CONTRIBUTIONS OF PROSODIC SENSITIVITY AND MORPHOLOGICAL AWARENESS TO WORD LEVEL READING: A PERCEPTUAL TASK DEVELOPMENT STUDY

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ABSTRACT

Morphological awareness and prosodic sensitivity are metalinguistic skills, which have been shown to be significant predictors of word level reading in children (Clin, Wade-Woolley, Heggie, 2009; Jarmulowizc, Tarran, & Hay, 2007). The current studies first validated an experimental auditory lexical decision task for prosodic sensitivity to stress shifting in words and pseudowords; secondly, they validated a stress perception task for words; and third, they validated a morphological awareness task. The relationship between prosodic sensitivity, morphological awareness, and reading tasks was also analyzed. Results of the first study indicated that the experimental prosodic sensitivity task accounted for 9% of the variance in word level reading outcomes and that it was significant for real words but not pseudowords. The contribution of prosodic sensitivity to stress shifts in real words was unique when controlling for age, vocabulary, and morphological awareness. This study also found that morphological awareness predicted an additional 4% of the variance in word reading outcomes.

The results of the second study found that the prosodic sensitivity to accurate stress and morphological awareness were not significant predictors in word or passage level outcomes. Although both metalinguistic skills were not significant predictors when individually predicting unique contributions in word level outcomes, they were found to be significant components in a metalinguistic factor through factor analysis. This metalinguistic factor was found to significantly predict 5% of the comprehension

outcomes for children in 3, 4, and 5 grades. These findings strengthen the notion that word storage is a highly dependent on integration and interrelatedness in the processing of linguistic information.

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LIST OF ABBREVIATIONS

DSA – developmental spelling analysis

DWPT – derived word production task

ELL – English Language Learner

LD – Learning Disabled

LQH - Lexical Quality Hypothesis

LW ID – Letter Word Identification, a subtest of the Woodcock Johnson, third edition Achievement battery.

MAT – morphological awareness task

PST – prosodic sensitivity task

TELPA – Test of English Language Proficiency

TWS – test of written spelling

VOCAB – vocabulary raw score on the Woodcock Johnson, third edition Achievement battery.

WA – word attack, a subtest of the Woodcock Johnson, third edition Achievement battery.

WJ-III – Woodcock Johnson Achievement Test, third edition.

WRT-extended (WRT-E) - word reading task by Carlisle (2000) extended with a fourth set of low frequency morphologically complex words.

LIST OF KEY TERMS AND DEFINITIONS

Derived form. The form of a word where the base of the word is changed by adding an affix. For example some derived forms of *kiss* are *kisses, kissing,* and *kissed.*

Lexicon. In a language, it is the vocabulary. In a person, it is the mental dictionary where words are stored.

Lexical. It is of or relating to the words or vocabulary of a language.

Lexical specificity. It is the the precision by which words are stored in the mental dictionary (lexicon). Coined by Charles Perfetti in his Lexical Quality Hypothesis (Perfetti, 2007).

Linguistic awareness. The understanding of how words and language work.

Metalinguistic awareness. The conscious knowledge and awareness for the structure and function of language and the ability to think about, reflect upon, and consciously manipulate it.

Morpheme. The smallest meaningful unit in language. It is a word (*teach, catch,* etc.) that cannot be divided any further or an affix that cannot stand alone (*-er*, *-ing,* etc.).

Morphology. The study of the structure of language, how words are combined.

Morphological awareness. The conscious knowledge of and the ability to manipulate word structure. In the tasks for these studies, this was assessed by asking a participant if there was a smaller word inside of a lager word (e.g. *teach/teacher*).

Morphophonology. Pertaining to rules or aspects of language that specify the pronunciation of morphemes; pertaining to a writing system that spells meaningful units (morphemes) instead of surface phonetic details in speech; a characteristic of English orthography (Moats, 2010).

Orthography. A writing system.

Orthographic transparency. When a base word maintains its orthographic structure in the derived form. For example, *move* retains its orthographic string within *movement* therefore, it is orthographically transparent.

Phonology. The area of linguistics focused on the study of the speech-sound system and the sound patterns of spoken language, including the rules and patterns by which the phonemes are combined into words and phrases.

Phoneme. The smallest sound unit in language that influences the meaning of a word, e.g. the word *cat* is made up of three phonemes: /c/, /æ/, and /t/, if one of these phonemes is changed, the word also changes. Phonemes are considered abstract because when the listener hears spoken language he/she does not hear separated phonemes in words but rather a blending of syllables into a sound stream. There are a total of 41 phonemes in Standard English.

Phoneme (or phonemic) awareness. The understanding that words are composed of individual sounds.

Phonological awareness. The understanding that spoken words can be broken down into smaller parts such as syllables, onset-rimes, and phonemes. Phonological awareness may be categorized as a subset of skills within the broader areas of phonological processing and metalinguistic knowledge.

Phonological processing. The use of phonological information in processing spoken and written language. Phonological processing encompasses phonological awareness as one construct but also distinguishes two other constructs: 1) coding phonological information in working memory, and 2) retrieving phonological information from long-term memory.

Phonological transparency. When a base word maintains its phonological features in the derived form making the pronunciation stable. For example, *enjoy* retains its phonological features within the derived form of *enjoyment*. It is therefore phonologically transparent. Children who recognize phonological units that speakers attach to words begin to realize regularities and attach meaning (*-ment* means 'a state or quality' and is attached to verbs).

Prosodic sensitivity. The ability to detect suprasegmental phonological aspects in words. In this research project, it is the awareness of and/or sensitivity to correct stress production in derived words. The skill at which a participant will hear incorrect stress, such as VOLcanic (strong-weak-weak stress pattern), and still know that although the word is incorrectly stressed it is a real word.

Prosody. Broadly defined, it is the rhythm, stress, and intonation of speech. In this study the aspect of stress within words was considered. More specifically, the PST tested prosodic sensitivity to prosodic shifts that occur when the suffixes *–ic* and *–ity* are added to base words.

Semantic transparency. When a derived word meaning embraces the meaning of the base word form (e.g. *teacher* from *teach*).

Shift words. Words where the base form of the word is not fully represented in the derived form (morphologically complex word). For example, in the word *natural* where *nature* is the base word in the affixed word *natural* but the derived form has phonological (long 'a' to short 'a') changes and orthographic changes (dropping the silent –e to add –al). In this body of research these words are present in the WRMT.

Structural transparency. A term relating to word structure and it encompasses phonological, orthographic, and semantic transparency. The transparency, or efficiency in lexical access, is mediated by the components of structural transparency, which is the degree to which words can be easily processed for their parts (Carlisle, 2004). The more structurally complex a word is the more difficult it becomes to read.

Suprasegmental phonological features. Aspects of the sound system that are not language. They are the pitch, rhythm, loudness, meter, and rate that are overlaid onto the system of phonemes when language is spoken.

Surface frequency. A term used in word frequency research which defines the frequency of an exact orthographic string of letters. The surface frequency of the word *catch* would be calculated by finding how many times the exact string of letters c-a-t-c-h appeared in text. Words with high surface frequency are more prevalent in text.

Transparent words. Words where the base form of the word is fully represented in the derived form (morphologically complex word). For example, in the word *powerful* where *power* is the fully represented base word in the affixed word *powerful.* In this body of research these words are present in the WRT.

CHAPTER I

GENERAL INTRODUCTION

Overview

Word identification involves the continuous coding and decoding of linguistic components that include phonological strings (including prosodic units), morphemes, orthographic patterns, and words (Verhoeven & Carlisle, 2006). The lexical quality, or the extent to which the linguistic components are fully specified, collectively interwoven, and interlocked in a reader's memory, plays a role in how quickly and accurately word identification occurs both in listening and reading (Reichle & Perfetti, 2003). The more skilled a reader becomes, the more quality lexical representations have, resulting in improved comprehension and learning (Stanovich, 1986). Higher quality lexical representations create stability and synchronicity in the reading brain networks because linguistic knowledge about spellings, pronunciations, and meanings is more tacit (Berninger & Richards, 2002; Frost et al., 2009; Perfetti, 2007).

The quality of a reader's lexicon increases as the reader becomes more aware of the linguistic components of language; this is otherwise called *metalinguistic awareness* (Carlisle, 2000). Metalinguistic awareness is the conscious knowledge and awareness for the structure and function of language (Westby, 2004). Many studies have shown that metalinguistic awareness of phonological components, phonological awareness, is a necessary precursor to language and reading development and that its acquisition is the best-known predictor of later reading achievement (Share & Stanovich, 1995; for reviews see Adams, 1990; National Reading Panel, 2000). More recent studies have also established the existence of a relationship between the awareness of suprasegmental phonological features (rhythmic and stress patterns), or *prosodic sensitivity*, and reading ability (David, Wade-Woolley, Kirby, & Smithrim, 2007; Goswami et al., 2002; Holliman, Wood, & Sheehy, 2008).

Morphological awareness, the conscious knowledge of and the ability to manipulate word structure, has received less attention than phonology. Nevertheless, recent work has begun to establish a strong relationship between morphological awareness and literacy development (Carlisle, 2000; Carlisle, 2003; Freyd & Baron, 1982; Nagy, Berninger, & Abbot, 2006; Tyler & Nagy, 1990). Morphological and prosodic sensitivity together correlate with reading ability in children who have mastered basic decoding, even when controlling for phonological awareness (Deacon & Kirby, 2004; Whalley & Hansen, 2006). Furthermore, beyond the unique relationships among morphological awareness, prosodic sensitivity, and reading ability a linguistic interaction exists among them, which may be referred to as *morphophonology* (Jarmulowicz, Hay, Taran, & Ethington, 2008). Morphophonology plays an increasing role in reading ability as students begin to read more complex words (Henry, 2010; Nagy, Berninger, Abbott, & Vermeulen, 2003).

Understanding the contributions of morphological awareness to reading may require distinguishing it from or understanding the shared variance with, the awareness of suprasegmental phonological features, *prosodic sensitivity*. Fowler and Liberman (1995) suggest that the contribution of morphological knowledge is seen as a derivative of phonological abilities, while others see it as an independent contributor to reading (Singson, Mahony, & Mann, 2000). It is also plausible for morphological and suprasegmental phonological information to be viewed as representational properties, or features, which need to be bound together to create fully specified words in the lexicon. If the latter is the case, the quality of linguistic representations and the stability of the knowledge about form and meaning change and affect the lexical access. One example of this view is Perfetti's (2007) *Lexical Quality Hypothesis*, in which 'quality' is defined as the "extent to which a mental representation of a word specifies its form and meaning components in a way that is both precise and flexible" (p. 359). Precision is necessary because *prude* and *prune* and *won* and *one* are not the same. Flexibility is also necessary to compare, contrast, and find similarities in information like "*googled*" and the idea, "a search on the internet done using the Google search engine." A reader also needs precision and flexibility for words like *dessert,* as in "*you can eat your dessert now*" or "*we traveled through the dessert*" (Perfetti & Hart, 2001).

The degree to which representations are specified within the lexicon has speed and accuracy implications for retrieval, which are important when considering that both morphological and suprasegmental phonological knowledge contribute to a fully specified stored word in the lexicon. A high quality, fully specified word has accurate representations for all linguistic components -phonology, grammar, morpho-syntax, and constituent binding, where the binding is a consequence of specified components, which together create the word identity (Perfetti, 2007). A low quality word is not fully specified and is therefore, less stable. Lack of specification and stability slows, and potentially impairs, word retrieval when linguistic components are activated and retrieved asynchronously, resulting in slow and laborious decoding, inaccurate stress production/perception, and inaccurate meaning. This asynchronous or synchronous retrieval of the linguistic components in words, such as the morphological and prosodic information in the case of the following studies, may contribute information about accurate retrieval when predicting reading skills and comprehension.

The present studies are experimental investigations validating the use of two word level measurement tasks for morphological awareness and prosodic sensitivity of third through fifth grade children and adults. The studies entail assessment of language knowledge (vocabulary), metalinguistic development (suprasegmental phonological awareness and morphological awareness), and performance on different reading tasks (word and general outcome measures). They include the following research questions:

1) Would performance on auditory lexical decision tasks measuring prosodic sensitivity to stress shifting in single words significantly account for performance on reading tasks when controlling for age, ACT, and vocabulary in adults? This was the primary research question of the first study with adults. It was an exploratory study examining the relationship between a created prosodic sensitivity task and reading ability. The task was an auditory lexical decision task designed to pinpoint the construct of prosodic sensitivity in isolation of other metalinguistic processes. Being that the task was related to word level reading outcomes, the next stage of the study was data collection with children for the confirmation of a behavioral response, the goal of the second study.

2) Would performance on auditory lexical decision tasks measuring prosodic sensitivity to stress shifting and morphological awareness in single words significantly account for performance on reading tasks, including morphologically complex tasks, in third through fifth grades when age and vocabulary were controlled for? Morphological awareness and prosodic sensitivity to more complex derived words was expected to

contribute significant but small amounts of variance in word level reading tasks. Prosodic sensitivity to stress shifting words was expected to contribute a greater portion of unique variance as found in previous research (Clin, Wade-Woolley, & Heggie, 2009; Jarmulowicz, Taran, & Hay, 2007; Thompson, in preparation [Manuscript #1]). Thus, it was anticipated that language knowledge would account for more of the variance on third through fifth grade reading outcomes than would both morphological awareness and prosodic sensitivity combined, but each would contribute small but significant variance. It was also anticipated that those who did well on all outcome measures would also do better on the experimental tasks, suggesting they have fully specified lexical representations, which contribute to reading comprehension. There were also expected grade level performance differences as found in Singson et al. (2000).

3) Would the newly created auditory lexical decision tasks for morphological awareness and prosodic sensitivity be validated as consistent behavioral measurement tools when delivered through a standardized protocol on a computer? As noted in the first goal, the main purpose in the creation of auditory lexical decision tasks, which mimicked what previous research had done with production tasks, was to isolate these tasks from other metalinguistic skills. The creation of both of these tasks on computer also removed examiner bias or error as a confounding factor. Creating measures of prosodic sensitivity and morphological awareness that are easy to administer, valid, and reliable, would be ideal. It was expected that the tasks would have a consistent behavioral measurement in the prediction of word level reading and that they would correlate significantly with other linguistics and reading outcomes.

LITERATURE REVIEW

Linguistic Skills and Reading Development

A critical feature of language development and therefore reading development is the extraction of language from meaningful contexts for reflection upon its structural properties (Kuo & Anderson, 2006). This reflection on structural properties requires sensitivities to features in the language known as metalinguistic awareness. This awareness allows a person the appreciation of the ways oral language maps onto the written language -- how sounds map onto graphemes, how words are made up of sounds, etc. There are different aspects of metalinguistic awareness and the following studies focus on two, suprasegmental phonological awareness (prosodic sensitivity) and morphological awareness.

Early reading development and acquisition is focused on the mapping of oral language onto written language. This requires the metalinguistic awareness for phonology and how the sound system of the language can be segmented, blended, and manipulated, which are necessary skills for early and later reading achievement (Ehri, 2004). However, as words grow increasingly more complex in later elementary years, other aspects of linguistic awareness are necessary in the development of reading words and reading comprehension (Carlisle, 2003). These aspects include morphological awareness and prosodic sensitivity (Clin, et al., 2009). Because the studies in this dissertation focus on these metalinguistic skills, further discussion is warranted.

Morphological Awareness

Morphology refers to the understanding of word structure and the creation of words using the smallest meaningful units in words, morphemes. Morphemes may be whole words (*help*), parts of words (*pre-, -less*), or single phonemes (*-s*) (Arnoff & Fudeman, 2005). The conscious sensitivity to infer and manipulate word meaning and/or function through morphemes is morphological awareness (Ebbers, 2008). Explicitly, morphological awareness refers to the knowledge about how two metalinguistic skills go together, sound (phonological awareness) and meaning (semantic awareness), as seen in Figure 1 (Kuo & Anderson, 2006).

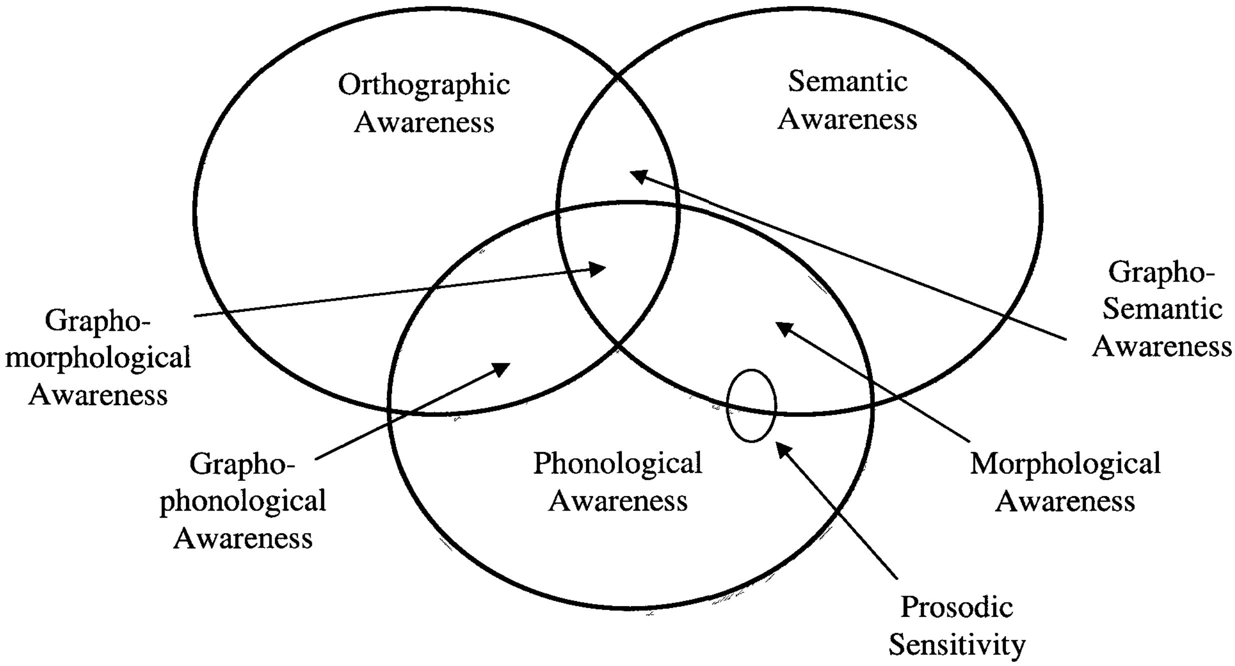

Figure 1. Relationships between metalinguistic skills (adapted from Kuo & Anderson, 2006). Copyright 2006, reproduced with permission of TAYLOR & FRANCIS INFORMA UK LTD - JOURNALS in the format Dissertation via Copyright Clearance Center.

Morphological awareness is also the knowledge pertaining to a word formation rule system, which is largely implicit and guides the possible combinations of morphemes. Contributions of morphological awareness to reading proficiency for the school age population are well established (Carlisle, 2000; Deacon & Kirby, 2004; Nagy et al., 2006; Nagy et al., 2003; Singson et al., 2000), and this contribution becomes larger as students develop literacy skills beyond decoding (Henry, 1993). For example, in second grade morphological awareness may account for 15% of the variance in vocabulary understanding (McBride-Chang, Wagner, Muse, Chow & Shu, 2005) and by fifth grade for potentially 53% (Carlisle, 2000).

As children progress through school, their knowledge of language and how to think about language become more explicit as they are instructed in the acts of reading and writing. Anglin (1993) suggested there is a gradual increase in morphological problem solving as students move from grade one to grade five. In this study, older children were able to demonstrate they could figure out a likely meaning of an unfamiliar word by analysis of the word parts. The ability to understand talk about how a *treelet* is a 'very small tree' is considered explicit knowledge. In Anglin's (1993) study, he discussed how a fifth grader knew what a *riverlet* was which implied the student used analogical reasoning to infer meaning for an otherwise unfamiliar word. This is important in relation to the current studies because as Anglin (1993) noted, grade level differences in morphological awareness give insight into morphological problem solving abilities and impacts on reading comprehension.

Two of the factors that affect morphological development are frequency and structural transparency. Frequency is important at the base word and affix level. Structural transparency is composed of three other transparencies: phonological, orthographic and semantic. The effects of frequency and structural transparency on morphological awareness development will be discussed with relevance to their contributions to these studies.

Frequency. Frequency refers to the number of times a base word or an affix occurs. Frequency is important in the study of morphological awareness because as Nagy and Anderson (1984) found, affixed words (having free and bound morphemes) outnumber base words (having a free morpheme) by a factor of about four to one. Specifically, White, Power, and White (1989) looked at affixed words and found that 80% of the prefixed words in children's texts contain the most common prefixes, and of the 80% of words that had suffixes, 90% of them were inflectional or neutral derivational suffixes (e.g., inflectional: *-ing*, *-ed*; neutral: *-ment, -ful*). Nagy and Anderson (1984) commented "while context is often not sufficient to determine the meaning of an unfamiliar word, it may provide enough information to permit a guess at the appropriate meaning of a word whose semantic content is partially determined by its morphology" (p. 327). For the most part, this ability to guess at the appropriate meaning of a word is based on the frequency of most common affixes in printed text. Thus, the more frequent a word's parts are and the more known the context is, the greater the likelihood that the student will know it semantically.

Throughout the language literature, lexical frequency effects on production are plentiful (Grainger, 1990; Jarmulowicz & Taran, 2007; Newman & German, 2002). For example, in a study by Jarmulowicz and Taran (2007) words were chosen for a derived word production task (DWPT) based on both high and low lexical frequencies. The DWPT consisted of specifically chosen semantically transparent high and low frequency words and neutral and neutral stress-changing suffixes, such as *–tion* and *–ity*, within sentences and in isolation to examine their questions. The DWPT was completed in two formats, with or without semantic context. Half of the group received the words in sentences and half received the task without semantic context. Each participant receiving the semantic context was presented with the sentence in writing, and the sentence was read aloud. Once the sentence was read, the participant was asked to add the appropriate suffix to the base word. For example, participants were asked to "put /ʃən/ (*-tion*) on the end of *illustrate*" to produce the word *illustration.* The children in the no context condition were told to integrate two parts of a word in order to make a new word (e.g., illustrate + *-tion*). High frequency words contributed significantly to both knowing word meanings and accurately producing primary stress (Jarmulowicz & Taran, 2007). Therefore, it appears that frequency of words and their constituent morphemes affect morphological perception and production.

