THE ROLES OF COGNITIVE AND LANGUAGE ABILITIES OF THIRD GRADE STUDENTS WITH READING DISABILITIES RESPONSIVENESS TO MORPHOLOGICAL AWARENESS INTERVENTION

By

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THE ROLES OF COGNITIVE AND LANGUAGE ABILITIES OF THIRD GRADE STUDENTS WITH READING DISABILITIES RESPONSIVENESS TO MORPHOLOGICAL AWARENESS INTERVENTION

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Repeated studies have established that skill in morphological awareness (MA) is a key predictor of both vocabulary knowledge and reading comprehension. There is evidence that students with reading disabilities, however, have underlying cognitive and language deficits that hamper their ability to learn MA skills, even when presented with explicit, systematic instruction. Additionally, the research examining instruction in MA for students with reading disabilities is small compared to the research examining the development of these students' early decoding skills.

The purpose of this study was to examine the predictive ability of students' entering language and cognitive variables in their responsiveness to an intervention designed to improve MA skills involving the use of prefixes. Thirty-nine 3rd grade students scoring below the 25th percentile on the FAIR's word analysis scores participated in this study. The participants were assessed on seven independent variables prior to starting the intervention, and received the MA intervention twice a week, for a total of 10 sessions. Students' MA skills were measured by assessing their recognition of base words (BR) and prefix and base words (PBR) combined, and their

understanding of words with prefixes in a sentence (SC). Data was collected through two pretests and two posttests.

Results showed that (a) verbal comprehension played an essential role in the improvement of third graders with word decoding deficits on recognizing and understanding multisyllabic words, (b) students' ability to recognize prefixes and base words as a consequence of the MA intervention was also predicted by other cognitive and language variables such as RAN, orthographical knowledge, verbal working memory, and (c) initial responsiveness to MA intervention in MA was the strongest predictor of later MA performance as measured by both word recognition and tasks that involve understanding words with prefixes in sentences. Findings from this study provide evidence to support that (a) cognitive and language variables play different roles in predicting student responsiveness to the MA intervention, (b) the influence of students' cognitive and language skills varies depending on the demands of the MA task, and (c) students' initial learning gains might be useful in predicting future learning.

CHAPTER 1
INTRODUCTION

The English language is morphophonemic; its spelling system consists of both phonemes (i.e., linking sounds to letters) and morphemes (i.e., linking sounds to meaning) (Carlisle & Stone, 2005; Lombardino, 2012), and phonemes and morphemes maintain the alphabetic orthography of the language (Ehri, 2010). Recognizing, reading, and writing words in English involve the process of “the acquisition of mappings between phonemes and graphemes” (Verhoeven & Perfetti, 2003, p. 211). Therefore, in order to learn familiar and novel words and read complex words in English, children need to recognize the underlying morphology of words, the influence of morphology on the meaning of words, and the grammatical role of morphemes embedded in the words. That is, they must be morphologically aware and able to understand how the smallest meaning units of words or morphemes (e.g., bind and -er in the word binder) influence the pronunciation and meaning of words as well as the grammatical role words play (Verhoeven & Perfetti, 2003). This is an important aspect of linguistics related to literacy and language development for children.

Morphological awareness (MA) refers to children’s “conscious awareness of the morphemic structure of words and their ability to reflect on and manipulate that structure” (Carlisle, 1995, p. 194). Learning to read depends on children’s knowledge of morphemes and their understanding of how to manipulate these morphemes, which is referred as morphological knowledge (Carlisle, 2003; Lombardino, 2012). Accordingly, the level of students’ knowledge of morphemes must influence their ability to decode words and comprehend text (Carlisle, 2004; Carlisle, 2007). More importantly, studies have repeatedly established that MA skill has a direct impact on students’ phonology and orthography, and it is a key predictor of vocabulary knowledge (Carlisle, 2007; Nagy, Berninger, & Abbott, 2006), spelling (Arnbak & Elbro, 2000; Hauerwas & Walker, 2003; Nagy et al., 2006; Siegel, 2008), and reading comprehension skills (Carlisle, 2000; Nagy et al., 2006). Moreover, previous research has demonstrated an association between depressed performance on MA tasks and dyslexia as well as below average reading abilities (e.g., Arnbak & Elbro, 2000; Casalis, Cole, & Sopo, 2004; Reed, 2008).

