analyses were conducted.

7.7. Discussion

The aim of Study Two was to answer the four following research questions: *(1) To what extent do individual differences in prosodic competence account for unique variance in prosodic passage reading ability in a second sample of experienced adult readers? (2) To what extent do individual differences in prosodic passage reading ability account for unique variance in reading comprehension in a second sample of experienced adult readers? (3) To what extent do individual differences in prosodic competence account for unique variance in reading comprehension ability in a second sample of experienced adult readers? (4) If prosodic competence accounts for unique variance in reading comprehension (after controlling for word-level reading skills), is this variance explained by prosodic passage reading?*

Markedly, unlike Study One, this study controlled for differences in segmental PA and single word reading, in addition to vocabulary and passage reading efficiency. Moreover, a number of additional limitations were accounted for: the number of items for all measures were increased to improve inter-item reliability, participants were directly asked to report any histories of reading difficulties, and the passage reading measures were assessed individually so that participants were instructed to read for comprehension, read for expression, and read for efficiency in three separate tasks.

The other notable difference between Study One and Study Two was that that the current study was administered in an entirely asynchronous online setting. This change in methodology was due to the restrictions put in place by the government in response to the Covid-19 pandemic.

However, the adaptation of Study Two also offers insight into the feasibility of administering reading related studies, and specifically studies assessing prosodic competence, in this format.

Hypotheses for this study were adjusted to be consistent with the previous study; it was predicted that the results of Study Two would replicate the pattern of findings in Study One. Accordingly, it was predicted that (a) individual differences in prosodic competence would be associated with prosodic passage reading, even after controlling for differences in vocabulary, segmental PA, single word reading, and reading efficiency and (b) individual differences in prosodic competence and prosodic passage reading would be associated with reading comprehension, but that this relationship would be completely accounted for by differences in other reading related skills such as vocabulary, segmental PA and single word reading.

Results of Study Two were entirely consistent with these adjusted hypotheses. The findings illustrated that prosodic competence was associated with prosodic passage reading after not only accounting for vocabulary and passage reading efficiency, but also segmental PA and single word reading. In this section, I reflect on the results of Study Two in relation to previous research, I compare these results with the results of Study One, and finally I discuss some potential limitations.

7.7.1. Concurrent Relationships between Prosodic Competence and Prosodic Passage Reading

The results of this study demonstrated that participants' overall performance on the prosodic competence tasks was positively correlated (r = .64) with their prosodic passage reading score—a noticeably stronger correlation than in Study One (r = .42). Correspondingly, the contribution of prosodic competence to prosodic passage reading in this study was even more robust; whereas in Study One prosodic competence accounted for 18% of variation in prosodic passage reading, in the present study, prosodic competence accounted for 41% of variation. In a model accounting for all word-level reading skills (including vocabulary, segmental PA, and single-word reading), in addition to prosodic competence, 42% of variance in prosodic passage reading was accounted for and 8% of this variance was uniquely predicted by prosodic competence. Accordingly, this study provides further evidence that the relationship between prosodic competence and prosodic passage reading goes beyond word-level reading skills (Figure 24).

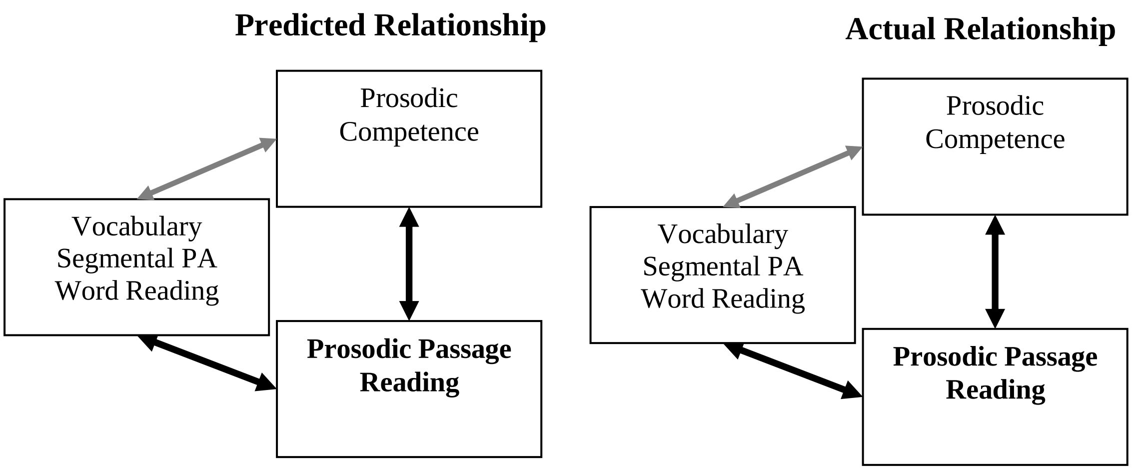


Figure 24. Study Two: Predicted and Actual Relationships between Prosodic Competence and Prosodic Passage Reading

Note. Solid arrows represent unique variance (direct relationship); Dashed arrows represent variance shared with word level skills (indirect relationships); Grey lines represent previously established relationships

There are a couple of plausible reasons as to why prosodic competence and prosodic passage reading were more strongly associated in the current study. Firstly, in the current study, the utilized prosodic competence tasks may have simply been more sensitive to individual differences in prosodic competence. Alternatively, these tasks may have involved some of the same processes as prosodic passage reading. To explicate, whereas both prosodic competence tasks Study One were picture-based, in Study Two, the prosodic competence tasks were picture-based and text-based. Therefore, although none of these tasks involved oral reading, it is possible that other reading-related skills (e.g. segmental PA and word reading) facilitated performance on the syllable stress or word stress tasks. Nevertheless, the analyses also showed that prosodic competence still accounted for unique variance in prosodic passage reading after controlling for these other skills in Study Two (8% unique variance) relative to Study One (6% unique variance)—even though Study Two controlled for more skills.

Another possibility is that the methodology used to assess prosodic passage reading may have served as a better measure of individual's true ability to imbue a text with prosody. Whereas participants in Study One were simultaneously assessed on prosodic passage reading, passage reading efficiency and passage reading comprehension, participants in Study Two were given specific instruction to focus on expressive reading in the prosodic passage reading task (i.e. "*Read this passage out loud as EXPRESSIVELY as possible; imagine reading to a group of people. It does not matter how quickly you read.").* This robust relationship, therefore, suggests that an individual's ability to demonstrate prosodic passage reading is actually more closely associated with prosodic competence when given the appropriate instructions. Consequently, future researchers interested in prosodic passage reading ability should consider explicitly instructing participants to read with expression.

Unexpectedly, this study also demonstrated that, in the final model, passage-reading efficiency did *not* contribute any unique variance to prosodic passage reading. One explanation for this finding is that the contribution of passage reading efficiency to prosodic passage reading was completely accounted for by the other word-level reading skills assessed (e.g., single-word reading). However, zero order correlations (Table 16) demonstrated that passage reading efficiency was not even significantly correlated with prosodic passage reading. Rather, the lack of relationship between prosodic passage reading and passage reading efficiency was surprising given that (a) both are measures of fluent reading and (b) both measures were significantly correlated with the other reading related measures (e.g. vocabulary, segmental PA, and word reading). Furthermore, prosodic passage reading and passage reading efficiency were significantly positively associated—albeit weakly (r = .36)—in Study One. However, these findings are in line with the partial independence hypothesis of reading fluency (Cowie et al., 2002), which suggests that these skillsets are only partially related. Therefore, I suggest that future research exploring the relationship between passage reading efficiency and prosodic passage reading also consider the role of reading development; the current results indicate that these two measures of fluency may be even more independent in experienced readers. The implication of these results will be further discussed in Chapter Nine.

7.7.2. Concurrent Relationships between Prosodic Passage Reading and Reading Comprehension

Results of this study demonstrated an even weaker relationship (r = .20) between prosodic passage reading and reading comprehension (Figure 25). Furthermore, the contribution of prosodic passage reading to reading comprehension was completely accounted for by differences in word-level reading skills. This was consistent with the adapted hypotheses.

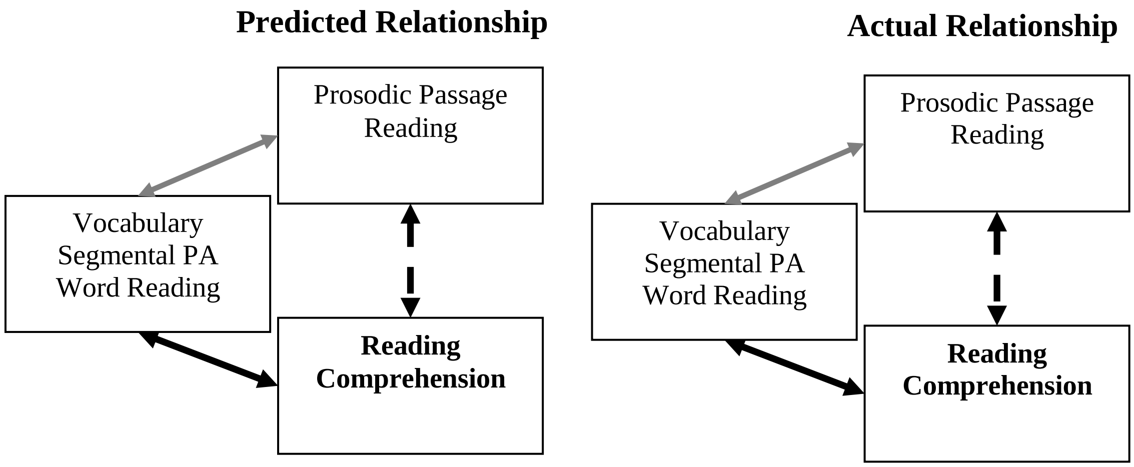


Figure 25. Study Two: Predicted and Actual Relationships between Prosodic Passage Reading and Reading Comprehension

Note. Solid arrows represent unique variance (direct relationship); Dashed arrows represent variance shared with word level skills (indirect relationships); Grey lines represent previously established relationships

As in Study One, these results suggest that prosodic passage reading may not be as important for reading comprehension in experienced readers as originally proposed. Once again, this supports the hypothesis that the facilitating qualities of prosodic passage reading in relation to reading comprehension are no longer important after individuals reach a certain level of automaticity. To explicate, I suggest that prosodic passage reading only supports syntactic and semantic processing during early development—and therefore, the readers in Study One and Two no longer need to rely on these prosodic skills.

Given that all reading related measures predicted a markedly small proportion of variance in reading comprehension, another potential explanation of these results is that prosodic passage reading may be more strongly associated with micro-comprehension processes (e.g. sentence level comprehension), rather than passage level comprehension. Kuhn and Stahl (2003) suggest that although the role of prosody in relation to reading may be syntactic processing, it may be relatively less important for passage-level comprehension—which is instead influenced by global strategies and background knowledge. Although the comprehension questions used in this study included both literal and inferential items (in closed multiple choice and open answer format), it is possible that these were not sensitive to such micro-comprehension processes. Therefore, I also suggest that future research specifically investigate sentence-level comprehension.

7.7.3. Concurrent Relationships between Prosodic Competence and Reading Comprehension

The correlation between prosodic competence and reading comprehension in this study (r =.27) was comparable to that of Study One (r = .20). Moreover, the same pattern of results was demonstrated; although prosodic competence predicted a small proportion of variance in reading comprehension (7%), this was entirely accounted for by differences in word-level reading skills (vocabulary, segmental PA, and word reading) (Figure 26).

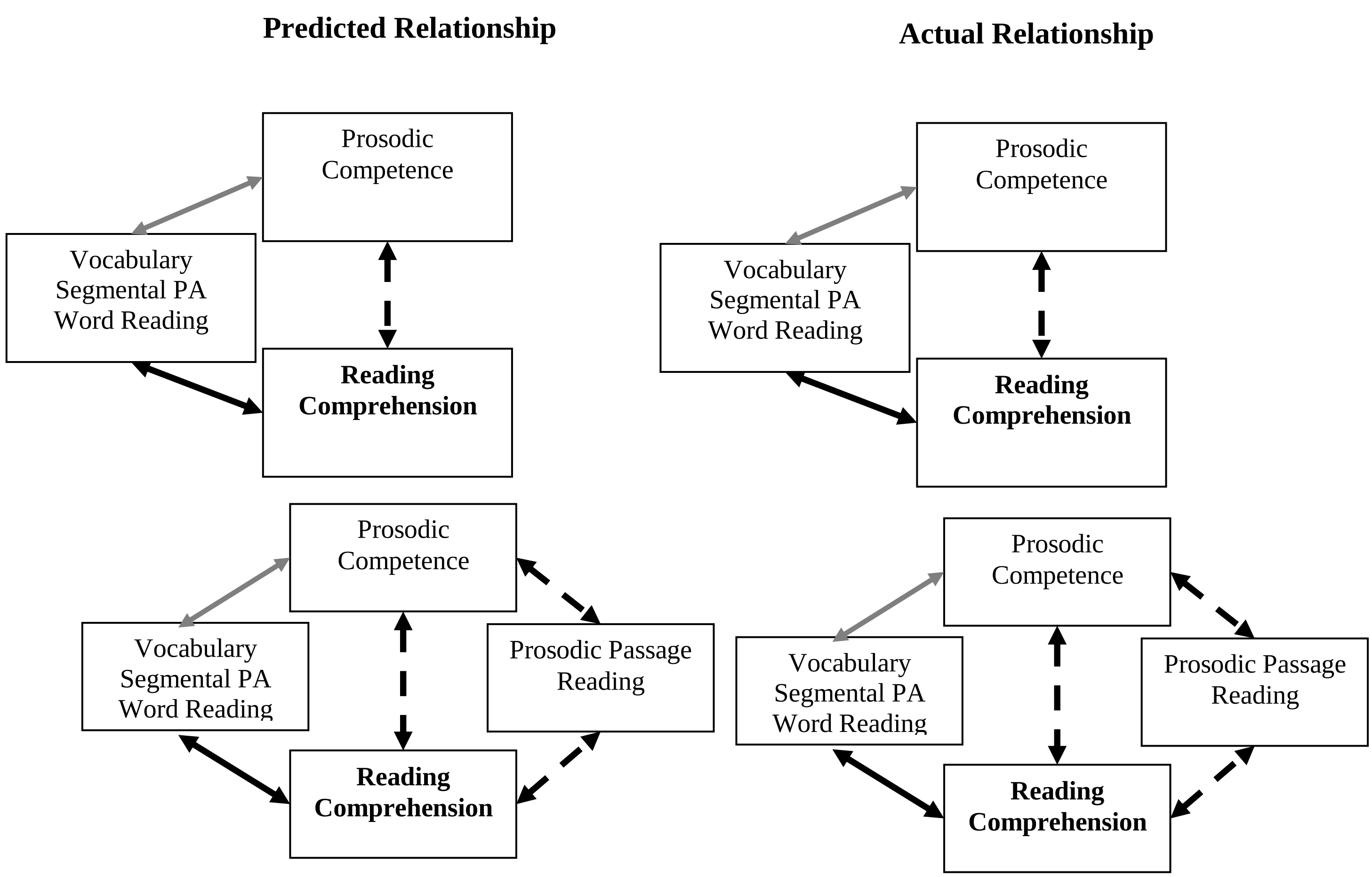


Figure 26. Study Two: Predicted and Actual Relationships between Prosodic Competence and Reading Comprehension

Note. Solid arrows represent unique variance (direct relationship); Dashed arrows represent variance shared with word level skills (indirect relationships); Grey lines represent previously established relationships

Markedly, however, in a model including all known predictors of reading comprehension (vocabulary, segmental PA, single-word reading, passage reading efficiency, and prosodic passage reading), only 13% of variation in reading comprehension was accounted for. This suggests that performance on the reading comprehension measure was not particularly reliant on the skills assessed in the current study. Most notably, the lack of independent relationship between prosodic competence and reading comprehension once again suggests that an understanding of prosody may not be as important for higher-level comprehension skills as originally predicted. Accordingly, consistent with Study One, this study does not support the hypothesis that prosodic competence contributes to reading comprehension by facilitating prosodic passage reading.

7.7.4. Other Considerations

7.7.4.1. Response Times

One minor difference in methodology between Study One and Study Two was that the prosodic competence tasks in Study Two directed participants to answer *quickly* as well as accurately. This additional direction was included in order to encourage participants to perform the task based on their initial understanding of prosodic cues—as opposed to calculating a response based on other skills (e.g., reasoning).

One of the subsequent considerations is how this instruction may have affected results. A post-hoc analysis of response times was therefore carried out (**Appendix M**), demonstrating that all measures of prosodic competence—with the exception of the explicit text-based tasks, in which participants were allowed to listen to items multiple times—were significantly negatively correlated with response time (i.e., faster response times were associated with higher accuracy). I suggest that this finding supports the validity of these tasks, as it demonstrates that, as expected, performance on these tasks was based on initial understanding of the prosodic cues rather than a calculated response. In particular, this is demonstrated by the strong correlation (r = -.60) between accuracy and response time on the implicit sentence text task. In this task, participants read a sentence to themselves and, using context, decided which word should be stressed (e.g., given the context "Who visited his big sister?" which word in the sentence should be stressed: "Patrick visited his big sister). A potential concern about this task was that participants may have been able to decipher the correct response using reasoning rather than prosodic competence; the stressed word was always the novel word (e.g., the word not repeated in the question). However, participants who used this reasoning likely would have taken longer to answer the item than participants who relied on their implicit prosody. Consequently, I suggest that a follow-up study assessing this hypothesis would be beneficial—as the novel task itself may be a helpful measure of phrase-level implicit prosodic competence for future work.

7.7.5. Limitations

As a whole, this study successfully addressed many of the limitations of Study One. To illustrate, the utilised measures demonstrated better internal reliability, the effect of reading instruction was accounted for, participants were directly asked to report any histories of reading difficulties or disorders, and, most markedly, the study controlled for other reading-related skills (segmental PA and single word reading). However, there were limitations in relation to the validity of some of the novel measures.

These limitations are generally due to the online nature of the study; tasks that involved ongoing interaction with the researcher, particularly tasks in which the researcher was required to mark oral responses, were not easily translated to an online setting and therefore replaced with novel versions. These novel measures, including the segmental PA and prosodic competence tasks, have not previously been validated against other standardised assessments. Additionally, although the reading comprehension measure was a standardised assessment (DCT; Brookshire & Nicholas, 1993), chosen because permission from the authors could be secured for its use in an open online experiment, it should be considered that the original version of this task was created for use a measure of discourse comprehension (e.g. listening comprehension) as opposed to reading comprehension. Therefore, this study would benefit from follow-up research validating these assessments against more traditional measures with in-person administration. Notably, however, all of these measures did act as anticipated (e.g. demonstrated established patterns) and showed reasonable inter-item reliability.

Additionally, in the current study, it should be recognised that the measures of reading fluency were independent from the measure of reading comprehension. Therefore, it may be more appropriate to refer to these assessments as measures of ‘prosodic passage reading ability’ and ‘ability to read a passage efficiently’, rather than the extent to which the reader actually used prosody or read efficiently during the reading comprehension task. This is one possibility as to why the relationship between prosodic passage reading and reading comprehension was weaker in the current study (accounting for 5% of variance) than in Study One (accounting for 10% of variance). Markedly, however, both the fluency and comprehension texts in the current study were taken from the same standardised test and carefully matched for difficulty level (DCT; Brookshire & Nicholas, 1993). Accordingly, it was assumed that a participants’ ability to read the prosodic passage reading text with appropriate prosody should reflect their ability to read the comprehension texts with appropriate prosody; even if the participants chose to read the comprehension texts silently, their ability to imbue these text with appropriate prosody should still have been reflected in their overall comprehension score. Support for this assumption comes from research demonstrating significant relationships between oral prosodic reading and implicit prosodic reading (Bishop, 2020). However, future research investigating the relationship between implicit prosodic passage reading and oral prosodic passage reading in adults would further support this interpretation.

Another possible explanation as to why prosodic passage reading and reading comprehension exhibited a weaker relationship in the current study is that the passages differed from Study One in both level and text genre. To demonstrate, the passage from the Adult Reading Test (ART; Brooks et al., 2004) of Study One had a Flesch Reading Ease of 44.8 and was largely expository (i.e., focused on clear description of facts and events). The passage from the Discourse Comprehension Test (DCT; Brookshire & Nicholas, 1993) in Study Two, on the other hand, had a Flesch Reading Ease of 80.2 and was largely narrative (i.e., providing character details and following a narrative arc with a climax). These Flesch Reading Ease scores indicate that the passage in Study One was relatively “difficult” and the passage in Study Two was relatively “easy” (Flesch, 1948). According to Koriat et al (2002), a facilitating role of prosodic passage reading is that prosody is a tool for extracting syntactic structure from a text. Given the lower reading level of the texts used in this study, this role of prosodic passage reading may have simply been less important. This is also consistent with the findings of Benjamin and Schwanenflugel (2010), who reported that children’s prosodic passage reading was more robustly related to reading comprehension when reading a difficult text. Moreover, in a recent study Álvarez Cañizo et al. (2020), researchers explored the relationship between prosodic passage reading and reading comprehension in two types of texts: expository and narrative. In a sample of forty-three Spanish Speaking adolescents (one sample of 12- to 13-year-olds and one sample of 13- to 14-year-olds), the researchers found that prosodic passage reading was more important for comprehension when reading the expository texts than when reading the narrative texts—suggesting that readers rely more on prosody when reading (generally more difficult) expository passages. This is consistent with the findings of Study One and Two, which showed a closer relationship between prosodic passage reading in Study One than Study Two. Accordingly, I also suggest that future research with experienced readers consider exploring the importance of text genre in relation to these research questions. Nonetheless, these differences were only in effect size; the pattern of relationships in Study Two replicated that of Study One. Therefore, taken together, the results of both studies provide sufficient evidence for the demonstrated relationships.

7.8. Conclusion

This study entirely supported the adapted hypotheses. Consistent with Study One, results confirmed that (a) in skilled adult readers prosodic competence accounts for unique variance in prosodic passage reading after controlling for word-level reading skills and passage reading efficiency and (b) neither prosodic competence nor prosodic passage reading accounts for unique variance in reading comprehension after controlling for word-level reading skills. Moreover, the results of this study established that these patterns were still evident even after accounting for differences in segmental PA and single word reading. These findings have implications as to how we conceptualise prosody in theoretical frameworks of passage reading and how we approach future research. This will be discussed in Chapter Nine. However, in order to apply these findings to educational settings, we need to first understand the role of prosody in relation to children's early passage reading. This is addressed in Study Three, described in the following chapter.

8. Study Three. Examining the Role of Prosody in Early Passage Reading

8.1. Introduction

The results of Study One and Two demonstrated that, in two separate samples of experienced adult readers, the contribution of prosodic competence to reading comprehension was entirely accounted for by word-level reading skills. However, the results of these studies also confirmed that the contribution of prosodic competence to prosodic passage reading was independent of differences in vocabulary, segmental PA, word reading, and reading efficiency. Accordingly, this suggests that, in experienced readers, (a) well-developed prosodic competence is associated with prosodic passage reading ability, independently of word-level reading skills and (b) the relationship between prosodic competence and reading comprehension is completely explained by word-level reading skills.

The purpose of Study Three was to investigate whether this same pattern of relationships would emerge in a sample of early readers, children 7- to 11-years-old. As discussed in previous chapters, there is much research demonstrating that, in samples of children, prosodic competence is implicated in foundational word-level reading skills such as vocabulary knowledge (Cristia & Seidle, 2011; Holliman, Critten, et al., 2014), segmental PA (Cardillo, 2008; Holliman, Critten et al., 2014) Goodman et al., 2010), and word reading (Critten et al., 2021; Holliman, Critten et al., 2014). There are also studies demonstrating a positive association between children's prosodic competence and reading comprehension (Chung & Bidelman 2021; Holliman, Williams et al., 2014; Lochrin et al., 2015; Veenendaal et al., 2014). One of the overarching aims of this thesis is to better understand the mechanisms by which prosodic competence might facilitate passage reading. According to the Simple View of Reading (SVR; Hoover & Gough, 1990; Gough et al., 1996), the strongest predictor of passage reading comprehension for early readers is word level decoding skills. Moreover, a small handful of previous studies have found that the contribution of prosodic competence to children's reading comprehension is largely accounted for by these reading skills (Holliman et al., 2010a; Deacon et al., 2018). Therefore, it was hypothesised that the role of prosodic competence in early readers would primarily be facilitating word-level skills. The four specific research questions are below.

Study Three Research Questions

(1) To what extent do individual differences in prosodic competence account for unique variance in prosodic passage reading ability in a sample of early readers (children ages 7- to 11-years-old) after controlling age?

   a) Is the contribution of prosodic competence to prosodic passage reading ability still significant after accounting for individual differences in vocabulary, segmental phonological awareness and single word reading?

   b) Is the contribution of prosodic competence to prosodic passage reading ability still significant after accounting for individual differences in passage reading efficiency?

(2) To what extent do individual differences in prosodic passage reading ability account for unique variance in reading comprehension in a sample of early readers (children ages 7- to 11-years-old) after controlling for age?

   c) Is the contribution of prosodic passage reading ability to reading comprehension still significant after accounting for individual differences in vocabulary, segmental phonological awareness and single word reading?

   a) Is the contribution of prosodic passage reading ability to reading comprehension still significant after accounting for individual differences in passage reading efficiency?

(3) To what extent do individual differences in prosodic competence account for unique variance in reading comprehension in a sample of early readers (children ages 7- to 11-years-old) after controlling for age?

   d) Is the contribution of prosodic competence to reading comprehension still significant after accounting for individual differences in vocabulary, segmental phonological awareness and single word reading?

   a) Is the contribution of prosodic competence to reading comprehension still significant after accounting for individual differences in passage reading efficiency?

(4) If prosodic competence accounts for unique variance in reading comprehension (after controlling for word-level reading skills), is this variance explained by prosodic passage reading?

8.2. Hypotheses

In line with the theoretical and empirical research previously described, hypotheses for Study Three are below.

- **Hypothesis 1:** In early readers, individual differences in prosodic competence will account for variance in prosodic passage reading ability, but this variance will be entirely explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading).
- **Hypothesis 2:** In early readers, individual differences prosodic passage reading ability will account for variance in reading comprehension, but this variance will be entirely explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading).
- **Hypothesis 3:** In early readers, individual differences in prosodic competence will account for variance in reading comprehension, but this variance will be entirely explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading).
- **Hypothesis 4:** In early readers, variance in reading comprehension will be explained by differences in word-level reading skills (vocabulary, segmental phonological awareness, and single word reading) rather than by prosodic passage reading.

8.3. Change in Methodology as a Result of Covid-19

Originally, this study was intended to be administered in person, and measures were chosen primarily because they were standardized and reliable assessments of the constructs of interest. This included a sub-set of tasks from the York Assessment for Reading Comprehension (YARC; Snowling, 2009) including sound deletion, word reading, and passage reading, and additional measures of prosodic competence including the Stress Assignment task (Holliman et al., 2012) and the Story Telling Task (adapted from Veenendaal et al., 2014). Unfortunately, part-way through data collection, a restriction on face-to-face data collection (due to the Covid-19 pandemic) was put in place and the study had to be discontinued. A further description of the measures and data collected before this restriction are in **Appendix A.** Given the time-sensitive nature of this set of studies, a new online version of Study Three was designed. Copyright infringement rules prevented some of the original measures used in the first version from being adapted into an online format (e.g, YARC sub-tests), while others were removed due to difficulty of online administration (e.g., Stress Identification and Story Telling). Therefore, the measures included in this new version of the study were partly chosen due to the feasibility of administering them in an online format.

8.4. Ethical Considerations

Prior to participant recruitment, ethical approval for the study was obtained from the Nottingham Trent University Research Ethics Committee (within the School of Business, Law and Social Sciences). As this study involved data collection with primary school children ages 7- to 11-years-old, a number of ethical issues were considered. Firstly, Disclosure Barring Service (DBS) clearance for the researcher was obtained prior to contact with children. Secondly, the purpose of the study and the tasks involved in taking part were explained to both the participants and their parent/guardians during a video call. This also gave both parents and children the opportunity to ask the researcher any questions prior to administration. Parents were also invited to stay and observe the video call with the children if they chose. During the sessions, the researcher ended the sessions if the child (or parent) asked for the session to end, or, if the child was visibly uncomfortable. If any session ended early, the participants were invited to complete the study another time if they chose. The researcher continually checked in with the children to ensure that they were happy to carry on throughout the video call.