Although the Jarmulowicz and Taran's (2007) research demonstrated that frequency effects impact how students produce derived words, it also illustrated that when given semantically known words, children were more apt to produce the correct derived word in the production task. This semantic knowledge is impacted by 'semantic transparency', which is part of how structurally transparent a word is and will be discussed along with orthographic and phonological transparency in the following section.

Structural transparency. Structural transparency is the degree to which words can be easily processed for their parts. Transparency in morphologically complex words is affected by relational knowledge between phonological structure, orthographic structure, and semantic content (Carlisle, 2004). These aspects of language can obscure how a word is processed morphologically and a person's awareness of the morphemes within a word. Carlisle (2004) suggested "to the extent that a morphologically complex word lacks transparency in sound, spelling and meaning, its morphological composition will go unnoticed by a large portion of the children who encounter it" (p. 324). These individual forms of transparency deserve further discussion.

Semantic transparency. The degree of semantic transparency (e.g., relatively transparent to relatively opaque) affects the perception of morphological relationships and morphological learning. As students learn language, their awareness of semantic relationships is affected by the complexities of word meanings and this, in turn, influences perceptions of how morphemes relate to each other (Carlisle, 2004). Semantic transparency has been addressed in the literature. For example, Derwing and Baker (1979) gave children and adults word pairs which varied on two dimensions – phonologically similar (PS) and semantically similar (SS). Participants were asked to indicate whether they thought one word "came from" another (e.g. *teacher/teach* (PS), *puppy/dog* (SS)). Findings suggested younger school-age children tended to think two words were related when they were phonologically similar while the older students were more able to recognize morphological relations (Derwing & Baker, 1979).

In another study relating to semantic transparency, Nagy and Anderson (1984) found that unfamiliar words in printed classroom texts tend to be semantically transparent, especially those with phonological and orthographic similar bases (e.g. *fair/fairness*) as well as those with derived forms and known affixes. The authors estimated that there were 139,020 semantically transparent derived forms in children's text in grades 3-9 and only 49,080 derived words that were relatively opaque. This large corpus of semantically transparent words allows children to access the morphological information easier and it also allows the teacher to explicitly instruct students about the morphological information in unfamiliar derived words.

Orthographic transparency. The current studies do not use an experimental measure where orthographic structure affected lexical decision tasks but nonetheless, an orthographic knowledge task was used as an outcome measure in Manuscript #2 (Chapter 3). Understanding the relationship between orthography and morphology is important for this reason.

Orthography is the conventional spelling system of the English language. Regularities in the orthography, like those in phonology, are believed to contribute to a student's awareness of the relationships in morphologically complex words that vary in their phonological forms (Carlisle, 2004). When reading words however, processing of morphological information may be inhibited when the derived form retains relatively little of the orthographic gestalt of the base form such as in the words *divide* and *division* (Ebbers, 2004). A study by Carlisle (1988) examined the relationships of oral knowledge of derivational morphology and the spelling development of fourth, sixth, and eighth graders. Typically progressing fourth, sixth, and eighth graders were compared with ninth graders with learning disabilities on both oral and written word generation. For all age levels, the ability to generate derived forms orally was the antecedent to spelling these forms. The complexity of the relationship between the base word and the derived word affected how easily the word was spelled, especially the words that had phonological and orthographic changes (Carlisle, 1988). These findings offer insight into Perfetti's (2007) *LQH* suggesting the more fully specified a word is for all its features, even for complex relationships between the base and derived forms, the more efficient retrieval is, in this case spelling.

Phonological transparency. Phonologically transparent words are those for which the pronunciation of the base form remains intact in the derived form (e.g., *hard* and *harder*). In contrast, a phonologically nontransparent, or opaque, word is a base word, which undergoes a change in pronunciation as it becomes derived (e.g., *redeem* and *redemption).* The effects of phonological transparency in reading have been investigated. Fowler and Lieberman (1995) researched the effects of phonological transparency in reading and concluded that both good and poor readers exhibited difficulties with phonologically opaque words. In addition, poor readers had difficulties in perceiving morphological relations that change the sound pattern.

Difficulties with phonologically opaque words also appeared in research by Singson et al. (2000). In this study, the authors created morphological tasks in efforts to examine if morphemes were an essential component of decoding. This was done to clarify if morpheme manipulation tasks also distinguish good and poor readers. Singson et al. (2000) used four derivational suffix tasks measuring sensitivity to morphology. The tasks consisted of close sentences using both real and nonsense words (e.g., *She ignored the feeling of* ___________ [A. dead B. deadly C. deadness D. deaden] *in her feet).* The tasks were presented in two formats and in two experiments. First, they were presented in written format, where the participants read along with the examiner and circled the best choice. Second, the tasks were given orally, where the participants chose if the sentence they heard was grammatically correct or incorrect by circling 'yes' or 'no'. In both experiments, written and oral sentences, awareness of morphological parts of words played a fundamental role in the decoding process after controlling for phonological awareness and vocabulary.

Decreased phonological knowledge and phonological processing difficulties appear to affect morphological processing and awareness in degrees (Carlisle, 2004). This conclusion is further supported by the lexical quality hypothesis where high quality representations are fully specified when all components have specificity for their features. Therefore, one cannot access a high quality word without full knowledge of phonological and morphological aspects, even the suprasegmental aspects of phonology as discussed in the following section.

Prosodic Sensitivity

While it has been established that phonological awareness is the ability to recognize and manipulate sound segments in spoken language - such as syllables, rhymes, and individual sounds (phonemes) - the reason some children fail to acquire phonological awareness, even after explicit instruction, is less well understood (Wood, 2006). This difficulty may be attributed to a child's phonological representations of spoken words, which are impacted by suprasegmental phonological information, which is word level prosody. Broadly defined, at the word level prosody encompasses the suprasegmental phonological information of language (Whalley & Hansen, 2006). An example of how the linguistic awareness for word level prosody is a unique, but possibly inseparable component of phonology, is shown in Figure 1. Prosodic sensitivity in Figure 1 represents the overlap between phonology and morphology (semantics) in derived words, which are the stimuli used in these studies. Prosodic sensitivity then, refers to the awareness of suprasegmental phonology or the acoustic properties of speech that convey information beyond the sound segments of words (Breen & Clifton, 2011). Prosody is composed of three components: lexical stress, intonation, and phrasing (Breen

& Clifton, 2011; Maddox & Conner, 2008), all of which are expressed through variations of several acoustic aspects (e.g., frequency, duration, and intensity). Within prosodic sensitivity there is the sensitivity to the meter, the alternation of stressed and unstressed syllables, and rhythm, which refers more to the way the syllables are distributed in time.

The observed relationship between speech rhythm and word reading has been discussed in theoretical research over the past two decades. Cutler and Mehler (1993) hypothesized that children are born with a periodicity bias, which allows them to have attentional focus on the rhythmic properties (stress) of speech in the first language they are exposed to. In the case of these studies, English is the first language and it is considered a stress-timed language characterized by patterns of strong (stressed) and weak (unstressed) syllables. In a 1999 study by Jusczyk, English-learning infants appear to have word segmentation abilities that conform to the predominant stress pattern by age 7.5 months. By 10.5 months of age, infants have sensitivity to other acoustic information such as statistical regularities, allophonic cues, and phonotactic patterns that help facilitate understanding of word boundaries (Jusczyk, 1999). Lastly, infants have adult like speed and accuracy, which allows for recognition of words from fluent speech by 24 months (Jusczyk, 1999). Since a critical aspect for acquiring native language vocabulary is the ability to segment words from fluent speech, it is possible that sensitivity to prosodic features, such as rhythmic properties, may also impact word storage.

Past research measuring sensitivity to the rhythmic properties (nonlinguistic tasks) in speech found that children with dyslexia were significantly less sensitive to beat detection, and associated auditory characteristics, than their non-dyslexic counterparts (Goswami, 2002). These findings support the suggestion that suprasegmental phonological features influence reading development. Similar research has further substantiated a relationship between the perception of rhythmic timing with reading and spelling acquisition in normal and dyslexic children and adults (Goswami et al., 2002; Pasquini, Corriveau, & Goswami, 2007). Goswami et al. (2002) measured speech rhythm through a beat detection task, "because speech rhythm is one of the earliest cues used by infants to discriminate syllables and is determined principally by the acoustic structure of amplitude modulation at relatively low rates in the signal" (p. 10911). In this task they measured children's sensitivity to the perceived beat of the spoken syllable (the peaks in amplitude of the speech signal), or the "rise time." The findings revealed individual differences between dyslexic and non-dyslexic children existed for beat sensitivity and they accounted for unique contributions in word reading (25%), spelling (25%), and nonword reading (14%) acquisition when controlling for age, nonverbal IQ, and vocabulary. Furthermore, speech rhythm contributed an additional 9% of the variance in word reading after phonological processing (rhyme oddity) was accounted for in the prediction. This research suggests that skilled reading requires implicit understanding of the suprasegmental features of phonology.

Goswami et al. (2002) interpreted the results by arguing sensitivity to the suprasegmental components of speech might facilitate the development of phonological awareness and reading. At the word level, this is important information because beats correspond to vowel location and sensitivity to them may facilitate the identification of vowels (Goswami et al., 2002). When vowel detection is possible, a person can identify the onset (the word part before the vowel) and rime (the syllable part which includes the vowel) in words and the boundaries between them, which are important skills in the reading development process. These deficits in beat detection are not isolated to children. Thomson, Fryer, Maltby, and Goswami (2006) found similar confirmatory outcomes with adults, suggesting that auditory rhythm sensitivity and literacy are related and that the relationship persists beyond childhood.

While Goswami et al. (2002) contributed valuable insight into the perception of acoustic signals (beat detection) and the correlation it has with reading and spelling acquisition, other studies using measurement tools for prosodic sensitivity also show significance using production tasks (Carlisle & Fleming, 2003; Jarmulowicz et al., 2007; Singson et al., 2000; Wood, 2006) and perception tasks (Clin et al., 2009; Singson et al., 2000).

Of particular interest to the current studies, is the impact of word level prosodic sensitivity to lexical stress on word level reading and general outcome measures. Lexical stress is determined by the syllable or phoneme in a word that gets emphasized. Within the English language, primary prosodic stress is marked by the auditory indexes of syllable duration, presence or degree of intonational movement (vowel quality), and acoustic salience expressed by pitch or loudness (van Donselaar et al., 2005). The marking of these indexes and the pattern of stressed and unstressed syllables (referred to as strong[S] and weak[W]) is an aspect of metrical phonology. Prosodic stress has been found important in lexical access because it limits the lexical search, independent of segmental information (phonemic, the sounds that make up a word), which suggests stress information is useful for stored word access if the stress is on the correct syllable (van Donselaar, Koster, & Cutler, 2005). It has been argued that without prosodic sensitivity, accurate phonological representations are not stored in the lexicon and therefore impacts outcomes in both language and reading (Pasquini et al., 2007).

Using the prosodic sensitivity to rhythm, Wood and Terrell (1998) investigated the relationship between suprasegmental phonological features and reading development in typically developing children and those with reading disabilities. They hypothesized sensitivity to speech rhythm (measured by sensitivity to metrical stress) may facilitate spoken word recognition and contribute to overall phonological awareness. In their study, Wood and Terrell (1998) used a rhythm matching task where participants were required to match a particular stress pattern with a low-pass filter leaving only the intonation pattern and no phonemic information, with a sentence sharing the intonation pattern. After hearing the filtered sentence, the children were given two spoken sentence and asked to pick the one that had the same stress pattern. The children with reading difficulties performed at a significantly lower skill level than age-matched controls at sensitivity to speech rhythm.

These findings imply a relationship between speech rhythm and reading development exists. However, there was great diversity in the poor reader sample due to a broad age range, and the rhythm matching task was memory intensive (Holliman, Wood, & Sheehy, 2008). Wood (2006) readdressed methodological limitations of the Wood and Terrell (1998) study and explored the association between stress sensitivity and reading development in 4-5 year-old children. The original task was created to be age appropriate for preschool and less memory intensive. Children were asked to find objects in a line drawing of a pretend house. The object names contained two syllables with the primary lexical stress on the first syllable and a weak syllable in the second syllable (e.g., *SOfa*). Children were presented with a mispronunciation task and were required to listen to mispronounced household words (e.g., *soFA*) and then locate the appropriate picture that corresponded to the word from the pretend house. Mastery of this task requires sensitivity to stress properties in a word, understanding that the word has been incorrectly stressed, and then be able to produce a correct pronunciation (Wood, 2006). This correction demands that the child know how to apply stress to the unstressed syllable or reverse the stress so that the word can be fully specified and accessed from the mental lexicon (Holliman et al., 2010; Wood, 2006). Wood's (2006) investigation found that performance on the mispronunciation task was significantly related to early word reading and spelling. Holliman, Wood, and Sheehy (2008) followed up this study using the same task and found that it predicted unique variance in word reading (3.8%) in early readers after controlling for age, vocabulary, phoneme deletion, and rhyme detection ability (phonological awareness).

The sensitivity to mispronunciations (e.g. saying VOLcanic with a SWW stress pattern instead of volCANic, with a WSW pattern) in words is the goal of the prosodic sensitivity task in the current studies, for adults and children. At present, the prosodic sensitivity task using real words has been found to predict word level reading outcome measures for adults (Thompson, in preparation [Manuscript #1]).

Although validation of a consistent behavioral response to the prosodic sensitivity task with children is a main goal of these studies, another is to confirm contributions of morphological awareness and prosodic sensitivity to reading ability when controlling for other phonological and morphological knowledge and to know if it can help discriminate between good and poor readers.

Current Studies

There were some unique and combined purposes of the current studies. The first purpose was to develop and validate the experimental task for prosodic sensitivity and utilize a previously used child morphological awareness task with an adult sample. The follow-up study was done for the validation of the tasks with children in grades three, four, and five. The child study was done to validate unique contributions of prosodic sensitivity and morphological awareness to word level reading and comprehension in language arts general outcome measures. To this point, the unique contribution of both studies was the use of a standardized protocol administered on computer with minimal or no examiner participation, although it was still test and item dependent. The hypothesis for the first study was that prosodic sensitivity to correct stress would significantly predict word level and text level reading. The hypothesis for the second study was that prosodic sensitivity to correct stress and morphological awareness for word parts would significantly predict word level and general outcome measures for reading (TCAP). At present, Thompson (Manuscript #1) found both measures to predict word level reading and general outcome measure reading scores in adults and in Manuscript #2 with children, important outcomes suggested the metalinguistic skills matter in general reading outcome measures. In another study by Thompson, Denny, and Powell (in preparation) where only a longer version of the morphological awareness task was used, it also predicted outcomes on a comprehensive reading battery (ACT) and gave further support for the task predicting passage level reading outcomes.

The broad purpose of this research was the creation of ecological measurement tools to inform educators of linguistic processing skills, which contribute to reading comprehension in the upper elementary grades. With consistent behavioral results in these studies, future test construction and validation may allow for this broad goal to be met and to contribute to the assessment of reading ability in upper elementary grades through standardized tools with quick and informative tasks built upon the foundations of decades of research.

CHAPTER II

MANUSCRIPT #1

Abstract

Prosodic sensitivity is a metalinguistic skill that has been shown to be a significant predictor of word level reading in children (Clin, Wade-Woolley, Heggie, 2009; Jarmulowicz, Tarran, & Hay, 2007). The current study validated an experimental auditory lexical decision task for prosodic sensitivity to stress shifting in words and nonwords. The relationship between prosodic sensitivity and other metalinguistic tasks (i.e., morphological awareness), and reading tasks was also analyzed. The newly created perceptual prosodic sensitivity task accounted for 9% of the variance in word level reading outcomes of real words but not nonwords. The contribution of prosodic sensitivity to stress shifts in real words was significant when controlling for age, vocabulary, and morphological awareness.

Introduction

As words grow increasingly more complex in later elementary years, many aspects of linguistic awareness become necessary for word reading and reading comprehension (Carlisle, 2003). One aspect of linguistic awareness that has recently received more attention in research is prosodic sensitivity. This research has provided evidence for the existence of a relationship between prosodic sensitivity and reading ability (Clin, Wade-Woolley, & Heggie, 2009; Goswami et al., 2002; Holliman, Wood, & Sheehy, 2008; Jarmulowicz, Taran, & Hay, 2007; Wood & Terrell, 1998). Prosodic sensitivity has been measured two ways, through perception of prosodic patterns in sentence level tasks (Clin et al., 2009) or production of stress shifting words (Jarmulowicz et al., 2007). At present, there were no studies using perceptual lexical decision tasks without additional production responses for the measurement of prosodic sensitivity. The goal of the current study was to create a word level experimental measurement task for prosodic sensitivity that predicts word level reading. Specifically, the aims were twofold. The primary aim was to create an auditory lexical decision task measuring the construct of prosodic sensitivity to stress shifting in single words. The hope was that the task would have significant unique variance in the prediction of word reading and at the text level when controlling for age and vocabulary. The secondary aim was to validate the task's behavioral contributions for continued test development purposes.

Phonology, can be analyzed at two levels: *segmental* and *suprasegmental.* Segmental phonology has to do with the sound segments of the language that can be separated in speech, such as phonemes. Suprasegmental phonology is the overarching pattern of the speech stream, this includes prosodic features such as stress, intonation, and timing (Holliman, Wood, & Sheehy, 2010). Some researchers suggest that underspecified lexical representations of stored words may be due to deficits in speech perception of both segmental and suprasegmental phonology (Kitzen, 2001; Holliman et al., 2010). At present, the preponderance of research on phonology has been done at the segmental level to understand children's reading development (for reviews see Adams, 1990; Gillon, 2004; National Reading Panel, 2000), however it has been argued that without prosodic sensitivity, phonological representations are not accurately stored in the lexicon and therefore impact both language and reading outcomes (Pasquini, Corriveau, & Goswami, 2007). Wood, Wade-Woolley, and Holliman (2009) predicted that research will find associations between rhythm sensitivity and segmental phonological awareness and that this sensitivity to speech rhythm may be the prerequisite to reading achievement.

Recently, more focus has been given to suprasegmental phonology where researchers have begun to look at the roles of speech rhythm in reading outcomes (Clin et al., 2009; Holliman et al., 2010; Jarmulowicz et al., 2007; Wood, 2006). The knowledge of the suprasegmental features of phonology and the sensitivity to them are far less understood, and one of the challenges is the creation of "speech rhythm sensitivity measures that are appropriate for use with children" (Wood, Wade-Woolley, & Holliman, 2009, p. 12). Nevertheless, the creation of the tasks is essential if there is to be a measurement that can predict later reading difficulties, which would allow for early intervention. Assessment measures typically use sensitivity to prosodic changes as the following section details.

Prosodic Sensitivity

The awareness of these suprasegmental phonological features is considered prosodic sensitivity (Clin et al., 2009). Prosodic stress in the English language is carried by variations in syllable duration, intensity, and frequency. Clin et al. (2009) suggest that a distinguishing factor of prosody beyond segmental phonology is the breadth of effect it has on spoken language. Prosody therefore, is the carrier of suprasegmental sound information across more than phonemes, being present in onsets, rimes, and phonemes (Clin et al., 2009).

Wood (2006) found that performance on a stress reversal condition was the one condition related to word reading in preschool children. Holliman and Sheehy (2008) further developed the stress mispronunciations task from Wood (2006) by having children ages five to eight listen to a household word that had been mispronounced (stress was reversed, SOfa became soFA) and locate the word on a corresponding picture. To accurately complete the task the children had to be sensitive to the stress properties of the word, understand that the word was mispronounced, be able to place the stress correctly and locate the correct form in the mental lexicon. Holliman and Sheehy (2008) found that this task predicted significant variance in word reading (3.8%). In a subsequent study, Holliman et al. (2010) further simplified the task by limiting the visual search from a line drawing of a house to a four choice drawing. Children were then required to identify the picture that represented the mispronounced word. This study also contained non-speech perception tasks used to further understand what type of rhythm sensitivity predicts reading achievement. The authors concluded that there may be some degree of overlap between the processing of speech and non-speech rhythm at a receptive, perceptual level but the important finding was that stress sensitivity to speech was able to predict significant variance in reading achievement after controlling for age, vocabulary, memory, phonological awareness, and non-speech rhythm. These findings suggest lexical access is limited by prosodic stress independent of segmental information (phonemic), which supports stress information is useful for accessing stored words if the stress is on the correct syllable (van Donselaar, Koster, & Cutler, 2005).

Other recent research measuring sensitivity to speech rhythm has found a relationship between the perception of rise-time (a beat detection task) and reading and spelling development in normal and dyslexic children and adults (Goswami et al., 2002; Pasquini et al., 2007). Goswami et al. (2002) found differences between groups in sensitivity to amplitude changes (beat detection) accounted for unique contributions to word reading (25%), spelling (25%), and nonword reading (14%) after controlling for age, nonverbal IQ, and vocabulary. Lastly, when controlling for phonological processing (a rhyme oddity task), beat detection was further able to predict 9% of the variance in word reading. In the interpretation of these findings Goswami et al.(2002) suggested that the sensitivity to the suprasegmental phonological components of speech may be a mediator in the development of segmental phonological awareness and reading.

While Goswami et al. (2002) contributed valuable insight into the understanding of beat detection sensitivity and the correlation it has with reading and spelling acquisition, other studies using sublexical measurement tools for prosodic sensitivity also show significance using lexical production tasks. Another way researchers have measured the impact of prosodic sensitivity on lexical-semantic factors has been through stress pattern production tasks. Stress pattern changes occur in morphologically complex words.

Prosodic Sensitivity Through Morphology

Linguistically speaking, morphology is the internal structure of words where a morpheme is the smallest meaningful unit of the language. Our sensitivity to the internal structure and morphemes in words is called morphological awareness. Morphologically complex words have a stem and an affix. The stem can be two things, 1) a root word with an affix added to it (e.g., *sheep* + *ish*) or, 2) a derived form which takes an additional affix (e.g., *sheepish* + *ly*). There are two types of affixes, inflectional and derivational. Inflectional affixes change the tense or plurality of a root (e.g., *walk* to *walks* to *walked*). Derivational affixes change the class of a word form (noun to verb), which causes them to change the meaning and grammatical function of the word (e.g., *nation* [n.] to *national* [adj.]).