The contribution of MA to reading abilities is critical for both beginning readers and upper elementary students. As students are progressing to upper elementary school, the nature of their literacy instruction shifts from “learning to read” to “reading to learn” (Chall, 1983), exposing them to more and more words in print. Moreover, these curriculum changes are accompanied by frequent exposure to unfamiliar multisyllabic words as well as more content specific instructional texts. Therefore, in order to become efficient and fluent readers, students are required to combine knowledge of root words they have learned with their knowledge of the morphemic structure of words to acquire many new and unfamiliar words meanings without being taught specific words directly. That is, it is essential for learners to be able to attend to segments of words that are larger than the phoneme such as affixes (i.e., prefixes and suffixes) and to acquire the meaning and grammatical roles of unfamiliar words by using their knowledge of morphological structures related to such affixes.

Understanding the role of morphological knowledge along with its developmental contributions to lexical knowledge provides researchers with the foundation for creating curriculum and other educational materials that can help students with reading disabilities make important decoding and meaning connections. Research examining interventions in MA shows that students benefit from instruction in MA (Arnbak & Elbro, 2000; Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003; Berninger et al., 2008; Bowers & Kirby, 2009; Dixon & Englemann, 2001; Katz & Carlisle, 2009; Nagy, Berninger, Abbott, Vaughn, & Vermeulen, 2003). Additionally, instruction in MA has been shown to improve students' abilities to transfer their word knowledge to novel words involving the roots and affixes learned and sometimes their comprehension of text (Baumann et al., 2003).

Not all students, however, benefit similarly from effective MA instruction (Fuchs et al., 2002; Al Otaiba & Fuchs, 2002). A majority of students who are unresponsive to generally effective reading or literacy intervention tend to have deficits in phonological processing skills (Adams, 1990; Al Otaiba & Fuchs, 2002; Snow, Burns & Griffin, 1998; Torgesen, Wagner, & Rashotte, 1994), rapid automatized naming (Badian, 1998; Kirby, Parrila, & Pfeiffer, 2003; Wolf & Bowers, 1999), or working memory (Alloway, Gathercole, Willis, & Adams, 2004; Meyer, Samlimpoor, Wu, Geary, & Menon, 2010). In addition, students with higher verbal comprehension scores on intelligence tests are more likely to profit from such instruction and transfer their knowledge more easily (Katz & Carlisle, 2009). A study also showed that there was a positive correlation between MA and decoding only among dyslexics with above average non-verbal IQ (Elbro, 1990). Therefore, it can be hypothesized that students' cognitive and language characteristics may influence their responsiveness to reading instruction.

Little is known regarding whether or not students who have reading disabilities can also be responsive to morphological instruction, and the cognitive and language abilities that might help them respond to morphological instruction. Currently, the contribution of cognitive and language variables to children's responsiveness to MA instruction is poorly understood. Researchers do not have sufficient knowledge about the efficacy of providing students with reading disabilities instruction in MA, or how these students' varying cognitive and language profiles might influence their ability to respond to instruction. Only a small number of studies have demonstrated that students with reading disabilities could be instructed effectively in MA (Nagy et al., 2003; Mahony, 1994), and other variables likely to predict response to MA instruction, such as decoding efficiency, phonological processing, or working memory, were not included.

The Roles of Cognitive and Language Skills in Reading Development

The effectiveness of morphological instruction for students with disabilities likely differs according to student related factors (Bowers, Kirby, & Deacon, 2010). It is well known that students with reading disabilities often show phonological and orthographical deficits such as difficulties differentiating between sounds, letters, letter-sound corresponding patterns, and different orthographic representations of the same sound (Ehri, 2005; Duke, Pressley, & Hilden, 2004). The difficulties students exhibit in these linguistic abilities are closely intertwined with morphology because all aspects of linguistics (i.e., phonology, orthography, and morphology) are interrelated in supporting the process of reading. Thus, students who experience such difficulties logically have trouble acquiring MA skills. Weak morphological skills disadvantage students with reading disabilities when they confront complex words that involve the use of affixes (i.e., prefixes, suffixes), complex spellings, and root words that change in spelling and sound depending on the surrounding syllables (Nagy & Anderson, 1984). Furthermore, some studies have found that MA skills may contribute to students' reading comprehension and pseudoword reading abilities, and their contribution may be comparable to or greater than phonological awareness abilities (Carlisle, 2004; Carlisle & Stone, 2005; Deacon & Kirby, 2004).