8.5. Participants

A total of 54 children took part in the study between May and August 2020. The study involved three phases: one video call and two asynchronous computer sessions. After completing the online tasks, parents were asked to specify how much they assisted with tasks. Data from 5 children was removed due to either a lack of completion of all measures or because parents indicated that they provided assistance completing the tasks. Data from 49 children between the ages of 7- and 11-years-old (29 females, 20 males; mean age = 109 months (9 years), *SD* = 15.5 months) was included in analysis. Parents of all children also completed a final survey, responding to the question *“[h]ow much did you assist your child with the computer portion of the task?”* Out of these 49 children, 49% of parents selected “*Not at all (my child completed the* *tasks independently)",* 24.5% selected *"I provided encouragement, but did not provide assistance"* and 8.2% selected *"I provided assistance on how to complete the tasks but did not assist with any answers."* Standardized scores on the British Picture Vocabulary Scale indicated that the sample represented a wide range of verbal ability, averaging slightly above the 50th percentile (Min = 3rd percentile (SS = 71), Maximum= 98th percentile (SS = 130), Mean = 70th percentile (SS= 108; *SD* = 14.7).

Parents/guardians were recruited via social media, school newsletters, and experiment sharing websites. Prior to participating, parents were presented with an online information sheet and asked to sign a virtual consent form (via the online survey software program Qualtrics). This consent form also included questions about demographics and children's reading habits **(Appendix N).**

After completing the initial sign up, parents were then contacted by email and asked to schedule an initial video call with the lead researcher. During this video call, the researcher administered the vocabulary task and both the parent and child were given the opportunity to ask any questions they had about the research.

After the call, parents were sent two personalized links to part one and part two of the online computerised portion of the study. Parents were given brief instructions as to how to set up their child to take these portions of the study via email. These instructions included to (a) set up their child in a quiet room with few distractions (b) use a computer mouse, rather than touch pad, if possible and (c) that parents may provide encouragement if needed but not to assist with answers. All children completed these tasks within 15-35 minutes. If children needed a break, or experienced any technical issues (e.g. computer crash, loss of internet), during the computer portion, then a new personalized online link to the remaining tasks was emailed to the parents so that the children could complete the experiment. Children were given the option to take part one and part two one after the other, or, to take as much of a break as needed between these portions—including taking each part on separate days. All children completed part two within 3 weeks from the completion of part one.

After completing both portions of the study, the parent was asked to fill out one final survey about how much guidance they provided during the computer portion of the study. In this survey parents were given the option to enter their child into a raffle to win a goody bag in return for participation **(Appendix O).** Children also received the option to receive a certificate of completion for completing the study **(Appendix P).**

8.6. Measures

The following section provides a summary of the measures used in Study Three. All measures, with the exception of vocabulary, were administered during the online-computerised portions of the study. Prior to each task, children were also presented with an instructional screen that included a brief explanation of subject (e.g. "What is a syllable?") and how to do the task (e.g. "In this task click on how many syllables are in the word"). Instructions for all tasks were presented in audio as well as writing, and children were directed that instructions could always be repeated during any task if they clicked on 'Buzz the Bee' (an image which was always in the top left corner of the screen). See **Appendix Q** for instructional screens. Children also completed two practice trials with feedback (i.e. correct or incorrect) prior to starting each online computer task.

8.6.1. Vocabulary

Vocabulary was assessed with the British Picture Vocabulary Scale (BPVS-3; Dunn et al., 2009). All participants, with the exception of four children, completed the BPVS-3 virtually via a Teams video call. The four other participants completed the BPVS-3 in person in a school setting prior to the Covid-19 face-to-face restrictions. An independent samples t-test was run to check for differences between participants who completed the BPVS online and in-person, indicating that there were no significant differences in the standard scores for online administration (M = 108.3, SD = 14.7) and in-person administration (M = 111.5, SD = 18.7); $t(47) = .42$, $p = .84$. In the virtual administration, the BPVS-3 picture booklet was propped in front of the researcher's web camera and children were asked to provide answers verbally. Larger numbers were added to the booklet to make it easier for children to see the numbers on a computer screen. In the case that any children struggled to answer verbally, they were asked to point at the screen and a parent was instructed to verbalize which number they were pointed to. Raw vocabulary score (number of correct items) was used for analysis. Internal reliability was high (Cronbach's alpha = .96).

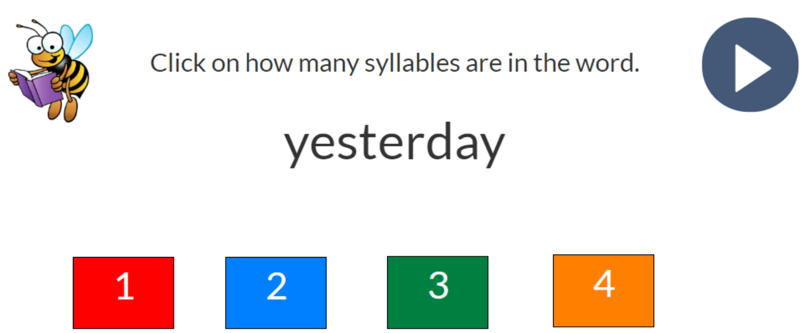
8.6.2. Segmental Phonological Awareness

8.6.2.1. Syllable Identification Task

Syllable identification was assessed using a simple computerised task in which children were presented with a word and asked to click on how many syllables were in the word. Children were given the following instructions in writing and audio "*In this task you will hear a word. Click on how many syllables you think are in the word. To hear the word again press the triangle play button.*" Words were presented in audio and in writing.

The task consisted of 16 trials: four words with 1 syllable, four words with 2 syllables, four words with 3 syllables, and four words with 4 syllables. All words were taken from The English Lexicon Project database (Balota et al., 2007) and were of a similar frequency, according to the Hyperspace Analogue to Language (HAL) corpus (Lund & Burgess, 1996). Inter-item reliability was acceptable for this task (Cronbach's alpha = 0.74). For a list of all words and relevant lexical properties, see **Appendix R.** See Figure 27 for example item.

AUDIO: "**Yesterday**"



Correct response is: [3]

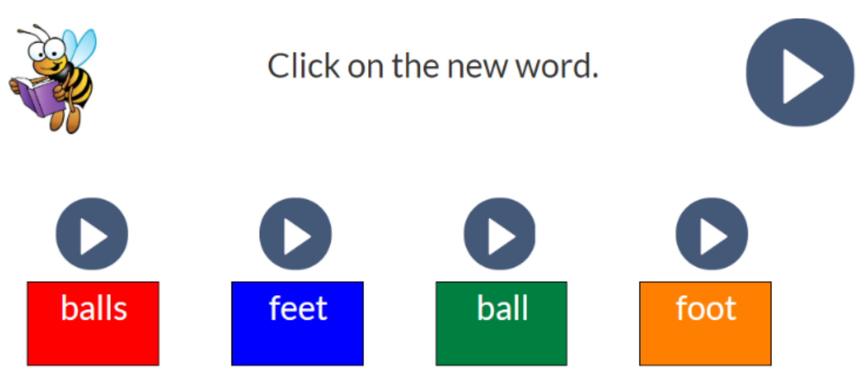
Figure 27. Item Example of Study Three Syllable Identification Task

8.6.2.2. Sound Deletion Task

Sound deletion was assessed using a simple computerised task in which children were presented with a word (e.g. football) and asked take away a sound from that word (e.g. ball). This task was modelled on the Sound Deletion subtest of the York Assessment for Reading Comprehension (Snowling et al., 2009), but adapted so that children would not need to produce an oral response. Children were given the following instructions in writing and audio "*In this task you will hear a word and be asked to remove a sound from that word. Click on the new word that is made when the sound is removed. To hear the original word again press on the big play button. To hear the new words press on the small play button.*" Answers were presented in both audio and writing.

The task consisted of 16 trials: 7 with the sound removed from the word beginning, 7 with the sound removed from the word end, and 2 with the sound removed from the word middle. All words were taken from The English Lexicon Project database (Balota et al., 2007) and were of a similar frequency according to the Hyperspace Analogue to Language (HAL) corpus (Lund & Burgess, 1996). Inter-item reliability was acceptable for this task (Cronbach's alpha = 0.70). For a list of all words and relevant lexical properties see **Appendix R.** See Figure 28 for example item.

AUDIO: "**What is the word football, without the sound foot**"



Correct response is: [ball]

Figure 28. Item Example of Study Three Sound Deletion Task

8.6.3. Prosodic Competence

Prosodic competence was assessed using six tasks: three picture-based tasks and three text-based tasks.

8.6.3.1. Picture-Based Tasks

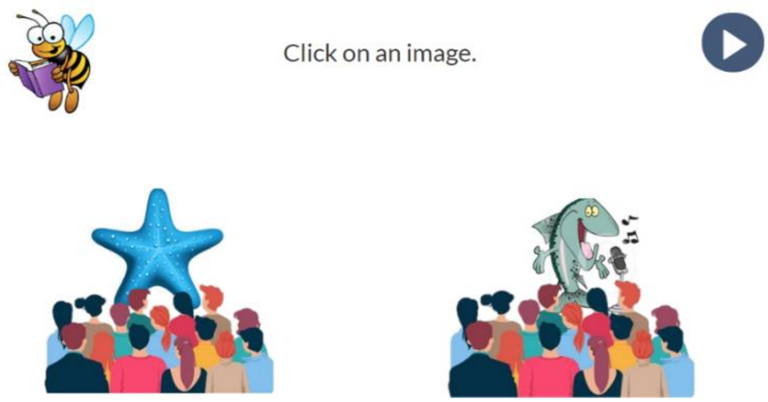
All tasks involved participants listening to items recorded by a female native British English speaker with a Received Pronunciation (RP) accent.

Accent Disambiguation Task

This task was a child-appropriate version of the Accent Disambiguation Task used in Study One and Two. Accordingly, the task was modelled on the adult Accent Disambiguation task (Landi et al., 2018) and the child-equivalent 'Phrase Stress (Receptive)' subtest of the PEPS-C (Peppe & Mcann, 2003; Peppe, 2015), but adapted to online administration. In this task, children listened to a sentence containing a target word and were presented with two pictures. Children were then asked to click on which pictures they thought best fit the sentence. Children were given the following instructions in writing and audio: "*In this task you will hear a sentence. Look at the two pictures and click on the picture that you think best matches this sentence. To hear the sentence again click on the triangle play button."* Each sentence had two ambiguous meanings represented by pictures A and B, and differentiated only by the prosody of a target word(s) (e.g. "everybody watched the [STARfish]" represented by a picture of a starfish and "everybody watched the [star] [FISH]" represented by a picture of a fish who is a popstar). The task consisted of 16 trials: 8 sentences with two interpretations each. One interpretation was always a compound noun (e.g. green-house or ice-cream) and the other was either an adjective noun (e.g. green house) or noun verb (e.g. I scream). For a list of all sentences see **Appendix S.** See Figure 29 for example item.

Upon closer look, although the distribution of the data appeared normal, participants' scores on this task were noticeably low, with an average total score of 5.8 out of 16 trials correct (*min* = 2, *max* = 10, *SD* = 2.0), suggesting that participants were scoring below chance on each of the trials. This called into question whether the children understood the aim of the task—and therefore, the validity of this measure. Consequently, this measure of prosodic competence was not included in the final analysis. See the next sections for further discussion of the exclusion of this task.

AUDIO: “**Everybody watched the star FISH**”



Correct response is: [B]

Figure 29. Item Example of Study Three Accent Disambiguation Task

Stress Mispronunciations Task

The Stress Mispronunciations Task was a computer adapted version of The Revised Stress Mispronunciations Task (Holliman et al., 2010a; Holliman et al., 2010b), in which children listened to a single word that was pronounced with incorrect stress placement (e.g., spi-DER instead of instead of SPI-der) and were presented with four pictures. Children were asked to click on the picture that they thought matched the word. Before starting the task, all participants were given the following instructions in writing and audio: “*In this task you will her a word. However, this word will not be said properly. This means it won’t sound quite right! Click on the picture which you think best matches the word. Listen carefully, you can only hear the word once.”* The task consisted of 16 trials. Upon closer look, there were seven items with zero variance in score (with all children answering correctly). These items were removed for a total of nine items remaining. A list of all final (and removed) items can be found in **Appendix S.** Inter-item reliability for this task was notably low, likely due to the low number of items. See Figure 30 for example item.

AUDIO: **“BaKER”**

Correct response is: [A]

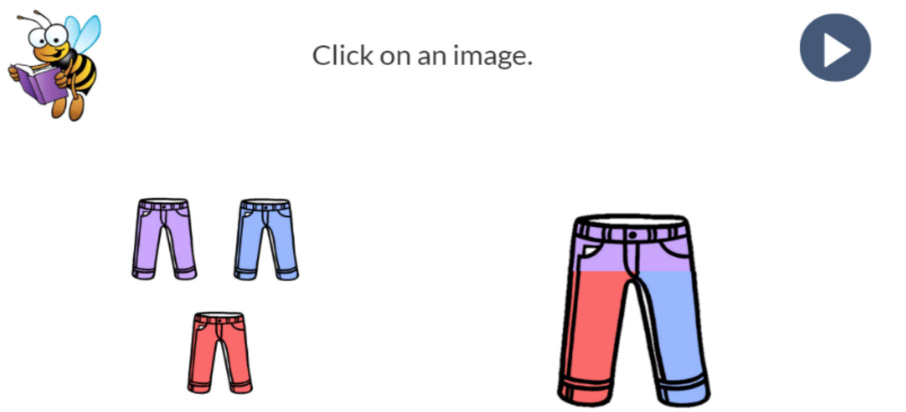
Figure 30. Item Example of Study Three Mispronunciations Task

Receptive Phrasing Task

This task was a child-appropriate version of the Receptive Phrasing Task used in Study One and Two. Accordingly, the task was modelled on the adult Subject-Object Focus task (Landi et al., 2018) and the child-equivalent ‘Boundary (Receptive)’ subtest of the PEPS-C (Peppe & Mcann, 2003; Peppe, 2015), but adapted to online administration. In the receptive phrasing task, children listened to a sentence containing a target word and were presented with two pictures. They were then asked to click on one of two pictures which they thought best fit the sentence. Children were given the following instructions in writing and audio: “*In this task you will hear a sentence. Look at the two pictures and click on the picture which you think best matches this sentence. To hear the sentence again click on the triangle play button.”* Each sentence had two ambiguous meanings represented by picture A and B and differentiated only by the prosody of the sentence (e.g. “look at my [blue black and pink socks]” represented by a picture of one pair of socks that are blue black and pink and “look at my [blue], [black], and [pink] [socks]” represented by three pairs of socks, one blue one black and one pink).

The task consisted of 16 trials: 8 sentences with two interpretations each. One interpretation was always referred to a single item of clothing (e.g. look at my [red blue and purple trousers]) and one interpretation referred to either two, three, or four individual items of clothing (e.g. look at my [red], [blue], and [purple] [trousers]). Inter-item reliability was acceptable for this task (Cronbach's alpha = 0.75). For a list of all sentences see **Appendix S.** See Figure 31 for example item.

AUDIO: **"Look at my [purple], [blue], and [red] trousers."**



Correct response is: [A]

Figure 31. Item Example of Study Three Receptive Phrasing Task

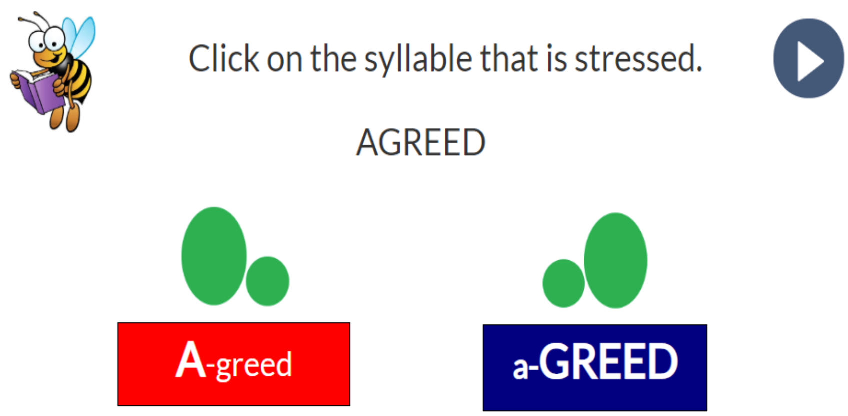
8.6.3.2. Text-Based Tasks

Explicit Syllable Stress Task

The explicit syllable stress task was a child-appropriate version the Study Two measure. Accordingly, this task was modelled on the adult Stress Identification task (Chan & Wade-Woolley, 2018; Wade-Woolley et al., 2012) and child-equivalent 'Lexical Stress (Receptive)' subtest of the PEPS-C (Peppe & Mcann, 2003; Peppe, 2015), but adapted to online administration. In this task, children were presented with a word and multiple visuals representing syllable stress of the word. Syllables were represented by green circles: a large circle represented a stressed syllable, and a small circle represented an unstressed syllable (Figure 32). Children were given the following instructions: "*In this task you will hear a word. Look at the pictures: the big circle shows which syllable is stressed. If the big circle is first, the first syllable is stressed. If the big circle is second, the second syllable is stressed. Select which picture you think is correct. To hear the word again press the triangle play button."*

The task consisted of 18 trials: six two syllable words (3 with first syllable stress, 3 with second syllable stress), six 3 syllable words (2 with first syllable stress, 2 with second syllable stress, and 2 with third syllable stress), and six 4 syllable words (3 with second syllable stress, and 3 with third syllable stress). All words were taken from The English Lexicon Project database (Balota et al., 2007) and were of a similar frequency according to the Hyperspace Analogue to Language (HAL) corpus (Lund & Burgess, 1996). Inter-item reliability was noticeably low for this task (Cronbach's alpha = 0.53). Consequently, two items were removed to improve reliability (Cronbach's alpha = 0.58). A list of all final (and removed) items and relevant lexical properties can be found in **Appendix T.** See Figure 32 for example item.

AUDIO: **"agreed"**



Correct response is: [B]

Figure 32. Item Example of Study Three Explicit Syllable Stress Task

Implicit Syllable Stress Task

In the implicit version of the text-based syllable stress task, children were presented with a word and asked to identify the stressed syllable—only this time, the word was presented in writing but not audio. Participants given the following instructions *"This is the same task [as previous-explicit syllable stress task]. However, this time, you will not hear the word. That means you will read the word to yourself and decide which syllable you think should be stressed. Look at the pictures: the big circle shows which syllable is stressed. If the big circle is first, the first syllable* *is stressed. If the big circle is second, the second syllable is stressed. Select which picture you think is correct."*

The task consisted of 12 trials: six two syllable words (3 with first syllable stress, 3 with second syllable stress) and six 3 syllable words (3 with first syllable stress, 1 with second syllable stress, and 2 with third syllable stress). All words were taken from The English Lexicon Project database (Balota et al., 2007) and were of a similar frequency according to the Hyperspace Analogue to Language (HAL) corpus (Lund & Burgess, 1996). Inter-item reliability was noticeably low for this task (Cronbach's alpha = 0.48). Consequently, two items were removed to improve reliability (Cronbach's alpha = 0.54). A list of all final (and removed) items and relevant lexical properties can be found in **Appendix T.** See Figure 33 for example item.

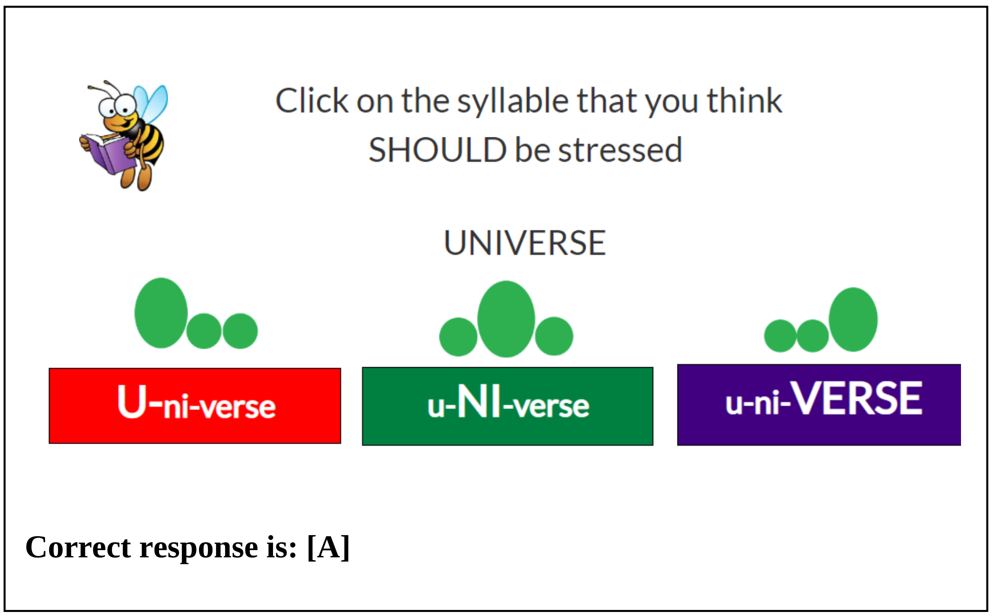


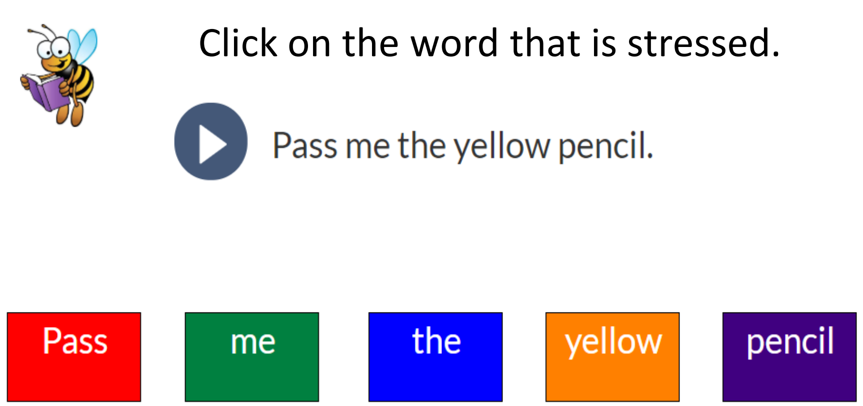
Figure 33. Item Example of Study Three Implicit Syllable Stress Task

Word Stress Task

In the novel word stress task, children were presented with a five-word sentence and a visual of each individual word in the sentence. Children were given the following instructions: "*In this task you will hear a sentence. Listen carefully and click on which word you think was stressed. To hear the sentence again press on the triangle play button."*

The task consisted of 18 trials: 9 sentences with two separate prosodic readings. In ten of these trials the noun was stressed, in four trials the verb was stressed, in two trials the adjective was stressed, and in two trials the preposition was stressed. Inter-item reliability was high for this task (Cronbach's alpha = 0.91). For a list of all sentences see **Appendix T.** See Figure 34 for example item.

AUDIO: **"Pass me the YELLOW pencil."**



Correct response is: [yellow]

Figure 34. Item Example of Study Three Explicit Word Stress Task

8.6.4. Single Word Reading

Single word reading was assessed using a computerised task in which children were asked to read words aloud from a computer screen. Children were given the following instructions *"In this task you are being recorded, so it is important to read out loud! You will be recorded automatically, so just start when you see the words. Read all of the words on the page. If you get to a word you do not know you can take your best guess, or just say pass. Press the big green button when you have finished."* All words were taken from the UK National Curriculum-English Spelling Appendix (Department for Education, 2014), with words getting progressively more advanced (from reception level, to year 1 level, to year 2 level, to year 3-4 level, and finally year 5-6 level. A list of words is in **Appendix U.** Inter-item reliability was high for this task (Cronbach's alpha = 0.92). See Figure 35 for an example items.

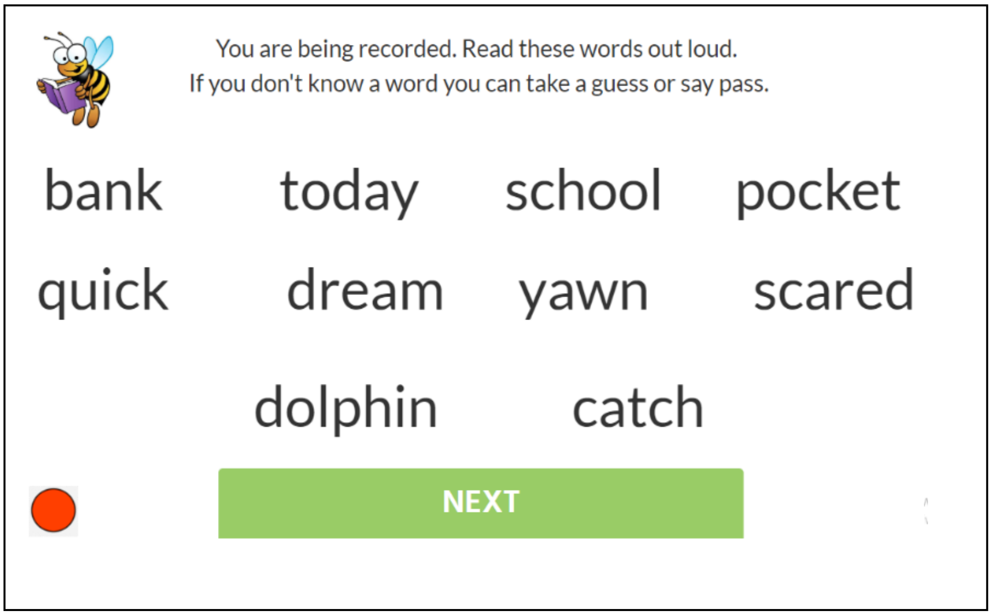
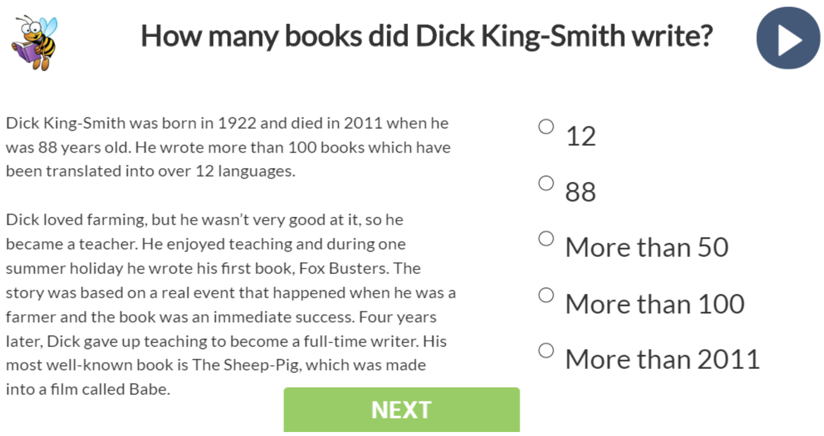


Figure 35. Item Example of Study Three Word Reading Task

8.6.5. Reading Comprehension

Reading comprehension was assessed using a simple computerised task in which children were presented with three passages, "Dick-King Smith," "Charlie Bone and the Time Twister" and "Eye of the Wolf" from the Rising Stars Reading Planet Online Library (Rising Stars and RS Assessment, n.d.). Each passage increased in difficulty, with passage one at Year 3 level, passage two at Year 4 level, and passage three at Year 5 level (as determined by Rising Stars). After each passage, the children were asked five multiple choice questions about the passage (Figure 36). These questions were all taken from the teacher resources associated with the Rising Stars Reading Planet, however small adaptions were made so that the questions could be easily answered in an online format. Inter-item reliability was high for this task (Cronbach's alpha = 0.82). Full passages and comprehension questions are in **Appendix V.** See Figure 36 for example item.

AUDIO: **“How many books did Dick King-Smith write”**



Correct response is: [D]

Figure 36. Item Example of Study Three Reading Comprehension Task

8.6.6. Reading Fluency

Reading fluency was assessed using age-appropriate adaptations of the Study Two methodology. Accordingly, passage reading efficiency and prosodic passage reading were marked independently from the reading comprehension task, and from one another.