There are two types of derivational suffixes in English, neutral and nonneutral. In particular interest to this study are the nonneutral suffixes because they create phonological changes in the root, specifically stress pattern changes (e.g., *LEgal* to *leGALity*). The addition of non-neutral suffixes creates for morphophonological complexity, which can alter the pronunciation of both word- and utterance-level stress. Furthermore, research has consistently found a strong link between morphological awareness and reading outcomes (Carlisle, 1988, 2000; Fowler & Liberman, 1995; Nagy, Berninger, & Abbot, 2006; Singsing, Mahoney, & Mann, 2000). It is plausible then that given the complex morphological structure of English students may need to have a conscious awareness of morphophonology to use morphological knowledge when reading (Clin et al., 2009). If this were true, then developmental trends would become evident on derivational morphology tasks, which require knowledge of morphophonology.

While using such tasks, Carlisle (1988) found these developmental trends when studying morphological awareness development in children in grades 4, 6, and 8. In this study there were two subtests, both containing four categories of derivational morphemes. The four categories were: morphemes that cause an orthographic change (e.g., *sun/sunny*), a phonological change (e.g., *sign/signal*), an orthographic and phonological change (e.g., *expand/expansion*), or no change (e.g., *enjoy/enjoyment*). The first subtest required children to compose a word form when given the root (e.g., *farm to farmer*) while the second subtest required the children to decompose a word form (e.g., *driver* to *drive*). Each word was presented with an incomplete sentence that required a specific derived form. Outcomes showed that in addition to the developmental trends, more advanced children used the derivational morphemes more successfully and with greater frequency.

In a related study by Jarmulowicz (2006), developmental changes in phonological accuracy of derived English words was also found, suggesting that development of morphophonological knowledge begins early in school-aged children (ages 7, 8 and 9). The uniqueness of the Jarmulowicz (2006) task was that unlike Carlisle (1988), it did not require knowledge of the word meaning in context, the child only had to apply the affix to the word (e.g., "Put *–ity* onto the end of *active*). The elimination of semantic and syntactic demands made the task a more singular morphophonological task. The findings of this study showed an important variable in accurate production of derived forms appears to be the number or degree of phonological changes between the stem and derived word. Results of an analysis of variance (ANOVA) found significant main effects for both age and suffix type and a significant interaction between the two. All children reached ceiling levels on stress-neutral affixes. However, older children had more accuracy on pronunciation of derived forms with non-neutral affixes involving stress. These findings suggested children do have trouble creating derived forms with stress changes which Carlisle (1988) suggested. In a follow-up study by Jarmulowicz et al. (2007) using a derived word production task to predict word level outcomes, the author concluded that the relationship between accurate stress production and decoding appears to be strong and bidirectional, which offers new insights into the specificity of morphophonological knowledge inside developing readers' minds.

Of particular interest to this study is that Jarmulowicz (2006) designed a stress production task to evaluate derived words that both did and did not exhibit phonological changes in the base word. As discussed earlier, derivations cause phonological, orthographic, or both types of changes. Phonological changes increase the complexity of the English derivational system of neutral or non-neutral affixes. There are three types of phonological changes that decrease phonological transparency, stress alteration (e.g., *motive* to *motivation*), consonant alterations (e.g., *electric* to *electricity*), and vowel quality changes (e.g., *human* to *humanity*). Across a growing body of research phonological transparency between base and derived forms has been shown to be an important variable in the study of the process of derivational development (Carlisle, 2000; Carlisle, Stone, & Katz, 2001; Jarmulowicz et al., 2007; Windsor, 2000). Windsor (2000) and Carlisle (2000) demonstrated that the ability to produce derived words with nonneutral suffixes and to separate a suffix from its base in a semantic context are both strongly related to reading outcomes. Furthermore, auditory recognition (Windsor & Hwang, 1999) and speed and accuracy in derived word reading (Carlisle et al., 2001) are negatively impacted by phonological opacity.

Jarmulowicz et al. (2007) discussed the fact that phonological transparency has been largely overlooked in reading research, saying that derived forms with both segmental and suprasegmental phonological changes are often times grouped in the same phonologically opaque category. For example, *explosion* from *explode*, *heavily* from *heavy,* and *curiosity* from *curious* are all included in a 'shifting' category where phonological shifts occur (Carlisle, 2000); yet, the stimuli exhibit a range of phonological changes (consonant, vowel, and stress). In efforts to find stimuli that are systematically phonologically opaque Jarmulowicz (2006) and Jarmulowicz et al. (2007) used rhythmic suffixes where the prosodic regularity in derived may be used as an indicator of morphophonology.

The final goal of reading is to have efficient and accurate access of word meanings which is facilitated by high quality lexical storage. In Perfetti's (2007) *Lexical Quality Hypothesis* (*LQH*), 'quality' is defined as the "extent to which a mental representation of a word specifies its form and meaning components in a way that is both precise and flexible" (p. 359). In this hypothesis, morphological and suprasegmental phonological information are viewed as features, which need to be bound together to create fully specified words in the lexicon (Perfetti, 2007). The lexical access therefore, depends on the quality of linguistic features, to the least of which are morphological and suprasegmental phonological aspects of the word.

The consistent nature of rhythmic suffixes is potentially a lexical quality indicator. At this point, primary stress has been found to be significant in limiting the lexical search, independent of segmental phonological information (van Donselaar et al., 2005). This suggests that if a reader maintains the stem phonology of a derived word with a stress-shift like *acidic* (*Acidic* and not *aCIDic*), then the stored representational form associated of *aCIDic* may not be efficiently accessed (Jarmulowicz et al., 2007). Another route to lexical access through stress is through composition where a reader constructs the stress pattern based on the information provided by the stem and suffix. In the case of composition, morphological structure may be the gatekeeper to lexical access success.

Current Study

The purpose of the current study was twofold. The first purpose was the creation of a prosody task to uniquely identify the interaction between accurate stress perception of derived words and nonwords (prosodic sensitivity) in reading outcomes when controlling for age, vocabulary, and morphological awareness. The hypothesis was that prosodic sensitivity to correct stress would make it easier to recognize real words and harder to reject correctly stressed nonwords. To the extent of this author's knowledge, this was the first use of a perceptual auditory lexical decision task for the measurement of prosodic sensitivity using real and nonwords in a study to predict reading outcomes. The second purpose was to determine the specificity of the prosodic sensitivity task; whether it measures word but not text processing. The second hypothesis was that prosodic sensitivity, along with morphological awareness, would account for significant variance at the word level but not in text level reading. Since the task was created to measure word level knowledge about words and nonwords, it was not predicted that this would relate to the oral reading fluency measure because it is not a measure of comprehension at the adult level.

Method

Participants

A convenience sample of undergraduate psychology students participated in this study. All participants were registered in Psychology courses at a state-funded university. Of the 82 undergraduate college students who were tested, data from 79 participants was retained (38 were women, 41 were men, M_{age} = 20.68 years, SD_{age} = 4.24). Of the three participants that were excluded, one student wrote an incorrect student identification number on the consent form, one had hearing difficulties and did not complete the prosodic sensitivity task, and one data set was thrown out due to a computer program error. Participants earned a small amount of extra credit towards Psychology classes for participating, and participation was based entirely on participant consent. All participants were English speakers but they were not screened for any other criteria for participation in the study. Descriptive data about first language or hearing difficulties were not obtained. Participants voluntarily provided informed consent assent at the time of testing consistent with the local university institutional review board.

Measures

The data for this study were gathered as part of an ongoing research project. Three standardized measures from one published test measured vocabulary, word reading, and alphabetic code knowledge. The prosodic sensitivity, morphological awareness, and oral reading fluency measures were not standardized.

Reading tasks

Word reading. Subtests of the Woodcock-Johnson III Tests of Achievement were administered to measure reading skill (WJ-III: Woodcock, McGrew, & Mather, 2003). On the Letter-Word Identification subtest participants read a list of real words and nonwords on the Word Attack subtest, both of increasing difficulty. The publisher reported reliability coefficients for Letter-Word Identification and Word Attack are .94, and .87. Raw scores were based on total correct responses and were transformed using the norms in the test manual. Transformed scores have a mean of 100 and a standard deviation of 15. Word Identification served as the word level dependent variable in prediction analysis.

Passage reading. An oral reading fluency (ORF) probe was created from a college level book. The passage was examined using the Dale-Chall readability formula (Chall, 1995) for grade-level difficulty. It was rated as a college level text. In this formula, grade equivalent scores are based on the average number of words per sentence and the percentage of words not found on the Dale-Chall word list. The more words not on the Dale-Chall word list equals an increase in reading difficulty. Fluency scores were defined as the number of words read aloud correctly during a one-minute period. Each participant was given standard directions and asked to read the same oral reading fluency probe for one minute. A total for words correct per minute (WCPM) was used as the raw score for passage level reading. For example, if a participant read 177 words correctly with 2 errors, then WCPM = 175 (177 correct – 2 errors). All participants read the same passage. Oral reading fluency served as the dependent variable for text reading skill.

Word knowledge tasks

Vocabulary. A vocabulary score was obtained from the WJ-III Synonyms, Antonyms, and Analogies subtests. The composite score for reading vocabulary was used as a general word knowledge measure (WJ-III: Woodcock et al., 2003). The publisher reported reliability coefficients for the composite Reading Vocabulary was .90. In the synonyms and antonyms subtests, participants were presented with printed words and expected to read the word and orally stated the synonyms or antonyms. In the analogies subtest, participants read and orally completed printed analogies (e.g., *elephant* : *big* :: *mouse* : ____). Raw scores from each subtest were based on total correct responses and were transformed using the norms in the test manual and a composite was obtained. Transformed scores have a mean of 100 and a standard deviation of 15. The Reading Vocabulary composite score served as a word level knowledge outcome measure and as an independent variable in regression analysis.

Metalinguistic Tasks

Morphological awareness task (MAT). The morphological awareness task was adapted from Rubin (1988), Rubin, Patterson, and Kantor (1991), and Carlisle and Fleming (2003). This experimental task was used as a perceptual task to assess participants' ability to identify two-morpheme and one-morpheme words. The participants were asked a carrier phrase question with every stimulus (e.g., "Is there a smaller word inside of (*lined*) that means something like (*line*)?"). For this study, unlike previous studies, the participant was given the two-morpheme word (e.g., *lined*) and its one-morpheme base (e.g., *line*). Previous studies used the carrier phrase and put the stimuli in both parts (e.g. "Is there a smaller word inside of (*teacher*) that means something like (*teacher*)?"). If the participant correctly answered 'yes,' they would be asked to produce the base one-morpheme word (e.g., *teach*). Successful performance required the ability to decompose the morphologically complex words into their parts and to produce the correct stem. In the task for this study, participants were given stems, half were stems of derived or inflected forms and the other half were foils.

There were 28 words in the task, 14 were phonologically matched pairs of one-morpheme and two-morpheme words (e.g. *kind/lined, dinner/winner*). No word was longer than two syllables. There were seven words with inflectional suffixes (*-s, -ed, -ing*) and seven with derivational suffixes (*-y, -er*). The 28 items were presented so phonological items were not presented consecutively (e.g., *dinner* and *winner*). A list of the items appears in Appendix A.

The examiner administered the morphological awareness task verbally with standard instructions, trial items, and test items. Participants were asked to identify whether items were morphologically complex (two morphemes, e.g., *lined*) or not (one morpheme, e.g., *list*). Prior to actual task administration, two training trials presented, one with a bimorphemic word (*teacher/teach*) and another with a monomorphemic stem and a foil (*fist/fiss*). In the training trials the participant was given directions to respond to the questions with a yes/no response. In the first question the participants were asked, "Is there a smaller word inside of *fist* that means something like *fiss*?" If the response was correct, the examiner proceeded to the next training item. If the response was incorrect the examiner repeated the question, provided the correct response along with a brief explanation (e.g., "No, *fiss* is not a word and therefore there is no *fiss* in *fist,* the answer is no"), and asked the question again. The procedure was also repeated once if an incorrect response was given for the second practice item. On the test trials, no repetitions, demonstrations, or feedback were provided. The total possible MA test score was 28. Each item was scored dichotomously, either as correct or incorrect, and subjects received credit by answering.

Prosodic sensitivity task (PST). This task was designed to test the participant's ability to distinguish lexicality (word/nonword) when words and nonwords were presented with correct and incorrect stress. Each participant was presented with 40 items, an equal number of words and nonwords that were correctly and incorrectly stressed. All words were suffixed with two stress-shifting suffixes (e.g., *–ity* and *–ic*). Within each cell of this design, 10 items were adjectives suffixed to form nouns with *–ity* (e.g., *equality*) and the other 10 items were nouns suffixed to form adjectives with *–ic* (e.g., *athletic*). The nonwords were 10 nouns and 10 adjectives that did not form real words when suffixed with *–ic* (e.g., *planetic*) or *–ity* (e.g., *herbality*). Half of the items in each cell of the design were presented with weak-strong stress (e.g., *cenTRALity*), which was correct for the suffixed forms, and half were presented with strong-weak stress, which was incorrect for the suffixed forms (e.g., *CENtrality*). This created incorrect primary stress in real words. An additional 10 correctly stressed items that did not appear in the experimental stimuli, five words and five nonwords, were created for practice trials. The items for the prosodic sensitivity task are listed in Appendix B.

Items were digitally recorded in a soundproof booth and the speaker was a female with a clear speaking voice and a Northeastern American English accent. This was done to facilitate standard administration. Base words and their suffixed forms were recorded independently. Incorrectly stressed words were then created using a cross-splicing procedure, by replacing the base word contained in the affixed form with the base word recorded independently. In addition, in order to avoid any co-articulation artifact that could result from the cross-splicing procedure, the speaker was asked to pronounce each base word followed by another word starting with the same first two phonemes as in the affix used to create the suffixed form of the base word. Items were not repeated in either condition (correct or incorrect). Two lists were formed and each item was presented with correct and incorrect stress across participants.

Items of the prosodic sensitivity task were presented and responses collected with a computer running E-prime version 1.4 (Psychology Software Tools, 2000). Participants listened to the stimuli on a desktop computer over headphones in a semi-quiet room in the psychology department. All items, except trials, were presented in random order. Each trial began with a blank screen that appeared for 1 second, followed by a 500 millisecond ready screen with a central marking to indicate a sound file was coming, followed by the presentation of the sound file. Responses were allowed immediately after the termination of the sound file. Participants clicked the left button of a mouse to indicate an item was a word or the right button of a mouse to indicate that an item was a nonword. The central marking disappeared after a response was recorded. Accuracy feedback was given during practice trials but not during the experiment trials. If a response was not made within 3 seconds a warning message was presented and a null response was recorded. Warning messages for null responses were presented during all trials.

General Outcome Measure

ACT®. The ACT test is a general outcome summative assessment taken at the end of high school. The ACT assesses a student's general educational development and ability to complete college-level work. The test is composed of multiple-choice questions in four skill areas: English, mathematics, reading, and science. ACT scores in Reading were gathered with participant consent. The ACT was used as a general outcome measure of comprehension and used in correlation analysis.

Procedure

All participants completed a test battery given in one session lasting approximately 30 minutes. The examination took place in a psychology department lab. Participants were tested individually by three different trained administrators on the described measures and received them in the following order: WJ-III Tests of Achievement Letter-Word Identification, Word Attack, Synonyms, Antonyms, and Analogies (Woodcock et al., 2003), morphological awareness, oral reading fluency, and prosodic sensitivity. The experimenter-designed prosodic sensitivity task was administered via a desktop computer. The examiners administered all other tasks. To control for possible order-effects, half the participants received the assessments in reverse order.

Reliability

There were three examiners, the author and two lab assistants from the Psychology Department. Each examiner was trained in standard test administration, which included observations and recordings to ensure inter-rater reliability. Greater than 25% of the testing sessions conducted were checked for scoring reliability by the author. Reliability was determined by observation of the WJ-III subtests by the author. Inter-rater agreement for all tasks ranged from 95% to 100%. All disagreements between raters were resolved by adhering to the rules of the test.

Results

Descriptive statistics for the measures in the test battery are presented in Table 1. In the college age adult sample, the mean scores on the standardized tests were at or slightly below the published means. The mean accuracy on the morphological awareness task was 89%, with a mean score of 24.80 (SD = 2.52). For the prosodic sensitivity task, the mean accuracy for correct stress (saying a real word was a word when it was correctly stressed) was 93.4% (SD = .71). The mean accuracy to real words with incorrect stress was 69.7% (SD = 2.35). The mean accuracy to nonsense words both correctly and incorrectly stressed was 71.8% (SD = 1.63) and 78.9% (SD = 1.79), respectively. The mean fluency score was 159 words read correctly (SD = 26), while the mean ACT Reading score was 24 (SD = 26). The mean scores for the WJ-III standard scores are as follows: Basic Reading M = 99.11 (SD = 13.56); Vocabulary M = 99.91 (SD = 13.11); Letter Word Identification M = 100.56 (SD = 13.50); and Word Attack M = 97.22 (SD = 13.59).

Table 1 contains Pearson product-moment correlations for the morphological awareness task, the prosodic sensitivity task, the oral reading fluency measure, all reading tasks, and ACT Reading. Raw scores were used for all measures. The correlations between the experimental measures morphological awareness and prosodic sensitivity were significant. Correlations involving prosodic sensitivity were strongest with Letter-Word ID (r = .525), vocabulary (r = .326), and ACT Reading (r = .351). The highest correlations for morphological awareness were moderate with reading vocabulary (r =

.455), accuracy for correct stress ($r = .431$), and ACT Reading ($r = .467$). The correlations between morphological awareness, prosodic sensitivity, and vocabulary are all moderate to strong and support the interrelated nature of the three tasks. Previous research using the derived word production tasks for prosodic sensitivity (Jarmulowicz et al., 2007) had similar correlations with morphological awareness ($r = .453$).

A series of analyses were conducted first to examine performance within the auditory lexical decision task between real words and nonwords and secondly, to examine how the perception of lexical stress is related to other reading outcomes.

Effects of Stress and Lexicality in Auditory Lexical Decision

The first analyses evaluated the effects of word-level stress accuracy (correct / incorrect) and lexicality (word / nonword) on responses in auditory lexical decision. In the primary analyses, repeated measures univariate ANOVA through the MANOVA approach were used. The analysis was used to identify overall differences for the within-subjects factors of stress and lexicality with accuracy as a dependent variable.

Accuracy analysis. The number of correct responses in the auditory lexical decision task (acceptance of real words and rejection of nonwords) appears in Figure 1. Accuracy for real words ($M = 8.16$, $SD = 2.71$) was significantly higher than for nonwords ($M = 7.53$, $SD = 1.71$), $F\,(1, 77) = 5.602$, $p < .02$, $\eta^2 = .068$. Accuracy for correctly stressed items ($M = 8.26$, $SD = 1.17$) was significantly higher than accuracy for incorrectly stressed items ($M = 7.43$, $SD = 2.08$), $F\,(1, 77) = 30.783$, $p < .001$, $\eta^2 = .286$. The interaction between stress and lexicality was also significant, $F\,(1, 77) = 75.708$, $p < .001$, $\eta^2 = .496$. This shows that increased accuracy depends on correct stress and if the word is real, suggesting that interpretation of prosodic information may be closely tied to word meaning. Additionally, when a real word is incorrectly stressed participants were more likely to get it wrong, suggesting that without correct phonological representations in the lexicon, word meaning access is decreased. The accuracy for both correct and incorrect stress in nonwords were not significantly different from each other but they were significantly different from real words. This also contributes to the idea that prosody is intricately linked bound with meaning and that when there is no meaning, perception of correct stress decreases.

Prediction of word and text reading analysis. The second sets of analyses examine the extent to which accurate perception of stress (prosodic sensitivity) in real words makes unique contributions to word reading when other language factors are controlled for. Hierarchical multiple regression analysis was used to show predictive relationships between morphological awareness, prosodic sensitivity, and reading outcomes by other researchers (e.g., Clin et al. 2009; Jarmulowicz et al., 2007). Stress perception accuracy is defined as the number of correctly stressed real words that were accepted in the lexical decision task. Subtest raw scores were used in the prediction analysis. The model for regression analysis is commonly used in tests of the simple model of reading (e.g., Catts et al., 1999; Conners, 2009; Gottardo et al., 1996). After controlling for vocabulary and decoding skills in steps one and two, two analyses were conducted for each dependent variable by changing the order of the two relevant predictors (stress perception and morphological awareness). The author changed the order of the variables to determine whether one of the predictive variables contributed variance to the dependent measures that was not already explained by the other.

The results are summarized in Table 2. Both predictors, prosodic sensitivity and morphological awareness, accounted for independent variance for the dependent measure Word Reading but not Passage Fluency. For word reading, prosodic sensitivity accounted for a good portion of the variance on the word level measures (9.6%) when it was entered before morphology. Morphological awareness explained another 4.7% for word reading over and above prosodic sensitivity. Even when prosodic sensitivity was introduced after morphological awareness, it continued to account for nearly the same amount of variance in word reading (8.7%) while morphological awareness accounted for 5.6% of the variance. Given the positive outcomes with the adult sample, prosodic sensitivity for stress in non-neutral derivational forms and morphological awareness for inflectional and derived forms suggest that suprasegmental phonological information and morphological knowledge matter and continue to impact the reading process even after school age.

As predicted, prosodic sensitivity and morphological awareness did not account for a significant portion of the variance in the oral reading fluency measure. Both experimental tasks are word level tasks and therefore are sensitive to the representational features therein. A fluency task is considered gross measurement of the integration of all linguistic processes that are necessary for fluent reading (phonological, orthographic, semantic, syntactic, and context). Being that it is a gross measure and has been shown to loose it's prediction power for reading comprehension past third grade, this prediction outcome was expected. A more sensitive reading outcome measure catching the nuances of word level processing would be more appropriate for this prediction.