The grapheme-phoneme conversion process necessary for word decoding involves both the processing and storage of phonological information associated with cognitive and language processing skills (Adams, 1990). A longstanding line of research has attempted to identify which linguistic and cognitive skills best predict or contribute to later reading outcomes (e.g., Badian, 1994; Catts, Fey, Zhang, & Tomblin, 2001; Compton, Fuchs, Fuchs, & Bryant, 2006; Elbro, Borstrom, & Petersen, 1998; Scarborough, 1998). The most widely investigated language and cognitive predictors of reading success are phonological awareness (Adams, 1990; Catts et al., 2001; Catts & Kamhi, 2005; O'Connor & Jenkins, 1999; Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004; Wagner & Torgesen, 1987), rapid letter naming (Schatschneider et al., 2004; Savage &Fredrickson, 2005), orthographic awareness (Carlisle, 2000; Hauerwas & Walker, 2003), verbal ability (Katz & Carlisle, 2009), working memory (Alloway, Gathercole, Kirkwood, & Elliott, 2008; Meyer et al., 2010), and executive function (Meyer et al., 2010; Swanson, Saez, Gerber, & Leafstedt, 2004; Swanson & Beebe-Frankenberger, 2006). Many of these cognitive and language predictors also likely predict the development of MA skill (Katz & Carlisle, 2009).

Students with reading disabilities have underlying cognitive and language deficits that may hamper their ability to learn MA skills, even when presented with explicit, systematic instruction. Additionally, the research examining instruction in MA for students with reading disabilities is small compared to the research examining the development of these students' early decoding skills. As with other types of reading instruction, students with reading disabilities are likely to respond to MA instruction differently depending on their entering language and cognitive abilities. Studies examining the role of language and cognitive variables in response to reading intervention show that struggling students are those with demonstrated deficits in rapid naming (of letters, colors, and numbers), phonological awareness, verbal ability, orthographic awareness, executive function, working memory, or a combination of these variables (Al Otaiba & Fuchs, 2006; Fletcher et al., 2011; Nelson, Benner, & Gonzalez, 2003). Deficits in most of these areas are also likely to impact students' ability to respond to interventions designed to improve different aspects of MA. Therefore, there is a need to better identify those MA skills that students with reading disabilities can learn and the degree to which learning those skills will influence these students performance on broader reading outcomes.

Statement of the Problem

As students progress through elementary school, they encounter increasingly complex words that involve the use of affixes (i.e., prefixes, suffixes) to decode multisyllabic words, complex spellings, and root words that change in spelling and sound depending on the surrounding syllables (Katz & Carlisle, 2009; Nagy & Anderson, 1984). In the English language, different spellings represent vowel sounds that sound similarly (e.g., gate, gait, neigh, stay, hey), and the spelling and pronunciation of root words can change depending on whether they are transparent (i.e., spelled and pronounced consistently as in bat and batter) or opaque (i.e., spelled and pronounced differently depending on the affixes added as in calf and calves or sign and signal). In order to decode, spell, and understand complex words in English, students must develop either explicit or implicit understandings about the underlying morphology of words. That is, they must be morphologically aware and able to understand how the smallest meaning units of words or morphemes (e.g., sign in signatory) influence the pronunciation and meaning of words as well as the grammatical role words play.

As MA involves a specific skill to aware and have access to word structure with form and meaning (e.g., root words, prefixes, suffixes, and grammatical inflections), it requires skills and abilities that are necessary to recognize the underlying structure of morphemes in relation to words and understand the meaning of morphologically complex words (McBridge-Chang, Wagner, Muse, Chow, & Shu, 2005). In order for a child to successfully read morphologically complex words, they need to take a series of processes sequentially or simultaneously in reading such as recognizing, using words parts that carry significance, and understanding the meaning of those words, which requires complex cognitive and language processes. Thus, an individual's underlying cognitive and language skill weakness can cause limited performance with word recognition, using words parts (e.g., prefixes, suffixes, root words), or combining words parts consisting of morphologically complex words (Bowey, 2001; Gathercole et al., 1999). Therefore, it is important to comprehend specific deficits in cognitive and/or language abilities to better understand student reading performance.

In spite of the significance of building morphological knowledge to become proficient readers, there has been scant attention to the development of MA skills of students with disabilities. The existing literature in the field of reading has highlighted the importance of effective reading programs that include the five essential reading skills acquired between kindergarten and third grade necessary for skilled reading, consisting of phonemic awareness, phonics, vocabulary skills, reading fluency, and reading comprehension (National Reading Panel, 2000). Accordingly, most intervention studies have focused on such skills, and reading intervention studies for struggling readers or students with specific learning disabilities have put more emphasis on phonology and phonics training (Katz & Carlisle, 2009). The use of morphological knowledge in oral and written language tasks is relatively less researched (Arnbak & Elbro, 2000; Bowers et al., 2010).