8.6.6.1. Passage Reading Efficiency

Reading efficiency was quantified using the same criteria as Study Two (see Table 1; Qualitative Reading Inventory). The passage used to assess passage reading efficiency, “Bats” from the Rising Stars Reading Planet Online Library (Rising Stars and RS Assessment, n.d.) was at a Year 2 level. The following written and oral instructions were given to participants “*Read the story as QUICKLY and ACCURATELY as you can.”* The total number of errors recorded ranged between 1-30 (M = 4.4, SD = 4.7).

8.6.6.2. Prosodic Passage Reading

Prosodic passage reading was quantified using the Multi-Dimensional Fluency Scale (MDFS; Zutell & Rasinski, 1991; Rasinski, 2004). The passage used to assess passage reading efficiency, “Cassie and the Kiss Soldier” from the Rising Stars Reading Planet Online Library (Rising Stars and RS Assessment, n.d.) was at a Year 2 level. The following written and oral instructions were given to participants "*Pretend you are reading to a younger child. Try to make the story as exciting as possible! (Remember: it does not matter how quickly you read. Try to read EXPRESSIVELY).*" All recordings were assessed by two independent raters. Initially, the initial inter-rater reliability for total prosodic score was low, at 37%. However, score matched within +/-1pt for 85% of participants and within +/-2 for 98% of participants. After this initial matching of scores, the two raters agreed upon final scores for all discrepancies. The given total prosodic scores ranged between 4-16 (M = 13.8, SD = 2.8). All passages are in **Appendix V.** See Figure 37 for example item.

Figure 37. Item Example of Study Three Prosodic Passage Reading Task

8.7. Results

This section presents the results of Study Three. Sections 10.7.1 and 10.7.2 provide a descriptive summary of participants' performance on the administered measures, and correlations between these measures. Sections 10.7.3 – 10.7.6 address Research Questions 1 through 4.

8.7.1. Data Preparation

Before addressing the research questions, the assumptions for running a multiple linear regression were checked. The same process for checking these assumptions was used as in Study

One and Two. Accordingly, the same note of caution as to using regressions to analyse non-continuous data applies in relation to this set of data.

Regressions predicting reading comprehension

Data from 49 children between the ages of 7- and 11-years-old (29 females, 20 males; mean age = 109 months (9 years), *SD* = 15.5 months) were included in analysis (see section 10.3 for details of removed participants). Firstly, an analysis of standard residuals demonstrated that all z-scores were within +/- 3.29, indicating no outliers (Field 2018) *(Std. Residual Min* = -2.47, *Std. Residual Max* = 1.73*).* Secondly, the assumption of collinearity was checked. VIF and Tolerance scores were all within a reasonable limits (VIF < 10; Tolerance > .10; Tabachnick & Fidell, 2001), indicating that multi-collinearity was not a concern (Vocabulary, *Tolerance* = .47, *VIF*= 2.13; Segmental PA, *Tolerance* = .51, *VIF* = 1.98, Prosodic Competence, *Tolerance* = .71, *VIF* = 1.42, Word Reading, *Tolerance* = .27, *VIF* = 3.73, Passage Reading Efficiency, *Tolerance* = .33, *VIF* = 3.00). The data also met the assumption of independent errors (*Durbin-Watson value* = 1.84) and non-zero variance (Vocabulary, *Variance* = 374.2, Segmental PA, *Variance* = 4.9, Prosodic Competence, *Variance* = 129.8, Word Reading, *Variance* = 51.7, Passage Reading Efficiency, *Variance* = 1655.2, Prosodic Passage Reading, *Tolerance Variance* = 8.01). Histograms and scatter plots were used to check assumptions of homoscedasticity, linearity, and random normally distributed errors. A histogram of standardised residuals demonstrated that errors were approximately normally distributed. A P-P plot of standardised residuals demonstrated that the data met assumptions of homogeneity of variance and linearity (points close to the line).

Regressions predicting total prosodic passage reading

An analysis of standard residuals demonstrated that all z-scores were within +/- 3.29, indicating no outliers (Field 2018) *(Std. Residual Min* = -2.61, *Std. Residual Max* = 1.78*).* A Durbin-Watson test indicated that the data met the assumption of independent errors (*Durbin-Watson value* = 1.20). Histograms and scatter plots were used to check assumptions of homoscedasticity, linearity, and random normally distributed errors. A histogram of standardised residuals demonstrated that errors were approximately normally distributed. A P-P plot of standardised residuals demonstrated that the data met assumptions of homogeneity of variance and linearity (points close to the line).

8.7.2. Descriptive Statistics

Descriptive statistics were used to explore participants' performance on each of the administered measures (Table 25). In line with the previous studies, a composite measure of prosodic competence was created. Once again, scores of individual subtasks were adjusted so that each task evenly contributed to the score. Inter-correlations between individual measures are in **Appendix W**.

A composite segmental phonological awareness score was initially going to be created, however, the two segmental PA tasks (sound deletion and syllable identification) were statistically independent from one another (r = .04, p = .80). Given previous research demonstration that phoneme and rime awareness are more appropriate measures of segmental PA for children over 4-years-old (Goswami & Bryant, 1990; Zeigler & Goswami, 2005), the sound deletion task was used as the measure of segmental PA in future analyses.

Table 25. *Study Three: Means and Standard Deviations for all Measures (n = 49)*

	Min	Max	Mean	Std Dev
Age in Months (Years)	84 (7.0)	143 (11.9)	109.0 (9.1)	15.5
Vocabulary (max = 168)	77	160	130.9	19.3
Segmental PA (SD) (max = 16)	5	16	13.7	2.2
Syllable Identification (max = 16)	7	16	14.3	2.2
Word Reading (max = 47)	8	47	33.3	7.2
Passage Reading Efficiency (WCPM)	22.8	199.9	128.0	36.9
Prosodic Competence* (max = 90)	38	87	64.1	11.4
Picture-Based Tasks (max = 36)	21	36	30.6	4.0
Mispronunciations (max = 9)	6	9	8.7	0.7
Receptive Phrasing (max = 16)	4	16	11.8	2.9
Text-Based Tasks (max = 54)	11	52	33.5	9.3
Explicit Word (max = 16)	3	14	11.8	3.0
Implicit Word (max = 10)	1	10	5.1	2.1
Explicit Sentence (max = 18)	0	18	14.0	4.6
Prosodic Reading (max =12)	4	16	13.8	2.8
Reading Fluency as Phrasing (max =4)	1	4	3.4	0.8
Reading Fluency as Expression (max = 4)	1	4	3.6	0.8
Reading Fluency as Smoothness (max = 4)	1	4	3.2	0.9
Reading Fluency as Pacing (max = 4)	1	4	3.6	0.8
Reading Comprehension (max = 15)	3	15	11.9	2.9

Note. *subscales adjusted to contribute evenly to total, PA = phonological awareness, WCPM = words read per minute, SD = sound deletion

Correlations between measures are shown in Table 2. Prosodic competence was significantly correlated with all measures with the exception of passage reading efficiency. Total prosodic passage reading was significantly correlated with all measures. Reading comprehension was significantly correlated with all measures with the exception of age (Table 26).

Table 26. *Study Three: Correlations (n = 49)*

	Age	Vocab	PA	WR	RE (WCPM)	Prosodic Competence	Prosodic Reading	Reading Comp
Age	-	.58**	.20	.42**	.52**	.36*	.40**	.23
Vocabulary	-	-	.43**	.67**	.60**	.41**	.58**	.63**
Segmental PA	-	-	-	.43*	.22	.48**	.57**	.61**
Word Reading	-	-	-	-	.73**	.35*	.80**	.63**
Passage Reading Efficiency	-	-	-	-	-	.18	.73**	.43**
Prosodic Competence	-	-	-	-	-	-	.34*	.44**
Prosodic Passage Reading	-	-	-	-	-	-	-	.69**

Note.** p < .01, * p < .05, PA = phonological awareness, WR = single word reading, RE = passage reading efficiency, WCPM = average correct words read per minute

8.7.2.1. Parental Assistance

A chi-square test of independence was conducted to explore whether there was a significant association between parental assistance and performance on the online tasks. Results demonstrated no significant association between parental assistance and performance on the segmental PA measure ($\chi^2(24) = 18.93$, $p = .76$), prosodic competence measure ($\chi^2(69) = 66.87$, p = .55), word reading measure ($\chi^2(45) = 42.88$, $p = .56$), or reading comprehension measure ($\chi^2(30) = 25.21$, $p = .72$).

8.7.3. Contribution of Prosodic Competence to Prosodic Passage Reading

This section will address Research Question 1 *(To what extent are individual differences in prosodic competence associated with prosodic passage reading in a sample of early readers (children 7- to 11-years-old), after controlling for age?)*

As demonstrated in Table 26, prosodic competence was significantly moderately correlated with total prosodic passage reading ($r = .34$). A multiple linear regression demonstrated that prosodic competence accounted for an additional 4% of non-unique variation in total prosodic passage reading ability, after accounting for age $F(2,46) = 6.00$, $p = .005$ (Table 27).

Table 27. *Study Three: HMLR Accounting for Variance in Prosodic Passage Reading from Age and Prosodic Competence (n = 49)*

Prosodic Passage Reading	R	R^2	ΔR^2	β	*t*	B
Step 1	.40	.16	.16			
Age				.40	2.9**	.07
Step 2	.45	.20	.04			
Age				.32	2.2*	.06
Prosodic Competence				.22	1.6	.06

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

A hierarchical multiple linear regression was performed to explore the contribution of prosodic competence to prosodic passage reading ability after accounting for individual differences in vocabulary, segmental phonological awareness, and single-word reading. At step one, these measures accounted for 72% of variation in prosodic passage reading ability, $F(4,44) = 27.7$, $p < .001$. At step two, although the model was still significant, $F(5,43) = 22.0$, $p < .001$, prosodic competence did not account for any additional variance (Table 28).

Table 28. *Study Three: HMLR Accounting for Variance in Prosodic Passage Reading from Age, Vocabulary, Segmental PA, Word Reading, and Prosodic Competence (n = 49)*

Prosodic Passage Reading	R	R^2	ΔR^2	β	*t*	B
Step 1	.85	.72	.72			
Age				.08	0.8	.02
Vocabulary				-.04	-0.3	-.01
Segmental PA				.29	3.2**	.37
Word Reading				.68	6.1**	.27
Step 2	.85	.72	.00			
Age				.10	1.0	.02
Vocabulary				-.03	-0.3	-.01
Segmental PA				.32	3.2**	.40
Word Reading				.68	6.1**	.27
Prosodic Competence				-.07	-0.8	-.02

Note. ** $p < .01$, * $p < .05$, PA = phonological awareness

A second hierarchical multiple linear regression was performed to explore the relative contribution of passage reading efficiency to prosodic passage reading. Results demonstrated that, at step two, passage reading efficiency accounted for an additional 5% of variance $F(5,43)=29.36$, $p< .001$. At step three, prosodic competence did not contribute any unique variance, $F(6,42)=23.92$, $p< .001$ (Table 29).

Table 29. *Study Three: HMLR Accounting for Variance in Prosodic Passage Reading from Age, Vocabulary, Segmental PA, Word Reading, Passage Reading Efficiency and Prosodic Competence (n = 49)*

Prosodic Passage Reading	R	R^2	ΔR^2	β	*t*	B
Step 1	.85	.72	.72			
Age				.08	0.8	.02
Vocabulary				-.04	-0.3	-.01
Segmental PA				.29	3.2**	.37
Word Reading				.68	6.1**	.27
Step 2	.88	.77	.05			
Age				-.00	-0.0	.00
Vocabulary				-.08	-0.7	-.01
Segmental PA				.33	3.9**	.42
Word Reading				.44	3.6**	.17
Passage Reading Efficiency				.38	3.3**	.03
Step 3	.88	.77	.00			
Age				.00	0.0	.00
Vocabulary				-.08	-0.7	-.01
Segmental PA				.34	3.7**	.43
Word Reading				.44	3.5**	.17
Passage Reading Efficiency				.38	3.2**	.03
Prosodic Competence				-.02	-0.2	-.00

Note. ** p < .01, * p < .05, PA = phonological awareness

8.7.4. Contribution of Prosodic Passage Reading to Reading Comprehension

This section will address Research Question 2 (*To what extent are individual differences in prosodic passage reading ability associated with reading comprehension in a sample of early readers (children 7- to 11-years-old) after controlling for age?).* In order to answer this question, a series of regressions were performed. As demonstrated in Table 26, prosodic passage reading was strongly correlated with reading comprehension (r = .69). A linear regression demonstrated that prosodic passage reading accounted for an additional 43% of variance in reading comprehension, after accounting for age $F(2,46) = 21.51$, $p < .001$ (Table 30).

Table 30. *Study Three: HMLR Accounting for Variance in Reading Comprehension from Age and Prosodic Competence (n = 49)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.23	.05	.05			
Age				.23	1.6	.04
Step 2	.70	.48	.43			
Age				-.06	-0.5	-.01
Prosodic Passage Reading				.72	6.2**	.75

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

A second hierarchical multiple linear regression was performed to explore the contribution of prosodic passage reading to participants' reading comprehension after accounting for age, vocabulary, segmental PA, and single word reading. Results demonstrated that, at step one, these measures contributed significantly to the regression model, $F(4,44) = 17.28$, $p < .001$, and accounted for 61% of variance in reading comprehension. At step two, prosodic passage reading accounted for an additional 4% of variance in reading comprehension, and this change in R^2 was significant $F(5,43) = 15.67$ $p < .001$ (Table 31).

Table 31. *Study Three: HMLR Accounting for Variance in Reading Comprehension from Age, Vocabulary, Segmental PA, Word Reading and Prosodic Passage Reading (n = 49)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.78	.61	.61			
Age				-.20	-1.7	-.04
Vocabulary				.39	2.7**	.06
Segmental PA				.36	3.4**	.47
Word Reading				.30	2.3*	.12
Step 2	.80	.65	.04			
Age				-.22	-2.0	-.04
Vocabulary				.41	2.9**	.06
Segmental PA				.26	2.3*	.34
Word Reading				.06	0.3	.03
Prosodic Passage Reading				.35	2.0*	.37

Note. ** p < .01, * p < .05, PA = phonological awareness

A final hierarchical multiple linear regression was performed to explore whether prosodic passage reading accounted for additional variance in reading comprehension after also accounting for passage reading efficiency. Results demonstrated that, at step three, prosodic passage reading still accounted for an additional 4% of variance in reading comprehension, and this change in R^2 was significant $F(6,42) = 13.32$ $p < .001$ (Table 32).

Table 32. *Study Three: HMLR Accounting for Variance in Reading Comprehension from Age, Vocabulary, Segmental PA, Word Reading, Passage Reading Efficiency and Prosodic Passage Reading (n = 49)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.78	.61	.61			
Age				-.20	-1.7	-.04
Vocabulary				.39	2.7**	.06
Segmental PA				.36	3.4**	.47
Word Reading				.30	2.3*	.12
Step 2	.78	.61	.00			
Age				-.20	-1.6	-.04
Vocabulary				.39	2.7*	.06
Segmental PA				.36	3.3**	.47
Word Reading				.30	1.9	.13
Passage Reading Efficiency				-.01	-.06	-.00
Step 3	.81	.66	.05			
Age				-.22	-1.7	-.04
Vocabulary				.38	3.1**	.06
Segmental PA				.32	1.8	.28
Word Reading				.28	0.6	.05
Passage Reading Efficiency				.02	-0.1	-.01
Prosodic Passage Reading				.11	2.4*	.47

Note. ** $p < .01$, * $p < .05$, PA = phonological awareness

8.7.5. Contribution of Prosodic Competence to Reading Comprehension

This section will address Research Question 3 (*To what extent are individual differences in prosodic competence associated with reading comprehension in a sample of early readers (children 7- to 11-years-old), after controlling for age?).* In order to answer this question, a series of regressions were performed. As demonstrated in Table 26, prosodic competence was moderately correlated with reading comprehension (r = .44). A hierarchical linear regression revealed that prosodic competence accounted for an additional 15% of variance in reading comprehension, after accounting for age $F(2,46) = 5.80$, $p = .006$ (Table 33).

Table 33. *Study Three: HMLR Accounting for Variance in Reading Comprehension from Age and Prosodic Competence (n = 49)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.23	.05	.05			
Age				.23	1.6	.04
Step 2	.45	.20	.15			
Age				.08	0.5	.01
Prosodic Competence				.42	2.9**	.11

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

A second hierarchical multiple linear regression was performed to explore the contribution of prosodic competence to participants' reading comprehension after accounting for age, vocabulary, segmental phonological awareness, and single word reading. Results demonstrated that, at step one, these measures contributed significantly to the regression model, $F(4,44) = 17.28$, $p < .001$, and accounted for 61% of unique variation in reading comprehension. At step two, prosodic competence did not account for any additional variance in reading comprehension $F(5,43) = 14.00$ $p < .001$ (Table 34).

Table 34. *Study Three: HMLR Accounting for Variance in Reading Comprehension from Age, Vocabulary, Segmental PA, Word Reading and Prosodic Competence (n = 49)*

Reading Comprehension	R	R^2	ΔR^2	β	*t*	B
Step 1	.78	.61	.61			
Age				-.20	-1.7	-.04
Vocabulary				.39	2.7**	.06
Segmental PA				.36	3.4**	.47
Word Reading				.30	2.3*	.12
Step 2	.79	.62	.01			
Age				-.22	-1.8	-.04
Vocabulary				.38	2.6*	.06
Segmental PA				.32	2.8**	.42
Word Reading				.30	2.3*	.12
Prosodic Competence				.11	1.0	.03

Note. ** $p < .01$, * $p < .05$, PA = phonological awareness

8.7.6. Role of Prosodic Passage Reading

This section will address Research Question 4 *(If prosodic competence accounts for unique variance in reading comprehension (after controlling for word-level reading skills), is this variance explained by prosodic passage reading?).* The results of this study demonstrated that prosodic competence did not account for any variance in reading comprehension after controlling for vocabulary, segmental phonologic awareness, and word reading. Therefore, no further analyses were conducted.

8.8. Discussion

The aim of Study Three was to answer the following three research questions: (1) *To what extent do individual differences in prosodic competence account for unique variance in prosodic passage reading ability in a sample of early readers (children 7- to 11-years-old), after controlling for age?* (2) *To what extent do individual differences in prosodic passage reading account for unique variance in reading comprehension in a sample of early readers (children 7-*

to 11-years-old), after controlling for age? (3) To what extent do individual differences in prosodic competence account for unique variance in reading comprehension ability in a sample of early readers (children 7- to 11-years-old), after controlling for age? (4) If prosodic competence accounts for unique variance in reading comprehension (after controlling for word-level reading skills), is this variance explained by prosodic passage reading?

Initial hypotheses predicted that: (a) individual differences in prosodic competence would account for variance in prosodic passage reading and reading comprehension, but that this variance would be entirely accounted for by differences in in vocabulary, segmental PA, word reading, and passage reading efficiency and (b) individual differences in prosodic passage reading would account for variance in reading comprehension, but that this variance would be entirely accounted for by differences in in vocabulary, segmental PA, word reading, and passage reading efficiency.

These predictions were only partially supported. As expected, prosodic competence was associated with both prosodic passage reading and reading comprehension, and these relationships were completely accounted for by age and word-level reading skills. However, results also demonstrated that the relationship between prosodic passage reading and reading comprehension was independent of these skills. In this section, I first reflect on the results of this study in relation to previous research and Study One and Two, and then discuss potential limitations.

8.8.1. Concurrent Relationships between Prosodic Competence and Prosodic Passage Reading

Zero-order correlations demonstrated that children's performance on the prosodic competence tasks was significantly correlated (r = .34) with their prosodic passage reading score. This positive relationship between these two prosody-related skill-sets in early readers reflects the findings of a just a small handful of previous studies (Holliman et al., 2010a; Veenendaal et al., 2014; Veenendaal et al., 2016). However, regression analysis demonstrated that prosodic competence did not predict any unique variance in prosodic passage reading after controlling for age. Rather, the best predictors of prosodic passage reading were segmental PA, single-word reading, and passage reading efficiency (Figure 38). Notably, whereas Holliman et al., (2010a) reported similar findings; prosodic competence at Time One did not predict prosodic passage reading at Time Two as smoothness, expression, or pacing, however prosodic competence did predict the phrasing component of the MDFS after controlling for age, vocabulary, and segmental PA. Accordingly, a post-hoc analysis of the current data was carried out, to explore whether prosodic competence predicted the phrasing component of prosodic passage reading after controlling for these variables in the current data (**Appendix X**). However, the results of this study indicated that, once again, although the model was significant ($F(2,44) = 3.82$, $p = .01$), with age, vocabulary, and segmental PA accounting for 26% of phrasing, at step two prosodic competence did not account for any additional unique variance. Notably, in the study by Holliman et al. (2010a), prosodic competence was quantified according to the same Revised Stress Mispronunciations task used in the current study, though in Holliman et al. (2010a) administered the task in person. However, the children in this study were between the ages of 5-years-old and 8-years-old—markedly younger than the current study (7- to 11-years-old). Therefore, while children in the current study scored very highly on this task (with all 49 children answering 7/9 items correctly), the task likely was more appropriate for this age range. Nevertheless, even when performance on this task was combined with the other prosodic competence measures, no such effect was found. I therefore suggest that future work is necessary to better understand to what extent prosodic competence is independently associated with prosodic passage reading in early readers.

On the other hand, the findings of the current study are in line with the more recent findings of Kim et al., (2021) who reported that word reading was the primary driver of prosodic passage reading in children ages 6 to 9-years-old. In this study, researchers investigated the relative contribution of word reading and listening comprehension at Time One to prosodic passage reading at Time Two—reporting that, when modelled together, word reading was the primary driver of prosodic passage reading. In the current study, when all reading skills were included in a regression, word reading (rather than vocabulary) was also the strongest predictor of prosodic passage reading.

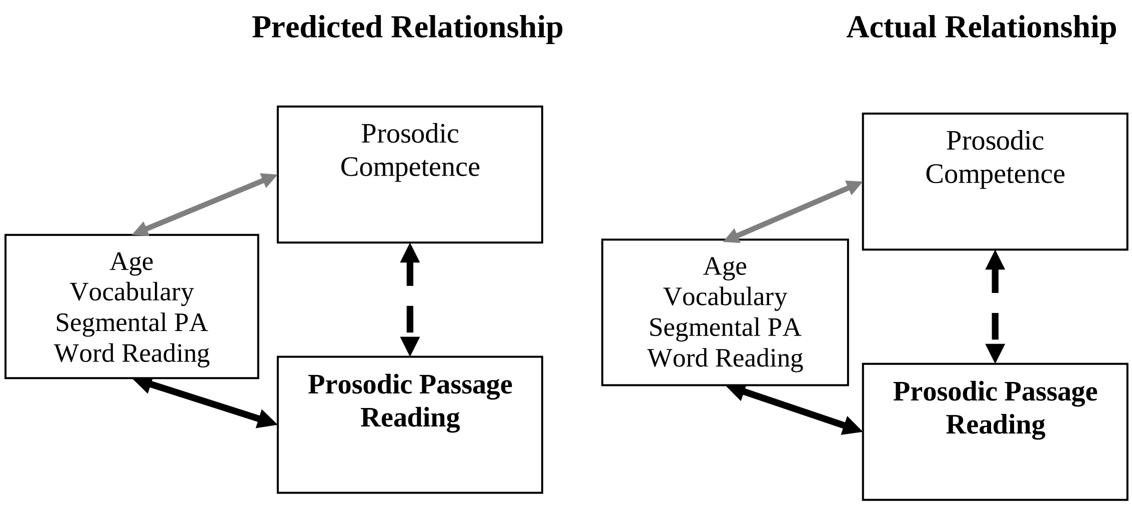


Figure 38. Study Three: Predicted and Actual Relationships between Prosodic Competence and Prosodic Passage Reading

Note. Solid arrows represent unique variance (direct relationship); Dashed arrows represent variance shared with age and word level skills (indirect relationships); Grey lines represent previously established relationships

Overall, the results of the current study indicate that well-developed prosodic competence is not a sufficient skillset to master prosodic passage reading. Rather, early readers first need adequate word-level reading skills—specifically efficient decoding skills—before prosodic competence emerges as important. Notably, this finding is consistent with the other accounts of reading fluency discussed in Chapter Three, all of which note that reading efficiency is typically a precursor to prosodic passage reading (Cowie et al., 2002; Godde et al., 2020; Kuhn & Stahl, 2003; Miller & Schwanenflugel, 2006).

8.8.2. Concurrent Relationships between Prosodic Passage Reading and Reading Comprehension

The relationship between prosodic passage reading and reading comprehension was significant across all three samples, however, the correlation was notably stronger in this sample of early readers (r = .69) than in either sample of experienced readers (r =.31 and r =.22 respectively). Furthermore, the contribution of prosodic passage reading to reading comprehension went above and beyond all other reading skills assessed—including vocabulary, segmental PA, word reading, and passage reading efficiency. This was counter to the original hypotheses, which suggested that prosodic passage reading would be uniquely related to reading comprehension in experienced adult readers, but entirely accounted for by word-level reading skills in early readers (Figure 39).

As hypothesised in Chapters Six and Seven, these findings—in combination with the findings of Study Two and Three—suggest that prosodic passage reading likely facilitates reading comprehension at a passage level (i.e., after controlling for word reading and word-level comprehension), but only during early reading. To clarify, as originally suggested, these results indicate that prosodic passage reading does potentially support comprehension by aiding syntactic processing (Wolters et al., 2022) and creating an auditory sequence of information in working memory (Kuhn et al., 2010)—but only during reading development. More advanced readers, on the other hand, appear to not depend on these skills for successful comprehension.

Another potential explanation of these results is that the measure of prosodic passage reading used for the three current studies (a hand-scored multi-dimensional fluency rubric) may have been more sensitive to features of prosodic reading that are more variable in early readers. To explicate, in the meta-analysis by Wolters et al. (2022) (assessing the relationship between prosodic passage reading and reading comprehension), the researchers suggest that the association between these measures depended on what prosody features were assessed. Namely, the researchers point out that the relationship between reading comprehension and prosodic passage reading was stronger in samples of early readers when prosodic passage reading was quantified by prosody features such as appropriate pausing (better captured by hand-scored rubrics), and stronger in samples of more experienced readers when prosodic passage reading was quantified by prosodic features such as appropriate use of pitch (better captured by spectrographic measurements). Upon reflection, the researchers suggest that appropriate pausing is often associated with decoding issues, and appropriate use of pitch is often associated with semantic processing. This is consistent with the current study, which used hand-scored rubrics and found a more robust relationship in early readers. However, the results of the current study also demonstrated that the relationship between prosodic passage reading and reading comprehension survived controlling for decoding related skills. Therefore, while this explanation may partly explain the relationship, I argue that the present results still provide strong evidence that prosodic passage reading is associated with reading comprehension above and beyond word-level skills in early readers.

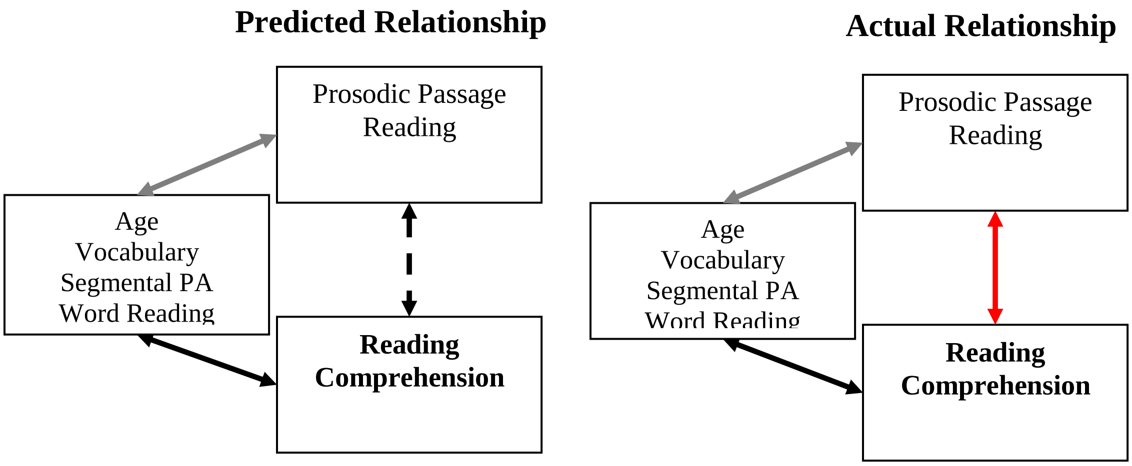


Figure 39. Study Three: Predicted and Actual Relationships between Prosodic Passage Reading and Reading Comprehension

Note: Solid lines represent unique variance (direct relationship); Dashed lines represent variance shared with age and word level skills (indirect relationships); Grey lines represent previously established relationships;

These results also have implications as to how we approach passage reading in educational settings. For example, in line with the view that prosodic passage reading facilitates reading comprehension, these results suggest that providing early readers with training on prosodic passage reading should aid higher-level comprehension skills. This will also be further discussed in the following chapter.