In order to provide an estimate of the reliability on the morphological awareness task, Cronbach's alpha was calculated. Internal consistency reliability for the MAT was low but not unacceptable ($\alpha = .63$). Appendix C contains item level information for the MAT. The following items had zero variance and were removed from the scaling: *funny, lover, hunter, foggy.* Items with strong item-to-total correlations were *messed, soggy, dinner, sterling,* and *boney.* Since Cronbach's alpha was computed based on the variance in each item, the low internal consistency may not necessarily mean it is a poor test. It may mean the items are not appropriate for adults. However, they may be useful for children.

Discussion

This study had two primary purposes: to create a prosodic sensitivity task that would capture the interaction between accurate stress perception and lexicality for stress-shifting derived words and nonwords and to determine if the prosodic sensitivity task that would continue to account for unique variance in the prediction of word reading but not text reading when controlling for age, vocabulary, and morphological awareness.

The first finding was that prosodic sensitivity to accurate stress production in real words was significantly and positively related to all but one of the other measures included in this study: morphological awareness, reading real and nonsense words, vocabulary, and a comprehensive outcome measure (ACT Reading). What was rather surprising was how large the correlation between prosodic sensitivity to correct stress in real words was with reading words ($r = .525$) and ACT Reading ($r = .467$) for an adult sample. Furthermore, the correlations for reading words and ACT Reading were also significant with morphological awareness ($r = .431$ and $r = .467$). This is suggestive of something Rubin (1991) said about morphological awareness acquisition being neither learned by exposure to reading nor by maturation since the adult sample continues to demonstrate strong connections to morphophonemic knowledge well past the developmental window for reading acquisition.

Another interesting finding is that while accuracy to accept correctly stressed real words was significantly higher than to accept incorrectly stressed real words, there was no effect of stress on nonword accuracy. It is also compatible with the idea that stress is used to limit the lexical search and is not itself a primary feature used to initiate a search of the lexicon. This outcome is compatible with the results of van Donselaar et al. (2005), in which it was found that primary stress constrains the lexical search independent of segmental phonological information. Both studies show stress might not be a feature that is used to activate a candidate set in the lexicon, rather to pare down a set.

The lack of a stress effect on accuracy for nonwords, is also an important finding with respect to the development of a recognition test for prosody. Contrary to expectations, correct stress did not make it harder to reject nonwords. The participants were 72% accurate at rejecting for correct stress nonwords and 79% accurate for rejecting for incorrect stress nonwords. The outcome tells us something simple, the prosody task is related to reading outcomes but the nonwords are may not contribute anything to this task other than making it a true lexical decision task. For future task development, the nonword items should be removed or perhaps they will work better with full nonwords (e.g., *nonword stem + real suffix*). The removal of nonword items allows for the creation of a pure stress recognition task. This also solves a problem in the training (practice trials) component of the task and in the task itself – the ability to provide accuracy feedback. In a true lexical decision task, feedback cannot be given on accuracy because the auditory mispronounced real words are perceived as auditory nonwords (*VOLcanic* vs. *volCANic*). By omitting nonwords for future use, the ambiguousness of the task is removed and the task changes from recognizing lexicality to a stress perception task and that allows for a true correct/incorrect response. Additionally, corrective feedback can be given through trials and continuous feedback throughout the tasks.

As was originally hypothesized, sensitivity to prosodic changes in non-neutral stress shifting derivational forms did account for unique variance (9.6%) beyond that of morphology (4.7%) in reading words but not in a fluency outcome measure. What was interesting about this finding was that both prosodic sensitivity for correct and incorrect stress in real words predicted word level reading outcomes, but there was no significant prediction when using accuracy to correctly rejected nonwords as the independent variable. Not only does sensitivity to correct stress in real words appear to matter in lexical decision tasks, it also matters significantly in the prediction of reading words for an adult population. This outcome may be more robust than expected due to the fact that there was no measure of segmental phonology in the battery. The prosody task may be accounting for all of the unique phonological variance in word reading although, other studies have consistently suggested that the relative contributions of phonemes vs. morphemes is age dependent (Singsing et al., 2000) and that its prognostic value decreases after second grade (Scarborough, 1998). There may be additional information gained by having a segmental phonological task in the assessment battery due to the fact that the importance of segmental phonological knowledge to reading is consistent well into the high school years (MacDonald & Cornwall, 1995).

The results indicate the prosodic sensitivity task may use the same foundational skills necessary for the process of decoding – mapping sounds onto letters. The significant and strong correlation ($r = .525$) between the prosody task and the decoding measure (Letter-word ID) give strength to this supposition. Jarmulowicz et al. (2007) suggested that accurate performance on a morphophonological task may be a later developing skill like it is in decoding where phonological and morphological awareness are precursors in the developmental continuum. The fact that the sample in this study has a mean age of 20.68 years and is on average two years post high school reinforces the interpretation that understanding stress increases with age and with more oral and written language experience.

Although the direct intent of the this work was to develop a standardized prosodic sensitivity task, another curious finding came out of the data set with the morphological awareness task. This task was included in efforts to quantify the interactions between the metalinguistic skills of morphology and phonology and to also explore the unique contributions by morphological awareness in word reading tasks in an adult population. It was chosen because Rubin et al. (1991) found that adults with reading disabilities performed similar to typical second graders showing that it continued to have differentiation power into adulthood even though it was created for early readers (K & first grades). In this study the task was altered and instead of a decomposition task where the participant was asked to decompose the bi-morphemic words into a stem and affix (e.g., *teacher* to *teach* and *–er*), they were asked to identify if a smaller word was inside of a larger word. Results showed that some college age students thought there was a *pone* in *pony* and a *cuv* in *cover.* With an overall 89% accuracy on the MA task and its significant unique variance in word reading, it appears as though the task worked at measuring adult's awareness of the structure of language to some extent.

These findings also contribute valuable insight into the morphological awareness skills of an adult sample and warrant further development and study. Nagy et al. (2006) suggested the unique contribution of morphological awareness to some literacy skills, such as decoding rate, is consistently evident only by 8 and 9 grades. Although, the rate measure in this battery was not a standardized measure, the correlation between rate (fluency) and MA was significant.

Conclusion

The development of a prosodic sensitivity task delivered in a standard format is an ongoing and evolving effort. The interplay between morphological and phonological skills is a logical beginning point for the measurement of sensitivity to prosodic information since morphology can change prosody. The consistent nature of non-neutral stress-shifting derivational forms is a reliable way to measure sensitivity to prosodic changes since all words have phonological changes with the addition of *–ic* and *–ity* suffixes. There are many ways in which prosody may contribute to reading outcomes (beat detection, intonation of phrases, etc.) but in this study only word level prosodic information was considered. The prosodic sensitivity for correct stress in real words contributed significant unique variance to word level outcomes when controlling for age, vocabulary, and morphological awareness skills. It was also significantly correlated with a comprehension outcome measure. These are valuable findings for an adult sample.

Future studies should address task development with the omission of nonwords and the addition of standardized reading outcome measures (phonology, rate, working memory) are necessary to more fully understand the contributions of the task to literacy skills.

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Table 1

Correlations Among all Tasks in the Battery

	1	2	3	4	5	6	7
1. Morphology	1	.203	.431**	.121	.455**	.224*	.467**
2. Accuracy for correct stress		1	.525**	.255*	.326**	.216	.351**
3. Letter Word ID			1	.559**	.487**	.326**	.546**
4. Word Attack				1	.266*	.318**	.394**
5. Vocabulary					1	.176	.739**
6. Fluency						1	.454**
7. ACT® Reading							1

Note. * $p < .05$ level (2-tailed); ** $p < .01$ level (2-tailed)

Table 2

Hierarchical Regression Analysis on the Contribution of Stress Perception and Morphological Awareness to Reading after Controlling for Vocabulary and Decoding

		Word Reading		*Passage Fluency*		
Step		R^2	ΔR^2	Step	R^2	ΔR^2
Version 1						
-	Letter Word ID	--	--	1	.106	.106**
1	Vocabulary	.237	.237 ***	2	.107	.000
2	Word Attack	.435	.198 ***	3	.134	.027
3	Stress	.531	.096 ***	4	.137	.004
4	Morphology	.578	.047 **	5	.153	.016
Version 2						
-	Letter Word ID			1	.106	.106**
1	Vocabulary	.237	.237***	2	.107	.000
2	Word Attack	.435	.198***	3	.134	.027
3	Morphology	.491	.056**	4	.148	.014
4	Stress	.578	.087***	5	.153	.005

* $p < .05$ level; ** $p < .01$ level, *** $p < .001$

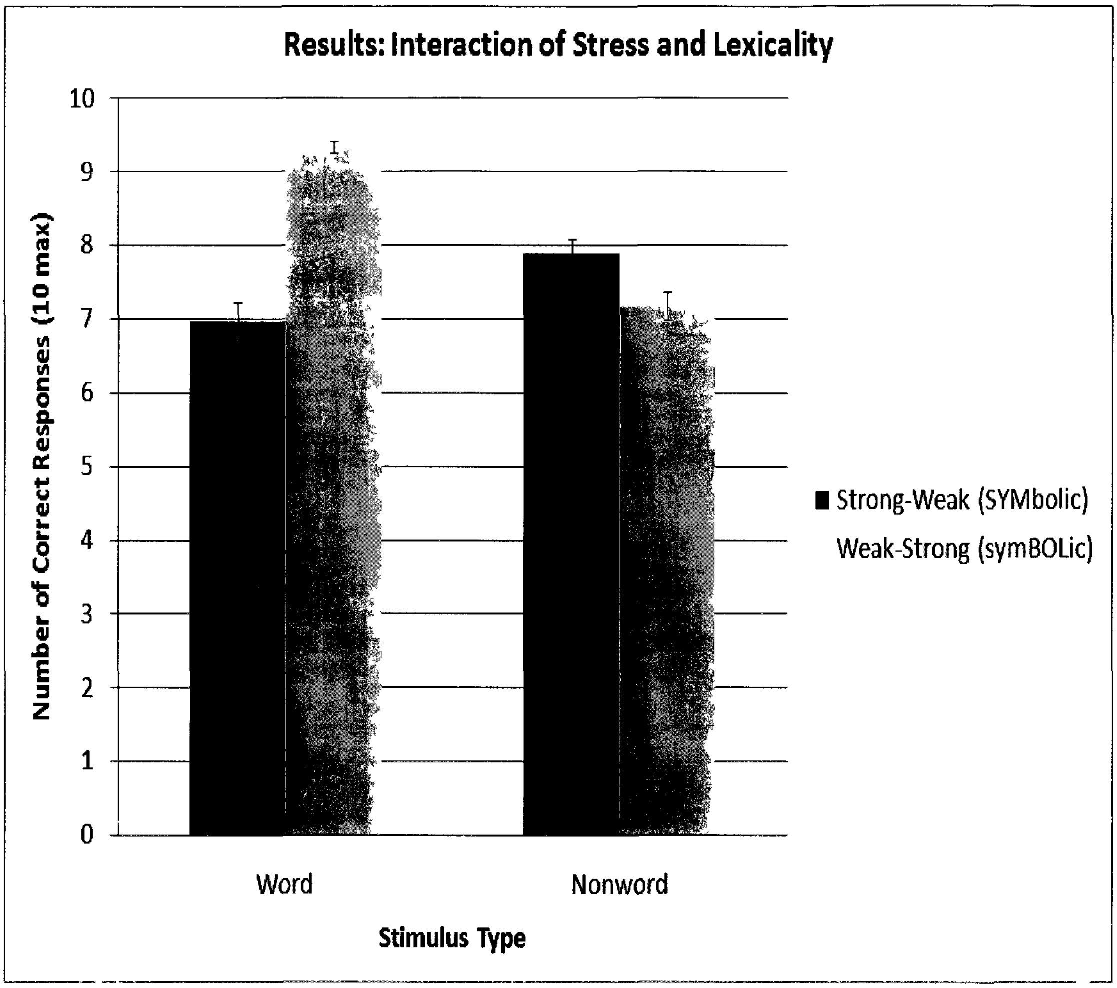

Figure 1.

Accuracy for stress.

Appendix A. Morphological Awareness stimuli (Rubin, Patterson, & Kantor, 1991)

Monomorphemic	**Monomorphemic Nonword**	**Bimorphemic**
kind	kine	lined
list	liss	kissed
nest	ness	messed
wise	why	pies
winter	wint	hunter
dinner	din	winner
money	mon	funny
round	roun	drowned
cold	cole	rolled
cover	cov	lover
lady	lade	shady
soggy	sog	foggy
sterling	sterl	curling
pony	pone	boney

Note. Original stimuli were from Rubin, Patterson, & Kantor (1991). These stimuli are from an adaptation by Jarmulowicz, Taran, and Hay (2007) with the addition of nonwords created as foils with monomorphemic words. The one morpheme base of each bimorphemic word was used in presentation, i.e. "Is there a word inside of *lined* that means something like *line*?"

Appendix B. Prosodic Sensitivity stimuli set A and B

Non Words	Suffix	Incorrect Stress	Word	Suffix	Incorrect Stress
astrality	ity	SW	artistic	ic	SW
bottomic	ic	SW	brutality	ity	SW
coastality	ity	SW	centrality	ity	SW
dieselic	ic	SW	demonic	ic	SW
glaciality	ity	SW	formality	ity	SW
itemic	ic	SW	heroic	ic	SW
lucidic	ic	SW	legality	ity	SW
rentality	ity	SW	magnetic	ic	SW
salmonic	ic	SW	mentality	ity	SW
virality	ity	SW	symbolic	ic	SW

Non Words	Suffix	Correct Stress	Word	Suffix	Correct Stress
carrotic	ic	WS	acidic	ic	WS
dentality	ity	WS	angelic	ic	WS
floristic	ic	WS	athletic	ic	WS
herbality	ity	WS	atomic	ic	WS
lemonic	ic	WS	equality	ity	WS
pistolic	ic	WS	locality	ity	WS
planetic	ic	WS	neutrality	ity	WS
postality	ity	WS	normality	ity	WS
spatiality	ity	WS	robotic	ic	WS
tribality	ity	WS	vitality	ity	WS

Appendix C. Item-To-Total Correlations for MAT

Target word	**Item-total Correlation**
money (mun)	.283
drowned (drown)	.316
pies (pie)	.190
cover (cuv)	.454
shady (shade)	.465
nest (ness)	.316
pony (pone)	.283
cold (coal)	.242
dinner (din)	.441
rolled (roll)	.316
messed (mess)	.465
soggy (sog)	.502
sterling (sterl)	.369
lady (laid)	.242
kissed (kiss)	.264
lined (line)	.242
curling (curl)	.156
list (liss)	.242
winner (win)	.264
round (roun)	.242
wise (why)	.190
kind (kine)	.156
winter (wint)	.218
boney (bone)	.441

CHAPTER III

MANUSCRIPT #2

Abstract

This work is a measurement validation study examining the contributions of morphological awareness and prosodic sensitivity, measured by auditory lexical decision tasks, to word and text reading. The sample was composed of typically developing children in grades three, four, and five (n = 130). Data on phonology, decoding, vocabulary, spelling, comprehension, morphological awareness, and prosodic sensitivity were collected across the grades. In a hierarchical regression, no significant unique variance was accounted for by the measures. Commonality analysis revealed shared variance between decoding and metalinguistic tasks and a factor analysis found two unique factors: 1) decoding skills and 2) morphophonological skills. Using the factors, a follow-up regression analysis with comprehension as an outcome measure revealed the metalinguistic skill factor contributed an additional 5% of the variance beyond decoding skills. These findings do not validate an adequate behavioral response for the new measures but they strengthen the notion that word storage is a highly integrated and interrelated processing of linguistic information.

Introduction

Reading and language development are intrinsically linked and because of this, reading ability is affected by the awareness of language and its linguistic processes. Over the past decade studies have analyzed two linguistic skills, morphological awareness (Carlisle, 1988; Carlisle, 2000; Carlisle & Nomanbhoy, 1993; Clin, Wade-Woolley, & Heggie, 2009; Jarmulowicz, Taran, & Hay, 2007; Rubin, 1988; Rubin, Patterson, & Kantor, 1991; Singsing, Mahoney, & Mann, 2000) and prosodic sensitivity skills (Clin et al., 2009; Goswami et al., 2002; Holliman, Wood, & Sheehy, 2008; Holliman, Wood, & Sheehy, 2010; Jarmulowicz et al., 2007; Wood & Terrell, 1998), for their contributions to reading ability beyond phonological segmentation. Phonological awareness is the most well-known and understood predictor of reading achievement (Share & Stanovich, 1995; see also Adams, 1990 & National Reading Panel, 2000 for reviews) but evidence suggests that although phonological skills are necessary, they are not sufficient for reading comprehension and that other linguistic skills are needed beyond segmental phonology (Fowler & Liberman, 1995; Shankweiler et al., 1995).

The present study is an experimental investigation validating the use of two word level experimental measurement tasks for morphological awareness and prosodic sensitivity of third, fourth, and fifth grade children. It entails assessment of language knowledge (vocabulary), metalinguistic skill (segmental phonology, suprasegmental phonology and morphology), and performance on different reading tasks (word, nonword, and text).

Understanding the contributions of morphological awareness and prosodic sensitivity to reading comprehension may require distinguishing them from each other, understanding their shared variance, or finding empirical evidence of their integration with word knowledge. It has been theorized that morphological and suprasegmental phonological information can be viewed as representational properties, or features, which need to be bound together to create fully specified words in the lexicon (Perfetti, 2007). Lexical access therefore, depends on the quality of linguistic representations and the stability of the knowledge about form and meaning. In Perfetti's (2007) *lexical quality hypothesis* (*LQH*), 'quality' is defined as the "extent to which a mental representation of a word specifies its form and meaning components in a way that is both precise and flexible" (p. 359).

Nagy's (2009) *metalinguistic hypothesis* contributes ideas about reading comprehension and word knowledge that are similar to Perfetti's *LQH* (2007). Nagy's hypothesis suggests that some of the shared variance in vocabulary knowledge and reading comprehension can be attributed to metalinguistic abilities that impact both. This suggests that both vocabulary and reading comprehension require more metalinguistic knowledge and skill than is commonly assessed or taught. The present study examines how feature knowledge (morphology and prosody) contributes to lexical quality, word reading, and reading comprehension. It includes the following research questions:

1) Do the experimental auditory lexical decision tasks measuring prosodic sensitivity to stress accuracy and morphological awareness in single words significantly account for performance in reading words and text, in third, fourth, and fifth grades when age and vocabulary are controlled for? Morphological awareness and prosodic sensitivity to stress accuracy in derived words was expected to contribute significant but small amounts of variance to word level reading tasks. Prosodic sensitivity to stress accuracy

in words was expected to contribute a greater portion of unique variance as found in previous research (Clin et al., 2009; Jarmulowicz et al., 2007; Thompson, Manuscript #1). Thus, it was anticipated that basic vocabulary and language knowledge would account for more of the variance on third, fourth, and fifth grade reading outcomes than would both morphological awareness and prosodic sensitivity combined, but each metalinguistic skill would contribute significantly.

2) Do the tasks for morphological awareness and prosodic sensitivity have a consistent behavioral response and are they valid and reliable as consistent behavioral measurement tools? It was expected that valuable item and test information would be gathered and that this information would contribute to continued development of an ecological, reliable, and efficient assessment measures for morphological awareness and prosodic sensitivity.

Metalinguistic Contributions to Reading

Prosodic sensitivity. There are two dimensions of phonology, segmental and suprasegmental. Prosody is a suprasegmental dimension, which encompasses the acoustic aspects of language - stress, intonation, and phrasing (Maddox & Conners, 2008; Whalley & Hansen, 2006). The awareness of these suprasegmental features is considered prosodic sensitivity (Clin et al., 2009). Within the English language, primary stress is marked by the auditory indexes of syllable duration, intensity, and frequency. Prosodic stress has been found to be important in lexical access because it limits the lexical search, independent of segmental information, which suggests stress information is useful for stored word access if the stress is on the correct syllable (van Donselaar, Koster, & Cutler, 2005). It has been argued that without prosodic sensitivity, accurate phonological representations are not stored in the lexicon, which impacts outcomes in both language and reading (Pasquini, Corriveau, & Goswami, 2007).

At present, the causal connection between children's phonological skills at the segmental level and their acquisition of language and reading is well established (Gillon, 2004; National Reading Panel, 2000; Share & Stanovich, 1995). The knowledge of the suprasegmental features of phonology and the sensitivity to them are far less understood, especially when discussing contributions to reading outcomes and unique and shared variance with other linguistic processes, such as morphological awareness. Recent research measuring an aspect of prosody has found a relationship between the perception of the amplitude envelope and reading and spelling acquisition in normal and dyslexic children and adults (Goswami et al., 2002; Pasquini et al., 2007). Goswami et al. (2002) found individual differences in sensitivity to the shape of amplitude modulation (beat detection) accounted for 25% of unique variance in word reading, 25% in spelling, and 14% in nonword reading when controlling for age, nonverbal IQ, and vocabulary. This research suggests that skilled reading requires implicit understanding of the suprasegmental features of phonology, which Fodor (1998) suggests in the *implicit prosody hypothesis*, which states that when a person reads, a mental representation of the intonation is created. It also suggests that it if suprasegmental differences can be perceived with non-linguistic stimuli and predict linguistic outcomes then, sensitivity to prosody in words should also contribute to linguistic outcomes.

While Goswami et al. (2002) contributed valuable insight into the perception of beat detection and the correlation it has with reading and spelling acquisition, other studies measuring prosodic sensitivity also show significance using lexical production tasks (Carlisle, 2000; Carlisle & Fleming, 2003; Jarmulowicz et al., 2007) and perception tasks (Clin et al., 2009; Holliman, Wood, & Sheehy, 2010; Wood, 2006). The perception of the prosodic variability in words with accurate and inaccurate stress placement is the goal of the prosodic sensitivity task in the current study.

Although validation of a consistent behavioral response to the prosodic sensitivity task was a main goal of this study, another was to confirm its contributions when controlling for other phonological and morphological knowledge. Therefore, the second linguistic aspect this paper will address is morphological awareness and its contributions to reading outcomes.

Morphological awareness. Morphological awareness is the conscious sensitivity to morphological units within words, including the ability to infer and manipulate word meaning and/or function through the relation between base words (e.g., *teach*) or roots (e.g., *-struct*) and related inflected and derived words (e.g., *teacher, teaches, construct, instruct*; Apel & Lawrence, in press; Carlisle, 1995; Ebbers, 2008). Morphological awareness is also the knowledge pertaining to a word formation rule system, which is largely implicit and guides the possible combinations of morphemes (Carlisle, 2003).