8.8.3. Concurrent Relationships between Prosodic Competence and Reading Comprehension

A number of previous studies have demonstrated positive significant relationships between children's sensitivity to prosody and performance on reading comprehension measures (e.g., Chung & Bidelman 2021; Deacon et al., 2018; Defior et al., 2012; Holliman et al., 2010a; Holliman, Williams et al., 2014; Kim & Petscher, 2016; Lochrin et al., 2015). In the current study, results also demonstrated that prosodic competence accounted for 15% of additional variance in reading comprehension after accounting for age. Markedly, age was significantly associated with better prosodic passage reading ability (i.e., older children demonstrated increased prosody during reading) but not with reading comprehension. Yet the final model also indicated that, after also controlling for vocabulary, segmental PA, and word reading, the contribution of prosodic competence to reading comprehension was no longer unique (Figure 40).

Notably, this same relationship was also found in both samples of experienced adult readers—however, whereas the contribution of prosodic competence to reading comprehension in the samples of experienced adult readers was largely accounted for by vocabulary, in the early readers, the contribution was largely accounted for by segmental PA and word reading. Therefore, we can infer that although the contribution of prosodic competence to reading comprehension is closely related to word-level language comprehension in experienced readers, it is more so implicated in the process of word decoding in early readers.

The results of this study are also largely consistent with previous research assessing the relative contribution of prosodic competence to reading comprehension after accounting for other reading related skills. For example, in longitudinal studies with early readers, researchers have reported that the contribution of prosodic competence at Time One, to reading comprehension at Time Two is entirely accounted for by other word-level skills, including segmental PA (Holliman et al., 2010a) and morphological awareness (Deacon et al., 2018). In concurrent studies—with comparable designs to the current study—similar results have been reported, although with some exceptions. Chung and Bidelman (2021) found that prosodic competence (as quantified by a Mandarin version of the DeeDee task) accounted for variance in the reading comprehension of Mandarin-speaking pre-schoolers, even after accounting for age and segmental PA. Likewise, Lochrin et al., (2015) reported that prosodic competence, as quantified by the PEPS-C battery, accounted for unique variance in reading comprehension of 7 to 12-year-old English speaking children after accounting for age and segmental PA. However, in the study by Lochrin et al. (2015), only one of the six sub-tests of the PEPS-C (the expressive chunking task) accounted for this variance. Moreover, neither of these studies controlled for differences in vocabulary or word decoding. Accordingly, these results are not inconsistent with the current study, which also reported that prosodic competence accounted for variance in comprehension after controlling for age. Therefore, the present results indicate that the variance in reading comprehension demonstrated by both of these studies is likely explained by these word-level reading skills.

In another concurrent study, Veenendaal et al. (2014) also reported that prosodic competence accounted for unique variance in reading comprehension. In this study, researchers controlled for differences vocabulary, word decoding, and syntactic awareness. Markedly, however, prosodic competence in this study was quantified by a Story Telling task. As described in Chapter Five, in this task individuals are presented with a set of pictures that they use to make up a story. When telling the story, participants are then rated on prosodic story telling—for example, using the MDFS (phrasing, expression, smoothness and pacing). In combination with the current results, I argue that prosodic competence, as quantified by children's ability to use prosody in this manner, embodies a potentially distinct set of prosodic skills. In other words, the Story Telling Task may assess prosody related abilities that the composite measure of prosodic competence in the current study was not sensitive to. Markedly, unlike all common measures of prosodic competence (at least all measures described in the current thesis), this measure is both expressive in nature and assesses prosodic competence at a discourse level (rather than a phrase-level or word-level). Therefore, I suggest that future research consider using this task; it is possible that expressive prosodic competence at a discourse level may provide insight into the relationship between prosodic competence and passage-level comprehension.

Nevertheless, the results of the current study did not provide any evidence that prosodic passage reading explained the contribution of prosodic competence to reading comprehension; the variance in reading comprehension predicted by prosodic competence was explained by lower level reading skills (Figure 40).

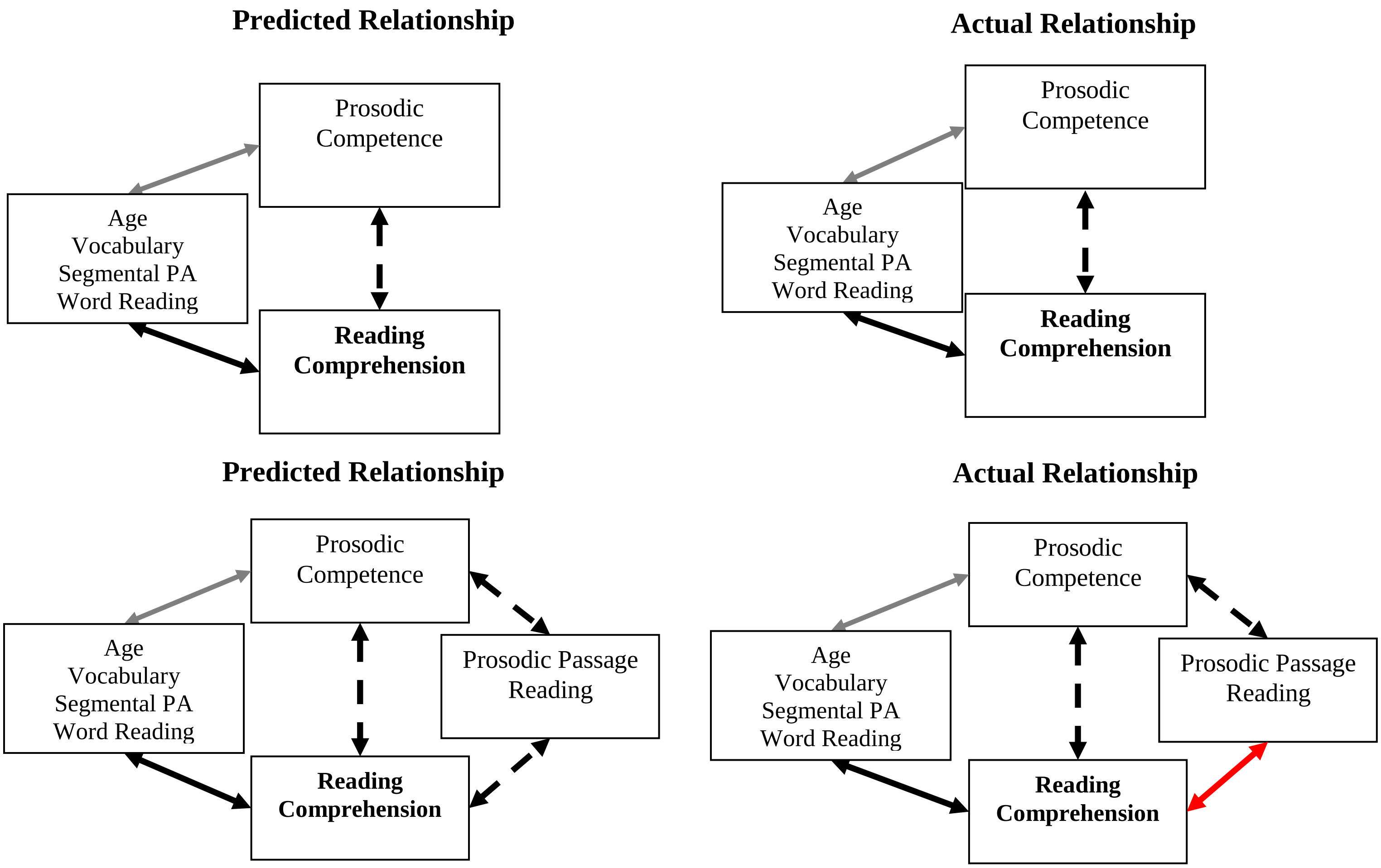


*Figure 40***.** Study Three: Predicted and Actual Relationships between Prosodic Competence, Prosodic Passage Reading and Reading Comprehension.

Note. Solid arrows represent unique variance (direct relationship); Dashed arrows represent variance shared with age and word level skills (indirect relationships); Grey lines represent previously established relationships; Red lines indicate unexpected results

8.8.4. Limitations

As in Study Two, perhaps the most notable limitation of the current study was that a number of the utilised measures have not yet been validated for online administration; the move to an online medium made it difficult to use standardised and/or previously validated assessments of segmental PA, prosodic competence, and reading comprehension— so measures were adapted and/or developed for the current study. Asynchronous administration also made it more difficult to recognise whether children understood individual tasks—possibly why the Accent Disambiguation task was ultimately excluded. Largely, however, these measures demonstrated acceptable internal reliability (with the exception of individual prosodic competence tasks) and, on the whole, were successfully administered online. Furthermore, the practice trials and instructional screens generally appeared to provide sufficient instruction. Nevertheless, it would be valuable for future studies exploring this topic to replicate the results with standardised assessments.

The administration of the BPVS (Dunn et al., 2009) in an online setting, rather than an in-person setting, is also of note. Recent work has suggested that online administration of the BPVS may lead to slightly higher scores in comparison to in-person administration. In a study by Ashworth et al. (2021), researchers compared the performance of children with Williams Syndrome (WS) on the BPVS and Raven's Coloured Progressive Matrices (RCPM) when assessed in person and on-line. However, the potential reasons for this difference suggested by the researchers included (a) recruitment bias (i.e. children who were assessed online had higher verbal ability) (b) scoring errors (i.e. children who were scored in person may have had more errors) and (c) differences due to the population (i.e. those with WS syndrome may be more distracted by the researcher in person). Notably, in the current study, because almost all participants (92%) were recruited and assessed online, and because the scores for all participants (100%) were calculated by hand, this should not have implications in relation to the pattern of relationships reported.

Another concern around online administration across all measures (both the video call and asynchronous tasks) was that parents may have influenced children's performance. Ashworth et al. (2021) also addressed this concern—reporting no significant difference between online administration (with potential parental input) and in-person administration on the RCPM. In the current study, specific directions were given to parents around aiding children during the tasks, and data from children whose parents reported helping them with the tasks was not included in the final analysis. A chi-square test indicated no significant association between parental assistance and performance on the tasks in the current study.

Another limitation of the current study was the lack of a measure of morphological awareness. Markedly, this measure was originally included in the design of the current study, yet removed part way through data collection in order to decrease the number of participant sessions necessary to take part in the study—and consequently reduce participant attrition. As results did not demonstrate any unique contribution of prosodic competence to reading comprehension, the exclusion of this measure was of little consequence in relation to the overall research question. Nevertheless, the inclusion of a morphological awareness measure would have allowed for a better understanding as to the relative importance of an understanding of morphology in relation to an understanding of prosodic competence. Moreover, it is possible that morphological awareness may have accounted for the unique contribution of prosodic passage reading to reading comprehension. Accordingly, I argue that future studies investigating these relationships include assessments of other meta-linguistic skills, such as morphological and syntactic awareness.

8.9. Conclusion

Results of this study partially supported the hypothesised role of prosody in relation to passage reading of early readers (Figure 40); although it was predicted that the contribution of prosodic passage reading to reading comprehension would be largely accounted for by differences in segmental PA and word reading (Lopes et al., 2015; Schwanenflugel et al., 2004), prosodic passage reading predicted reading comprehension after controlling for all measures of reading ability. However, in line with predictions, the contribution of prosodic competence to prosodic passage reading and reading comprehension was accounted for by lower level reading skills. In combination with results of the previous two studies, these findings also demonstrated that the concurrent relationships between prosodic competence, prosodic passage reading, and reading comprehension change over the course of development. The implications of these findings will be discussed in detail in the following chapter.

9. General Discussion

In this chapter I will first summarize the results of all three empirical studies, and then discuss the implications of these results in relation to theory, future research, educational policy, and existing frameworks of reading. Finally, I will reflect on the strengths and weakness of the current methodology.

The results of Study One, Two, and Three demonstrated that the role of prosody in relation to reading comprehension is not static over the course of reading development. Rather, prosodic competence and prosodic passage reading skills appear to be implicated in markedly different reading-related processes in early readers and experienced adult readers. A summary of these results is illustrated in Figure 41. Notably, due to the concurrent nature of the study, the direction of these pathways cannot be confirmed. Therefore, all lines are double arrowed to indicate potentially bidirectional relationships. Nevertheless, previous research can guide us as to how we interpret the direction of these relationships. This will be further discussed in this section.

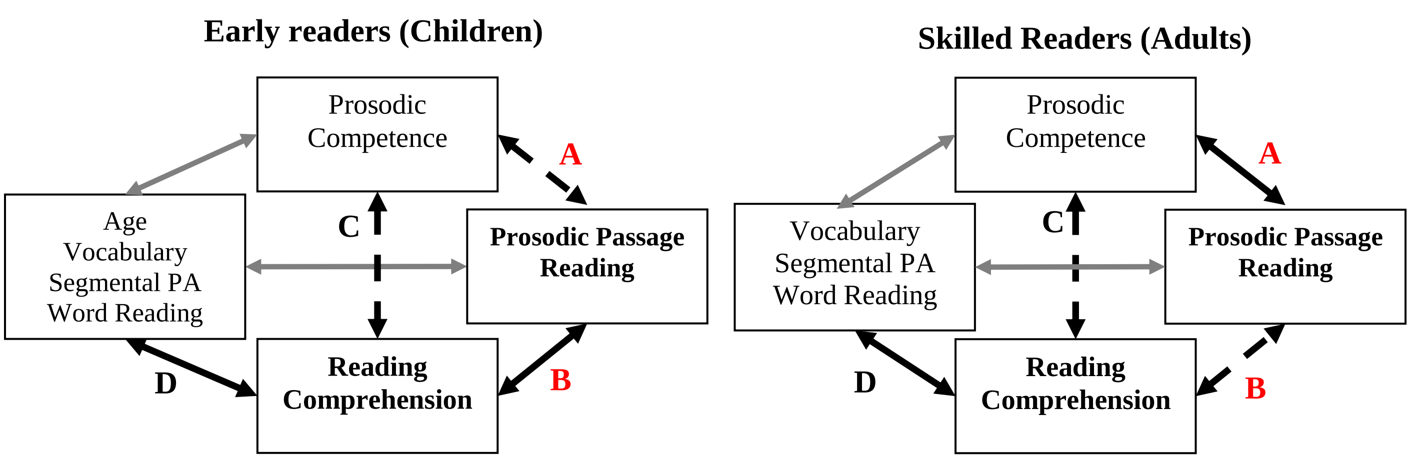


Figure 41. Results of All Three Studies

Note. Solid arrows represent unique variance (direct relationship); Dashed arrows represent variance shared with age and word level skills (indirect relationships); Grey lines represent established relationships; Red letters indicate different pattern of relationship between children and adults.

Taken together, I argue that the three primary findings are as follows:

(1) The relationship between prosodic competence and prosodic passage reading is independent of word-level reading skills, but only in experienced adult readers (pathway A; figure 41).

(2) The relationship between prosodic passage reading and reading comprehension is independent of word-level reading skills, but only in early readers (pathway B; figure 41).

(3) Word-level reading skills account for the contribution of prosodic competence to reading comprehension in both early and experienced readers (pathway C; figure 41).

Additionally, results of these three studies emphasize the well-known importance of foundational skills including vocabulary, segmental phonological awareness, and single word reading, in relation to reading comprehension (Figure 41; Arrow D).

9.1. Primary Finding: Prosodic Competence explains unique variance in Prosodic Passage Reading in Experienced Readers (but not Early Readers)

This is one of the first sets of studies to empirically demonstrate that the constructs of prosodic competence and prosodic passage reading are statistically associated with each other. Yet, the results of these three studies illustrate that this relationship is dependent on the development variety of other reading related skills. In experienced adult readers, the association between prosodic competence and prosodic passage reading was independent of lower level reading skills (including vocabulary, segmental PA, single word reading, and passage reading efficiency), while in early readers, the relationship between prosodic competence and prosodic passage reading was completely accounted for by differences in these skillsets.

9.1.1. Implications for Theory and Future Research

The results of Study One and Two suggest that an understanding of prosody likely underpins the ability of experienced adult readers to imbue a text with prosodic cues during oral reading. Given that this relationship was independent of all lower level reading skills in both studies, we can surmise that an experienced reader's prosodic competence likely facilitates prosodic passage reading at a passage level. In other words, the relationship between prosodic competence and prosodic passage reading is not simply that prosodic competence supports word reading—it also supports higher-level comprehension processes. This is in line with previous research suggesting that a primary role of prosodic competence in relation to reading may be facilitating syntactic awareness (Koriat et al., 2002) and awareness of punctuation in text (Heggie & Wade-Wooley, 2018; Ryken, 2019)—both of which are recognised as crucial for reading a passage with appropriate prosody (Godde et al., 2020; Wolters et al., 2022)

These results also suggest that, in samples of experienced adult readers, prosodic competence and prosodic passage reading are closely related constructs; after readers have reached a certain level of reading efficiency, measures of prosodic competence can serve as a relatively reliable indicator of well-developed prosodic passage reading ability. Moreover, the reverse is also true—an experienced reader who is able to appropriately imbue a text with prosody likely has a sufficient prosodic competence. This has implications for future researchers interested in assessing these prosodic skills, suggesting that it may not be crucial to quantify them separately.

On the other hand, Study Three demonstrated that, in early readers, the relationship between prosodic competence and prosodic passage reading was not independent of lower level reading skills. Rather, the contribution of prosodic competence to prosodic passage reading was completely explained by differences in segmental PA and single word reading. One explanation for these findings is that the contribution of prosodic competence may have simply been accounted for by age, which was controlled for across all analyses of Study Three. The decision to control for age was influenced by the relatively wide age range of children in the Study Three sample (a five year range between 7 and 11 years old), in addition by previous research which has noted the importance of either use age standardised measures or controlling for chronological age when considering reading development (e.g., Clin et al., 2009; Deacon et al., 2018; Lochrin et al., 2015). However, given that the development of prosodic competence is documented as improving with age (e.g., Clin et al., 2009)—and also demonstrated in Study Three—it is possible that this may have prevented the results from demonstrating a significant contribution of prosodic competence to prosodic passage reading. Accordingly, a post-hoc analysis was conducted in order to explore whether prosodic competence accounted for addition variance in prosodic passage reading when controlling for lower-level reading skills. but not age. However, the results of a hierarchical multiple linear regression with vocabulary, segmental PA, word reading, and reading efficiency at step one and prosodic competence at step two demonstrated that prosodic competence still did not contribute additional variance to the model $F(5,43) = 32.83$, $p < .001$ (**Appendix Y**).

Given these results, I suggest that in future research with early readers, it is important to assess prosodic competence separately from prosodic passage reading. Whereas these two skillsets may be related, the ability to read with appropriate prosody appears to be dependent not only on prosodic competence, but on the many building blocks of efficient reading. Taken together, I suggest that the results of these three studies indicate that prosodic competence only facilitates prosodic passage reading once a certain level of reading efficiency has been achieved. This is consistent with a handful of other studies which have demonstrated that reading-efficiency is a pre-cursor to prosodic passage reading (Cowie et al., 2002; Schwanenflugel et al., 2015; Yildiz et al., 2008)

9.1.1.1. Alternative Explanation

A counter interpretation of these findings is that the assumed directional relationship between prosodic competence and prosodic passage reading is unfitting. Originally, I suggested that—in line with the notion that an understanding of a concept should precede the use of that concept—prosodic competence precedes prosodic passage reading ability. However, given that these two skillsets are not robustly related until adulthood, it is also possible that prosodic passage reading facilitates prosodic competence. In other words, as children start to experiment with prosodic cues during reading, they improve their overall understanding of how prosody functions. If this is the case, prosodic competence and prosodic passage reading are likely bidirectional; learning to read with appropriate prosodic cues leads to improved prosodic competence, and improved prosodic competence leads to increased prosodic passage reading ability. This notion is arguably supported by a recent training study with 22 Thai-speaking adults learning English as a Foreign language (EFL) (Lekwilai, 2021). Rather than receiving training on prosodic competence, participants took part in an oral reading fluency intervention (‘Reader’s Theatre) which involves reading and engaging with a theatre script. Participants were assessed on prosodic passage reading and prosodic competence (a speech perception task in which participants listened to a passage and marked pauses and intonation) before and after the intervention. Notably, researchers reported that after taking part in the intervention, a majority of the participants demonstrated improvements in prosodic competence as well as prosodic passage reading) (Lekwilai, 2021). This also has educational implications—namely that explicitly teaching early readers about prosodic competence may not be necessary, as long as prosodic passage reading is sufficiently incorporated into curricula. In other words, it may not be important which specific route is taken, as long as prosody is, in some manner, integrated into lessons. Nevertheless, the concurrent nature of the current study means that this relationship cannot be inferred one way or the other. Therefore, I suggest that future research longitudinal research assessing prosodic competence and prosodic passage reading in early readers is warranted.

9.1.2. Implications for Educational Policy

The results of Study One and Two demonstrated that prosodic competence was robustly associated with prosodic passage reading in experienced adult readers. Accordingly, increasing an individual's sensitivity to prosodic cues would likely improve prosodic passage reading ability for an experienced reader with sufficient decoding skills. This supports the introduction of prosodic competence training for readers who specifically struggle with prosodic passage reading. Notably many methods of adult-directed prosodic competence training have already been developed—yet almost exclusively for second language learners (Anderson-Hsieh, 1992; Hardison, 2010; Gilbert, 2008; Golonk et al., 2014; Kjellin, 1999; O'Brien et al., 2018; Pourhosein Gilakjani & Sabouri, 2017; Tergujeff et al., 2020) and/or language interpreters (Yenkimaleki& van Heuven, 2019; Yenkimaleki& van Heuven, 2020). These methods include audio-visual computer-based activities, where individuals are able to speak and receive visual feedback on their use of prosody (e.g., Hardison, 2004; Pourhosein Gilakjani & Sabouri, 2017) and teacher-led activities, such as oral repetition activities—including the use of a kazoo to mimic prosodic phrasing (Gilbert, 2008; Tergujeff et al., 2020). This focus on prosodic competence training for second language speakers is not surprising, particularly given the well-recognised association between ability to speak with appropriate prosody and the comprehensibility (and/or accentedness) of a speaker (Lengeris, 2012). However, to my knowledge, these training methods have yet to be utilised for native speakers who may have sufficient word-level reading skills, but struggle with phrase-level prosodic cues. Therefore, I strongly recommend future training studies on the effectiveness of such methods for native speakers. In line with research demonstrating poorer prosodic competence in individuals with sufficient decoding skills but low comprehension (Breen et al., 2016; Groen et al., 2019), I suggest that such activities may be particularly appropriate for readers (adults and children) identified as poor comprehenders.

For early readers, however, the primary role of prosodic competence in facilitating oral reading appears to be at the word-level; prosodic competence was associated with prosodic passage reading, but the variance was entirely explained by segmental PA and word reading. Consequently, I suggest that prosodic competence training may be most helpful in relation to word reading. Very few controlled studies have assessed the effectiveness of lexical-level prosodic competence training, with only one such study to date (Harrison et al., 2018). As discussed earlier, this study consisted of placing children into three training groups: one focusing on prosodic competence, one on segmental PA, and one on mathematics (control group). Within the prosodic competence training group, activities focused on the elements of stress, intonation, and timing; children practiced identifying correct and incorrect lexical stress, identifying phrase vs. statement intonation, and identifying word breaks. Additionally, children were read aloud stories that specifically followed a strong and predictable rhythm. Researchers reported that children in this group performed significantly better on measures of word reading than children in the control group—thereby supporting the directional relationship between prosodic competence and word reading.

I argue that the results of the final study do not indicate that prosodic competence isn't important for early prosodic passage reading, but rather, that fluency-focused curricula for early readers should be balanced. In this way, prosodic competence training should bolster word reading skills (as demonstrated by Harrison et al., 2018), but should be delivered hand in hand with other well-known foundational literacy skills that we know are important for efficient reading. Accordingly, I suggest that only after sufficient word-reading automaticity is reached, does prosodic competence training become important for prosodic passage reading.

9.2. Primary Finding: Prosodic Passage Reading explains unique variance in Reading Comprehension in Early Readers (but not Experienced Readers)

Results of this study demonstrated that in experienced adult readers, prosodic passage reading did not explain unique variance in reading comprehension after controlling lower level reading skills. However, in early readers, prosodic passage reading did account for unique variance in reading comprehension after controlling for age, vocabulary, segmental PA, word reading, and passage reading efficiency (Figure 40; Arrow B).

9.2.1. Implications for Theory and Future Research

Consistent with previous research (Wolters et al., 2022), results revealed that prosodic passage reading was a strong predictor of reading comprehension in early readers. Moreover, the findings not only supported the premise that prosodic passage reading likely facilitates successful reading comprehension—they suggested that it does so at a passage level. In other words, the relationship between prosodic passage reading and reading comprehension in early readers survived controls for all lower level reading skills. In contrast, the results of the first two studies demonstrated a minimal relationship between prosodic passage reading and reading comprehension in the experienced adult readers. Accordingly, I maintain that the facilitating role of prosodic passage reading in relation to reading comprehension is much more prominent for early readers—who are more likely to depend on oral reading a comprehension tool.

On the other hand, it is also possible that prosodic passage reading only facilitates reading comprehension in experienced readers when the text is sufficiently challenging (Benjamin & Schwanenflugel, 2010). To explicate, prosodic passage reading theoretically facilitates reading comprehension by helping the reader segment the text into syntactically appropriate phrases (Dowhower, 1991). According to the Flesch Reading Ease measure, the text in Study One was more difficult than the texts in Study Two. Fittingly, prosodic passage reading also accounted for more variance in reading comprehension in Study One. However, the passage in Study One also contained markedly more advanced vocabulary—likely the reason that the vocabulary measure accounted for all unique variance in reading comprehension. It is also notable that the passages differed in genre; whereas the passage in Study One was expository in nature, the passage in Study Two was narrative. Therefore, I suggest that future research examining the contribution of prosodic passage reading to reading comprehension not only control for these variables, but use experimental methods to investigate whether these differences can help us understand the relationship at hand (e.g., comparing the contribution of prosodic skills to reading comprehension for texts which are syntactically complex vs. easy, narrative vs. expository, and contain simple vs. advanced vocabulary).

9.2.2. Implications for Educational Policy

These results have implications in relation to how educators approach passage reading assessment and teaching. Firstly, the relatively weak, albeit significant, relationship between prosodic passage reading and passage reading efficiency in Study One (r = .36), and the lack of a significant relationship in study two, suggests that, in experienced readers, simply assessing an individual's ability to read a text quickly and efficiently does not provide a full picture of passage reading ability. Rather, I recommend that to quantify skilled passage reading fluency it is necessary to assess both passage reading efficiency and prosodic passage reading. Likewise, in early readers, although passage reading efficiency was a much stronger predictor of prosodic passage reading (r = .73), analyses demonstrated that prosodic passage reading accounted for variance in reading comprehension after controlling for passage reading efficiency. Accordingly, this recommendation also applies to classroom settings with early readers—especially if reading fluency is being used to understand a child's passage comprehension; when assessing passage reading level or growth, it is necessary to not only assess a child's ability to read quickly and accurately, but also to use appropriate prosodic cues.

Given the evidence that prosodic passage reading, rather than prosodic competence, is robustly associated with reading comprehension in early readers, we can also infer that teaching curricula focused on prosodic passage reading (i.e. prosody within the context of reading) may be a more effective approach for improving reading comprehension than curricula focused on teaching prosodic competence (i.e. prosody outside the context of reading). Similarly, we can deduce that prosodic competence training likely will not lead to an improvement in prosodic passage reading without a focus on the other foundational reading skills. This suggests that the best curricula are even-handed: including tuition in all reading-related skills rather than focusing on only prosody related abilities. Nevertheless, the independent contribution of prosodic passage reading fluency to reading comprehension in early readers (even after accounting for the lower level reading skills and passage reading efficiency), suggests that including training on prosodic passage reading may be crucial for successful comprehension. This is consistent with the previous assertion that oral reading, particularly prosodic reading, may be a helpful tool for comprehension. As described earlier, reading aloud with prosody can theoretically aide comprehension by not only creating an auditory representation of the text in working memory (Kuhn et al. 2010), but also strengthening the readers representation of the how the text is organised (i.e., segmenting the text into appropriate syntactic phrases) (Dowhower, 1991). In practice, reading aloud is also a recognised means to improve comprehension, and specifically to compensate for confusion (Walczyk & Griffith-Ross, 2007). To explicate, reading aloud is a tool that is often employed to help a reader focus attention—for example, when reading in noisy environments or when a text reaches a certain level of difficulty (Chall 1996). For early or atypical readers, reading aloud can also provide opportunities to become more familiar with unknown words and give individuals auditory feedback on reading accuracy (Ehri, 1994). Accordingly, the following sections review some of the existing methods used to teach fluent reading, and specifically, prosodic passage reading.

9.2.2.1. Training Reading Fluency

The two most well-known methods used to teach early reading fluency include repeated reading (Samuels, 1997) and assisted reading (Heckelman, 1969). Repeated reading is primarily aimed at improving passage reading efficiency (as opposed to prosodic reading), and involves a student repeatedly reading a passage until they reach a certain reading rate (i.e. 100 words per minute). Conversely, assisted reading involves a student reading with a model of fluent reading—usually a teacher or a recording. Although this method similarly centres passage reading efficiency, it also provides the reader with modelled prosodic reading.

In a review of twenty-two controlled studies on fluency instruction, Kuhn and Stahl (2000) compared the efficacy of repeated reading versus assisted reading on both passage reading efficiency and prosodic passage reading. The researchers concluded that while both methods of instruction led to improvements in passage reading efficiency, only assisted reading led to improvements in prosodic passage reading (Kuhn and Stahl, 2000). Given the robust relationship between prosodic passage reading and reading comprehension (above passage reading efficiency) demonstrated in Study Three, I suggest that this finding provides strong support for curricula which specifically train prosodic passage reading, such as assisted reading curricula.

Further support for the inclusion of prosodic passage reading in literacy curricula comes from a training study by Calet et al. (2017), in which researchers compared the efficacy of training passage reading efficiency versus prosodic passage reading in a sample of 122 Spanish-speaking children in Grades 2 and 4. In this study, researchers randomly assigned children into one of three conditions: repeated reading with a focus on reading efficiency (in addition to phonological and orthographic awareness activities), repeated reading with a focus on prosodic passage reading (in addition to prosodic competence activities), and a control group receiving no instruction. After four months of training (three 45 minutes sessions a week; total of 22 sessions), children in both the passage reading efficiency and prosodic reading groups demonstrated significantly better passage reading efficiency than children in the control group. Moreover, children in the prosody-training group also demonstrated significantly higher scores on prosodic passage reading and sentence comprehension than either of the other groups. These results demonstrate that providing explicit instruction on how to use prosody not only improves prosodic reading, but also improves reading efficiency and sentence comprehension (though researchers did not see an improvement in comprehension at the text level). Notably, Calet, Pérez-Morenilla & De los Santos-Roig (2019) also carried out an AB design case study exploring the impact of prosodic reading training for a single child (age 9-years-old) with fluency and comprehension difficulties. After a total of seventeen 45-minute-long sessions (delivered over six weeks), the researchers reported that the child demonstrated significant improvement in not only prosodic reading, but also reading efficiency and text reading comprehension.

Another common method of teaching prosodic passage reading is Reader's Theatre (Young & Rasinski, 2009; Young & Rasinski, 2018), a strategy in which children are provided with training as to how to read 'theatre' scripts. By asking children to perform and engage with these scripts, they are thereby encouraged to use prosodic expression. Although this strategy was developed to improve reading fluency, recent studies have also reported that children who take part in Reader's Theatre demonstrate improved comprehension in comparison to other (control) reading curricula (Young et al., 2019; Young et al., 2020).

There are also more novel approaches to training prosodic passage reading. Most recently, Bolden and Beach (2021) designed a Prosody and Music lesson in which students invented notation to mark a written text with prosodic cues. In this lesson, students listen to the teacher demonstrating how volume, duration, and pitch can change the sound of passage, and then work in groups to create and notate their own representations. The researchers reported positive feedback on the lesson from students and teachers, however, further research is needed to evaluate the efficacy of this approach in relation to improving comprehension.

This approach is somewhat similar to the use of prosodically enhanced writing—another training technique in which prosodic cues are notated, although not in the context of music. Perhaps one of the first prosodically-enhanced orthographies was developed by Rude (2002, 2013, 2016). This visual code, referred to as Prosodic Writing (PW), uses grapheme curvature, size, and arrangement to portray pitch (intonation), duration (time), and intensity (loudness) (Figure 42). In a number of small studies of Japanese students learning the German language, Rude (2012, 2016) found that students who utilized PW increased their correct accentuation of sentences and provided positive feedback on the experience. More recently, the NEU CadLab developed another version of prosodically-enhanced writing software by the name of ReadN'Karaoke (Patel & McNab, 2011; Patel & Furr, 2011; Patel et al., 2014). Similar to PW, the ReadN'Karaoke program portrays prosodic cues of intonation, stress, and timing using visual cues. Unlike PW, the ReadN'Karaoke the software was developed for young beginner readers rather than second language learners. Researchers within the CadLab have developed two types of prosodically enhanced writing: manipulated writing and augmented writing (Figure 43). Manipulated writing more closely resembles PW (Rude, 2013) in that it portrays visual cues by adapting grapheme characteristics, whereas augmented writing portrays prosodic cues using overlaid visuals of pitch (intonation), duration (time), and intensity (loudness). In a comparison of the two methods of prosodically-enhanced writing, Patel & Furr (2011) found that children reported more difficulty with word recognition in the manipulated text condition and an easier time in the augmented text condition. Importantly, however, both versions resulted in prosodic gains when reading. In particular, results of a later study focusing on augmented text demonstrated that when children read the prosodically-enhanced text they significantly improved in correctly marking pitch accents and word duration. Furthermore, at post-training when they were given a text without the augmented cues, participants still demonstrated improved prosodic passage reading (Patel et al., 2014). Once again, more research is needed to understand how prosodically-enhanced text may enhance comprehension. Nevertheless, I argue that the results of the final study, in combination with other intervention research discussed thus far, support the efficacy of this type of method for improving comprehension.

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Figure 42. Example of Prosodic Writing (PW) with axis illustrating prosodic cues (Rude, 2016, pg. 107)

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Figure 43. Example of Read'N'Karaoke Manipulated Text and Augmented Text (Patel et al., 2014, pg. 110)

No matter how promising these novel interventions may seem, I argue that there is still a lack of focus on prosody in relation to oral passage reading. In a recent systematic review of oral reading fluency interventions, Hudson et al., (2020) identified intervention studies aimed at primary school aged-children with reading difficulties published over the last twenty years. Out of the 16 identified studies, only three specifically assessed prosodic reading as an outcome (all of which reported significant improvements in prosodic passage reading). On the whole, I argue that much more attention should be given to the development and assessment of prosody focused fluency-training curricula. Of course, the current thesis studies are concurrent, and therefore cannot demonstrate that prosodic passage reading facilitates reading comprehension. Nonetheless, previous research has provided strong evidence for such a directional effect (Frazier et al., 2006; Jenkins et al., 2003; Kim et al., 2021; Kim & Wagner, 2015). Moreover, Study Three demonstrates that the robust association between prosodic passage reading and reading comprehension survives even after accounting for differences in all word-level reading skills and after accounting for differences in passage reading efficiency. Therefore, I argue that the importance of training prosodic passage reading—over and above passage reading efficiency—should not be underestimated, but rather considered a strategy to improve early reading comprehension.

9.3. Primary Finding: Word-level Reading Skills Explain the Contribution of Prosodic Competence and Reading Comprehension in Early and Experienced Readers

In both experienced adult readers and early readers, the contribution of prosodic competence to reading comprehension was explained by lower level reading skills (Figure 40; Arrow C). Accordingly, there was no evidence that prosodic passage reading played a mediating role between prosodic competence and reading comprehension in either samples of readers.

9.3.1. Implications for Theory Future Research

A primary aim of this thesis was to better understand the mechanisms by which prosodic competence contributes to reading comprehension. One of the original hypotheses was that, at least for experienced adult readers, the contribution of prosodic competence to reading comprehension would go beyond lower level reading skills (including vocabulary, segmental PA, and single word reading). However, all three studies demonstrated that the variance in reading comprehension explained by prosodic competence was completely accounted for by these lower level skills.

It is notable, however, that in studies one and two prosodic competence did contribute unique variance to prosodic passage reading. This made the lack of relationship between prosodic competence and reading comprehension surprising, particularly given that many of the processes involved in prosodic passage reading (e.g., syntactic awareness, semantic processing) are also involved in reading comprehension. I suggest three plausible explanations for this finding.

The first explanation is that, in experienced adult readers, the role of prosodic competence in relation to reading comprehension is simply confined to word-level comprehension skills. Although findings demonstrate that prosodic competence accounts for variance in prosodic passage reading at a passage level, this variance is unique to oral reading skills—of which skilled readers (who typically engage in silent reading) do not rely on for reading comprehension. The second explanation is that, in experienced adult readers, prosodic competence accounts for variance in sentence-level, rather than passage level, comprehension skills (Kuhn & Stahl, 2003). Given that the comprehension items in the current study were at the passage level, this may not have been observed. A final explanation is that prosodic competence only accounts for variance in reading comprehension above the word-level when the passage is sufficiently difficult for the reader. Notably, although text difficulty was considered in the current thesis—with Study One comprised of a relatively difficult text, it is possible that this text was difficult at the word-level (e.g., vocabulary) rather than passage-level (e.g., syntactically complex). Accordingly, I suggest that future research further investigating these hypotheses is warranted, as it would provide a much clearer picture of the proposed relationships between prosodic skills and reading comprehension.

9.4. Implications for Theoretical Frameworks

The findings of these three empirical studies also have implications for existing theoretical frameworks of reading. In this section, I revisit the Reading Systems Framework (Perfetti, 1999; Perfetti & Stafura, 2014) in relation to the primary results of the three studies. The RSF demonstrates the role of the linguistic system, the orthographic system, the lexicon, comprehension processes, and background knowledge in relation to creating a comprehensive situation model (Figure 4). The three empirical studies presented in this thesis evaluated concurrent relationships between prosody and reading comprehension, while accounting for processes associated with the lexicon (e.g., vocabulary) and linguistic and writing system knowledge (e.g., segmental PA and single word reading). In Chapter Two, I argued that prosodic competence is implicated in virtually all of these processes. The results of these studies generally support this argument; all three studies demonstrated that an understanding of prosody (i.e., prosodic competence) was significantly associated with performance on measures of vocabulary, segmental PA, and single word reading (see Table 6, Table 16, and Table 27). However, analyses also demonstrated that prosodic competence did *not* account for unique variance in reading comprehension after controlling for these measures. Accordingly, in relation to the Reading Systems Framework, it may be most appropriate to view prosodic competence as a component of each of these systems, rather than its own system. In other words, prosodic competence appears to be integrated into the lexicon, linguistic, and orthographic systems but does not independently contribute to the comprehension processes.

On the other hand, results of Study Three suggest that, in early readers, prosodic passage reading contributes to reading comprehension independently of these other systems; children's prosodic passage reading predicted their performance on the reading comprehension task even after accounting for vocabulary, segmental phonological awareness, single word reading, and reading efficiency.

Together, these results support the adapted Reading Systems Framework recently proposed by Wade-Woolley et al. (2021) (Figure 44). In this framework, prosodic competence is incorporated into each of the individual systems, while prosodic passage reading functions in tandem with comprehension processes.

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Figure 44. Prosody Incorporated in the Reading Systems Framework (Wade-Woolley et al., 2021, pg. 2)

Notably, results of the current thesis demonstrated that prosodic passage reading only facilitated comprehension processes independently of the other systems in early readers. Therefore, I suggest that a caveat to this framework is that a developmental approach to the Reading Systems Framework needs to be considered; the independent contribution of 'reading with expression' may only be present in certain phases of reading development.

9.5. Methodological Considerations

In this section, I consider what the current methodology can tell us about the present results, and how it can inform future research.

9.5.1. Novel Measures

This thesis introduced a number of novel assessments. This includes (a) a hand-scored fluency rubric (ADMFS; Adult Multi-Dimensional Fluency Scale) appropriate for use with experienced adult readers (b) a series of asynchronously administered segmental PA tasks for both adults (syllable identification, sound identification and sound deletion) and children (syllable identification and sound deletion) and (c) a series of asynchronously administered prosodic competence tasks for both adults (explicit syllable stress, implicit syllable stress, explicit word stress, implicit word stress) and children (explicit syllable stress, implicit syllable stress, and explicit word stress).

The AMDFS proved to be a reliable measure of prosodic passage reading for two separate samples of skilled readers, and will be discussed in more detail in the next section. On the whole, however, I suggest that this measure is appropriate for use in future work. The segmental PA tasks in both Study Two and Study Three were largely modelled on existing measures—notably the Elision subtest of the CTOPP (Wagner et al., 1999) and the sound deletion subtest of the YARC (Snowling et al., 2009). These tasks all demonstrated acceptable to excellent inter-item reliability, with Cronbach's alpha between .70 and .90 for all measures. Accordingly, I suggest that these measures may be particularly useful for future literacy research in an online setting. However, I also recommend that future work validate these measures against existing standardised assessments, as that could not be done in the current thesis due to restrictions. Finally, a number of the prosodic competence tasks in Study Two and Three were novel measures. These tasks were also largely modelled on existing measures—with the explicit syllable stress task, specifically, a common assessment of word-level prosodic competence for both adults and children (see Stress Identification task, Chapter Five; Chan & Wade-Woolley, 2018; Wade-Woolley et al., 2012; McCann & Peppe, 2003). The main difference in administration of this task in the current thesis was that participants were directed to 'click' on the stressed syllable, rather than to identify it by clapping or giving an oral response. This task had markedly higher inter-rater reliability in the sample of adults (Cronbach's alpha = .84) than the sample of children (Cronbach's alpha = .58). This is not particularly surprising, however, given previous research reporting that performance on this task improves with age of participants (Calet et al., 2015). Nevertheless, I suggest that future work consider validating the children's versions of these prosodic competence measures with in-person administration. This would also allow us to understand the importance of having a researcher explain the concept of 'prosody' to children person, versus giving the child pre-recorded (standard) tutorials (see **Appendix Q**).

The most novel tasks included in the current study—not closely modelled on existing measures of prosodic competence—were the text-based word stress task(s) and the implicit versions of the text-based (syllable and word stress) tasks. The text-based word stress task, included in both Study Two and Three, required the participant to listen to (and/or read) a sentence, and then to identify which word was stressed (Figure 22; Figure 34). Of course, the ability to identify a stressed word in a phrase or sentence is the same general skill assessed in the picture-based tasks (Accent Disambiguation, Receptive Phrasing). Notably, in Study Two, performance on these picture-based tasks were strongly correlated with performance on the text-based explicit word stress task (r = .63 and r = .64 respectively)—suggesting decent validity. In Study Three, performance on the Receptive Phrasing task (the Accent Disambiguation task was removed from analysis) was also positively correlated with performance on the word stress task, although this relationship was not as strong (r = .34). Nevertheless, these correlations indicate that this novel task taps into the same skill.

The versions of text-based tasks without audio (Figure 21; Figure 23) required the participant to read a word or sentence and identify which syllable or word *should* be stressed. These tasks were included as a measure of ability to imbue appropriate prosodic cues onto text, rather than simply identifying oral cues, but without requiring an oral response. Perhaps the main hesitation regarding these implicit text-based measures (word and syllable stress) was that, unlike the other prosodic competence tasks, they heavily relied on the participant to use word reading skills. However, given that word reading ability was controlled for in Study Two and Three, this task was deemed an appropriate measure of implicit prosodic competence. In respect to the implicit syllable stress measure, experienced adult readers demonstrated parallel performance when the word was presented with and without audio (r = .98). However, in the early readers, although performance on this explicit and implicit version of this task was significantly positively associated, there was a much weaker relationship (r = .34). Accordingly, I suggest that implicit prosodic competence at the lexical level is not solidified until later in reading development.

In respect to the implicit word stress measure (only administered to the adult sample), performance on the task with and without audio was also strongly correlated, although this relationship was not as robust as the syllable stress task (r = .65). As discussed earlier, an uncertainty about the implicit word stress task was that participants would be able to answer the items by using reasoning skills rather than prosodic competence. However, analyses demonstrated that response time was negatively correlated with performance on all implicit items—indicating that participants who were able to answer items accurately were also able to answer quickly (likely using implicit prosody, rather than reasoning). Markedly, in an online setting, these text-based tasks were also much simpler to explain. Given the difficulty of finding ambiguous sentences for picture-based tasks, in combination with this instructional clarity, I suggest that such measures will likely be useful in future research investigating prosodic competence.

9.5.1.1. Comparison of Adult and Child Measures

Notably, to draw comparisons between the pattern of relationships (of prosodic skills and passage reading) in the samples of skilled adult readers and early child readers, it has to be assumed that the measures used in study two and three are analogous. This is particularly the case in relation to the measures of prosodic competence, which are relatively less standardised than the other reading assessments. The prosodic competence measures in the latter two studies were designed to be roughly equivalent in the two samples. However, adapting measures to be appropriate for or adults and children has challenges; measures can be adapted to be more or less challenging by making both quantitative and qualitative changes. For example, a measure of syllable stress awareness for adults can be simplified by either reducing the number of items in the measure (10 items instead of 30 items), or reducing the number of syllables in the words (2-3 syllables instead of 2-7 syllables). On the other hand, this task can also be simplified by changing the layout of the task; rather than relying on the participant to identify syllable stress in writing, syllable stress can be denoted visually using shapes (see Explicit Syllable Stress Task in Chapter Seven and Explicit Syllable Stress Task in Chapter Eight). In order to allow for comparison between studies two and three, the quantitative and qualitative adaptations between equivalent tasks were designed to be as minimal as possible while still at an appropriate age level. Nevertheless, it is important to consider how the adaptions made in this study, and in previous work, may influence the patterns of relationships reported. I assert that while this is a limitation of the current study, the measures used, which are largely in line with previous research, are both age appropriate (as demonstrated by normal distributions of scores) and comparable across studies. However, I also suggest that future work consider the impact of making such adaptations—and suggest the need for longitudinal work that assesses participant performance on these parallel measures over development.

9.5.2. Assessing Prosodic Passage Reading

In the current thesis I utilised a hand-scored rubric to assess prosodic passage reading. As discussed in the previous sections, both the original MDFS (Rasinski, 2004) and novel Adult Multi-Dimensional Fluency Scale (ADMFS) demonstrated reasonable inter-rater reliability and distributions. Accordingly, I suggest that these scales are appropriate for future research in the field. However, in line with Wolters et al. (2022), I also recommend that future replication studies utilise acoustic analyses in addition. This would thereby allow for an understanding as to how these two measures of prosodic reading are associated with passage comprehension.

In studies two and three, participants were also given direct instructions for the prosodic passage reading task; adults were directed to '*read this passage out loud as expressively as possible; imagine reading to a group of people'* whereas children were directed to *'pretend you are reading to a younger child. Try to make the story as exciting as possible.'* Notably, this same method was recently utilised in a separate study assessing children's prosody (Godde et al., 2021), in which similar instructions were given to participating children *('[read] as if [you are] reading a story to a pre-schooler'*). I maintain that asking participants to read with expression is the most appropriate way to gauge ability to read with prosodic cues. Nevertheless, the differentiation of oral passage reading tasks from passage comprehension tasks may also have implications as to our understanding of how readers use prosody when reading for comprehension. I suggest that future research strongly consider providing explicit direction for such tasks, however, that studies exploring the relation between prosodic reading when 'reading for expression' and 'reading for comprehension' are warranted.

In the current thesis, I also quantify prosodic passage reading as a global construct, rather than examining the dimensions of phrasing, expression, smoothness, and pacing separately. This is in line with holistic framework of prosody—which asserts that prosodic speech is the orchestration of all these elements (Chen, 2018; Ito et al., 2018; Wade-Woolley et al., 2021). Markedly, researchers have recently begun to take a closer look at the dimensionality of prosodic passage reading, in order to understand the extent to which these different dimensions should be considered different constructs. Kim et al. (2021) quantified eleven different measurements of text reading fluency—including the four dimensions of prosodic passage reading in the current study (phrasing, expression, smoothness, and pacing) and three different measurements of text reading efficiency, in addition to acoustic measurements not included in the current study such as pause frequency, pause duration, F0 change, and intonation contour. In this study, participants were 371 English-speaking children assessed at six time-points between the ages of 6 and 8-years-old. The researchers reported that, in the model of best fit, text-reading fluency was represented by three local factors: ratings and pause (i.e., phrasing, expression, smoothness, and pacing in addition to pause frequency and duration), prosody as pitch (i.e., F0 change and intonation contour), and text reading efficiency.

The results of this study largely supports the methodology of the current study, which considered all dimensions of the (A)MDFS as one variable, and passage reading efficiency as a second variable. However, it is notable that the study by Kim et al. (2021) was conducted with a sample of early readers, rather than experienced readers, and accordingly used the original MDFS. Therefore, a confirmatory factor analysis using data from the current thesis was conducted to examine whether the four dimensions of the AMDFS loaded onto one factor. In order to increase the power of this analysis, participant ratings of the AMDFS for Study One and Two (independent participant samples) were combined (n = 191).

To address the categorical nature of the ADMFS measures, a diagonally weighted least squares (DWLS) estimator was used. The comparative fit index (CFI) for a one-factor model was 0.998 and the Tucker-Lewis fit index (TLI) was 0.994, indicating a good fit. The Room Mean Square Error of Approximation (RMSEA) was 0.038, which also indicated a good fit between the single-factor model and the present data (MacCallum et al., 1996). See **Appendix Z** for factor loadings.

A second confirmatory factor analysis was run to explore examine whether the four dimensions of the MDFS also loaded onto a single factor in the final study. Once, again, a diagonally weighted least squares (DWLS) estimator was used. The comparative fit index (CFI) for a one-factor model was 1.00 and the Tucker-Lewis fit index (TLI) was 1.11, indicating a good fit. The Room Mean Square Error of Approximation (RMSEA) was 0.00, which also indicated a good fit between the single-factor model and the present data (MacCallum et al., 1996). See **Appendix Z** for factor loadings.

9.5.3. Online Data Collection

As previously discussed, the two final studies of the current thesis were moved online due to face-to-face restrictions brought on by the Covid-19 pandemic. Accordingly, a number of the measures included in these studies did not match the typical assessments used in much of the previous research. As discussed earlier, this has some ramifications in relation to the validity of the measures. However, the online nature of these studies did have benefits in relation to data collection. Notably, participants were able to be recruited from a much broader range of locations. Whereas participants who took part in Study One were largely University students (mean age = 25.2, *SD* = 9.1), participants who took part in Study Two were recruited using online advertisements from many settings (mean age= 35.2, *SD*= 12.29). The children who took part in Study Three were also recruited from a variety of different backgrounds—rather than a small handful of schools. It is important to mention, however, that due to the nature of online recruitment with children, participants all needed to have (a) access to internet and technology in the home and (b) parents who were willing to support their children through the sign up processes. Accordingly, these children came from families with sufficient resources. Given the nature of the study, I argue that it is unlikely this sampling would have an effect on findings. However, I also suggest that future research—both online and in-person—take this into account. On the whole, however, I maintain that this shift to online data collection demonstrated the feasibility of running large-scale reading studies on an online platform.

9.5.4. Concurrent Data Collection

The greatest limitation of the current thesis, in relation to understanding the changing contribution of prosody to passage reading, was that data collection for all three studies was concurrent; the early and experienced readers separate samples. Therefore, although the change in pattern of relationships between prosodic competence, prosodic passage reading, and reading comprehension can be interpreted with a development perspective, the data in this study only provides a window into the role of prosody for early and experienced readers. In Chall's (1983) stages of reading development, there is often a distinction drawn between stages in which individuals are 'learning to read' (0- to 8-years-old) and stages in which they are 'reading to learn (8+ years old). In the current study, the ages of participants spanned between 7- to 11-

years-old. Broadly speaking, therefore, we can assume that many of the ‘early readers’ had already progressed passed the earliest stages of decoding. Unfortunately, the sample size of the current study was not large enough to separate the early readers based on performance of the single word reading and passage reading efficiency scores—making it difficult to compare the progression between these theoretical stages. Therefore, I suggest that future research investigating the relationships between prosodic skills and passage comprehension (a) consider examining performance on these measures in children of more specific reading levels and (b) utilise longitudinal research designs.

9.6. Summary

In this section, I described the primary empirical findings of the current thesis and the implications of these findings for future research and educational policy. Specifically, I recommended that researchers and educators alike should consider evaluating both prosodic passage reading and passage reading efficiency during fluency assessments. I also suggested that prosodic competence likely facilitates prosodic passage reading only after individuals reach a certain level of passage reading efficiency. I concluded that prosodic passage reading appears to be a helpful comprehension tool for early readers, rather than experienced readers. I proposed that early literacy curricula (a) should be even-handed, including both prosody related skills in addition to foundational reading skills and (b) should not overlook the importance of prosodic passage reading training for successful comprehension. I then suggested that these findings should be incorporated into the Reading Systems Framework, arguing that the results of the three studies largely support the model proposed by Wade-Woolley et al. (2021). I also emphasized the importance of the novel methodology introduced in the current study. Finally, I argued that future research should consider longitudinal approaches when assessing the changing relationships between prosodic skills and passage comprehension.

10. Conclusion

This thesis makes an original contribution to knowledge as the first set of studies to not only assess the relationship between prosodic competence and prosodic passage reading in relation to passage reading comprehension, but also to explore performance on these measures in samples of both experienced adult readers and early readers (children 7- to 11-years-old). This thesis also makes a number of methodological contributions. This includes the introduction of a novel hand-scored prosodic passage-reading rubric appropriate for use with experienced adult readers (AMDFS), and, the introduction of a set of online asynchronous measures of prosodic competence for both children and adults.

Results of this thesis emphasize the markedly different pattern of concurrent relationships between prosodic skills and passage reading between experienced readers (adults) and early readers (children 7- to 11-years-old). Initial hypotheses predicted that, in early readers, prosodic competence would be associated with both prosodic passage reading ability and reading comprehension, but that this relationship would be explained by word-level reading skills. On the other hand, it was hypothesised that, in experienced readers, prosodic competence would predict unique variance in both prosodic passage reading ability and reading comprehension after controlling for word-level reading skills. The results demonstrated that these hypotheses were only partially correct. The contribution of prosodic competence to reading comprehension was completely accounted for by word-level reading skills in both experienced readers (adults) and early readers (children ages 7- to 11-years-old). Consistent with predictions, the contribution of prosodic competence to prosodic passage reading was independent of these skills in adult readers, but not early readers. Counter to predictions, the contribution of prosodic passage reading to reading comprehension was independent of word-level reading skills in early readers, but not in adult readers.

These results have implications as to (a) how we conceptualise prosody in theoretical frameworks of passage reading and (b) how we approach the incorporation of prosody into educational curricula. Specifically, I posit that results support the incorporation of prosody into the Reading Systems Framework, as proposed by Wade-Woolley et al. (2021), yet, that it is important to consider how the role prosody changes over the course of reading development. I also argue that the results of this thesis demonstrate specific prosody skills should be incorporated into literacy curricula depending on the reading outcome focus: for early readers, prosodic competence activities may be best suited to facilitate word-level reading skills and prosodic passage reading may be best suited to facilitate passage reading comprehension skills. Finally, I suggest that the field would greatly benefit from future longitudinal studies that examine how the relationships between prosodic competence, prosodic passage reading, and reading comprehension change over time.