Understanding the contributions of morphological awareness to reading in the upper elementary years requires distinguishing it from other metalinguistic skill, such as awareness of suprasegmental phonological features. It has been suggested that morphological knowledge is a derivative of phonological knowledge (Fowler & Liberman, 1995) while others have discussed it as an independent contributor to reading (Singson, Mahony, & Mann, 2000). Regardless of how it is viewed, research has clearly established the existence of shared and unique variance, which gives rise to the idea that morphological and suprasegmental phonological information (prosody) may be unique properties of words, which also contribute to accurate word storage. Lexical storage theories differ with regards to morphology but a common argument is seen in Perfetti's (2007) *lexical quality hypothesis*, according to which, all the linguistic components - phonology, grammar, morpho-syntax are interwoven and necessary for the creation of a word's identity. Fully specified components also undergo constituent binding (Perfetti, 2007). The quality and stability of lexical storage is influenced by morphological complexity.

Morphologically complex words are composed of inflections, derivations, and compound words. Inflections mark the grammatical function of words (e.g., singular/plural or past/present) but they do not change the class the word is within (e.g., *cat* to *cats*, they both remain nouns). Children's mastery of particular inflections has considerable variability. The acquisition time period of inflectional morphemes increases in children with specific language impairments (Leonard, 1998). In a review of literature on specific language impairments Leonard (1998) found that omission of a grammatical marker is the most common error found in language sample analysis (e.g. "Yesterday she help her grandma." The *–ed* in help being the grammatical marker). Rubin et al. (1991) used a morphological awareness task that required typically developing second graders and adults with a history of reading difficulties to apply morphological rules to new words (implicit knowledge). Both groups performed similarly, which suggests language exposure and maturation are not the sole contributors to acquiring implicit morphological knowledge (Carlisle, 2003). In a recent study by Thompson (Manuscript #1), where an adaptation of the Rubin et al. (1991) task was used, Rubin et al.'s (1991) original results were given further support. Some adults reached the ceiling with 100% accuracy but, the average for all typically developing participants was 89% with *SD* = 2.82. The morphological awareness task, originally created for diagnostic differentiation in young children, significantly predicted word level reading outcomes in adults when controlling for age and vocabulary. This suggests acquisition of implicit morphological knowledge is not parallel to exposure or maturation. The experimental task contains both inflectional and derivational morphology and it offers potential instructional insights into the strength of children's morphologic awareness and their implicit use of morphemes.

In contrast to inflectional morphology, derivations usually alter the meaning of the base word and the word class changes (e.g., *manage* [v.] to *management* [n.]). Words with derivational suffixes were used in both tasks. There are two types of derivational suffixes, neutral or nonneutral. Neutral suffixes do not change the base word phonologically (i.e. *nervous* to *nervousness*) while nonneutral suffixes affect stem phonology. Phonological changes include stress alternations (e.g. *'e qual* to *e 'quality),* consonant alternations (i.e. *opaque* to *opacity,* the final /k/ sound changes to an /s/ sound), and vowel quality changes (i.e. *easy* to *easily,* the final /i/ sound changes to a schwa). Nonneutral suffixes such as *–tion, -ic,* and *–ity* have one distinctive feature when added to a word, the primary stress will always fall on the presuffixal syllable in derivatives with these suffixes. With the addition of a nonneutral suffix the stress shifts to the right if the base word does not have primary stress on the final syllable (i.e. *'e qual* to *e 'quality*). This subset of nonneutral suffixes affects the prosodic pattern and they are considered stress-changing suffixes or *shifting* suffixes (Carlisle, 2000). These stress-changing suffixes reduce the phonological transparency between the stem and the derived form because they shift the stress to the syllable preceding the suffix.

Morphological Effects on Prosody

Stress shifts are a way researchers have measured the impacts of prosodic sensitivity on lexical-semantic factors (Carlisle, 2000; Jarmulowicz et al., 2007). In stress pattern production tasks, participants are asked to derive words with neutral suffixes, such as *nation* to *national*, and to derive words with nonneutral stress "shifting" suffixes, such as: "Put (*-ity*) on the end of (*equal*)." The participant is expected to say: *equality*.

A recent study shed light on developmental changes in phonological accuracy of derived English words (Jarmulowicz, 2006). Development of morphophonological knowledge begins early in school-aged children (ages 7 and 9) and an important variable in accurate production appears to be the number or degree of phonological changes between the stem and derived word. The relationship between reading skill and a person's ability to compose and decompose words with nonneutral suffixes in a semantic context has been established (Carlisle, 1988; Carlisle, 2000; Windsor, 2000). Rhythmic suffixes have also been analyzed in isolation of other neutral and nonneutral suffixes (Jarmulowicz, 2006; Jarmulowicz et al., 2007). The relationship between accurate stress production and decoding appears to be strong and bidirectional, which offers new insights into the specificity of morphophonological knowledge inside developing readers' minds (Jarmulowicz et al., 2007; Jarmulowicz, Hay, Taran, & Ethington, 2008).

Thompson (Manuscript 1) addressed this morphophonological knowledge through the creation and validation of an auditory lexical decision task for prosodic sensitivity to stress changing suffixes. Interestingly, the perceptual task found adult's word level reading skill was predicted by their ability to detect correct stress perception when controlling for age, vocabulary, and morphological awareness. Because of the predictions for word level reading and positive correlations with standardized reading comprehension (ACT = .467) it was used in following studies. In a study with third grade children by Orman (2011) the task was modified to use only real words with first and second syllable stress and stress shifting words. In addition to these modifications, a parallel auditory lexical decision task was created for morphological awareness based on previous research and knowledge from Rubin (1988), Rubin et al. (1991), Carlisle (1988), and Carlisle (2000). Although the sample was small (*n* = 14), results were significant and both word level and passage level reading were predicted by the prosodic sensitivity and morphological awareness tasks. Both of these tasks were modified again for the use in the current study.

Finally, the ultimate goal of reading is comprehension, and acknowledging the contribution of multiple linguistic awareness factors to literacy acquisition is consistent with current theoretical models of literacy development (Apel & Lawrence, in press). Perfetti (2007) argued for the *LQH* and stated that the foundation of efficient word reading is comprised of knowledge components; word forms (grammatical class, spellings and pronunciations) and meanings. With adequate reading experience and effective practice of these knowledge components, a reader obtains efficiency - rapid, low-resource retrieval of a fully specified word identity. Readers may have varying levels of knowledge of a given word's form and meaning constituents. The differences in word level knowledge at the orthographic, phonologic, meaning, and syntactic class levels affect how well a student comprehends. This variance in lexical quality is theorized to explain individual differences in word recognition and reading ability (Reichle & Perfetti, 2003) and may be considered a continuum of varying linguistic knowledge.

Summary and Rationale

Both sensitivity to prosodic features of speech (*e.g.* stress shifts in words) and awareness of morphemes have been shown to contribute to reading development and outcomes across a continuously growing body of research (Clin et al., 2009; Jarmulowicz et al., 2007). The purpose of the current study was threefold. The first purpose was the validation of morphological awareness and prosodic sensitivity tasks for children. Validation entailed measuring the extent to which tasks quantified the interaction between prosodic sensitivity, morphological awareness, and word and text level reading. The hypothesis was that prosodic sensitivity to correct stress and morphological awareness for word parts would predict word and passage level outcome measures for reading. The second purpose was to determine the specificity of the prosodic sensitivity and morphological awareness tasks; whether they are measures of word and/or text level linguistic processing and the extent of their shared and unique variance. The second hypothesis was confirmatory and examined how in a commonality (Amando, 2003) and factor analysis, prosodic sensitivity and morphological awareness accounted for unique and shared variance (morphophonology) at the word level and at passage level reading. The third purpose of the current study was the creation of ecological measurement tools that inform educators of linguistic processing skills and children's metalinguistic awareness of them, which contribute to reading comprehension in the upper elementary grades. The third hypothesis was that the prosodic sensitivity and morphological awareness tasks would contribute additional information to the test battery for the classification of students into Response to Instruction (RTI) instructional categories.

Method

Participants

A sample of 157 elementary school students (62 third graders, 40 fourth graders, and 55 fifth graders) participated in the study. All students attended a public elementary school in a middle- to low-socioeconomic class suburban area of the central Tennessee. Because the school requested that the study be made available to all students when parental consents were collected, students were prescreened for the following subgroup criteria but not omitted: a) English as a second language status, b) intervention for reading and language but not identified for special education, c) and identified as language or learning impaired with special education services. Subgroups were created for comparison and diagnostic differentiation analysis using the experimental measurement tools. The English Language Learner (ELL) and special education qualified groups were not included in the analysis although, descriptive data are included in this study. The children attended a school with a 78% free and reduced lunch rate.

The first group of participants (n = 130) were children with typical skills (63 boys and 67 girls) ages range from 8 years, 1 month to 12 years, 1 month (M = 9 years, 11 months SD = 12.05 months). Teachers reported students were performing within the average range on classroom measures of academic achievement with no apparent language concerns. The children were recruited through a school-wide recruitment for participation in research project and the project was made available to all students. Parents voluntarily provided informed consent consistent with the local university institutional review board and the children provided written assent at the time of testing.

Fifteen participants were qualified for special education services. Twelve were certified with a Learning Disability (LD) in reading, two were certified with Language Impairment (LI), and one participant was ELL and LD (10 boys, 5 girls; age range 8 years 9 months to 11 years 10 months). This subgroup of students was not included in the analysis although descriptive data on task performance is included in the study.

Twelve participants qualified as English Language Learners (ELL), one participant was also certified for special education (11 boys, 1 girl). This group of ELL students ranged in age from 8 years, 1 month to 11 years, 7 months (M = 9 years, 5 months, SD = 15.1 months). All ELL children were identified by school placement testing with the Test of English Language Proficiency (TELPA) and spoke two or more languages. This subgroup of students was not included in the analysis although descriptive data on task performance is included in the study.

Reading Measures

Word reading. Subtests of the Woodcock-Johnson III Tests of Achievement were administered to measure reading skill (WJ-III: Woodcock, McGrew, & Mather, 2003). Subjects read a list of real words (Letter-Word Identification) and pseudo words, both of increasing difficulty (Word Attack). The publisher reported reliability coefficients for Letter-Word Identification and Word Attack are .94, and .87. Raw scores were based on total correct responses and were transformed using the norms in the test manual. Transformed scores have a mean of 100 and a standard deviation of 15. Word Identification served as the word level dependent variable in regression analysis.

Word reading test - extended (WRT-E). This morphologically complex reading task was adapted from Carlisle's (2000) word reading test. The purpose of this test was to assess students' ability when reading morphologically complex words. The test included four groups of words as shown in the Appendix B. Set A was made up of 25 words that have high surface frequency. The frequency (using Standard Frequency Index, SFI) for these words was at or above 40. Set A contained nine words in which the base form was fully represented in the derived form (orthographically and phonologically), referred to here as Transparent words (e.g. *harmful, lovely*) and 16 words which were different from their base forms in terms of orthographic and/or phonological characteristics (referred to here as 'Shift Words'). The second set of words, Set B, consisted of 20 words with high frequency base words but low surface frequency (e.g. *puzzlement*). The third set of words, Set C, consisted of 20 words with low surface and low base frequency (average SFI = 39). For example, the base form is fully represented in the derived form in eight words and all other words have changes in phonological or orthographic characteristics. The final set of low frequency words was added due to previous ceiling effects in fifth grade with the use of only Set A and B (Carlisle, 2000). This task was used as a dependent variable in prediction analysis.

Spelling Measures

Test of Written Spelling, Fourth Edition (TWS-4; Larsen, Hammill, & Moats, 1999). Children's spelling knowledge was assessed with the TWS-4 test form A. Children spelled words dictated to them. The basal was five items correctly spelled and the ceiling was five items incorrectly spelled. The TWS-4 was group administered by classroom teachers and/or the author if the teacher requested assistance. Raw and standard scores were collected for data analysis. The publisher reported reliability was Chronbach's Alpha, .90. The TWS-4 was used in correlations, as variable in factor analysis, and as a test in the test battery entered in the discriminant function analysis.

Developmental Spelling Assessment (DSA). A 100-word spelling dictation task (i.e. *Letter name:* jet, got, went; *Within word:* girl, hurt, couch; *Syllable juncture:* furnace, tennis, complete; and *Derivational stage:* electrician, hostility, eruption), was taken from Ganske (2007) spelling inventories. The DSA was group administered by classroom teachers. All assessments were analyzed for developmental feature knowledge and word accuracy. Scoring was done as directed by the manual and developmental feature and item correctness scores were collected by the author for data analysis. Because the DSA was already given in the school it was used as part of the correlation analysis to obtain further knowledge about the covariance between word feature knowledge and the experimental measures (MAT, PST, and WRT-E).

Word Knowledge Measures

Vocabulary. Children's vocabulary knowledge was assessed using the WJ-III Synonyms, Antonyms, and Analogies subtests. Reading vocabulary was used as a general word knowledge measure (WJ-III: Woodcock et al., 2003). The publisher reported reliability coefficients for Reading Vocabulary was .90. Participants orally stated synonyms and antonyms for printed words and orally complete written analogies (e.g., *elephant : big :: mouse :* ____). Raw scores from each subtest were based on total correct responses and were transformed using the norms in the test manual and a composite was obtained. These transformed scores have a mean of 100 and a standard deviation of 15. The Reading Vocabulary composite score served as a word level knowledge outcome measure and as a dependent variable in regression analysis.

Metalinguistic measures

Morphological awareness task. The experimental morphological awareness task (MAT) was modeled after one used by Rubin (1988) and adapted and used by Rubin et al. (1991), Carlisle and Fleming (2003), and Jarmulowicz et al. (2007). This was a measure of children's ability to explicitly analyze words for their parts through recognition and identification of base morphemes in one and two morpheme words as administered via a computer. Although the original Rubin et al. (1991) task was composed of 44 items, 30 stimuli were used in the current study. Follow-up studies have found significant correlations with reading outcomes in grades other than kindergarten using lists of 28 items (Carlisle & Fleming, 2003; Jarmulowicz et al., 2007). Previous research using this task required an auditory lexical decision and a production of the correct one morpheme word inside the two-morpheme word upon a 'yes' answer. This study only required an auditory lexical decision task. Of these 30 words, 14 have one syllable and 16 have two syllables. The words were selected based on morphemic structure and each two morpheme word was paired with a one morpheme word (e.g. *kissed/list*). There were 15 phonologically paired words. There were 7 inflectional suffixes and 8 derivational suffixes. Items are in Appendix A.

Participants were given six training trials prior to test trials (raining, rains, rained, pillow, sink, teacher). The training trials were delivered in the following manner. First, the participant listened to each question and responded spontaneously. If the response was incorrect, the program repeated the question, provided the correct response along with a brief explanation, and asked the question again. This procedure was repeated until a correct response was made. Both words that contain smaller words and those that do not were in the training trials. On the 30 test trials, neither demonstration nor feedback was given.

The 30 test items were pseudorandomized so that the phonologically matched pairs were not consecutive, this procedure followed suit with previous research (Jarmulowicz et al., 2007; Rubin et al., 1991). In contrast to previous examiner delivery models, the test was delivered through computerized assessment for standardization, and the production part was omitted. The new procedure was a perceptual auditory lexical decision task asking participants to identify if the items are morphologically complex with the carrier phrase: *Is there a smaller word inside of _______ that means something like ______?* Answers were a dichotomous response, yes/no. For one morpheme words (e.g. *list*), the correct answer was "no." For words with suffixes (e.g. *kissed*) the answer was yes. Previous uses of this task required participants to produce the single morpheme word inside of 'kissed' but this was omitted from this task, making it a perceptual task only.

Items were digitally recorded in a soundproof booth and the speaker was the author, a female with a clear speaking voice and a Standard American English accent. All participants received standard instructions, trial items, and test items. Prior to actual task administration, trial items were administered until an 80% mastery level was met. If the entry criterion was not met, the student did not continue the task. Throughout all trial items feedback for correct and incorrect responses was given (e.g. a red frowning face 'x' for *no*, and a green happy face for *yes*). The total possible MAT score was 30. Each item was scored dichotomously, either as correct or incorrect and the participant received an accuracy score as well as a sensitivity score (*d´*; the sensitivity of detecting the signal when it is present, taking into account false alarms and accuracy for non-signal detection). The sensitivity score (*d´*) was used as the variable in all analyses. This test was used as an independent variable in prediction, and a variable in factor analysis. Furthermore, its test reliability and items were analyzed for internal consistency and item performance.

Phonological awareness task (AAT-Nonce). The phonological awareness task was adapted from Rosner and Simon (1971) and Singson et al. (2000). The original form was a 40 item Auditory Analysis Task (AAT) where the examiner pronounced an item and asked the child to repeat it while omitting certain sounds (e.g. "Can you say *sour* without /*s*/?"). Due to potential ceiling effects with older children, Singson et al. (2000) designed an additional test of phonological awareness using nonsense words, the AAT-Nonce. On this task the participants were asked to repeat *pseudo-words* without specific sounds (e.g. "Can you say *snile* without /*s*/?). Because both tasks worked in the Singson et al. (2000) study, and because this study is using older children, the AAT-Nonce was used as a segmental phonological awareness measure. Items are in Appendix C. This task was an independent variable in the prediction and a variable in factor analysis.

Prosodic sensitivity test (PST). The purpose of this task was to test the participants' ability to distinguish lexicality when presented with correct and incorrect stress in derived words. Each participant was presented with 40 items, an equal number of words correctly and incorrectly stressed, half with the stress on the first syllable (e.g.

brevity) and half with stress on the second syllable (e.g. *athletic*). Within each cell of this design, 10 items were adjectives suffixed to form nouns with –ity (e.g. *equality*) and the other 10 items were nouns suffixed to form adjectives with –ic (e.g. *athletic*). Half of the items in each cell of the design were presented with weak-strong stress (e.g. *cenTRALity*), which is correct for the suffixed forms where the stress is on the second syllable but incorrect for words with the stress on the first syllable. Half were presented with strong-weak stress, which was incorrect for the second syllable stress words (e.g. *CENtrality*), and correct for the first syllable stress words. The items for the PST are listed in the Appendix D.

Stimuli were digitally recorded and the speaker was the author, a female with a clear speaking voice and a Standard English accent. The stimuli were presented through headphones. Stimuli were not repeated in either condition (correct or incorrect). Two lists were formed and each item was presented with correct and incorrect stress across participants. Each participant received an accuracy and sensitivity score (d'). The overall sensitivity score (d' overall) in this task was an independent variable in the prediction analysis and a variable in factor analysis.

General Outcome Measure

Tennessee Comprehensive Assessment Program Achievement Test (TCAP). All students in the study took the Tennessee Comprehensive Assessment Program (TCAP) Achievement Test in the spring. The Achievement Test is a timed, multiple-choice assessment that measures skills in Reading, Language Arts, Mathematics, Science and Social Studies. Student results were gathered from the school. As a general outcome measure of comprehension, they were used as a dependent variable in prediction analysis.

Reliability

There were five examiners, the author, the research lab director, and three lab assistants from the psychology department. Each examiner was trained in standard test administration, which included observations and recordings to ensure inter-rater reliability. Over 25% of the testing sessions conducted were checked for scoring reliability by the author. Inter-rater reliability was determined by observation of the WJ-III subtests and the AAT-Nonce. Inter-rater reliability was determined by digital recordings of the WRT-extended. Inter-rater agreement for all tasks ranged from 95% to 100%. Disagreement was resolved by adherence to the rules of the test.

Procedure

All participants completed a test battery given in one session that lasted approximately 30 minutes. The session was broken up if students were fatigued and students were given tasks on multiple days in a given week (no more than two days). The examination took place in their elementary school in a quiet setting, the library office. Participants were tested individually by a test administrator on the described measures and received them in the following order: WJ-III Tests of Achievement Letter-Word Identification, Word Attack, Synonyms, Antonyms, and Analogies (Woodcock et al., 2003), MAT, WRT-extended, AAT-Nonce, and PST. The experimenter-designed morphological awareness and prosodic sensitivity tasks were administered via a desktop computer to ensure standardization in delivery of experimental conditions, all other tasks were administered by an examiner. The assessments were counterbalanced (given in reverse order) to control for order effect and student fatigue. All norm-referenced measures were administered and scored per standard guidelines listed in administration manuals.

The MAT items were presented and responses were collected with a computer running E-prime version 2.0 (Psychology Software Tools). Each trial began with a blank screen, which appeared for 1 second, and it was followed by a 500 millisecond ready screen with a central marking indicating the sound file would be coming. With all six trial item sound files, the participants were asked the carrier phrase in a script. For the list of 30 test items, the participants heard each word with no scripts. Participants received corrective feedback when they answered incorrectly during the trial period. For example, they were given corrective feedback by answering "no" to the following question: *Is there a smaller word inside raining that means almost the same thing as raining?* The corrective feedback was: *Listen to the question again. Is there a smaller word in raining that means almost the same thing as raining? The word rain is in raining. Rain and raining mean almost the same thing. Let's try raining again.* More examples are in Appendix A.

The PST items were presented and responses were collected with a computer running E-prime version 2.0 (Psychology Software Tools). Each trial began with a blank screen which appeared for 1 second, followed by a countdown clock with a central marking to indicate a sound file would be coming, followed by the presentation of the sound file. Responses were allowed immediately after the termination of the sound file. Participants clicked the left button of a mouse to indicate an item was a word or the right button of a mouse to indicate that an item was a nonword. The central marking disappeared after a response was recorded. Accuracy feedback was given during practice trials but not during the experiment trials. If a response was not made within 3 seconds a warning message was presented and a null response was recorded. Warning messages for null responses were presented during all trials.

Performance on the WRT-E was digitally recorded and scored by the researcher or the research assistants. The student received two points for reading the word correctly within two seconds. One point was given if a student delayed due to a false start, repetition, or a self-correction. Greater than 20% of the protocols at each grade level, were scored a second time by the researcher. The agreement between the two scorings was greater than 95%.