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Appendix A: Partially Completed Studies Interrupted by Covid-19 Restrictions

Original Study with Adults (Study Two)

Data Collection: November 23rd, 2019- March 19th, 2020
Participants: Experienced Adult Readers, 39 participants complete (without exclusion criteria)

Table A. *Corresponding Measures between Original and Adapted (Completed) Study*

Variable	Original Study	Adapted Study
Vocabulary	• **Vocabulary Subtest of the Wechsler Adult Intelligence Scale** (WAIS-IV; Wechsler, 2008) • Vocabulary Measure (see Study One)	• Vocabulary Measure (see Study One, with extra items)
Segmental Phonological Awareness	• **Elision Subtest from Comprehensive Test of Phonological Processing** (CTOPP; Wagner et al., 1999)	• Novel *online* adaptation of Elision Task • Novel *online* adaptation of Sound deletion Task
Single Word Reading	• National Adult Reading Test (NART; Nelson & Willison, 1991)	• National Adult Reading Test (NART; Nelson & Willison, 1991)
Expressive Prosodic Competence	• **Stress Manipulation** (adapted from Wade-Woolley et al., 2012) • **Story Telling** (adapted from Veenendaal et al., 2014)	***Removed***
Receptive Prosodic Competence	• Compound Noun Task (see Study One) • Subject Object Task (see Study One)	• Compound Noun Task (see Study One, with extra items) • Subject Object Task (see Study One, with extra items) • Stress Identification Task • Novel *online* Sentence Stress Task
Passage Reading	• **Adult Reading Test** (ART; Everatt, 2004)	• Discourse Comprehension Test (DCT; Brookshire & Nicholas, 1993)

Note. Measures no longer included in final study in bold, Novel measures in red

Table B. *Descriptive Statistics for Original Study with Adults (n = 39; 31 female, 8 male)*

	Min	**Max**	**Mean**	**SD**
Age	19.2	74.0	26.0	11.4
Vocabulary (WAIS) (max = 82)	56.0	80.0	66.5	6.2
Vocabulary (MC) (max = 10)	5.0	10.0	8.2	1.5
Segmental PA (max = 20)	7.0	20.0	14.8	2.5
Word Reading (max =50)	*	*	*	*
Prosodic Competence	*	*	*	*
Stress Manipulation (max = 40)	29.0	40.0	35.8	3.2
Accent Disambiguation (max = 26)	14.0	25.0	20.7	2.9
Story Telling (max = 16)	*	*	*	*
Prosodic Passage Reading (max = 16)	*	*	*	*
Passage Reading Efficiency (WCPM)	*	*	*	*
Reading Comprehension (max= 25)	14.0	25.0	20.7	2.9

Note. *Values not calculated

Original Study with Children

Data Collection: February 24th, 2020- March 19th, 2020
Participants: Children ages 7- to 11-years-old, 26 participants partially complete, 8 participants complete

Table C. *All measures which were adapted between Original and Completed Study Three*

Variable	Original Study	Completed Study Three
Vocabulary	• British Picture Vocabulary Scale (BPVS-3; Assessment, 2015)	• British Picture Vocabulary Scale: *Adapted for Online Administration* (BPVS-3; Assessment, 2015)
Segmental Phonological Awareness	• **Sound Deletion Subtest of York Assessment for Reading Comprehension** (YARC; Snowling et al., 2009)	• Novel *online adaptation* of Sound Deletion Task • Novel *online* Syllabe Identification Task
Single Word Reading	• **Early Word Recognition Subtest of YARC** (Snowling et al., 2009)	• Novel *online* Word Reading Task
Prosodic Competence	• Revised Stress Mispronunciations Task (Holliman et al., 2010a; Holliman et al., 201b) • **Stress Assignment** (Holliman et al., 2012) • **Story Telling** (adapted from Veenendaal et al., 2014)	• Revised Stress Mispronunciations Task: *Adapted for Online Administration* (Holliman et al., 2010a; Holliman et al., 2010b) • Novel *online* Compound Noun Task • Novel *online* Receptive Phrasing Task • Stress Assignment • Novel *online* Sentence Stress Task
Passage Reading	• **Passage Reading subtest of YARC** (Snowling et al., 2009)	• Rising Stars Reading Planet (Rising Stars and RS Assessment, n.d.).

Note. Measures no longer included in final study in bold, Novel measures in red

Table D. *Descriptive Statistics for Original Study with Children*

	Min	**Max**	**Mean**	**SD**
Age *(n = 26)*	7.6	11.4	9.4	1.3
Vocabulary *(n = 18)* (max = 168)	93	164	134.7	15.8
Segmental PA *(n = 26)* (max = 12)	8	11	9.8	1.1
Word Reading *(n = 18)* (max = 58)	38	58	48.8	5.7
Prosodic Competence	*	*	*	*
Stress Assignment *(n = 26)* (max = 15)	2	15	10.0	3.2
Mispronunciations *(n =26)* (max = 18)	13	18	16.7	1.5
Story Telling *(n = 8)* (max= 16)	9	16	13	3.1
Prosodic Passage Reading (max = 16)	*	*	*	*
Passage Reading Efficiency (# errors) *(n = 8)*	0	13	6.8	4.5
Listening Comprehension *(n = 18)* (max = 8)	2	8	4.7	1.9
Reading Comprehension *(n = 8)* (max = 8)	4	8	6.1	1.3

Note. *Values not calculated

Appendix B: Study One Information Sheet and Consent Forms

Participant Information Sheet

Study title: Understanding the role of prosody in adult reading fluency and comprehension

This study is part of a larger project exploring the potential of teaching children about prosody (i.e. speaking and reading with appropriate intonation, stress, and timing) to improve literacy development. The aim of this phase is to investigate the importance of prosodic cues in both spoken language and written language. In particular, this experiment aims to examine the importance of prosody as it relates to comprehension when speech perception and word recognition are under stress.

What is the purpose of the study?
The aim of the study is to investigate the importance of prosody in listening comprehension, reading comprehension, and reading fluency.

Who is running this study?
The project is being coordinated by Sarah Weidman at Nottingham Trent University, who is being supervised by Professor Clare Wood at Nottingham Trent University.

What does participation involve?
You will be asked to complete:

(i) A 10 item multiple choice vocabulary task.
(ii) Two 14 item multiple-choice tasks measuring sensitivity to prosody (i.e. stress, intonation, and timing of spoken language).
(iii) A sentence reading task which consists of reading 14 sentences out loud. You will be recorded during this task.
(iv) A reading task which consists of reading out loud short texts and answering corresponding comprehension questions. You will be recorded during this task.

How will you protect my confidentiality and anonymity?
Data and recordings collected from participants will be de-identified. Only the main researcher and her supervisor will have access to identifiable data. All data will be kept on an encrypted laptop in a locked filing cabinet. Raw data will be destroyed upon completion of the project, and all data will be destroyed upon five years of the publication of the research.

What are the benefits/risks in taking part?
There are no personal benefits to taking part in the study. However, you may be contributing to the design of a potentially novel and important literacy intervention.

Will I be recorded, and how will the recording be used?
You will be recorded during a repetition and reading task. These recordings will be de-identified, and only listened to by the researcher in order to measure for prosodic cues.

Can I withdraw my data from the research?
You may decide to withdraw your data from the research study at any time. You have the right to ask that any data we have already collected be withdrawn up until June 1st, 2019.

What will happen to the results of the project?

The research is being conducted as part of my PhD studies and will be analysed and written up as a thesis. Elements of the thesis may be written up for publication in academic journals and / or conference presentations. At no point will it be possible to identify the responses of individual participants in the way the data will be analysed and presented in these outputs.

Who is funding this research?
My PhD is funded through an NTU Vice Chancellor's Studentship Award.

What happens next?
If you would to take part in the research, please complete the attached consent form.

Contact details for further information
If you have any queries about this research, please contact:
Sarah Weidman- Email: Sarah.Weidman2017@my.ntu.ac.uk, Telephone: 07774074106
Alternatively, you can contact Clare Wood (PhD supervisor) Email: Clare.Wood@ntu.ac.uk

Consent Form

Study title: Understanding the role of prosody in adult reading fluency and comprehension
This study is part of a larger project exploring the potential of teaching children about prosody (i.e. speaking and reading with appropriate intonation, stress, and timing) to improve literacy development. The aim of this phase is to investigate the importance of prosodic cues in both spoken language and written language. In particular, this experiment aims to examine the importance of prosody as it relates to comprehension when speech perception and word recognition are under stress.
Please read and confirm that you consent to taking part in this research study checking the appropriate boxes.

☐ I confirm that the purpose of the project has been explained to me, that I have been given information about it in writing, and that I have had the opportunity to ask questions about the research.
☐ I understand that my participation is voluntary, and that I am free to withdraw my data anytime until up until June 1st, 2019.
☐ I give permission to be recorded while reading aloud during literacy assessments.
☐ I agree to take part in the study.

______________________ ____________________________
Participant Name Participant Signature

______________________ ____________________
Date of Birth Date of Signature

Please indicate your gender:____

________________________ ____________________
Researcher Signature Date Signed

For further information or to raise any concerns please contact either Sarah Weidman (sarah.weidman2017@my.ntu.ac.uk) or Professor Clare Wood (clare.wood@ntu.ac.uk).

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Appendix C: Study One & Two Vocabulary Measure

<u>Items included in Study One and Two:</u>

(1) Studying the day before an exam is no doubt a <u>beneficial</u> academic habit.
- (a) detrimental
- (b) obnoxious
- (c) <u>advantageous</u>
- (d) self-righteous
- (e) intellectual

(2) The new professor's greatest <u>asset</u> was his ability to hold the full attention of the class.
- a) deception
- b) <u>advantage</u>
- c) liability
- d) pride
- e) custom

(3) Although the student was shaking with nerves, she appeared relatively <u>composed</u> during her violin recital.
- a) <u>calm</u>
- b) charming
- c) irritating
- d) boisterous
- e) talented

(4) Daniel was visibly frustrated after the <u>deferment</u> of his school's field trip.
- a) cancellation
- b) termination
- c) announcement
- d) commencement
- e) <u>postponement</u>

(5) Musicians who graduated from the local school are usually <u>adept</u> at playing at least four instruments.
- a) <u>proficient</u>
- b) adjustable
- c) inadequate
- d) ponderous
- e) proverbial

(6) After Shelli posted the final cast for the drama club musical, one of the cast members <u>expostulated</u> with her about the results.
- a) showed gratitude
- b) <u>debated</u>
- c) acknowledged
- d) reprimanded
- e) praised

(7) You can usually tell quite quickly when homework is done <u>precipitously</u>
- a) carefully

b) abysmally
c) <u>hastily</u>
d) suitably
e) rigorously

(8) Jasmine's Halloween costume impressed the judges, although her friends found it too <u>ostentatious.</u>

a) unoriginal
b) <u>pretentious</u>
c) boring
d) transparent
e) obvious

(9) The judge let the university student off with <u>clemency</u> and a stern warning.

a) vengefulness
b) revenge
c) brutality
d) <u>mercy</u>
e) indifference

(10) Rahul's <u>taciturn</u> nature was often a comfort to his friends.

a) garrulous
b) equivocal
c) <u>quiet</u>
d) arrogant
e) gregarious

<u>Additional Items included in Study Two:</u>

(11) The state of the new restaurant's kitchen could only be described as <u>repulsive.</u>

a) charming
b) unblemished
c) pungent
d) <u>abhorrent</u>
e) welcoming

(12) Mum always used the same <u>brittle</u> tea cup that no one else dared to touch.

a) colourful
b) nostalgic
c) decorative
d) grimy
e) <u>fragile</u>

(13) It is important to be <u>meticulous</u> when planning a company's finances.

a) very generous
b) <u>very careful</u>
c) stern
d) uncompromising
e) good-humored

(14) The young man planned to <u>abscond</u> before the waitress returned with the bill.

a) <u>run away</u>
b) smarten up

c) reimburse
d) change appearance
e) make amends

(15) Sonia used the <u>malleable</u> material to make small statues.

a) bright-coloured
b) impenetrable
c) <u>ductile</u>
d) smooth
e) irregular

(16) The <u>erratic</u> weather made planning for the wedding anything but simple.

a) abysmal
b) <u>unpredictable</u>
c) extreme
d) scorching
e) freezing

(17) The siblings found themselves <u>consoling</u> one another as they grew up.

a) ignoring
b) quarreling with
c) contradicting
d) <u>comforting</u>
e) doting on

(18) Raphael's fans knew that his <u>dexterity</u> on the court would win him first place.

a) charm
b) <u>skillfulness</u>
c) goofiness
d) boasting
e) competitiveness

(19) There was a(n) <u>arcane</u> symbol etched into the rock.

a) <u>mysterious</u>
b) common
c) important
d) trivial
e) tedious

(20) The family <u>concurred</u> that it was time to sell the old house.

a) <u>agreed</u>
b) decided
c) announced
d) was relieved
e) celebrated

Appendix D: Study One & Two Prosodic Competence Picture-Based Tasks

Accent Disambiguation Task:

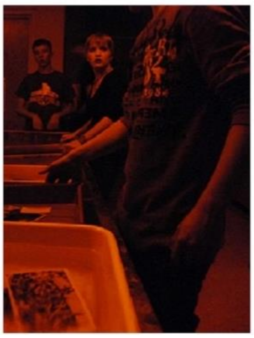
Items removed from original Accent Disambiguation task (Landi et al., 2018) due to concern of cultural translation. Adaptations (replacement items) **in bold:**

[BLUE-grass/ blue-GRASS]
[SOFT-ball/ soft-BALL]
[RED-wood/ red-WOOD]
[BLACK-board/ black-BOARD]
[BLACK-belt/ black-BELT]
[RED-coat/ red-COAT]

***Starred items removed from final measure due to low internal reliability

Nancy passed by a *[HOT-dog/ hot-DOG]* in the street.

Sam created some of his best work in a *[DARK-room/ dark-ROOM]*.



Luke parked his car outside of the *[GREEN-house/ green-HOUSE]*.

*****The doctor asked to look closer at the *[BACK-bone/ back-BONE]*.**


Phoebe handed her sister the *[BUTTER-cup/ butter-CUP]*.


Albert grabbed the *[TOP-hat/ top-HAT]* off the shelf.


John walks by the *[WHITE-house/ white-HOUSE] on* his way to work.


Gemma saw a *[GOLD-fish/ gold-FISH]* in the store window.

Shannon pushed the *[HIGH-chair/ high CHAIR]* closer to the table.

*****Sarah put on her *[FANCY-dress/ fancy-DRESS]* for the party.**

The *[TIGHT-rope/ tight-ROPE]* was so thin you could barely see it in the light.

Charlotte always noticed the *[LIGHT-house/ light-HOUSE]* on her morning walk

Alex couldn't wait for her new *[FISH-nets/ fish-NETS]* to arrive.

Reuben's favorite part of the movie was the *[SIDE-kick/ side-KICK].*

The *[HAMMER-head/ hammer-HEAD]* isn't dangerous if you know what you are doing.

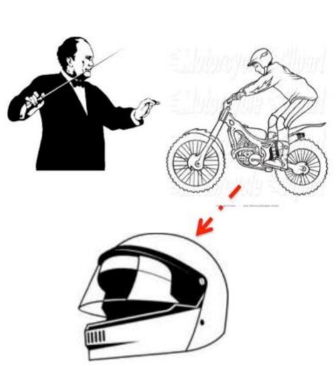
<u>Subject-Object Task:</u>

Items removed from original Subject Focus vs. Object Focus task (Landi et al., 2018) due to concern of cultural translation. Adaptations (replacement items) **in bold:**

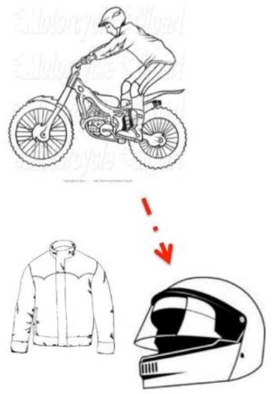
[Jack will drive to CALIFORNIA/ JACK will drive to California]

***Starred items removed from final measure due to low internal reliability

The *BIKERS* always wear *helmets.* / The *bikers* always wear *HELMETS.*

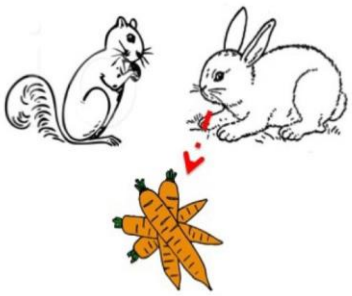


Who alwavs wears helmets?

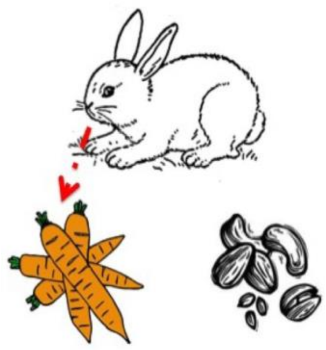


What do the bikers always wear?

The *RABBIT* will eat *carrots*. / The *rabbit* will eat *CARROTS.*

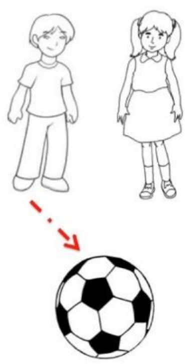


Who will eat carrots?

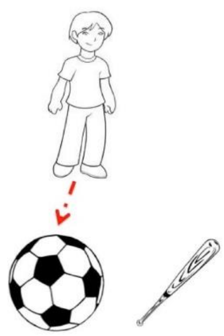


What will the rabbit eat?

JOHN likes to play *football*. / *John* likes to play *FOOTBALL.*

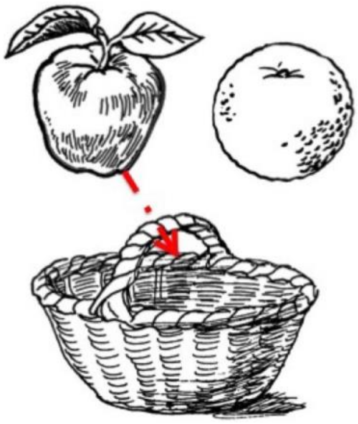


Who likes to play football?

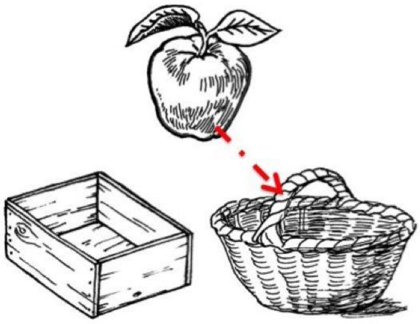


What does John like to play?

The *APPLE* goes in the *basket*. / The apple goes in the *BASKET*.

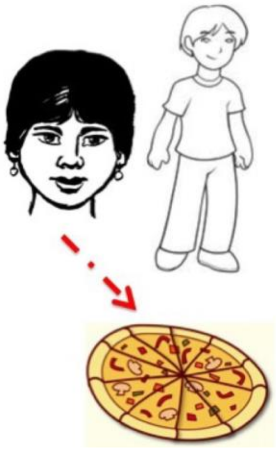


What goes in the basket?

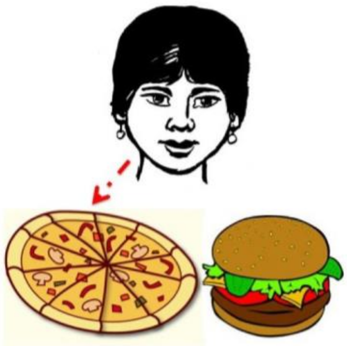


Where does the apple go?

SARAH will order a *pizza*. / *Sarah* will order a *PIZZA*.



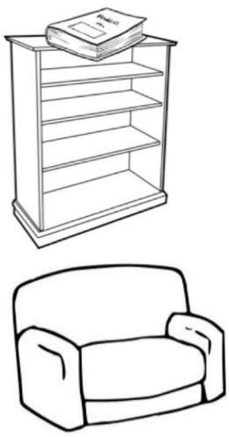
Who will order a pizza?



What will Sarah order?

The *BOOK* will order a *shelf*. / The *book* is on the *SHELF*.

What is on the shelf?



Where is the book?

HUSSEIN is drinking *coffee. / Hussein* is drinking *COFFEE.*

Who is drinking coffee?

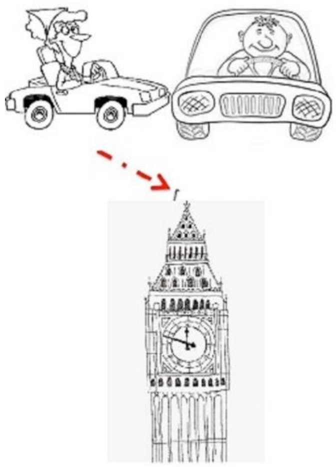
What is Hussein drinking?

The *MUFFIN* contains *cranberries. /* The *muffin* contains *CRANBERRIES.*

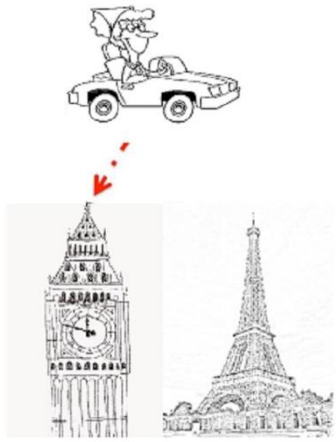
What contains cranberries?

What does the muffin contain?

MAYA* will drive to *London. / Maya* will drive to *LONDON.

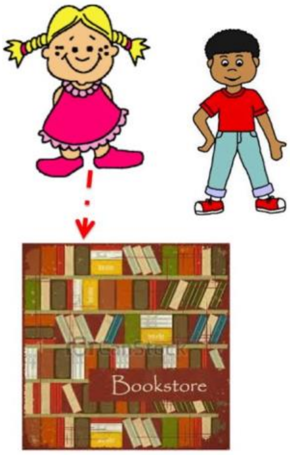


Who will drive to London?



Where will Maya drive?

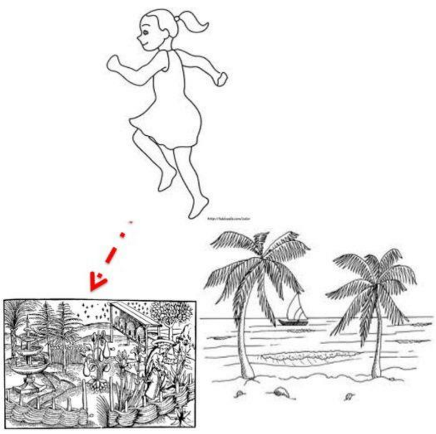
****RUTH* went to the *bookstore. / Ruth* went to the *BOOKSTORE.*



Who will go to the bookstore?

Where did Ruth go?

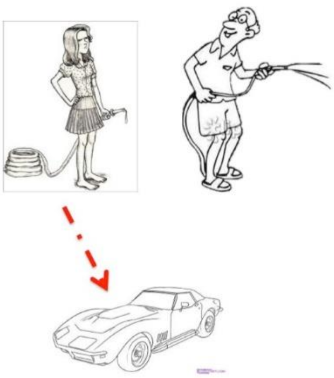
***The *GIRL* is skipping in the *garden. /* The *girl* is skipping in the *GARDEN.*

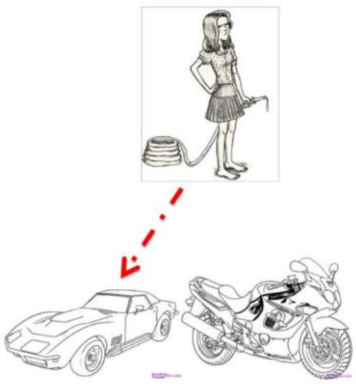


Who is skipping in the

Where is the girl skipping?

KIM is washing the *car*. / *Kim* is washing the *CAR.*

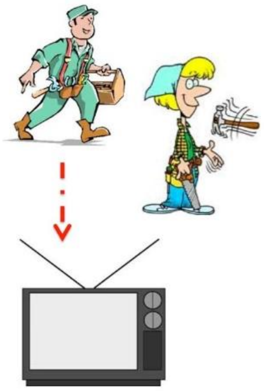




Who is washing the car?

What is Kim washing?

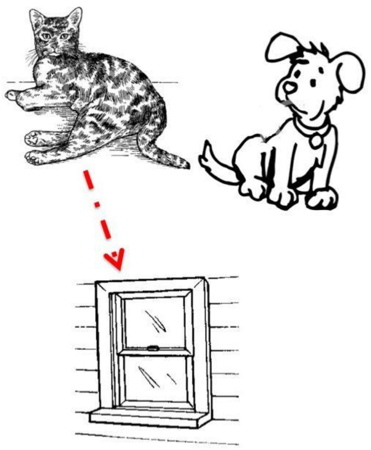
BEN fixed the *tv*. / *Ben* fixed the *TV*.

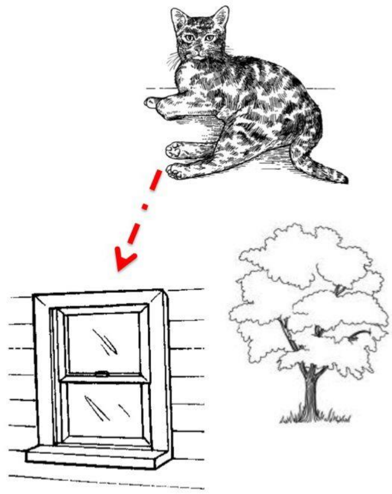


Who fixed the

What did Ben fix?

The *CAT* is sitting by the *window. /* The *cat* is sitting by the *WINDOW.*





Who is sitting by the window?

What is the cat sitting by?

NATALIE is wearing the *hat. / Natalie* is wearing the *HAT*.

Who is wearing the hat?

What is Natalie wearing?

Appendix E: Study One Adult Reading Comprehension Measure

Reading Comprehension Text and Questions

Adult Reading Test (Brooks et al., 2004)

When two non-inert gases are mixed together there are a number of possible reactions that might take place. Obviously, this depends on the chemical composition of the gases involved. Indeed, some combinations can have lethal consequences. Take, for example, the mixing of Trophine with Oxyphate. When these two gases are mixed at room temperature, an explosive combustion ensues. However, when these two gases are merged together at minus forty degrees Celsius, there is no evidence of a reaction taking place at all. This is because the atoms present in the Trophine are unable to destabilize at this temperature. Therefore, at this temperature, the combination of the two gases is rendered safe.

Rocket scientists, including the eminent Professor Giles, are now investigating the properties of these two gases to see if there is a proportional relationship between the temperature that they are mixed at and their level of combustibility. If there is a proportional relationship, then they may be able to be used to further the development of space launching technology. If, however, combustion occurs at a critical point, then they would not be able to be used.

Of course, the success of using the mixture will depend upon being able to keep the gases at a low enough temperature to make them safe. Initial tests have found that some combustion occurs at minus 35 degrees, but that the explosiveness of the mixture seems to increase rapidly with increased temperature.

One possibility is that the way forward may lie in controlling the temperature of the Oxyphate in particular. It appears that because of the molecular structure of the Oxyphate, it is prone to destabilization. Therefore, control under exact temperature conditions is of critical importance to the success of the project. Professor Giles' team is due to report their findings next spring.

1) According to the text, what are the names of the two chemicals utilized in the study?
   (a) Radon and Selenium
   (b) Trophine and Oxyphate.
   (c) Oxyphine and Radon.
   (d) Selenium and Thorium.
2) According to the text, at what temperature does mixing these two gases cause no reaction?
   (a) Minus 40 degrees Celsius
   (b) Minus 30 degrees Celsius
   (c) Minus 20 degrees Celsius
   (d) Text does not specify.
3) According to the text, what does the success of using this mixture for scientific purposes depend on?
   (a) Keeping the gases combined for long enough to conduct the research.
   (b) Keeping the gases at a low enough temperature to keep them safe.
   (c) Keeping the gases available to the relevant scientists.
   (d) Text does not specify.
4) According to the text, who is now investigating these gases?

(a) Doctor Larkin and team.
(b) Professor Lopez and team.
(c) Professor Giles and team.
(d) Text does not specify.