Results

Table 1 contains the means and standard deviations for all measures for students with typical skills ($n = 130$). The distribution of the scores on the measures was normal for all grade levels. Descriptive statistics of all measures for all ELL and students qualified for special education are provided in Table 2. These are not given by grade level due to the small sample sizes ($n = 11$ and $n = 15$). The distribution of the ELL and special education students' scores on the measures was lower than that of their typical skilled peers and there are unique differences between the ELL and special education qualified groups. ELL students scored higher than students qualified for special education on all measures in the test battery. Third grade TCAP scores are not reported in Table 1 or 2 as they were not available at the time of data collection. Performance on the morphological awareness and prosodic sensitivity tasks increased consistently over the range of grade levels examined. Univariate analysis of variance (ANOVA) was used to test the significance for each task by grade level grouping. There were statistically significant differences between the grade level groups for students with typical skills on the morphological awareness measure, F (2, 127) = 3.38, p = .04, η^2 = .05. A post hoc Tukey's procedure was used for pairwise comparisons between grade levels, and it showed that grade three and five were significantly different from each other but neither was significantly different from grade four. The MAT results are consistent with those of other studies (Nagy et al., 2006; Nagy & Scott, 1990) showing that morphological knowledge increases with age and that significant differences exist between grades three and five but that grade four is undifferentiated from either grade (Carlisle, 2000).

There were statistically significant differences among the grade level groups for students with typical skills on the prosodic sensitivity measure, F (2, 127) = 4.88 , p = .009, η^2 = .07. Post hoc Tukey's pairwise comparisons between grade levels revealed that there was significant difference between grade level three and five but neither three or five was significantly different from four for the prosodic sensitivity task. The developmental trend findings are consistent with past research on stress-shifting suffixation (Clin et al., 2009), where third grade students (d' = .83) are less likely to detect correct stress than fourth (d' = 1.84) and fifth graders (d' = 1.33).

There were statistically significant differences between the grade level groups for students with typical skills on the WRT-E, F (2, 127) = 6.08, p = .003, η^2 = .09. Post hoc Tukey's pairwise comparisons between grade levels for students with typical skills revealed that there was significant difference between grade level three and five but neither three or five was significantly different from grade four for the WRT-E.

Table 3 contains Pearson product-moment correlations for the MAT, PST, and WRT-E, reading tasks, and spelling tasks. Raw scores were used for all measures. All correlations between the experimental measures morphological awareness, prosodic sensitivity, and WRT-E were significant. Correlations involving prosodic sensitivity were weak to moderate. The highest correlations for morphological awareness were with reading vocabulary (r = .50), DSA feature score (r = .42), TWS (r = .40), and WRT-E (r = .39); all were moderate except the strong correlation with vocabulary. The highest and strongest correlations were for WRT-E with AAT-Nonce (r = .51), TWS (r = .76), DSA (r =.78), Word Attack (r = .60), Letter Word ID (r = .81), and vocabulary (r = .59). Correlations between WRT-E, Word Attack, and Letter Word ID should all be strong due to the fact that they are all decoding measures. The correlations between the WRT-E, morphological awareness, and vocabulary are all moderate to strong and support the interrelated nature of the three tasks. Previous research using the original WRT (Carlisle, 2000) had similar correlations with vocabulary (r = .54 for third grade, r = .57 for fifth grade).

Table 4 contains Pearson product-moment correlations for the experimental tasks (MAT, PST, and WRT-E) and the TCAP comprehension outcome measures – Reading and Language Arts, Science, Social Studies, and Math. MAT and WRT-E correlated significantly with all TCAP measures. The correlations are strong for TCAP Reading and Language Arts for both measures (MAT and WRT-E) but, the WRT-E has stronger correlations across all TCAP assessments (Science, Social Studies, and Math). This ability to read morphologically complex words, the strong correlation with vocabulary (Table 3), and the TCAP measures is again consistent with Carlisle's (2000) findings for the original version of the WRT-E. Carlisle (2000) found the WRT was a significant contributor to vocabulary outcomes and reading comprehension.

To provide an estimate of the reliability on the MAT, PST, and the WRT-E tasks, Cronbach's alpha and test-retest were calculated. Internal consistency reliability for the MAT was acceptable ($\alpha = .78$), and test-retest was $r = .72$, $p < .01$ for accuracy and $r = .246$, $p = .013$ for d-prime. Appendix E contains a complete list of item level information for the MAT. Students performed poorest on *drowned, sterling,* and *funny* and they performed well on *kissed, lady,* and *money.* Cronbach's alpha for the PST was below adequate ($\alpha = .47$ for list A, $\alpha = .36$ for list B), test-retest reliability using d-prime was weak for the PST ($r = .271$, $p = .005$). The WRT-E had strong internal consistency ($\alpha = .95$) and test-retest was also strong ($r = .90$, $p < .001$). Item analysis on the WRT-E showed strong p-value scores (from .3-.7) for all items except *subsistence* (p = .163), *penitentiary* (p = .166), *agitator* (p = .23), and *criterion* (p = .208). All items were in the low-surface frequency/low-frequency set of words (Set C).

Although the test-retest reliability for the sensitivity score, d-prime, is weak for both tasks, it is the data used in all the analysis because no significant difference in analyses outcomes were noted when using d-prime or accuracy. The sensitivity measure may not be appropriate data for test-retest reliability due to the fact that in retesting, children become more familiar with how to take a test and therefore, become more sensitive to foils and target items. This increase in sensitivity did affect the accuracy test-retest reliability, as seen on the MAT.

Predicting Word Level and Comprehension Reading Skills

To determine predictive relationships between the auditory lexical decision tasks (MAT and PST) and word level reading tasks, a series of four-step hierarchical regression equations were computed on the data set ($n = 130$ children). The dependent variables were word reading ability (Letter Word ID) and the word reading complexity task (WRT-E). The independent variables in fixed order were: (*i*) age, (*ii*) vocabulary raw score, (*iii*) AAT-Nonce, and (*iv*) the morphologic awareness task (MAT) and prosodic sensitivity task (PST). Although morphological awareness for early developing inflections and derivations and prosodic sensitivity to correct stress in derived words was expected to contribute significant variance to word level reading tasks, they did not (see Table 5). When word reading was the dependent variable (Letter Word ID), age and vocabulary accounted for 24% of the variance, phonological skills added another 7%, and morphological awareness and prosodic sensitivity added a non-significant 1%, $r^2 = .01$, $F(2,123) = 1.20$, $p = .30$. When the dependent variable was complex word reading (WRT-E), age and vocabulary accounted for 29% of the variance, phonological skills added another 10%, and morphological awareness and prosodic sensitivity added a non-significant 1%, $r^2 = .01$, $F(2,123) = .723$, $p = .487$.

Because theoretical hypothesis (Nagy, 2009; Perfetti, 2007) suggest vocabulary knowledge is the outcome of fully specified metalinguistic knowledge, which is integrated and overlapping in nature, commonality and factor analysis were used to empirically address these suppositions. When predicting word reading (Letter Word ID), commonality analysis revealed that code and word knowledge account for 40.2% of the variance while morphologic awareness and prosodic sensitivity add an additional 1%. The commonality between code and word knowledge and metalinguistic knowledge was 13.1% when predicting word reading. When predicting reading complex words (WRT-E) commonality analysis revealed that code and word knowledge account for 39.5% of the variance while morphologic awareness and prosodic sensitivity add an additional

1.1%. The commonality between code and word knowledge and metalinguistic knowledge was 15.5% when predicting WRT-E.

Due to the lack of significant unique variance accounted for in regression analysis, the significance in correlations, and the commonality between variables, an exploratory factor analysis using Promax rotation (oblique) with Kaiser normalization was conducted. The analysis yielded two factors explaining 66.37% of the variance for the entire set of variables. Factor I was labeled *decoding skills* due to high loadings by the following items: Word Attack, WRT-E, TWS, Letter Word ID, AAT-Nonce, and vocabulary. This first factor explained 51.76% of the variance (see Table 6). The second factor derived was labeled *morphophonological skills* due to the high loadings by the following factors: prosodic sensitivity and morphological awareness. The variance explained by this factor was 14.61%. Both factors eigenvalues are greater than 1.0 and the scree plot visually defined two factors. The correlation between factors was $r = .44$. These factors identify layers of language knowledge necessary to the coding and understanding of words. A stepwise regression analysis was used to analyze how much of the variance factor scores predicted in reading comprehension (TCAP Reading and Language Arts). Table 7 shows that decoding skill factor accounted for 25.7% of the variance in large outcome reading and language arts scores for fourth and fifth graders and an additional 5.1% of the variance was explained by the metalinguistic skill factor.

The results of the initial regression analysis answer the second research question and strongly suggest that the newly created word level tasks for morphological awareness and prosodic sensitivity were not validated as consistent behavioral measurement tools. However, the results of the factor analysis and subsequent stepwise regression using the created factors, suggest morphological awareness and prosodic sensitivity are important and significantly contribute to reading comprehension.

Discussion

The results of this test development study continue to fill in pieces of understanding around the value of morphological awareness and prosodic sensitivity to reading. The original goals of this study were to (a) develop and validate a morphological awareness and a prosodic sensitivity measure for children, (b) to determine the unique and shared variance the tasks contribute to word and comprehension outcome measures, and (c) to determine if morphological awareness and prosodic sensitivity help further define classification into RTI instructional categories. Each of these goals is discussed in turn.

Question 1 and 2: Do the metalinguistic measures account for unique variance in reading out comes for third, fourth, and fifth graders? Is there a consistent behavioral response?

The first finding was that morphological awareness to inflectional and derivational morphemes was significantly and positively related to each of the other measures: phonological awareness, reading real and nonsense words, reading morphologically complex words, vocabulary, spelling, all TCAP scores, and age. The prosodic sensitivity to accurate stress in real words was only significantly and positively correlated with: phonological awareness, reading real words, reading morphologically complex words, vocabulary, spelling, and age. Although, the tasks were related to the word level reading outcome measures, they did not account for any of the unique variance in the regression analysis predicting word reading. A follow-up commonality analysis strengthened previous research findings that morphological awareness and phonological awareness (although suprasegmental in this study) overlap considerably during the elementary years (Carlisle & Nomanbhoy, 1993; Jarmulowicz et al., 2007; Shankweilier et al., 1995; Singsing et al., 2000). Furthermore, when all data were entered in a factor analysis, both morphological awareness and prosodic sensitivity created a second factor (morphophonology) in addition to a decoding skills factor. When these factors were used in stepwise regression analysis the decoding factor accounted for 25.7% of the variance in general outcome reading and language arts scores for fourth and fifth graders. The morphophonological factor explained an additional 5.1% of the variance. The inter-factor correlation was $r = .44$.

The results are not wholly consistent with previous research where morphological awareness and prosodic sensitivity tasks contribute unique variance to word level outcomes (Clin et al., 2009; Jarmulowicz et al., 2007). This result is plausible considering the fact that this study did not set out to prove this connection but rather, to develop and validate measurement tools of both metalinguistic skills. One reason for the lack of significance may be due to the change in task format and delivery as discussed below.

Morphological awareness. The adaptation to a computerized task and making it an auditory lexical decision task may have affected the power of the MAT. Originally Rubin (1988), Rubin et al. (1991), and then Jarmulowicz et al. (2007) asked children to give a yes/no response to the carrier phrase, "Is there a smaller word in . . . that means something like . . . ?" If it was a two-morpheme word like *raining*, the student was expected to say "yes" and then, to obtain full credit the student had to produce the base morpheme *rain*. For this study, the production component was removed. The items were scored correct/incorrect and through a computation, a sensitivity score was obtained. The sensitivity measure addressed how well a student was able to recognize a correct item when it was correct and a foil when it was a foil. The elimination of the production component may have decreased the tasks ability to pull unique variance but nevertheless, it was significantly correlated with reading words and morphologically complex words, vocabulary, and general outcome comprehension measures in all areas (reading, social studies, and math).

Another reason the MAT may have lacked power to pull unique variance in word and text level reading is because it was measuring children's word structure knowledge of mono and bimorphemic words without the orthographic representation of the word. In future studies it would be plausible to pair this tool with other morphological tools addressing orthographic transparency and opaqueness in both inflected and derivation morphemes and derivational composition and decomposition. Previous research has shown that students at or above third grade can decompose morphologically complex words, especially when these words are a transparent relation to the base form (Carlisle, 1988; Carlisle, 2000; Tyler & Nagy, 1989) as well as produce them. Developing a task around the construct of morphology must require all aspects of perception and production to be taken into account.

Another consistent finding with the MAT was found in the special education sample, where students performed significantly lower than their typical peers. Rubin et al. (1991) found that typically developing second graders did not master the rules for adding morphological endings to new words, which infers learning continues into the upper elementary grades. In this same study, the adult sample with a history of severe reading difficulties performed at a level commensurate with the typically developing second graders. Rubin et al. (1991) suggested in children and adults with language and learning difficulties, explicit understanding of word structure is often delayed. This may result because children with language and/or learning difficulties often have problems explicitly monitoring their own language production (Carlisle, 2003).

The WRT-E was added as a morphologically complex word reading measure task and because of previous ceiling effects with the fifth grade population (Carlisle, 2000), an additional list of low surface frequency and low frequency words was added. A reliability measure revealed the additional list increased the reliability and there were no ceiling effects. The results of the correlations and factor analysis show that the aspect of reading derived forms (production) is significantly related to the coding processes of reading and that it contributes significantly to reading outcome measures (TCAP).

Prosodic sensitivity. The prosodic sensitivity task (PST) addressed participants' ability to distinguish lexicality when presented with correct and incorrect stress words with 20 stress shifting derivational endings (*-ic* and *–ity*). Some findings are consistent with past research showing developmental trends in stress-shifting suffixation, where third grade students are less likely to detect incorrect stress than students in fourth and fifth grade. In fact, in an analysis of variance a significant part of the variance (8%) in performance on the PST was attributed to grade and there were also significant group differences between third and fifth grade.

An interesting difference in the literature was that the PST did not significantly correlate with word attack (nonsense word reading). Jarmulowicz et al. (2007) found that a derived word production task significantly correlated with word attack ($r = .575$, $p < .001$) and in this study, with a derived word perception task, there was no correlation with word attack skill ($r = -.022$). There was also a decreased sensitivity to the words with the stress shifting suffixes of *–ic* and *–ity*. There are a few reasons why this could be the case. First, the task was an auditory lexical decision task and it required students to attend to the task, use working memory to access stored word representations, match what they heard for accuracy with their lexicon, and make a decision. It is possible that the load on working memory while trying to reify the stressed word and make a connection to a stored representation increased the demands of the task and did not actually address prosodic sensitivity to inaccurate stress but rather a decreased efficiency in working memory. Past research has suggested that deficits or inefficiencies in working memory may explain difficulties in reading processes (Gathercole & Alloway, 2010).

Secondly, the task may be too complex for students in grades three, four, and five and although the PST shows developmental changes across grade levels knowledge about stress shifts may not be a fully consolidated feature in the lexicon for this age group. The stronger correlations with the MAT and the outcome of the factor analysis give rise to the idea that these two skills are emerging and necessary for reading comprehension to occur but they are not adequate at this time. The fact that the PST does contribute to the metalinguistic factor as an auditory lexical decision task, brings the discussion to an idea noted by Goswami et al. (2002) about basic auditory processing. Goswami et al. (2002) contributed the idea that if basic auditory processing is a key component to the cause of the phonological deficit that characterizes developmental dyslexia, "then measures of basic auditory processing should predict reading, spelling, and phonological ability even when age, nonverbal IQ, and vocabulary are controlled (p. 10914)." It may be interesting for future studies to address this by assessing a group of children with dyslexia and comparing them to the data at hand.

Lastly, further development of the PST task may yield results that are more quantifiable. Holliman et al. (2010) and Wood (2006) used a prosodic sensitivity task that used context to address the developmental age range they were working with (*mean age* = 6.7). In this mispronunciation task the students were given an inaccurately stressed word and a set of pictures. They obtained full credit for the awareness of inaccurate stress by pointing to the picture that most adequately resembled the word they heard. In this case, the context provided additional information for problem solving lexicality. The addition of context to an auditory perception task for third, fourth, and fifth grade may not be entirely necessary but it may yield beneficial results.

Limitations and Future Directions

These test development findings give further support to the preponderance of research showing morphological awareness and prosodic sensitivity contribute to word and text level reading yet, there are several limitations to this study. First, the tasks were test dependent not only to the item set but, to the delivery. While previous researchers also used tests developed through classical test theory, they have also created multiple tasks that tap into several processes for a more adequate measure of the constructs of morphology and prosody. For example, Carlisle (2000) used a battery of two tasks, one addressing the reading of morphologically complex words and the other designed to assess students' awareness of base and derived forms which had a decomposition and derivational component. These decomposition and derivational components tapped into what Anglin (1993) referred to as morphological problem solving, where students gain meaning from other words to create understanding for new words they encounter. Other research has also made use of multiple tests for one construct (Nagy et al., 2006). This allows for the researchers to adequately measure all perception and production modalities. Secondly, as the PST required students to hold novel mispronounced words in working memory, the task may have been more about working memory than about prosodic sensitivity to inaccurately stressed words. Due to this, a working memory assessment would have been helpful to rule out this variable. This has been done in more recent research (Clin et al., 2009). Third, the MAT was a task of inflectional and derivational morphology with no phonological changes to the stem (i.e., no changes in primary stress, vowels, or consonants) (Jarmulowicz et al., 2007). As Jarmulowicz et al. (2007) suggested, the relationships with morphological awareness may have been stronger if more items with derivational morphology would have been used.

Lastly, the fact that this study was done at a low SES school with varying dialect influences (Black English, Southern American English, and foreign born) may affect auditory perception in the measures. Apel and Thomas-Tate (2009) found that dialect variations do not appear to influence morphological awareness and Jarmulowicz et al. (2007) concluded that results on a prosodic sensitivity task were similar between a Memphis, Tennessee and northeastern sample. Nevertheless, whether dialect affects prosodic sensitivity to correct stress and awareness for morphological structure may be an area of future study.

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Table 1

Descriptive Statistics for Students with Typical Skills (*n* = 130)

	3rd (*n* = 47)		4th (*n* = 36)		5th (*n* = 47)	
	Mean	SD	Mean	SD	Mean	SD
Age in months	105.87	4.69	119.64	4.71	131.89	4.73
Woodcock Johnson						
Basic Reading	106.70	9.92	99.53	8.17	99.70	11.47
Vocabulary	99.53	9.50	99.22	10.64	100.40	8.32
Letter-Word Identification	105.98	9.31	100.56	8.51	98.57	11.07
Word Attack	105.49	9.71	99.00	8.04	101.09	11.35
AAT-Nonce (40)	23.45	7.46	24.17	6.98	26.79	6.28
Test of Written Spelling (TWS)	105.83	15.48	102.47	10.44	101.66	10.88
DSA - Feature Score (100)	62.72	16.66	66.06	15.33	72.06	14.44
Morphological Awareness Task (30)						
Accuracy (percentage)	70%	17.46	75%	14.92	79%	10.55
Accuracy for one morpheme	69%	20.28	77%	16.33	79%	12.94
Accuracy for two morphemes	72%	19.34	73%	17.65	79%	12.89
d' overall	1.25	1.11	1.49	0.97	1.76	.73
Prosodic Sensitivity Task (40)						
Accuracy (percentage)	74%	7.84	77%	6.70	78%	7.19
Accuracy for first stress	88%	9.54	91%	7.61	92%	7.06
Accuracy for second stress	59%	15.24	64%	13.97	69%	12.02
d' overall	1.31	0.49	1.56	0.47	1.62	0.54
d' for first stress	2.00	0.70	2.01	0.65	2.07	0.61
d' for second stress	0.83	0.65	1.84	0.59	1.33	0.64
Word Reading Complexity Task (WRT-E) (130)	70.05	21.97	77.78	18.97	83.68	20.44
TCAP Language Arts	*NA*	*NA*	757.83	27.90	751.10	28.53
TCAP Science	*NA*	*NA*	757.42	30.94	748.70	24.21
TCAP Social Studies	*NA*	*NA*	213.47	20.37	203.83	15.66
TCAP Math	*NA*	*NA*	762.58	38.44	752.02	27.08

Note. Numbers in parenthesis indicate total possible points. All means for WJ-III subtests (Vocabulary, Letter-Word ID, and Word Attack), and TWS are from standard scores.

Table 2

Descriptive statistics for ELL and Special Education Qualified Students

	ELL (n = 11)		Special Ed. ID (n = 15)	
	Mean	SD	Mean	SD
Age in months	115.91	15.46	119.07	11.82
Woodcock Johnson				
Basic Reading	97.55	9.35	86.07	11.85
Vocabulary	87.09	9.81	84.60	14.95
Letter-Word Identification	95.36	10.15	85.13	9.80
Word Attack	100.73	8.80	89.73	13.68
AAT-Nonce (40)	25.00	6.77	19.33	7.09
Test of Written Spelling (TWS)	92.64	9.82	82.00	10.32
DSA - Feature Score (100)	42.00	14.16	33.29	10.86
Morphological Awareness Task (30)				
Accuracy (percentage)	62%	15.58	55%	14.39
Accuracy for one morpheme	62%	18.21	47%	18.30
Accuracy for two morphemes	61%	21.25	59%	16.19
d' overall	0.66	0.90	0.25	0.81
Prosodic Sensitivity Task (40)				
Accuracy (percentage)	72%	9.01	66%	8.25
Accuracy for first stress	85%	11.28	79%	13.56
Accuracy for second stress	63%	17.93	59%	17.92
d' overall	1.24	0.53	0.90	0.44
d' for first stress	1.72	.61	1.40	.81
d' for second stress	.82	.56	.56	.74
TCAP Language Arts	733.67	16.56	719.20	45.28
TCAP Science	717.83	27.39	713.60	50.09
TCAP Social Studies	197.67	11.81	190.20	29.44
TCAP Math	736.83	31.52	737.80	31.11

Note. Numbers in parenthesis indicate total possible points. All means for WJ-III subtests (Vocabulary, Letter-Word ID, and Word Attack), and TWS are from standard scores.

Table 3

Correlations Between all Experimental Tasks, Reading, and Spelling Variables (n = 130)

	1	2	3	4	5	6	7	8	9	10	11
1. MAT d'	1	.307**	.270**	.393**	.395**	.415**	.224*	.392**	.505**	.195*	.251**
2. PST d'		1	.177*	.226**	.247**	.147	-.022	.206*	.319**	-.039	.269**
3. AAT			1	.513**	.470**	.428**	.453**	.447**	.383**	.417**	.167
4. WRT				1	.762**	.782**	.600**	.805**	.587**	.646**	.244**
5. TWS					1	.825**	.612**	.660**	.605**	.502**	.383**
6. DSA Feature						1	.636**	.699**	.518**	.618**	.227**
7. Word Attack							1	.405**	.353**	.697**	.086
8. Letter Word ID								1	.541**	.658**	.243**
9. Vocabulary									1	.212*	.526**
10. Basic Reading										1	-.379**
11. Age in Months											1

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

Table 4

Correlations for Experimental Tasks and Outcome Measures (TCAP)

	1	2	3	4	5	6	7
1. MAT d'	1	.307**	.270**	.409**	.356**	.291**	.339**
2. PST d'		1	.177*	.058	-.068	-.045	-.083
3. WRT			1	.509**	.550**	.430**	.399**
4. TCAP Reading				1	.797**	.721**	.682**
5. TCAP Science					1	.700**	.651**
6. TCAP Social St.						1	.684**
7. TCAP Math							1

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

Table 5

Hierarchical Regression Predicting Word Reading for Letter Word ID and

Morphologically Complex Words (WRT-E)

Variables	R^2	R^2 Change	Adjusted R^2	*F*	*p*	*df*
Letter Word ID						
Age in months	.06	.06	.05	8.128	.005	(1, 127)
Vocabulary	.30	.24	.29	42.98	.000	(2, 126)
Phonological Awareness	.37	.07	.35	13.14	.000	(3, 125)
Morphology d' *Prosody d'*	.38	.01	.35	1.20	.30	(5, 123)
WRT-E						
Age in months	.06	.06	.05	8.16	.005	(1, 127)
Vocabulary	.35	.29	.34	57.37	.000	(2, 126)
Phonological Awareness	.45	.10	.44	21.69	.000	(3, 125)
Morphology d' *Prosody d'*	.46	.01	.43	.723	.487	(5, 123)

Table 6

Factor Loadings from Pattern Matrix, Promax Rotation with Kaiser Normalization

	Loadings	
	I	II
Variance Accounted for after Rotation (total 66%)	51.66%	14.61%
Eigenvalue	4.13	1.17
Vocabulary	**.465**	**.480**
Letter Word ID	**.732**	.168
Word Attack	**.931**	-.368
TWS	**.819**	.111
WRT-E	**.868**	.083
AAT-Nonce	**.679**	-.010
PST	-.246	**.913**
MAT	.166	**.651**

Note. Factor loadings > .40 are in boldface and denote which variables loaded on each factor.

Table 7

Regression Analysis with Factors I and II

Variables	R^2	R^2 Change	Adjusted R^2	*F*	*p*	*df*
TCAP Reading/LA						
FI – Decoding Factor	.257	.257	.247	27.605	.000	(1,80)
FII – Metalinguistic Factor	.307	.051	.290	5.812	.018	(1,79)

Appendix A. Morphological Awareness Test (MAT) stimuli (adapted from Rubin, Patterson, & Kantor, 1991)

Monomorphemic	**Bimorphemic**
kind	lined
list	kissed
nest	messed
wise	pies
winter	hunter
dinner	winner
money	funny
round	drowned
cold	rolled
cover	lover
lady	shady
soggy	foggy
sterling	curling
pony	boney
crust	crushed

Appendix B. Reading Morphologically Complex Words (WRT-E) (adapted from Carlisle, 2000)

<u>*Set A*</u>		<u>*Set B*</u>	<u>*Set C*</u>
Transparent	*Shift Words*	puzzlement	subsistence
powerful	explanation*	secretive	supplemental
suddenly	easily*	cookery	grievous**
harmful	solution*	corrective	inheritance
movement	curiosity*	pailful	vandalism
addition	natural*	organist	penitentiary***
friendly	heavily*	equalize	retrieval**
government	explosion*	wifelike	enigmatic*
lovely	trial**	sparkly	industrious**
quickly	daily**	oddity	rigorous
	moisture***	preventive	linguistic
	combination*	odorous	ignition*
	shiny**	queendom	egocentric
	invention***	stardom	agitator**
	direction***	dramatize	sarcastic*
	definition*	fearsome	embodiment*
	beautiful*	idealize	testimonial*
		bucketful	correspondence
		flowery	barbarity*
		beastly	criterion*

* Words with both phonological and orthographic changes.
** Words with orthographic changes.
*** Words with phonological changes.

Appendix C. Auditory Analysis Task (AAT) (adapted from Rosner & Simon, 1971 by Singson et al., 2000)

Practiced pseudo words:

A. dow (loy)
B. photo (cush)

Test pseudowords:

1. virth(cay)	11. (s)nile	21. (sh)rup	31. pe(cro)duce
2. ker(bot)	12. clea(se)	22. p(l)aw	32. s(n)eck
3. sel(t)	13. (p)ate	23. br(e)ate	33. de(lo)pany
4. (g)an	14. (c)lup	24. (sc)rain	34. s(l)in
5. (s)leck	15. pi(me)	25. s(n)oll	35. ho(ca)tion
6. ro(ne)	16. (sp)old	26. mis(ki)po	36. dant(in)ant
7. (v)our	17. (t) reak	27. per(na)ny	37. s(l)ong
8. (d)ray	18. so(de)	28. le(s)k	38. sar(ken)ter
9. stea(n)	19. (v)ill	29. st(r)ape	39. c(l)upper
10. (l)und	20. (b)rain	30. narto(no)mel	40. eff(er)ing

Appendix D. Prosodic Sensitivity Test (PST)

Second Syllable Stress	*First Syllable Stress*
equality	formula
vitality	battery
neutrality	brevity
normality	cavity
locality	charity
brutality	deity
legality	gravity
centrality	levity
mentality	purity
formality	quality
athletic	rarity
angelic	syllable
robotic	clinical
atomic	carnival
acidic	fantasy
demonic	structural
artistic	messenger
symbolic	nitrogen
heroic	calendar
magnetic	criminal

<u>*Practice Items*</u>

dramatic
poetic
volcanic
morality

Appendix E. Item-total correlations for MAT

Target word	Item-total Correlation
bony	.272
cold	.384
cover	.389
crushed	.384
crust	.406
curling	.358
dinner	.266
drowned	.013
foggy	.122
funny	-.074
hunter	.281
kind	.262
kissed	.643
lady	.497
lined	.415
list	.410
lover	.388
messed	.410
money	.507
money	.507
nest	.357
pies	.144
pony	.203
rolled	.289
round	.372
shady	.420
soggy	.091
sterling	-.203
winner	.162
winter	.370
wise	.405

CHAPTER IV

GENERAL DISCUSSION

The purpose of this dissertation was primarily to develop and validate tests for the efficient and ecological measurement of prosodic sensitivity and morphological awareness. Out of this process, the preceding two manuscripts have been prepared from data sets for adults and children. The first manuscript demarks the beginning of the research project and the first research question asked was, "can a task be developed that would uniquely measure prosodic sensitivity to stress changes in words and predict reading outcomes?"

In attempts to answer this question, it was found that there was a paucity of word level prosody task research across both samples and for what there was, it focused on English words with non-neutral stress changing suffixes (derivational morphology using *–ic* and *–ity*). This was an obvious place to begin answering the question. Derivational morphology has a substantial amount of supportive research in suggesting that awareness for structural changes in words plays an increasing role in reading development as children age (Carlisle, 1988; Carlisle, 2000; Jarmulowicz, Taran, & Hay, 2007; Nagy, Berninger, & Abbott, 2006; Singson, Mahoney, & Mann, 2000). This trend also exists well into the early high school years (Nagy et al., 2006).

Manuscript # 1 – the Adult Study

In the first study (Manuscript #1), a prosodic sensitivity task was developed using both real and nonwords. This task took morphologically complex real words, such as *acidic* and *normality*, and correctly stressed half of them (e.g. *aCIDic* and *norMALity*). The other half was incorrectly stressed and received primary stress placement when it should have been on the second syllable, creating a strong-weak stress (e.g. *FORmality* and *ARtistic)*. The same was done with morphologically complex nonwords. For example, *itemic* and *salmonic* were incorrectly stressed with a strong-weak stress (e.g. *Itemic* and *SALmonic*); and *carrotic* and *tribality* were correctly stressed (e.g. *carROtic* and *triBALity*). These items were recorded and a computer program, using E-Prime, was developed to ensure standard delivery of the correctly and incorrectly stressed items. Each participant (n = 79) listened to 40 words (20 real/20 nonword) through a headset. There was no feedback for these items.

The task at this phase was a lexicality task, where the participants were asked to choose if the stimuli were words or nonwords. The original idea for the stress task was to see if the stress feature used would activate a candidate set for correct stress in the lexicon – which led to the prediction of a crossover interaction (between stress and lexicality). It was originally thought that correct stress would help in the recognition of real words but hinder the rejection of nonwords, because they would sound more word-like. As a lexicality task, the participants were asked to choose if the stimuli were words or nonwords. The incorrect and correct stress became an independent variable predicting their ability to know whether the stimulus was a word or not. The original hypothesis suggested that correct stress for words would predict reading outcomes.

The results were interesting and somewhat intriguing. First of all, the real words worked at predicting word reading in adults and the Pearson product-moment correlations were strong between the task and ACT Reading. An average college age adult demonstrated something that had not been discovered in this sample before: word reading ability was intricately linked to and integrated with the metalinguistic knowledge of suprasegmental phonology. The fact that the nonwords in this task did not work is also informative because the failure of the nonword half supports ideas that stress is used to pare down the candidate set rather than to activate it in the first place (van Donselaar et al., 2005). The nonwords were included to allow for the fact that prosody may be the 'gate keeper' to lexical storage. In a modular view of information processing, this is plausible since babies begin to access language through prosodic patterning and because metalinguistic research in phonology has shown early acquisition of phonological awareness is highly predictive of reading achievement across the school ages (Adams, 1990). The fact that it did not take longer to reject correctly stressed nonwords gives rise to a valuable outcome that prosodic sensitivity to correct stress also depends on the knowledge of word meaning. Adults, unlike babies, may not use it as a primary access feature for word retrieval, but it does not mean accurate stress perception is not necessary. This relationship between prosodic sensitivity to stress in real words may be explained by, and give support to, the *lexical quality hypothesis* (*LQH*: Perfetti, 2007), which states that the quality of a word increases "when a reader's knowledge of a given word represents the word's form and meaning constituents" (p. 359). Without the fully specified meaning constituents in nonwords, the words became less stable and non significant in the prediction of reading outcomes. It is possible that the nonword section of this task could be revised using highly frequent and stable stem words (nonwords were a real stem + a illegal suffix, e.g. *astral* + *ity* = a nonword '*astrality*'). The words in the current study were not (e.g. *astral*, *salmon, lucid, etc.*). This frequency and familiarity with the stem words may have decreased the power of the task.

Perhaps this is not the case at all, perhaps the best way to measure a person's sensitivity to the prosodic features in words is not in the detection of correct stress in words and nonwords at the word level alone but rather, in the detection of correct stress in derived words in sentences. Similar tasks have been done with stress production and have also been shown to contribute significantly to reading outcomes (Clin et al, 2009; Jarmulowicz et al., 2007). It is plausible that a previously useful production task could be turned into a perception task in efforts to look at how stress impacts judgments of whether a word or nonword fits into a sentence. This may be very meaningful especially since the production tasks have already been shown to work in the prediction of reading outcomes.

In the creation of a new task for the perception of correct stress to derived words in sentences, the participant would first listen to a target word or nonword (correctly or incorrectly stressed), then listen to the word in a sentence and lastly, detect if the word correctly completed the sentence. For example, a stimuli item may be: *diVERsity* : There was a lot of *diversity* at the food buffet in the cafeteria. The items would be presented with correct and incorrect stress for both real and nonwords. A nonword example would be: *arRAYity* : There was an *arRAYity* of food at the buffet in the cafeteria. There could be a wide 'array' of food at the buffet but the *–ity* suffix is an illegal suffix on the noun *array.* Incorrectly stressed words would have stress changes where a weak-strong-weak-

weak (WSWW) pattern would become a strong- weak-weak-weak (SWWW) pattern (e.g. *Diversity* and *Arrayity*). As with previous research (Carlisle, 1988; Clin et al., 2009), real words would be chosen based on frequency in academic text in the target sample, syllable length (at least two), and controlled for phonemic changes (e.g. *elect*, *election*), stress changes (e.g. *artist*, *artistic*), both types of changes (e.g. *public*, *publicity*), or no change (e.g. *differ*, *difference*). Nonword stems would be chosen on frequency and the previous criteria could also be used for creation of derived forms.

Another meaningful outcome of the adult study was the inclusion of a commonly used morphological awareness task. The task was chosen as a second metalinguistic task because previous research using derivational morphology stimuli to measure prosodic sensitivity also used morphological awareness tasks (Clin, Wade-Woolley, & Heggie, 2009; Jarmulowicz et al., 2007). Originally, it was created as an oral task to detect developmental changes in kindergarten and first grade (Rubin, 1988). At inception, the words were chosen because they were part of an average kindergartener's spoken vocabulary. The reason it was adapted for this study was because Rubin, Patterson, and Kantor (1991) found that the task differentiated between typical skilled adults and those with reading difficulties and that those with difficulties performed similarly to typical second graders. These findings suggested that there would be variability with the adult sample, or that it would at least differentiate between those with typical skills and those identified as students with reading difficulties but not otherwise qualified for services.

The items were modified in this administration. In the original administration by Rubin et al. (1991) the participants were asked, "Is there a smaller word inside of *money* that means something like *money*?" The original presentation is primarily a decomposition task where the participant is required to decompose the base word into the constituents that make it up and answer yes/no. When the participant answered 'yes', they were required to come up with the base morpheme (e.g. *teach* in *teacher*). In the current study with adults the participants were asked, "Is there a smaller word inside of *money* that means something like *mon*?" The presentation in the current required decomposition and *morphological problems solving* (Anglin, 1993), where the participant had to identify if the second word was real and if it was related to the first word. In this case, the answer was 'no' and therefore, the word *mon* is not inside of *money.* This task was administered with two practice items and 28 test items.

Interestingly, there was no ceiling effect on the MAT in the adult sample. The average accuracy on this task was 24.80 correct (*Maximum* = 28, *Minimum* = 17). Due to the lack of the ceiling effect, a set of standardized directions, with a mandatory basal score of 80%, were created to ensure that all participants understood the task.

In Pearson product-moment correlations the MAT was strongly correlated with other reading measures including the general outcome measure, ACT Reading. The strong correlation with ACT Reading was surprising when found in an adult sample since the task was created for kindergarten and first graders. Although the samples were not the same this finding was consistent with findings with older students, where morphological awareness is correlated with comprehension (Nagy, Berninger, and Abbott, 2006). In prediction analyses the task was also found to be significant in addition to the prosodic sensitivity, and both were found significant to word level reading in adults.

There were several insights gained from the initial test development study with adults. First, while the goal was to create a prosodic sensitivity task, an additional task was adapted and found to have a consistent and reliable behavioral response. Second, the use of an adult sample makes these results unique in the literature where most experimental tasks for metalinguistic skills are created and used with developmental samples. Third, because it was an adult sample, the results are supportive of grade level studies including older middle and high school students suggesting that these later emerging metalinguistic skills continue to matter in reading outcomes into adulthood. Last, lexical quality appears to be dependent upon how specified morphological and prosodic features are in word storage.

Although there are favorable results in the first study it was not without its limitations. The major limitations to the study were the lack of assessments in segmental phonology, working memory, complex word reading, and a standardized rate assessment. These were all taken into consideration for the ensuing child study.

In conclusion, it is important to emphasize that even with limitations, this study has something to offer the greater scientific body as Wood, Wade-Woolley, and Holliman (2009) noted, "skilled adult reading and prosodic sensitivity has yet to be fully explored at the present time"(p. 17). These exploratory findings are supportive of other evidence in adult eye movement studies. In these studies Ashby and Clifton (2005) found evidence for a link between reading speed and the presence of stressed syllables. This study offers an examination of skilled adult readers' performance on measures of speech rhythm and the connections with reading outcome measures.

Manuscript #2 – the Child Study

The favorable and statistically significant results from the adult study (Manuscript #1) gave way to task adaptations and the creation of the child study (Manuscript #2). The child study began with the adaptations to the prosodic sensitivity task. The lack of significance for nonwords allowed for the creation of a true stress-perception task in lieu of the predecessor task of lexicality. In this developmental stage of the task, all items were presented twice, once with correct stress (e.g. *cenTRALity*) and once with incorrect stress, (e.g. *CENtrality*), although in a counterbalanced list so both versions were not delivered to the same person. Another addition to this task were the first syllable stress words to counter balance the second syllable stress words all ending in *–ic* and *–ity*. This was done not only because of the omission of the nonwords but because a student could develop and use a strategy in the task if all words were weak-strong-weak stress pattern.

The adaptations to the prosody task were not the only changes made. Although the morphological awareness task worked well for the adult sample, it was put back into its original format without the production component and developed into a computer administered task for standardization. This decision to go back to the original was made because it had been used in other research studies with significant outcomes based on similar expectations (Jarmulowicz, Taran, & Hay, 2007; Rubin et al., 1991). The task in the original format required a production component in addition to the decomposition component. For example, in the original task the child was asked, "is there a smaller word inside of *teacher* that means something like *teacher*?" Upon saying 'yes', the child was asked to give the stem, *teach*. Unlike previous work, the computerized version for the child study did not have the production component but, it did allow for the continuation of accuracy feedback during the experiment trials assuring that participants understood the task. The feedback also gave the participants the idea that there were consequences for not paying attention. After task adaptations were conducted, the additional assessments were added to the test battery: segmental phonological skill assessment (AAT-Nonce), morphologically complex word reading test (WRT-E), two spelling assessments (DSA and TWS), and a comprehensive academic achievement measure (TCAP).

The child study (Manuscript #2) also allowed for the measurement of different behavioral aspects of literacy (segmental phonology, reading morphologically complex words, and spelling) that were not present in the adult study. The reading morphologically complex words task (WRT-E) was added as an outcome measure but it was also adapted to avoid previously found ceiling effects in fifth graders (Carlisle, 2000). The task required students to read phonologically transparent and phonological shift words that varied in frequency in the English language. The fourth set of words that were both low surface frequency and low frequency words was added to counter the previously found ceiling effects. The WRT-E was included because it was a concise production measure for reading words with morphological complexity. The spelling measures were added to the battery because they were 'off-the-shelf' data that the school was already collecting and the data were available for analysis. Spelling skills are intricately linked to reading and metalinguistic skills (Larkin & Snowling, 2008) and the addition of them increased the knowledge about how the metalinguistic skill tasks related to various literacy outcomes, not only reading.

The correlations were significant for both tasks with reading and spelling measures although all correlations were higher for the MAT. It was found that the addition of the WRT-E added many beneficial aspects to the study. Like the MAT and PST, the WRT-E was strongly correlated with all reading and spelling tasks and with the metalinguistic tasks. All three tasks had statistically significant differences between grade levels and post-hoc analysis showed grades three and five performed significantly different from each other but not from grade four on the MAT, PST, and WRT-E. This finding replicated previous research (Carlisle, 2000).

Although the correlations and variance between grade levels were strong, the MAT and PST did not predict word level reading outcomes as was shown in the adult study. This result was somewhat surprising and a planned commonality analysis (Amado, 1999) was conducted to find that a significant portion of the variance in word reading outcomes was shared with both the MAT and PST (13.1% in Letter Word ID and 15.5% in WRT-E). Because there were more participants than expected, the large data set allowed for an unplanned, but useful, exploratory factor analysis. The results were favorable and encouraging. The analysis yielded two factors, one named the *decoding skills* factor and the other named the *morphophonological skills* factor. All the code level and segmental knowledge tasks (reading real and nonwords, spelling, AAT-Nonce) created the *decoding skills* factor accounting for 51.76% of the variance. The *metalinguistic skill* factor was primarily composed of the MAT and PST and explained 14.61% of the variance. Vocabulary loaded nearly the same on both factors, which is also confirmative in nature since vocabulary is largely a measure of language skill and should be related to both skill domains. A follow-up stepwise regression analysis using the factors as independent variables, and the general reading outcome measure (TCAP) as a dependent variable was conducted. Results indicated that the *decoding factor* accounted for 19% of the variance in reading comprehension and the *metalinguistic factor* contributed an additional 5% of the variance. Both were significant in the prediction.

Although it is not recommended to use factor analysis to prove theoretical underpinnings, the outcome is reflective of Perfetti's *LQH* (2007) where complete and fully specified word knowledge (vocabulary) is considered a by-product of how well a person knows the constituents of a word. These constituents include the phonology (AAT-Nonce, PST), orthography (TWS), grammar, meaning (vocab, morph), and the fifth is constituent binding – the degree to which the first are bound together. All, but grammar, of these constituents are represented in the factor solution. There appears to be coherence between the segmental phonology (AAT-Nonce), orthography (TWS), and meaning (vocab) in the *decoding skill* factor and between suprasegmental phonology (PST) and meaning (MAT, vocab) in the *morphophonological skills* factor.

The factor solution is also representative of literacy development. The first factor contains the basic code and background knowledge (phonemes, graphemes, vocabulary) necessary for the act of learning to read and write. These components of the solution, although necessary in early literacy, are not sufficient. Therefore, as students enter the middles school years, morphology and understanding of the phonological changes in derivational forms, become increasingly more important and necessary for higher-level language knowledge (Nagy, 2007; Nagy, et al. 2006).