5) According to the text, what is the molecular structure of Oxyphate prone to?
   (a) Destabilization.
   (b) Fast temperature changes.
   (c) Losing reactivity.
   (d) Text does not specify.
6) According to the text, when is Professor Giles' team due to report their findings?
   (a) Next Autumn.
   (b) Next Winter.
   (c) Next Spring.
   (d) Next Summer.
7) According to the text, if there is a proportional relationship between the combustibility and temperature, what might they be used for?
   (a) Further development automobile engineering technology.
   (b) Further development of solar cell technology.
   (c) Further development of space launching technology.
   (d) Text does not specify.
8) According to the text, what obstacles has the team had to overcome so far?
   (a) Limited access to the gases being investigated.
   (b) Limited funding for the project investigating these gases.
   (c) Limited previous research about these particular gases.
   (d) Text does not specify.
9) According to the text, what do you think would happen if the gases were mixed at minus 100 degrees Celsius?
   (a) Explosive (dangerous) combustion.
   (b) Some combustion.
   (c) No reaction.
   (d) Not enough information in the text.

Appendix F: Study Two Information Sheet & Consent Form

Information Sheet

Thank you for your interest in this study!
Below is some information about the project:
This study is part of a larger project exploring the potential of teaching children about prosody (i.e. speaking and reading with appropriate intonation, stress, and timing) to improve literacy development. The aim of this study is to investigate the importance of understanding prosodic cues as it relates to reading ability.

Who is running this study?
The project is being coordinated by Sarah Weidman at Nottingham Trent University, who is being supervised by Professor Clare Wood at Nottingham Trent University.

What does participation involve?
You will be asked to complete a variety of tasks assessing the following:

- Vocabulary
- Word Sounds
- Phrase Listening
- Word Stress
- Sentence Stress
- Word Reading
- Passage Reading

How will you protect my confidentiality and anonymity?
Data and recordings collected from participants will be de-identified. Only the main researcher and her supervisor will have access to identifiable data. All data will be kept on an encrypted laptop in a locked cabinet. Raw data will be destroyed upon completion of the project, and all data will be destroyed upon five years of the publication of the research.

What are the benefits/risks in taking part?
There are no personal benefits to taking part in the study. However, you may be contributing to the design of a potentially novel and important literacy intervention.

Will I be recorded, and how will the recording be used?

You will be recorded during the word reading and passage reading tasks. These recordings will be de-identified, and only listened to by the researcher in order to measure for prosodic cues.

Can I withdraw my data from the research?
You may decide to stop completing the experiment or withdraw your data from the research study at any time. You have the right to ask that any data we have already collected be withdrawn up until October, 2020.

What will happen to the results of the project?
The research is being conducted as part of my PhD studies and will be analysed and written up as a thesis. Elements of the thesis may be written up for publication in academic journals and / or conference presentations. At no point will it be possible to identify the responses of individual participants in the way the data will be analysed and presented in these outputs.
Who is funding this research?

My PhD is funded through an NTU Vice Chancellor's Studentship Award.
What happens next?

If you would to take part in the research, please complete the consent form below.

Contact Details:
If you have any queries about this research, please contact Sarah Weidman
Email: Sarah.Weidman2017@my.ntu.ac.uk

Alternatively, you can contact Clare Wood (PhD supervisor)
Email: Clare.Wood@ntu.ac.uk
+44 (0)115 848 6423

Department of Psychology
Nottingham Trent University
50 Shakespeare Street, Nottingham NG1 4FQ

Consent Form

Please read and confirm that you consent to taking part in this research study checking the appropriate boxes below:

- ○ **I confirm that I have been given information about the project in writing, and that I understand the aim of the research.**
- ○ **I understand that my participation is voluntary, and that I am free to withdraw my data anytime until up until October 2020.**
- ○ **I give permission to be recorded while reading aloud during literacy assessments.**
- ○ **I am 18+ years old and I agree to take part in the study**.

[All boxes required to start study]

Appendix G: Study Two Demographic Questions

Demographic Questions

- Please select your gender **[Female, Male, Other]**
- Have you been diagnosed with dyslexia or another language or learning disorder? **[No, Yes]**
- What dialect of English do you speak? **[British English, American English, Australian English, Canadian English, Other]**
- Approximately how often do you read for pleasure (e.g. books, entire news articles, etc.)? **[Every day or almost every day, At least once a week, At least once a month, Less than once a month]**
- Approximately how often do you read for work or school (e.g. journal articles, reports, etc.)? **[Every day or almost every day, At least once a week, At least once a month, Less than once a month]**
- Approximately how often do you read aloud to others (e.g. children, colleagues, etc.)? **[Every day or almost every day, At least once a week, At least once a month, Less than once a month]**

Appendix H: Study Two Segmental Phonological Awareness Measures

Sound Deletion Items

**Starred item removed from analysis due to difference between accents

Original Word	Word Frequency	New Word	Word Frequency	Sound Deleted	Sound Place	Phonetic	Number Phonemes Deleted
pray	9,582	ray	23,072	p	beg	Y	1
window	54,926	widow	1,887	n	mid	Y	1
chaos	19,314	case	199,506	o	mid	Y (sp)	1
seeing	38,729	sing	10,917	ee	mid	Y	1
share	57,769	air	81,115	sh	mid	Y (sp)	1
thunder	7,624	under	250,435	th	beg	Y	1
next	188,009	nest	2,558	k	mid	no	1
tax	62,254	tack	1,603	s	end	no	1
strain	9,705	sane	3,942	tr	mid	Y (sp)	2
ambush	1,823	bush	10,889	am	beg	Y	2
limit	43,874	lit	5,376	im	mid	Y	2
wishing	5,284	wing	15,248	ish	mid	Y	2
feature	34,110	fur	4,642	each	mid	no	2
**believe	208,406	leave	76,506	bu	beg	no	2
dungeon	3,526	done	173,968	jun	end	no	3
available	326,758	avail	14,304	ubl	end	no	3
childish	2,886	dish	7,237	chiel	beg	no	3
crashing	3,622	king	52,583	rash	mid	Y (sp)	3
investment	23,614	invest	7,965	ment	end	Y (sp)	4
rotation	4,180	wrote	1,028,146	aeshun	end	no	4

Syllable Identification Items

Word	Length	Frequency	Syllables
boss	4	10,002	1
teach	5	22,492	1
segment	7	11,246	2
conduct	7	11,248	2
instrument	10	10,141	3
mystery	7	10,205	3
conclusion	10	16,476	3
ridiculous	10	10,108	4
accessible	10	10,758	4
intellectual	12	10,969	4
recommendations	15	11,843	5
educational	11	20,906	5
possibility	11	22,286	5
compatibility	13	10,264	6
responsibilities	16	12,837	6
telecommunication	18	22,078	7

Sound Identification Items

Word	WF	Sound	Answer	Phonetic	Sound Type
winner	11,890	1st	w (“wet)	Y	Consonant
photo	13,910	1st	f (“fun”)	no	Consonant
shadow	17,543	1st	sh (“shut”)	Y	Consonant (Digraph)
thursday	14,696	1st	th (“thin”)	Y	Consonant (Digraph)
uncommon	19,316	1st	u (“under”)	Y	Vowel (short)
element	15,056	1st	e (“end”)	Y	Vowel (short)
earn	11,987	1st	er/ ur (“her”)	Y	Vowel (long)
opened	24,037	1st	oe (“toe”)	no	Vowel (long)
mystery	10,205	3rd	s (“sip”)	Y	Consonant
mixed	15,134	3rd	k (“kit”)	no	Consonant
hang	17,803	3rd	ng (“rung”)	Y	Consonant (Digraph)
leather	11,445	3rd	th (“the”)	Y	Consonant (Digraph)
prime	22,011	3rd	ie (“try”)	no	Vowel (short)
dropped	19,263	3rd	o (“dot”)	Y	Vowel (short)
trees	14,693	3rd	ee/ea (“free”)	Y	Vowel (long)
crowd	12,988	3rd	ow (“cow”)	Y	Vowel (long)
infinite	11,763	5th	n (“net”)	Y	Consonant
packages	22,532	5th	j (“jet”)	no	Consonant
decisions	15,390	5th	zh (“visiion”)	no	Consonant (Digraph)
permission	25,434	5th	sh (“shut”)	no	Consonant (Digraph)
edited	10,370	5th	i (inn)	no	Vowel (short)
submit	23,589	5th	i (inn)	Y	Vowel (short)
avenue	20,151	5th	ue (cue)	Y	Vowel (long)
provider	24,078	5th	ie (“try”)	no	Vowel (long)

Appendix I: Study Two Prosodic Competence Text-Based Tasks

Explicit Syllable Stress Task Items

Word	Length	Frequency	Syllable	Stress
strictly	8	10,697	2	1
scheduled	9	11,581	2	1
prepared	8	21,850	2	2
teaching	8	21,953	2	1
agreed	6	21,890	2	2
instruction	11	14,183	3	2
entitled	8	12,629	3	2
qualified	9	17,754	3	1
interrupt	9	15,428	3	3
offensive	9	11,087	3	2
valuable	8	15,458	3	1
accounting	10	15,754	3	2
officials	9	16,742	3	2
contributions	13	11,207	4	3
mathematics	11	11,777	4	3
fundamental	11	11,945	4	3
essentially	11	15,440	4	2
relationships	13	14,022	4	2
representative	15	12,459	5	3
investigation	13	12,801	5	4

Implicit Syllable Stress Task Items

Word	Length	Frequency	Syllables	Stressed
contacts	8	10,686	2	1
placement	9	10,692	2	1
proposed	8	21,887	2	2
marriage	8	21,299	2	1
compare	7	21,932	2	2
installing	10	14,022	3	2
domestic	8	12,573	3	2
newspaper	9	16,824	3	1
introduced	10	15,526	3	3
forgotten	9	10,999	3	2
satellite	9	15,422	3	1
expansion	9	15,963	3	2
dynamic	7	16,682	3	2
simulation	10	11,102	4	3
recognition	11	11,207	4	3
institutions	12	12,020	4	3
effectively	11	14,005	4	2
conservative	12	16,905	4	2
personality	11	12,265	5	3
evaluation	10	12,507	5	4

Explicit Word Stress Task Items

Sentence	Question	Answer	Target Word Class
The remote is on the cushion.	What is on the pillow?	The **remote** is on the cushion.	Noun
	Is the remote beside the pillow?	(No) The remote is **on** the cushion.	Preposition
The door of the house is blue	What part of the house is blue?	The **door** of the house is blue	Noun
	Is the door of the house yellow?	The door of the house is **blue.**	Adjective
The young boy did magic	What did the young boy do?	The young boy did **magic**	Verb
	Did the young girl do magic?	(No) The young boy did **magic**	Noun
Jeremy went hiking with his new friends.	Did Jeremy go hiking with his old friends?	(No) Jeremy went hiking with his **new** friends.	Adjective
	Did Jeremy go rafting with his old friends?	Jeremy went **hiking** with his new friends.	Verb
The red shirt is dirty.	Which shirt is dirty?	The **red s**hirt is dirty	Adjective
	Is the red shirt clean?	The red shirt is **dirty.**	Adjective
The teacher's favourite drink is coffee	Whose favourite drink is coffee?	The **teacher's** favourite drink is coffee	Noun
	Is the teacher's favourite drink tea?	(No) The teachers favourite drink is **coffee**.	Noun
The fluffy puppy hid the bone.	Which puppy hid the bone?	The **fluffy** puppy hid the bone.	Adjective
	Did the fluffy puppy chew the bone?	(No) The fluffy puppy **hid** the bone.	Verb
The cat is under the table.	Is the cat on the table?	(No) The cat is **under** the table.	Preposition
	Who is under the table?	The **cat** is under the table.	Noun

Implicit Word Stress Task Items

Sentence	Question	Answer	Target Word Class
The ring is on the dresser	What is on the dresser?	The **ring** is on the dresser.	Noun
	Is the ring in the dresser?	(No) The ring is **on** the dresser.	Preposition
Patrick visited his big sister	Who visited his big sister?	**Patrick** visited his big sister.	Noun
	Did Patrick visit his little sister?	(No) Patrick visited his **big** sister.	Adjective
Patty bought the pretty flowers	Did Patty grow the pretty flowers?	(No) Patty **bought** the pretty flowers	Verb
	Who bought the pretty flowers?	**Patty** bought the pretty flowers	Noun
The red bin is for rubbish	Which bin is for rubbish?	The **red** bin is for rubbish	Adjective
	What is the red bin for?	The red bin is for **rubbish**	Noun
Mum chose the green necklace.	Did mum choose the red necklace?	(No) Mum chose the **green** necklace.	Adjective
	Who chose the green necklace?	**Mum** chose the green necklace.	Noun
The waiter dropped the white wine.	Did the waiter drop the red wine?	The waiter dropped the **white** wine.	Adjective
	Did the waiter serve the white wine?	The waiter **dropped** white wine.	Verb
Steve wants the keys in the car.	Did Steve want the keys on the car?	Steve wants the **keys** in the car.	Preposition
	What does Steve want in the car?	Steve wants the **keys** in the car.	Noun
The tall glass needs to be washed	Which glass needs to be washed?	The **tall** glass needs to be washed.	Adjective
	Does the tall glass need to be put away?	(No) The tall glass needs to be **washed**	Verb

Appendix J: Adult Word Reading Measure

Single-Word Reading Task

National Adult Reading Test

Word List		
Chord	Hiatus	Gauche
Ache	Subtle	Topiary
Depot	Procreate	Leviathan
Aisle	Gist	Beatify
Bouquet	Gouge	Prelate
Psalm	Superfluous	Sidereal
Capon	Simile	Demesne
Deny	Banal	Syncope
Nausea	Quadruped	Labile
Debt	Cellist	Campanile
Courteous	Façade	Gauche
Rarefy	Zealot	Topiary
Equivocal	Drachm	Leviathan
Naïve	Aeon	Beatify
Catacomb	Placebo	Prelate
Gaoled	Abstemious	Sidereal
Thyme	Détente	Demesne
Heir	Idyll	Syncope
Radix	Puerperal	Labile
Assignate	Aver	Campanile

Appendix K: Study Two Passage Reading Measures

<u>Reading Comprehension Text 1 Passage</u>

Discourse Comprehension Test (Brookshire & Nicholas, 1993)

One-day last Autumn, several women on Willow Street decided to have a garage sale. They collected odds and ends from all over the neighbourhood. Then they spent an entire day putting prices on the things that they had collected.

On the first day of the sale, they put up signs at both ends of the block and another one at a nearby shopping centre. Next they made a pitcher of iced tea and sat down in a shady spot beside the Anderson's garage to wait for their first customer.

Soon a man drove up in an old truck. He looked around and finally stopped by a lumpy old mattress that was leaning against the wall. He gestured to it and asked how much they wanted for it. Mrs. Anderson told him that it wasn't for sale. Then she added that they were going to put it out for the trash collectors the next day. The man asked if he could have it. Mrs. Anderson said that he could.

Then she asked, "Why do you want such a terrible mattress?" "Well," he said, "My no-good father-in-law is coming to visit next week and I don't want him to get too comfortable."

<u>Reading Comprehension Text 1 Items</u>

(1) Did several women have a party?
   a. Yes
   b. <u>No</u>

(2) Were there a large number of things at the garage sale?
   a. <u>Yes</u>
   b. No

(3) Did the women put up a sign at the shopping centre?
   a. <u>Yes</u>
   b. No

(4) Was the mattress in terrible condition?
   a. <u>Yes</u>
   b. No

(5a) Was the man married?
   a. <u>Yes</u>
   b. No

(5b) How do you know?
   1 point: [any mention of] "in-law"

(6a) Was the man fond of his father in law?
   c. Yes
   d. <u>No</u>

(6b) How do you know?
   1 point: [any mention of] "not get too comfortable" or "terrible mattress"

(7a) Was it cold on the day of the garage sale?
   a. Yes
   b. <u>No</u>

(7b) How do you know?
1 point: **[any mention of] “iced tea” or “shady spot”**
.5 points: [any mention of] garage sale outside
(8a) Was the man driving a car?
a. Yes
b. No
(8b) How do you know?
1 point: [any mention of] old truck
.5 point: [any mention of] driving up

Reading Comprehension Text 2 Passage

Discourse Comprehension Test (Brookshire & Nicholas, 1993)

George arrived at the baseball park just as the sun went down. When he got to his seat, he put on an old baseball glove and began to practice catching imaginary foul balls. He told everyone sitting nearby that he had been a famous high school baseball star.

In the fifth inning, the batter hit a foul ball straight at George. George stood up and made a grab for the ball, but he fell over the railing onto the grass.

When George got back to his seat, a man tapped him on the shoulder. George turned around and the man handed him the ball and a business card. George asked him if he was a baseball scout. "Nope," said the main, "I'm with the circus. One of our clowns retired last week. Would you be interested in taking his place?"

Reading Comprehension Text 2 Items

(1) Did George go to a baseball game?
a. Yes
b. No
(2) Was the man a baseball scout?
a. Yes
b. No
(3) Was George’s baseball glove new?
a. Yes
b. No
(4) Did the batter hit a foul ball?
a. Yes
b. No
(5a) Did George try to impress the people around him?
a. Yes
b. No
(5b) How do you know?
1 point: **[any mention of] “famous high school star”**
.5 point [any mention of] “practice catching imaginary balls”
(6a) Was George sitting in the front row?
a. Yes
b. No
(6b) How do you know?
1 point: **[any mention of] “fell over railing into grass”**
(7a) Did George catch the ball?

a. Yes
b. <u>No</u>

(7b) How do you know?

1 point: [any mention of] "fell over railing into grass" or "man handed him the ball"

(8a) Was it an evening game?

a. <u>Yes</u>
b. No

(8b) How do you know?

1 point: [any mention of] "just as the sun went down"

Reading Efficiency Text

Discourse Comprehension Test (Brookshire & Nicholas, 1993)

Jim Hanson was a traveling salesman who sold paint to hardware stores throughout the state of Iowa. Shortly after breakfast one day, he was driving through the countryside when his car gave a sputter and died. He got out and looked under the hood, but he couldn't see anything wrong. He sat down under a tree beside the road for about half an hour, but nobody came by. Finally, he decided to try again and start the car. He was muttering to himself about cars always breaking down as soon as the warranty expired.

Suddenly he noticed that the needle of the gas gauge was resting on the red "E." Swearing to himself, he opened the trunk and got out an empty gas can. Then he started walking to a gas station.

After about a mile, he saw an old man standing beside the road. He stopped and asked the man how far it was to the nearest gas station. The man thought for a minute. Finally, he said, "Oh, I'd say a couple of miles, as the crow flies." The salesman wiped his sweaty forehead, and asked, "Well, how far is it if the crow is walking and carrying a gas can?"

Prosodic Passage Reading Text

Discourse Comprehension Test (Brookshire & Nicholas, 1993)

It was two days before Christmas and Don Moore was in a crowded waiting room at the airport. He was impatient to be on his way. His brother, who he hadn't seen in three years, was going to be at his parent's home for Christmas. The plane was supposed to leave at ten o'clock, but because of the weather, it was already an hour late.

Finally, the plane arrived and the people began getting in line. Then a woman announced that there was not enough space on the plane for all those who had tickets, and everyone in the room groaned. The woman said that some people would have to wait for the next plane, and she read off a list of names. Don's name was one of the ten that she read off. Immediately, people went over to the woman and began arguing with her.

When they had all left, Don approached the woman. He told her that his name was on the list. "But you see," he continued, "I'm flying to Denver to do an emergency transplant operation this afternoon." The woman smiled and said, "What a coincidence! You are the seventh person on the list who is scheduled to do emergency surgery this afternoon!"

Appendix L: Study Two Correlations between Individual Measures of Prosodic Competence and Segmental Phonological Awareness

Table E. *Study Two: Correlations between measures of prosodic competence (N = 86)*

	Picture Task (AD)	Picture Task (SO)	Text Task (Explicit Syllable)	Text Task (Explicit Word)	Text Task (Implicit Syllable)	Text Task (Implicit Word)
Picture Task (AD)	-	.67**	.51**	.63**	.53**	.50**
Picture Task (SO)	-	-	.55**	.64**	.59**	.52**
Text Task (E Syllable)	-	-	-	.32**	.98**	.28*
Text Task (E Word)	-	-	-	-	.36**	.65**
Text Task (I Syllable)	-	-	-	-	-	.31**
Text Task (I Word)	-	-	-	-	-	-

Note. ** p < .01, * p < .05, AD = Accent Disambiguation, SO = Subject Object, E = Explicit, I = Implicit

Table F. *Study Two: Correlations between measures of segmental phonological awareness (N = 86)*

	Sound Identification	Syllable Identification
Sound Deletion	.42**	.50**
Sound Identification	-	.25*

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

Appendix M: Study Two Correlations between Prosodic Competence Measure Accuracy and Response

Table G. *Study Two: Correlations between accuracy and response times on prosodic competence tasks (N = 86)*

	Picture Task (AD)	Picture Task (SO)	Text Task (Explicit Syllable)	Text Task (Explicit Word)	Text Task (Implicit Syllable)	Text Task (Implicit Word)
RT Picture Task (AD)	-.30**	-	-	-	-	-
RT Picture Task (SO)	-	-.26**	-	-	-	-
RT Text Task (E Syllable)	-	-	-.25*	-	-	-
RT Text Task (E Word)	-	-	-	-.05	-	-
RT Text Task (I Syllable)	-	-	-	-	-.36**	-
RT Text Task (I Word)	-	-	-	-	-	-.60**

Note. ** p < .01, * p < .05, AD = Accent Disambiguation, SO = Subject Object, E = Explicit, I = Implicit

Appendix N: Study Three Parent Consent Form, Information Sheet, and Additional Questions

Online Information Sheet

Study title: Understanding the role of speech prosody and speech rhythm in children's literacy skills

This study is part of a larger project exploring the potential of teaching children about prosody (i.e. speaking and reading with appropriate intonation, stress, and timing) in order to improve literacy skills.

This study is made up of two parts:

(a) a Skype video call with a researcher to answer any questions you may have, and complete a 10 minute vocabulary task with your child

and

(b) two 20 minute self-administered online study sessions of literacy related tasks.

Results of the study will be used to better inform the development of a prosody-related literacy intervention for early readers

What is "prosody" or "speech rhythm"?
Prosody refers the "musical aspects" of speech. Prosody plays a role in many aspects of everyday speech comprehension. For example, it helps differentiates between questions (e.g. "It is raining outside?") vs. statements (e.g. "It is raining outside.") and between positive responses (e.g. "I'm okay today!) vs. negative responses (I'm okay today).

What is the purpose of the study?
The aim of this study is to better understand how an competency of prosody may be important to reading fluency and comprehension skills.

Who is running this study?
The project is being coordinated by Sarah Weidman at Nottingham Trent University, who is being supervised by Professor Clare Wood at Nottingham Trent University.

Does my child have to take part?
Collecting data from your child is completely voluntary, and will not take place unless you give your consent. If your child wishes to stop at any time during the video call or the web-based assessment they may do so.

What would participation involve?
If you wish your child to participate, you will be asked to take part in a short (10 minute) video call with the lead researcher where you will have the opportunity to ask any questions about the research and help set up your child to take part in a video call vocabulary assessment. Your child will then complete two 20 minute self-administered online experiments. All data will be kept securely on an encrypted laptop and only used for research purposes.

How will you protect my child's confidentiality and anonymity?
Data collected from all children will be de-identified. Only the main researcher and her supervisor will have access to identifiable data. All data will be kept on an encrypted laptop in a locked filing cabinet. Raw data will be destroyed upon completion of the project, and all data will be destroyed upon five years of the publication of the research.

What are the benefits/risks in taking part?
There are no personal benefits of having your children take part in the study. However, your child may be contributing to the design of a novel and potentially important literacy intervention. If you choose, your child may also (a) be entered into a raffle to win a Goody Bag for participating and/or (b) receive a Personalised Completion Certificate.

Will my child be recorded, and how will the recording be used?
Your child will be recorded during the reading tasks. The recordings will be de-identified, and listened to only in order to assess reading fluency.

Can I withdraw my child's data from the research?
You may decide to withdraw your child's data from the research study at any time. You have the right to ask that any data we have already collected be withdrawn up until four weeks after taking part in the study.

What happens next?
If you would like your child to take part in the research, please complete consent form below.
You will then be sent and email with further instructions and (a) a link to set up a Skype call with the researcher (b) a link to the first 20 minute session and (c) a link to the second 20 minute session.

Contact details for further information
If you have any queries about this research, please contact Sarah Weidman
Email: Sarah.Weidman2017@my.ntu.ac.uk

Alternatively, you can contact Clare Wood (PhD supervisor)
Email: Clare.Wood@ntu.ac.uk

Thank you for taking the time to read this information sheet, and please do not hesitate to contact the researcher if you have any queries.

Consent Form

Click to confirm:

- I confirm that the purpose of the project has been explained to me, that I have been given information about it in writing, and that I have had the opportunity to ask questions about the research.

- I confirm that the purpose of the project has been explained to me, that I have been given information about it in writing, and that I have had the opportunity to ask questions about the research.

- I understand that my child's participation is voluntary, and that I am free to withdraw my child's data anytime until the close of the study (November 2020).

- I give permission for my child to be recorded while reading aloud during literacy assessments.

- I agree to have my child take part in this study.

Additional Questions

- What is your relationship to the child taking part in the study?
- Please type your name
- Please enter your child's name.
- Please enter your child's birth date (**DD/MM/YYYY**).
- Please select your child's gender. **[Male, Female, Other**]
- Is English your child's first language? [**Yes, No**]
- Does your child speak any other languages fluently or with adults at home? [**Yes, No**] [**If yes, which languages**]
- Which dialect of English does your child primarily speak? [**British, American, Australian, Other] [If other, what dialect]**
- Has your child been diagnosed with dyslexia or another language disorder? [**Yes, No] [If yes, short description]**
- Approximately how often do you read to your child at home? **[Every day or almost every day, Multiple times a week, About once a week, Multiple times a month, About once a month, Less than once a month]**
- Approximately how often does your child read at home? **[Every day or almost every day, Multiple times a week, About once a week, Multiple times a month, About once a month, Less than once a month]**
- Would you like your child to receive a Certificate of Completion after they have completed the study? (Via email to print out) [**Yes, No**]
- Please enter the email which you would like us to send you the link to the experiment.

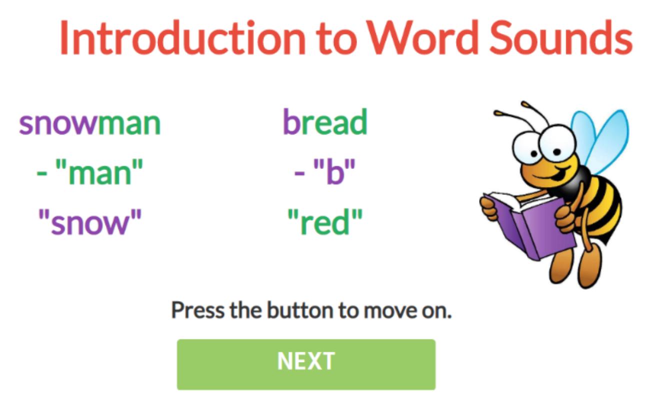
Appendix O: Study Three Closing Survey

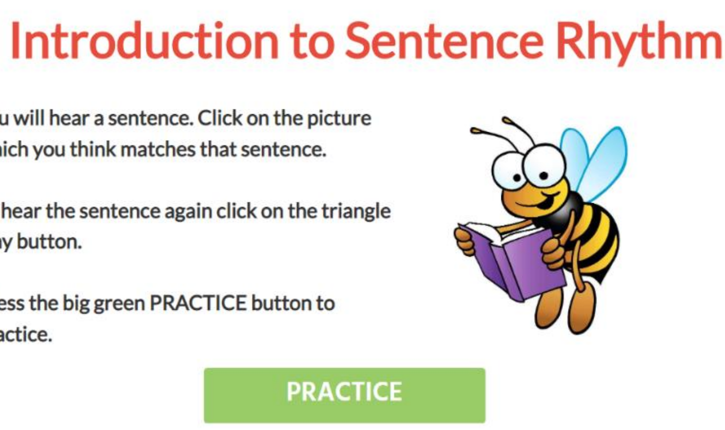
<u>Final Survey</u>

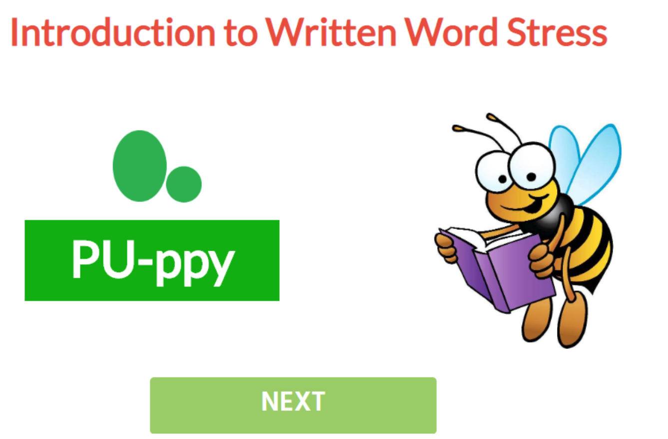
- Please enter your email
- How much did you assist your child with the computer portion of the task? [**Not at all (my child completed the tasks independently), I provide encouragement, but I did not provide assistance, I provided assistance on how to complete the tasks, but did not assist with any answers, I provided assistance with some answers, I helped my child throughout the tasks]**
- Would you be interested in taking part in any future speech rhythm or reading research studies? [**Yes, No]**
- Would you and your child like to be entered into a raffle to win a goody bag? [**Yes, No**]
- Please share any additional feedback.