Conclusion

In closing, a great amount of knowledge has been gained and with it, more research questions can be hypothesized. One of which is, why did the prosodic sensitivity task work with such significance in the adult study and then when nonwords were removed and explicit instruction and feedback were added, the task did not work as well with children. It is clear, the two studies cannot be directly compared due to sample differences but, the notable differences are hard not to attend to. The first task was a lexicality task where adults were asked to make a choice about if a word was real and half of the words presented were stressed incorrectly. The second task became a true stress-perception task, where the students were asked to say if a word was correctly stressed and half of the words were incorrectly stressed. It is possible that the first edition of the task was more of a word knowledge task rather than a prosody task yet, the correlations, although significant, are only moderate with vocabulary (r = .326). If the task is drawing more on word knowledge, then average adults should do better simply because they have more oral and written language exposure due to maturation. Another reason why the first task may appear to work better is a rather simple one, maybe students in grades 3, 4, and 5 do not have a sophisticated enough prosodic sensor to differentiate between correct and incorrect stress in non-neutral stress shifting derivations. Nagy et al. (2006) gives strong evidence for the later acquisition of morphological awareness (well into grades 8 and 9), it is possible that prosodic sensitivity is also acquired later. This is supported by the fact that the adults perform better on the prosody task, even with modifications. A future study investigating adult performance on the task is underway and results will potentially offer new solutions about whether there are limitations to a 'carrier phrase free' task and if there is construct validity to this measurement.

The difference in prediction outcomes is also true of the morphology task, where the MAT did not significantly predict word reading in children yet it did in the adult study. The first reason for this outcome may be due to the change in the task. It went from being a task that included morphological decomposition and morphological problem solving to a task that only contained decomposition. Positive outcomes in previous studies with children (Jarmulowicz et al., 2007) suggest the inclusion of a production component matters in prediction of word reading outcomes. In this case full credit was given only when the child identified the bi-morphemic word and stated the mono-morpheme word inside of it (e.g. *teacher/teach*). The production component was left off the computer adaptation because it would require the student to enter the word or give the word to the examiner. The first required orthographic knowledge (spelling), the second required the examiner to sit next to the student throughout the assessment which would defeat the creation of an efficient assessment for usage in a classroom. Nevertheless, the task continued to have significant correlations with all reading and spelling measures as well as general outcome measures.

As with any study in test development, the test and the items bring limitations to the process as well. In future adaptations and studies it is recommended that the assessment of the constructs be viewed more broadly and not solely focused on word level perception. It is possible that with a broader lens, a test composed of many questions from previously validated experimental measures, can be created using item response theory (IRT). Within this theoretical framework of test construction it would be possible to more clearly understand emerging skills versus mastery of skill in various aspects of both constructs and their individual contributions to reading during development. For example, when taking a test based on IRT, a set of questions in inflectional morphology (e.g. *boy* to *boys*) may be mastered with a high ability score in third grade, while a set of questions based on derivational morphology (e.g. *nature* to *natural*) may demonstrate emerging skill across an array of derivations for the same student. In a classical test theory (CTT) approach a child may have one morphology score without differentiation between items. The use of IRT offers item level analysis and ability levels that may be more instructionally helpful and dynamic in educational settings.

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APPENDICES

Appendix A. Copyright permission for Figure 1 in Chapter 1

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Appendix B. IRB Approval Letters for Manuscript #1

August 28, 2008

Cyrille Magne, Stuart Bernstein
Protocol Title: Auditory Lexical Decision Task
Protocol Number: 09-024

Dear Investigators,

The MTSU Institutional Review Board, or a representative of the IRB, has reviewed the research proposal identified above and has determined that the study poses minimal risk to participants and qualifies for an exempt review under 45 CFR 46.101(b)(2) 45 CFR 46.101(b)(4). This is based on the fact that the research is involving the use of surveys that will be recorded such that the human subjects cannot be identified, and disclosure of human subjects' responses could not reasonably place the subjects at risk; the research is involving collection of existing data that will be recorded in such a way that the human subjects cannot be identified.

Approval is granted for three (3) years following the date of this letter.

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance (c/o Tara Prairie, Box 134) before they begin to work on the project. Any change to the protocol must be submitted to the IRB before implementing this change.

You will need to submit an end-of-project report to the Office of Compliance upon completion of your research. Complete research means that you have finished collecting and analyzing data. Should you not finish your research within the three (3) year period, you must submit a Progress Report and request a continuation prior to the expiration date. Please allow time for review and requested revisions. Your study will expire on **August 28, 2011.**

All research materials should be retained by the principal investigator and stored securely in his office on campus for three years following the completion of the project.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918.

Sincerely,

Lisa M. Pritchett, Graduate Assistant to
Tara M. Prairie, Compliance Officer
MTSU Institutional Review Board

Appendix C. Consent form for Manuscript #1

Middle Tennessee State University Institutional Review Board
Informed Consent Document for Research

Principal Investigator: Cyrille Magne, Ph D
Study Title: Auditory Lexical Decision Task
Institution: Department of Psychology, MTSU

Name of participant ______________________________ Age. __________

The following information is provided to inform you about the research project and your participation in it Please read this form carefully and feel free to ask any questions you may have about this study and the information given below You will be given an opportunity to ask questions, and your questions will be answered Also you will be given a copy of this consent form

Your participation in this research study is voluntary You are also free to withdraw from this study at any time In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study.

For additional information about giving consent or your rights as a participant in this study, please feel free to contact Tara Prairie at the Office of Compliance at (615) 494-8918

1. **Purpose of the study:**
   The purpose of this experiment is to determine how people's perception of spoken language influences their reading skills

2. **Description of procedures to be followed and approximate duration of the study:**
The entire experimental session lasts approximately one hour and has two distinct parts:
a) You will listen to a series of spoken words presented by a computer, some of which are real words and some of which are not real words You task will be to decide as fast as possible whether each individual item is a real word or not, using a two button mouse
b) You will also complete a series of test aimed at measuring your reading skills

3. **Expected costs:**
   There will be no cost to you for the data collected for this study Your insurance company or other third-party payers will not be charged for the research or the examinations required specifically for this study

4. **Description of the discomforts, inconveniences, and/or risks that can be reasonably expected as a result of participation in this study:**
   The risk involved is minimal It is no more than one would experience in daily life activities The auditory presentation of the word stimuli is completely harmless

5. **Unforeseeable risks:**
   n/a

6. **Compensation in case of study-related injury:**
   n/a

7. **Anticipated benefits from this study:**
a) This study does not provide you with any health care The study is strictly for research purposes and will have no direct health or medical benefit to you as an individual
b) Results of these studies will contribute to the diagnosis and remediation of language-based reading disabilities

Middle Tennessee State University Institutional Review Board
Informed Consent Document for Research

8. **Alternative treatments available:**
   n/a

9. **Compensation for participation:**
   n/a

10. **Circumstances under which the Principal Investigator may withdraw you from study participation:**
    The investigator in charge of this study, if he/she deems it necessary, may stop the study and your participation in this study could be terminated without your permission

11. **What happens if you choose to withdraw from study participation:**
    You will be free to withdraw consent at any time without prejudice and that withdrawal would not in any way affect your standing with the University

12. **Contact Information.** If you should have any questions about this research study or possibly injury, please feel free to contact **Dr. Cyrille Magne** at **898-5599 or Dr. Stuart Bernstein at 898-5943**

13. **Confidentiality.** All efforts, within reason, will be made to keep the personal information in your research record private but total privacy cannot be promised. Your information may be shared with the MTSU University Institutional Review Board or if you or someone else is in danger or if we are required to do so by law.

STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY

I have read this informed consent document and the material contained in it has been explained to me verbally. I understand each part of the document, all my questions have been answered, and I freely and voluntarily choose to participate in this study.

______________________ ______________________________________

Date Signature of patient/volunteer

Consent obtained by:

______________________ ______________________________________

Date Signature

____

Printed Name and Title

Appendix D. IRB Approval Letters and all Change Acceptance Letters for Manuscript #2

August 2, 2010

Danielle M. Thompson
Department of Psychology
daniellemthompson@gmail.com

Protocol Title: "The Contributions of Prosody and Morphology to lexical access in Children: A reaction time study"
Protocol #: 11-009

Dear Investigator(s):

I have reviewed your research proposal identified above and your requested changes. I approve of the following change:

1. The changes to your informed consent document

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918. Any change to the protocol must be submitted to the IRB before implementing this change.

You will need to submit an end-of-project report to the Office of Compliance upon completion of your research. Complete research means that you have finished collecting data and you are ready to submit your thesis and/or publish your findings. Should you not finish your research within the three (3) year period, you must submit a Progress Report and request a continuation prior to the expiration date. Please allow time for review and requested revisions. Your study expires **July 28, 2011.**

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance before they begin to work on the project.

Please note, **all research materials must be retained** by the PI or **faculty advisor (if the PI is a student)** for at least **three (3) years after study completion**. Should you have any questions or need additional information, please do not hesitate to contact me.

Sincerely,

Emily Born
Office of Compliance
Middle Tennessee State University

October 13, 2010

Danielle M. Thompson
Department of Psychology
daniellemthompson@gmail.com

Protocol Title: "The Contributions of Prosody and Morphology to lexical access in Children: A reaction time study"
Protocol #: 11-009

Dear Investigator(s):

I have reviewed your research proposal identified above and your requested changes. I approve of the following change:

2. The addition of investigators: **Cyrille Magne, Dana Fuller, Rachel Anderberg, and Stuart Bernstein.**
3. Minor changes to the list of stimuli. – The morphological awareness test.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918. Any change to the protocol must be submitted to the IRB before implementing this change.

You will need to submit an end-of-project report to the Office of Compliance upon completion of your research. Complete research means that you have finished collecting data and you are ready to submit your thesis and/or publish your findings. Should you not finish your research within the three (3) year period, you must submit a Progress Report and request a continuation prior to the expiration date. Please allow time for review and requested revisions. Your study expires **July 28, 2011.**

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance before they begin to work on the project.

Please note, **all research materials must be retained** by the PI or **faculty advisor (if the PI is a student)** for at least **three (3) years after study completion**. Should you have any questions or need additional information, please do not hesitate to contact me.

Sincerely,

Emily Born
Office of Compliance
Middle Tennessee State University

October 15, 2010

Danielle M. Thompson
Department of Psychology
daniellemthompson@gmail.com

Protocol Title: "The Contributions of Prosody and Morphology to lexical access in Children: A reaction time study"
Protocol #: 11-009

Dear Investigator(s):

I have reviewed your research proposal identified above and your requested changes. I approve of the following change:

4. The addition of Melissa Brock as an investigator
5. The additional changes/words made to appendices.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918. Any change to the protocol must be submitted to the IRB before implementing this change.

You will need to submit an end-of-project report to the Office of Compliance upon completion of your research. Complete research means that you have finished collecting data and you are ready to submit your thesis and/or publish your findings. Should you not finish your research within the three (3) year period, you must submit a Progress Report and request a continuation prior to the expiration date. Please allow time for review and requested revisions. Your study expires **July 28, 2011.**

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance before they begin to work on the project.

Please note, **all research materials must be retained** by the PI or **faculty advisor (if the PI is a student)** for at least **three (3) years after study completion**. Should you have any questions or need additional information, please do not hesitate to contact me.

Sincerely,

Emily Born
Office of Compliance
Middle Tennessee State University

Appendix E. Permission Letter from Assistant Superintendent of Curriculum and Instruction, Rutherford County Schools.

Office of Compliance
Middle Tennessee State University
Sam H. Ingram Bldg. 011B
Murfreesboro TN 37132

July 29, 2010

Officer of Compliance,

Permission is given to Danielle M. Thompson, for the recruitment of research participants from Smyrna Primary School, a Rutherford County School. It is my understanding that students will participate in word level reading and judgment tasks and MTSU will be responsible for acquiring permission from the parents to participate in the research. It is also my understanding that the confidentiality of all Rutherford County Schools' children will be protected throughout this research project and thereafter. The research will help fulfill Danielle M. Thompson's doctoral dissertation.

Sincerely,

Don Odom
Assistant Superintendent Curriculum Instruction

Rutherford County Schools

Appendix F. Permission Letter from Smyrna Primary School Principal

Office of Compliance
Middle Tennessee State University
Sam H. Ingram Bldg. 011B
Murfreesboro TN 37132

July 23, 2010

Officer of Compliance,

Permission is given to Danielle M. Thompson, for the recruitment of research participants from Smyrna Primary School, a Rutherford County School. It is my understanding that students will participate in word level reading and judgment tasks and MTSU will be responsible for acquiring permission from the parents to participate in the research. It is also my understanding that the confidentiality of all Rutherford County Schools' children will be protected throughout this research project and thereafter. The research will help fulfill Danielle M. Thompson's doctoral dissertation.

Sincerely,

Gale Vogel, Ph.D.
Smyrna Primary School, Principal

Appendix G. Parental Consent Form, English Short Description

Dear Parents,

Danielle Thompson, a doctoral student at Middle Tennessee State University is doing a research project here at Smyrna Primary. The following forms are consent forms and for you to read and sign, your permission is necessary for your child to participate. This study:

- Is voluntary
- About how children read words
- Approximately 30 minutes long
- Will help us understand more about how to help struggling readers
- Confidential – your child's results will be shown to no person other than the researcher

If you are o.k. with your child participating, please read and sign the following consent form. You will be given a copy of the consent before we begin the study.

Thank you,

Danielle Thompson, MA CCC-SLP
Doctoral Student, Literacy Studies

Researcher use only: (Uso particular de investigacíón)

Code # ________

Appendix H. Parental Consent Form, English

Principal Researcher: Danielle M. Thompson **Faculty Advisor: Dr. Jwa Kim**
Project Number: 11-009
Study Title: The contributions of prosody and morphology to lexical access in children: A reaction time study
Department: Education and Behavioral Sciences, Middle Tennessee State University

The following information is provided to inform you about this research project and your child's participation in it. Please read this form carefully and feel free to ask any questions you may have about this study and the information given below. You will be given an opportunity to ask questions, and your questions will be answered. Also, you will be given a copy of this consent form.

Your consent for your child's participation in this research is voluntary. You are also free to withdraw your child from this study at any time. In the event that new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study.

For additional information about giving consent or your rights as a participant in this study, please feel free to contact the Compliance Officer at the Office of Compliance at (615) 494-8918, complian.mtsu@gmail.com.

Purpose of the study: This research project uses simple word reading tasks given by an examiner and on a computer. These tasks will evaluate a student's word reading skill and how different skills impact their reading ability. The purpose of this research is to determine if the tools being used measure aspects of word reading processing and if so, to determine how much they contribute to word reading in children grades 3, 4, and 5.

Duration of Participation: The session should last approximately 30 minutes and breaks can be taken at any time as needed. A follow-up session will be conducted randomly with 10% of the students; it will not exceed 15 minutes.

Description of procedures to be followed: Four tasks will be completed, two delivered by computer. First, the student will be asked to read two different lists of real words and one list of nonsense words. Second, the student will be asked to complete vocabulary tasks. Third and finally, the student will be asked to complete two computer-based tasks. The third task will ask them if there are parts of words, and the fourth will ask them to say if words are pronounced correctly.

We are also requesting permission to access student's passage fluency (ORF) and comprehension (DAZE), spelling data, their Tennessee Comprehensive Assessment Program (TCAP) reading comprehension score, their English language proficiency score or ELDA (English Language Developmental Assessment) score, and information regarding special education placement if applicable to student.

Description of the discomforts and/or risks that can be reasonably expected as a result of participation in this study: There are only minimal risks for participating in this session. These may include minor fatigue, stress or other similar reactions to a testing situation.

Anticipated benefits to the individual or others from this study: The potential benefits to you from this study are that students will be receiving supervised practice in reading and listening to words. The potential benefits to other students that may result from this study are developing a quick test to measure word processing knowledge that can be used to identify children at risk for low achievement in reading due to underlying language problems.

Circumstances under which the Principal Investigator may withdraw your child from study participation: If your child does not complete all tasks they will not be included in the results of this study, there is no penalty for this. A full set of data is necessary from each child participating.

Participation is Voluntary: Your child does not have to participate in this study, it is voluntary. If you give consent for your child's participation, you can withdraw at any time without penalty.

Contact Information: If you should have any questions about this research study, please feel free to contact the principal investigator Danielle Thompson at (406) 548-1963; dmt2w@mtmail.mtsu.edu; or Dr. Jwa Kim at (615) 494-8840; pykim@mtsu.edu.

Confidentiality: All efforts, within reason, will be made to keep the personal information in your child's research record private but total privacy cannot be promised. The information may be shared with MTSU or the government, such as the Middle Tennessee State University Institutional Review Board, Federal Government Office for Human Research Protections, if your child or someone else is in danger or if we are required to do so by law.

STATEMENT BY PERSON AGREEING TO GIVE CONSENT FOR CHILD'S PARTICIPATION IN THIS STUDY

I have read this informed consent document and the material contained in it has been explained to me verbally. I understand each part of the document, all my questions have been answered, and I freely and voluntarily choose to allow for my child to participate in this study. Further, I understand that information your child provides is only intended for research purposes and is not intended to be used by the researchers/university for diagnostic purposes.

____

(Please Print) Child's Name / Participant

____________________ ____________________________________

Date Parent or Guardian Signature

Consent obtained by:

____________________ ____________________________________

Date Researcher's Signature

Appendix I. Parental Consent, Spanish Short Form

Estimados padres:

La señorita. Danielle Thompson, M.A., del Universidad de Medio Tennessee Departamento de Educación, está haciendo un estudio. Su permiso y el de su hijo/a (los dos) son necesarios para poder participar en este estudio. El estudio:

- Es voluntario
- Sobre cómo los niños leer palabras
- Aproximadamente 30 minutos
- Ayudar a entender más acerca de cómo ayudar a problemas de lectura
- Confidencial - los resultados de su hijo se mostrarán a ninguna persona que no sea el estudiante Danielle

Si usted quiere que su hijo participe en la investigación, por favor, lea y firme el documento de permiso adjunto y devuélvalo a la maestra de su hijo.

Atentamente,

Danielle Thompson: M.A., del Departamento de Educación

Researcher use only: (Uso particular de investigación) Code # _________

Appendix J. Parental Consent, Spanish

Universidad de Medio Tennessee Departmento de Educación y Ciencias de la Salud Consentimiento de los Padres para la Participación de sus Hijos Menores de Edad en Estudios de Investigación

Nombre del Estudio

Las contribuciones de la prosodia y la morfología al acceso al léxico en niños: Un estudio sobre el tiempo que toma para reaccionar a palabras inventadas

La señorita. Danielle Thompson, M.A., del Departamento de Educación, está haciendo un estudio. El propósito de este estudio es adquirir nuevos conocimientos sobre el desarrollo de las habilidades lectoras. Su hijo/a ha sido invitado/a a participar de este estudio porque el aprendizaje acerca de cómo los niños aprenden a leer es importante

Su permiso y el de su hijo/a (los dos) son necesarios para poder participar en este estudio. Si usted esta de acuerdo y su hijo/a decide voluntariamente participar, va a pasar lo siguiente: se le presentaran palabras las cuales seran leídas, se le pedira al estudiante que piense en las palabras y que respondapreguntas sobre si partes de estas palabras pertenecen a las palabras y si las palabras han sido pronunciadas correctamente. Las preguntas podrán tomar hasta 30 minutos para completar. Su hijo/a puede negarse a contestar cualquier pregunta en cualquier momento. No hay riesgos conocidos de participar en este estudio, pero algunos niños pueden cansarse durante la sesión de pruebas. Todos estos datos van a ser guardados por el Dr. Jwa Kim bajo llave, en la oficina de Dr. Jwa Kim y después serán destruidos.

La participación en este estudio es voluntaria. Este estudio nos da la oportunidad de que su hijo pueda practicar la lectura y el conocimiento adquirido a partir del estudio ayudará a los investigadores a entender más acerca de cómo los niños aprenden a leer. Usted tiene el derecho de elegir no participar o retirar su participación en cualquier momento.

Si está interesado en participar o desea saber más de este estudio, por favor firme abajo y denos un número de teléfono para que uno de los investigadores pueda contactarlo; Envíenos esta forma a la escuela con su hijo. Si prefiere, puede llamar a Danielle Thompson al (406)548-1963 durante los días de semana de 8am a 5pm. Si no está interesado, por favor firme y marque el cuadrado que corresponda, así sabremos que ha sido contactado pero que no está interesado en participar.

Todos los resultados de las pruebas serán anónimos en el estudio de la lectura. Cuando recibiríamos las puntuaciones de los niños en el estudio, sus nombres serán eliminados y serán marcados con un número de código de identificación. Sólo los promedios del grupo se comunicarán en los informes del estudio – las puntuaciones individuales, incluso las anónimas, no se incluyen en los informes de investigación publicados.

Si tiene preguntas acerca de sus derechos como sujeto en este estudio de investigación, puede llamar al Oficial de Cumplimiento en la Oficina de Cumplimiento de (615) 494-8918, complian.mtsu@gmail.com.

Si usted quiere que su hijo participe en la investigación, por favor firme abajo y devuélvala a la maestra de su hijo.
Gracias por su ayuda.

☐ Estoy interesado en saber mas sobre este estudio. Numero de telefono para contactarlo:______

☐ Estoy de acuerdo en que mi hijo/a participle en este estudio.

☐ No estoy interesado en que mi hijo/a participle en este estudio.

Firma del Padre
____Fecha ________

Nombre del hijo/a menor
____

Appendix K. Child Assent

Project Title: The contributions of prosody and morphology to lexical access in children: A reaction time study
Research Project Number: 11-009
Investigator(s): Danielle Thompson, MA CCC-SLP; Jwa Kim, PhD
Department of Education and Behavioral Sciences, Middle Tennessee State University

Please read this or, we can read it with you. At any time, feel free to talk about what you have read or heard.

We are doing a study to find out how things work. We will ask you some questions and give you some tests to find out how you read words and how you understand smaller parts of words. We hope that the information from this study will help us understand more about how children read words so that someday we can help children that have trouble reading words, read better.

You can be in this study if you want to. If you want to be in this study, you will be asked to spend around 30 minutes with us reading words, thinking about words, and answering some questions about words on the computer. You can take a break if you want to, just tell us.

These tests may be like some tests in school but you are not graded and they will not make you sick. No teacher or adult (besides the tester) will see your tests or how well you did on them. You may get a little tired or find some of the words and questions difficult to do. This is why we want you to tell us when you need a break (and we will ask you if you need them too).

You don't have to be in this study. You can say "no" and nothing bad will happen. If you say "yes" now, but you want to stop later, at any time, that's okay too. No one will punish you if you want to stop. All you have to do is tell us you want to stop.

Do you have any questions? If you have any questions you can talk to us. If you want to be a part of this study, please sign your name.

I, ____, want to be in this research study. (write your name here)

____Date:______________
Investigator Signature