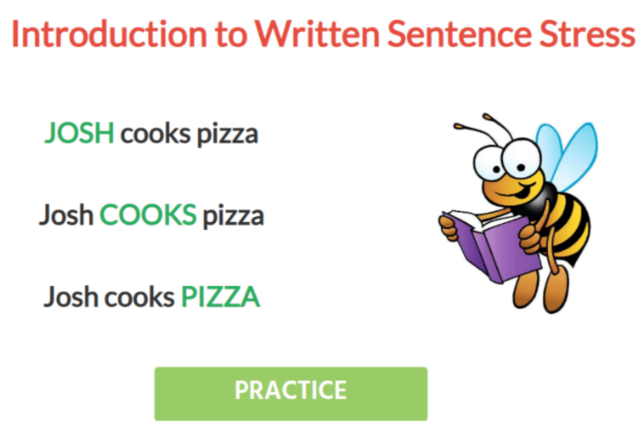
Appendix P: Study Three Participation Certificate

Appendix Q: Examples of Study Three Instructional Screens






Introduction to Written Word Stress
PU-ppy
NEXT


Introduction to Written Sentence Stress
JOSH cooks pizza
Josh COOKS pizza
Josh cooks PIZZA
PRACTICE


Introduction to Story Reading
In this task you are being recorded so it is important to read OUT LOUD! You will be recorded automatically, so just start when you press the green button.
Read the story as QUICKLY and ACCURATELY as you can.
Press the big green NEXT button to move on.
NEXT


Introduction to Story Reading #2
In this task you are being recorded so it is important to read OUT LOUD! You will be recorded automatically, so just start when you press the green button.
Pretend you are reading to a younger child. Try to make the story as exciting as possible!
Press the big green NEXT button to move on.
NEXT

Appendix R: Study Three Segmental Phonological Awareness Measures

Syllable Identification Items

Word	# Syllables	Word Frequency
warm	1	21,018
teach	1	22,492
shape	1	23,161
sports	1	26,037
guitar	2	24,781
adult	2	25,223
broken	2	25,599
plastic	2	26,405
instrument	3	10,141
interview	3	20,464
register	3	20,789
yesterday	3	21,313
activity	4	26,484
intelligence	4	26,776
relationship	4	33,496
responsible	4	41,150

Sound Deletion Items

Word	Word Frequency	Sound Removed	Sound Location	Correct Answer
football	17,788	foot	beg	ball
moonlight	1,138	light	end	moon
fireworks	1,609	fire	beg	works
butterfly	1,798	fly	end	butter
pray	9,582	p	beg	ray
share	57,769	sh	beg	air
thunder	7,624	th	beg	under
inquire	3,137	in	beg	choir
romance	5,730	ro	beg	mance
stripe	1,760	st	end	ripe
layer	9,745	er	end	lay
treat	15,558	t	end	tree
funny	36,614	ee	end	fun
speeding	2,101	ding	end	spee
chaos	19,314	o	mid	case
seeing	38,729	ee	mid	sing

Appendix S: Study Three Prosodic Competence Picture-Based Tasks

Accent Disambiguation Task Items

Everybody watched the *[STARfish/ star---FISH]*.

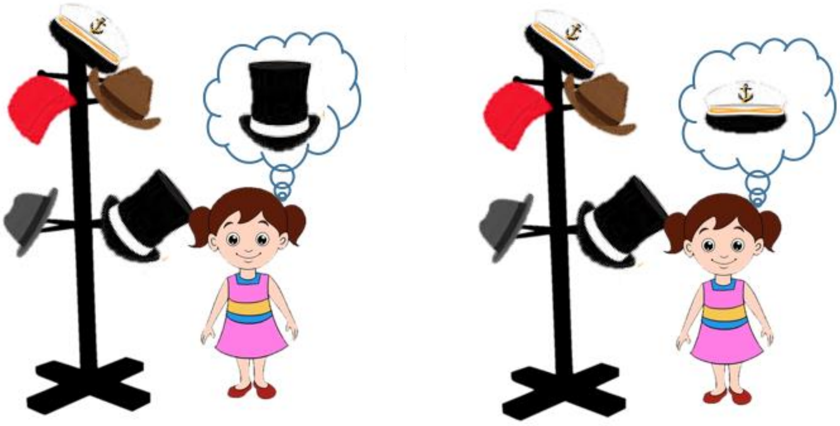
[*I---SCREAM/ ICE cream*] on beach when it's too hot.

Julia pointed at the large*[GREENhouse/ green---HOUSE]*

I live in the *[LIGHThouse/ light---HOUSE]*

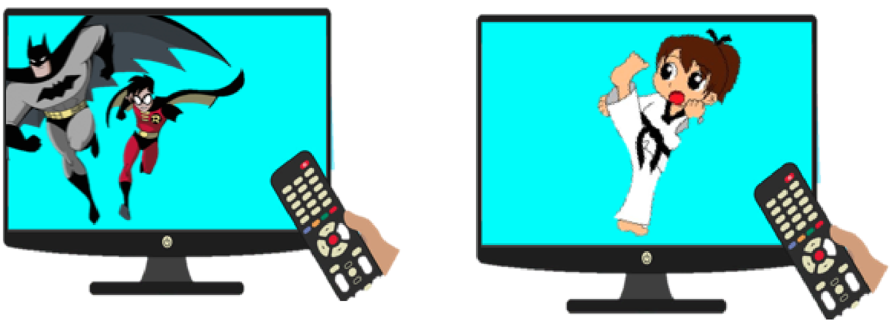
I keep the *[GOLDfish/ gold---FISH]* on the shelf

Can I wear the *[TOPhat/ top--HAT]*?



I don't need a *[HIGHchair/ high--CHAIR]*

Donna's favourite part of the movie was the *[SIDEkick/ side--KICK]*



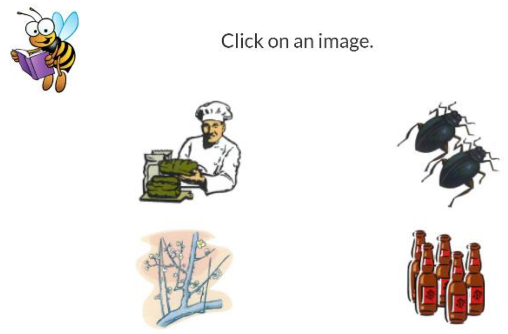
Mispronunciations Task Items

Items removed from original **Revised Stress Mispronunciations Task** (Holliman et al., 2010a; Holliman et al., 2010b) due to concern of cultural translation:

Plaster (Known as 'Band-aid' in US and Australia)
Rubber (Known as 'Eraser' in US)

***Item removed due to zero variability

***Ba-KER

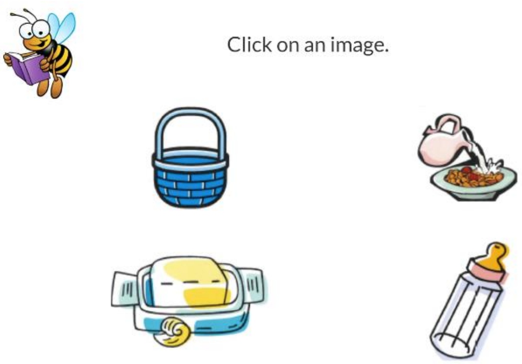


Bar-REL

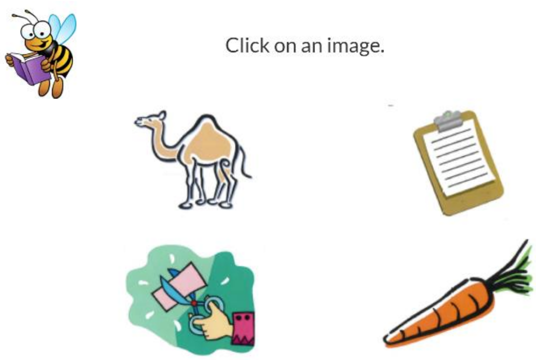
***Buil-DER

But-CHER

But-TER

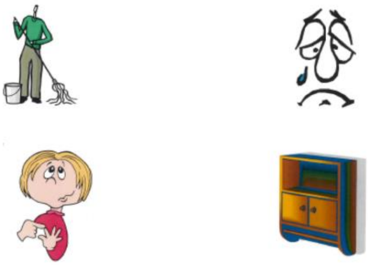


***Car-ROT



Clea-NER

Click on an image.



Coo-KER

Click on an image.

Jum-PER

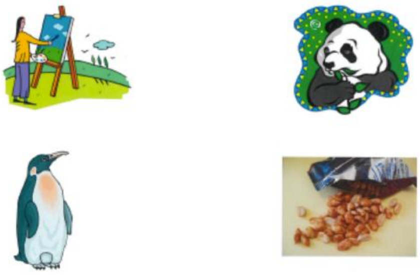
Click on an image.

Mir-ROR

Click on an image.

***Pain-TER

Click on an image.



***Par-ROT

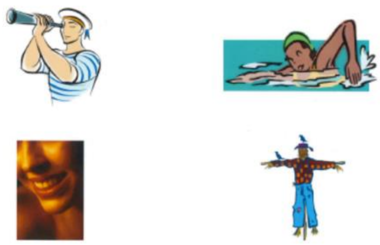
Click on an image.

Ru-LER

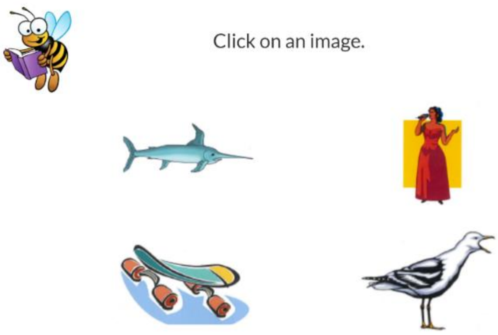
Click on an image.

Sai-LOR***

Click on an image.



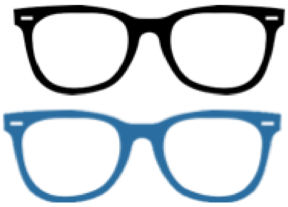
Sin-GER



Ti-GER***

Receptive Phrasing Task Items

Here are my *[blue]* and *[black]* glasses / Here are my *[blue and black]* glasses

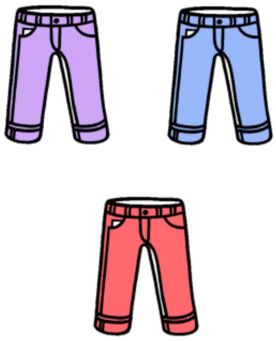


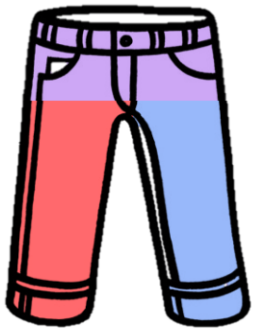
Here are my *[blue]* and *[green]* shoes / Here are my *[blue and green]* shoes

Here are my *[black]* and *[orange]* pants / Here are my *[black and orange]* pants

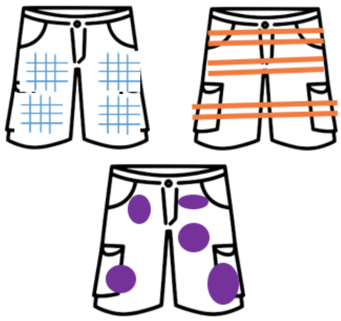
Here are my *[green] [red]* and *[blue]* socks / Here are my *[green, red, and blue]* socks

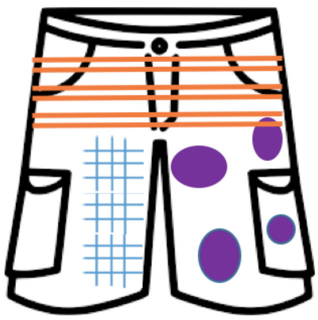
Here are my *[red] [purple]* and *[blue]* trousers / Here are my *[red, purple, and blue]* trousers



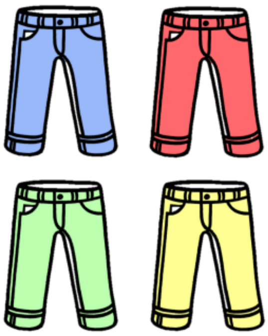


Here are my *[stripy] [dotty]* and *[plaid]* shorts / Here are my *[stripy, dotty, and plaid]* shorts





Here are my *[blue] [red] [green]* and *[yellow]* jeans / Here are my *[blue, red, green, and yellow]* jeans



Here are my *[purple] [blue] [green]* and *[yellow]* socks/ Here are my *[purple, blue, green and yellow]* socks

Appendix T: Study Three Prosodic Competence Text-Based Tasks

Explicit Syllable Stress Task Items

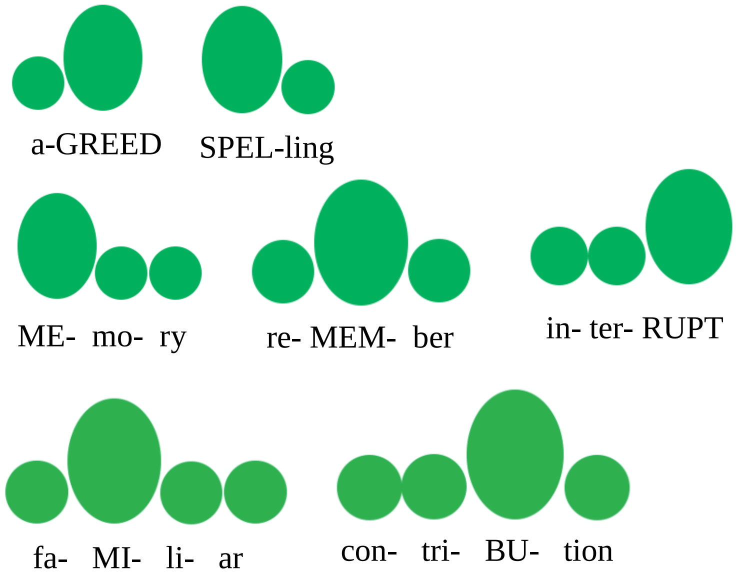
***Starred items removed from final measure due to low internal reliability

Word	Frequency	Syllable	Stress
strictly	10,697	2	1
***scheduled	11,581	2	1
prepared	21,850	2	2
agreed	21,890	2	2
spelling	12,926	2	1
afraid	23,303	2	2
instruction	14,183	3	2
qualified	17,754	3	1
interrupt	15,428	3	3
offensive	11,087	3	2
valuable	15,458	3	1
accounting	15,754	3	2
familiar	26,893	4	2
contributions	11,207	4	3
***mathematics	11,777	4	3
fundamental	11,945	4	3
essentially	15,440	4	2
relationships	14,022	4	2

Implicit Syllable Stress Task Items

Word	Frequency	Syllable	Stress
sunny	4,385	2	1
purple	9,407	2	1
provide	102,813	2	2
support	248,197	2	2
second	150,377	2	1
include	144,495	2	2
***universe	35,314	3	1
***remember	142,627	3	2
personal	108,044	3	1
volunteer	8,374	3	3
memory	114,930	3	1
disagree	25,581	3	3

Syllable Stress Task Images (with Example Items)



Sentence Stress Task Items

Sentence	Target Word Class
Pass me the **yellow** pencil.	Noun
Pass me the yellow **pencil.**	Noun
Where is the **blue** car?	Noun
Where is the blue **car**?	Noun
Jeremy is **outside** playing football.	Noun
Jeremy is outside playing **football.**	Noun
The **cat** is under the table.	Noun
The cat is **under** the table.	Preposition
Look at the bright **star.**	Noun
Look at the **bright** star.	Verb
The girls swam in the **lake.**	Noun
The girls **swam** in the lake.	Verb
The young **boy** did magic.	Noun
The **young** boy did magic.	Adjective
The fluffy puppy **hid** the bone.	Verb
The **fluffy** puppy hid the bone.	Adjective
Phoebe is **sitting** beside the pool.	Verb
Phoebe is sitting **beside** the pool.	Preposition

Appendix U: Study Three Word Reading Measure

Word Reading Task Items

words	year level	words	year level
jump	1	tongue	3/4
run	1	science	3/4
bit	1	international	3/4
work	1	autograph	3/4
rock	1	believe	3/4
set	1	caught	3/4
bank	1	difficult	3/4
today	1	guard	3/4
school	1	heart	3/4
pocket	1	imagine	3/4
quick	1	medicine	3/4
dream	1	various	3/4
yawn	1	occasion	3/4
scared	1	knowledge	3/4
dolphin	1	ancient	5/6
catch	1	awkward	5/6
write	2	leisure	5/6
table	2	stomach	5/6
badge	2	nuisance	5/6
nostril	2	conscious	5/6
donkey	2	disastrous	5/6
giraffe	2	convenience	5/6

Appendix V: Study Three Passage Reading Tasks

Passage Reading Efficiency Text

(Rising Stars and RS Assessment, n.d.).

Some bats have clever ways of hiding among trees, so hungry enemies can't see them.

Sharp-nosed bats rest on tree trunks. Their speckled fur is hard to see against the bark.

Golden-tipped bats hide in bird nests. Their fur looks like moss.

Some tiny tent-making bats make shelters from big leaves. They do this by biting along the middle of a leaf so the sides drop down. The leaf makes a tent shape and a group of bats hangs inside it.

Prosodic Passage Reading Text

(Rising Stars and RS Assessment, n.d.).

The first bright star twinkled in the sky.

Cassie and Grandpa watched it from her window.

"Bedtime, Miss!" said Grandpa, at last."But I don't want to go to bed," Cassie told him. "There's a scary thing living under it."

Grandpa made a funny face. "Really? How horrible!" he said. "What stuff you do dream up."

Cassie jumped into bed. "I won't go to sleep, not with that scary thing under here.

Grandpa rubbed his chin and thought. "Listen," he said. "You settle down, and I'll leave you a Kiss Soldier right here on the bedpost. He'll keep watch over you."

So Cassie snuggled down, and Grandpa put a kiss on his finger and left it on the bedpost. Then he went downstairs.

Reading Comprehension Text 1

(Rising Stars and RS Assessment, n.d.).

Dick King-Smith was born in 1922 and died in 2011 when he was 88 years old. He wrote more than 100 books which have been translated into over 12 languages.

Dick loved farming, but he wasn't very good at it, so he became a teacher. He enjoyed teaching and during one summer holiday he wrote his first book, Fox Busters. The story was based on a real event that happened when he was a farmer and the book was an immediate success. Four years later, Dick gave up teaching to become a full-time writer. His most well-known book is The Sheep-Pig, which was made into a film called Babe.

<u>Reading Comprehension Text 1 Items</u>

(Rising Stars and RS Assessment, n.d.).

(1) Why did Dick King-Smith become a teacher?
- a. He loved children
- b. He wasn't good at writing
- c. His wife was a teacher
- d. For the money
- e. <u>He wasn't good at farming</u>

(2) What is the name of Dick King-Smith's most well-known book?
- a. <u>The Sheep Pig</u>
- b. The Farmer
- c. Fox Busters
- d. Babe
- e. Summer

(3) What jobs did Dick Smith-King have before becoming a writer?
- a. <u>A farmer and a teacher</u>
- b. He was always a writer
- c. A zoo keeper
- d. A head teacher
- e. A shop-keeper

(4) How many books did Dick-King Smith write?
- a. 12
- b. 88
- c. More than 50
- d. <u>More than 100</u>
- e. More than 2011

(5) Why do you think Dick King-Smith gave up teaching?
- a. He wasn't very good at it
- b. He wanted to make a movie
- c. <u>He wanted to do more writing</u>
- d. He didn't enjoy teaching
- e. He missed farming

<u>Reading Comprehension Text 2</u>

(Rising Stars and RS Assessment, n.d.).

Fidelio and Charlie followed Mr O to the back of the counter. They walked through a tinkling bead screen and into the kitchen. Mr O showed them to a small door at the back of the kitchen, and then they were in a long passage lined with shelves of disgusting-looking pet food.

"Come along," urged Mr O as the boys gazed around them. The shelves came to an end and the passage narrowed. They were now walking on a rough stone floor and this very soon became a path of hard earth.

As Mr O scurried along he seemed more and more to take on the appearance of a mole or some other burrowing creature.

Charlie realized that the ceiling was now so low he could rest the flat of his hand on its damp surface. It was getting dark. When the light had almost petered out, they stepped into a small round cavern. It was lit by a single lantern hanging from the ceiling, and all around the walls, huge tea chests stood shoulder to shoulder with plastic sacks and wooden crates. There seemed to be no way out except the way they had come.

Reading Comprehension Text 2 Items

(1) Who did Fidelio and Charlie follow to the back of the counter?
   a. A small mole
   b. <u>Mr. O</u>
   c. They went alone
   d. A mysterious creature
   e. Charlie's mum

(2) Which of the following phrases was NOT used to describe the long passage?
   a. It was lined with shelves of pet food
   b. It became narrower
   c. <u>There were golden chests</u>
   d. There was a rough stone floor
   e. The path became hard earth

(3) What animal is Mr O compared to as he scurries along the passage?
   a. <u>A mole</u>
   b. A curious mouse
   c. A parakeet
   d. A large rodent
   e. An otter

(4) What impression of the cavern do you get from the story?
   a. It's very bright
   b. It's mostly empty
   c. <u>It's dark and gloomy</u>
   d. There are many doors
   e. There are animals living in it

(5) Which line(s) of the story makes you think the boys had never been into the cavern before?
   a. "A tinkling bead screen..."
   b. "They stepped into a small round cavern..."
   c. "It was getting dark"/ "It was lit by a single lantern..."
   d. <u>"The boys gazed around"/ "Charlie realized that the ceiling..."</u>
   e. "Disgusting-looking pet food"/ "Huge tea chests..."

Reading Comprehension Text 3

(Rising Stars and RS Assessment, n.d.).

The boy standing in front of the wolf's cage doesn't move a muscle. The wolf paces backwards and forwards. He walks the length of the enclosure and back again without stopping. He's starting to get on my nerves, the wolf thinks to himself.

For the last two hours the boy has been standing in front of the wire fencing, as still as a frozen tree, watching the wolf walking. What does he want from me? The wolf wonders. The boy makes him feel curious. He's not worried (because wolves aren't afraid of anything), just curious. What does he want? The other children jump and run about, shout and burst into tears, stick their tongues out at the wolf and hide their heads in their mums' skirts. Then they make silly faces in front of the gorilla's cage, or roar at the lion as he whips the air with his tail.

But this boy is different. He stands there silently, without moving a muscle. Only his eyes shift. They follow the wolf as he paces the length of his wire fencing.

What's your problem? Haven't you ever seen a wolf before?

Reading Comprehension Text 3 Items

(1) What does the wolf think is so unusual about the boy's behaviour?
   a. He doesn't make a sound
   b. He bursts into tears
   c. He sticks out his tongue
   d. He follows the wolf as he paces
   e. He stands completely still

(2) Why is the phrase still as a frozen tree a particularly appropriate simile for the wolf to use?
   a. The wolf has a frozen tree in his cage
   b. The boy holds his arms like branches
   c. It's freezing cold
   d. The wolf comes from a cold part of the world
   e. The wolf hates trees

(3) What do you think the wolf expects the boy, and the other children, to do?
   a. Ignore him completely
   b. Jump and run about, shout and burst into tears
   c. Stick fingers in his cage
   d. Take pictures and selfies
   e. Sing to him

(4) Which word in this section describes how the wolf feels?
   a. Worried
   b. Curious
   c. Frustrated
   d. Hungry
   e. Humoured

(5) What is the wolf's cage made out of?
   a. Metal bars
   b. Wire fencing
   c. There is no cage
   d. A large moat
   e. Four panes of glass

Appendix W Study Three Correlations between Individual Measures of Prosodic Competence and Segmental Phonological Awareness

Table H. *Study Three: Correlations between measures of prosodic competence (n = 49)*

	Picture Task (Mis)	Picture Task (RP)	Text Task (Explicit Syllable)	Text Task (Implicit Syllable)	Text Task (Explicit Word)
Picture Task (Mis)	-	.27+	.10	.27+	.50**
Picture Task (SO)	-	-	.21	.07	.34*
Text Task (E Syllable)	-	-	-	.34*	.47**
Text Task (I Syllable)	-	-	-	-	.35*

Note. ** $p < .01$, * $p < .05$, + $p < .01$, Mis = Mispronunciations, RP = Receptive Phrasing, E = Explicit, I = Implicit

Appendix X: HMLR Accounting for Variance in Phrasing

Table I. *Study Three: HMLR Accounting for Variance in Phrasing Component of Prosodic Passage Reading from Vocabulary, Segmental PA, Word Reading, and Prosodic Competence*

Prosodic Passage Reading	R	R^2	ΔR^2	β	*t*	B
Step 1	.51	.26	.26			
Vocabulary				.14	0.9	.01
Segmental PA				.21	1.2	.01
Word Reading				.30	2.1*	.11
Step 2	.51	.26	.00			
Vocabulary				.14	0.8	.01
Segmental PA				-.21	1.2	.01
Word Reading				.30	1.9	.11
Prosodic Competence				.02	0.1	.00

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

Appendix Y: HMLR Accounting for Variance in Prosodic Passage Reading (Without Age Control)

Table J. *Study Three: HMLR Accounting for Variance in Prosodic Passage Reading from Vocabulary, Segmental PA, Word Reading, Passage Reading Efficiency and Prosodic Competence (n = 49)*

Prosodic Passage Reading	R	R^2	ΔR^2	β	*t*	B
Step 1	.84	.71	.71			
Vocabulary				-.10	-1.0	-.01
Segmental PA				.35	4.4**	.45
Word Reading				.37	3.0**	.15
Passage Reading Efficiency				.47	4.1**	.04
Step 2	.89	.79	.00			
Vocabulary				-.10	-0.9	-.01
Segmental PA				.36	4.2**	.46
Word Reading				.37	3.0**	.15
Passage Reading Efficiency				.46	4.1**	.03
Prosodic Competence				-.02	-0.2	-.01

Note. ** p < .01, * p < .05, PA = phonological awareness

Appendix Z: Confirmatory Factor Analysis of AMDFS and MDFS

Table K. *Study One and Two Correlations between Four Dimensions of the AMDFS (n = 191)*

	Expression	Smoothness	Pacing
Phrasing	.66**	.62**	.56**
Expression	-	.49**	.39**
Smoothness	-	-	.59**

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

Table L. *Unstandardized Loadings (Standard Errors) and Standardized Loadings for One Factor Confirmatory Model of Adult Multi-Dimensional Fluency Scale (n=191)*

Factor 1	Unstandardized	Standardized
Smoothness	1 (-)	.744
Phrasing	1.02 (.163)	.865
Expression	0.78 (.124)	.667
Pacing	0.75 (.112)	.679

Table M. *Study Three Correlations between Four Dimensions of the MDFS (n=49)*

	Expression	Smoothness	Pacing
Phrasing	.60**	.79**	.75**
Expression	-	.54**	.72**
Smoothness	-	-	.77**

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

Table N. *Unstandardized Loadings (Standard Errors) and Standardized Loadings for One Factor Confirmatory Model of Multi-Dimensional Fluency Scale (n=49)*

Factor 1	Unstandardized	Standardized
Phrasing	1.0 (-)	0.859
Expression	0.95 (.331)	0.885
Smoothness	0.67 (.237)	0.685
Pacing	0.94 (.313)	0.902