Some studies of MA interventions include students with learning disabilities or dyslexia as a target group (e.g., Arnbak & Elbro, 2000; Casalis et al., 2004; Carlisle, 1987, 1996; Champion, 1997; Hauerwas & Walker, 2003; Siegel, 2008); however most intervention studies have excluded students who meet special education eligibility under the category of specific learning disability or have Individual Educational Programs (IEPs). Therefore, it appears that the way to develop MA skills for students with disabilities based on their specific characteristics (e.g., phonological awareness deficits, naming speed deficits) remains to be established.

More generally we know that research examining interventions in MA shows that instruction can improve students' abilities in this area (e. g., Arnbak & Elbro, 2000; Baumann et al., 2003; Berninger et al., 2008; Bowers & Kirby, 2010; Dixon & Englemann, 2001; Katz & Carlisle, 2009). Research has also demonstrated the importance of providing MA instruction in the earlier grades since MA is a better predictor of decoding ability than phonological awareness by 10 years of ages (Apel & Lawrence, 2011; Mann & Singson, 2003). Additionally, instruction in MA has been shown to improve students' abilities to transfer their word knowledge to novel words involving the roots and affixes learned and sometimes their comprehension of text (Baumann et al., 2003).

Not all students, however, benefit similarly from MA instruction. Students with reading disabilities have a variety of cognitive and linguistic deficits that affect their ability to respond to instruction. For instance, students with higher verbal comprehension scores on intelligence tests were more likely to profit from such instruction and transfer their knowledge more easily (Katz & Carlisle, 2009). Students with higher verbal IQ scores were more likely to demonstrate stronger growth and transfer of MA knowledge (Deacon & Kirby, 2004). The cognitive and language factors that have been causally related to the responsiveness of students with reading disabilities may influence development of MA skills targeted in instruction (McBridge-Chang et al., 2005). However, cognitive and language variables related to the acquisition of MA skills or using such skills in decoding and understanding meaning of words have been the focus of relatively little research. Therefore, there is a need to conduct more research focusing on which cognitive and language weaknesses or strengths are associated with developing MA skills among students with reading disabilities and how to provide them with appropriate MA instruction based on their language and cognitive abilities. This dissertation study has potential to contribute to our understanding of the roles cognitive and language deficits play in students' ability to learn. Additionally, the findings from this study may inform future intervention studies needed to more effectively teach students with reading disabilities to read and understand multi-syllabic words.

In short, what is known suggests that cognitive and language abilities are pivotal to many aspects of reading abilities. Children who have strong morphological skills might be able to approach a novel multisyllabic word and break it into parts in order to predict the meaning, or decode words as a whole without conscious phonetic or morphemic decoding. Children with reading disabilities show deficits in MA skills, and accumulated evidence demonstrates that children's cognitive and language abilities are significantly associated with reading achievements as a consequence of reading instruction. Different researchers have argued convincingly that certain cognitive and language skills are especially important for developing different reading skills (e.g., word recognition, reading comprehension, vocabulary etc.). However, the relationships among students' underlying cognitive and linguistic abilities and their response to MA instruction are not as well established for children with reading disabilities.

Purpose of the Study

The findings from previous research provide guidance on how to effectively provide normally achieving students with MA intervention. Unfortunately, the literature on effective MA instruction for students with reading disabilities is scarce. Moreover, there is no study investigating the roles of cognitive and language abilities in predicting students' responsiveness to MA intervention. To be most effective, intervention should be directed by sufficient information on students' strengths and weaknesses in cognitive and language abilities.

The primary purpose of this study was to investigate how well cognitive and language processing variables (i.e., phonological awareness, rapid naming, orthographic knowledge/awareness, verbal comprehension, working memory, executive function, non-verbal intelligence) predict the degree of responsiveness to MA instruction for third grade students with decoding deficits. More specifically, this study was designed to examine (a) how students with word analysis deficits respond to a previously researched MA intervention that involves learning about affixes (prefixes) and the role they play in changing a word's meaning, and (b) underlying cognitive and language variables that predict the abilities of students with decoding deficits to add prefixes to real words and then understand the meaning of those words in a sentence level comprehension task. The correct responses on three morphological tasks (i.e. base word recognition task, prefix and base word recognition task, sentence level comprehension task) were used as measures of responsiveness to morphological intervention. The following research questions were addressed:

1. What cognitive and language variables predict responsiveness to MA intervention on tasks emphasizing word recognition after accounting for pretest performance? Of these variables, which are the best predictors of MA intervention after accounting for pretest performance?

2. What cognitive and language variables predict responsiveness to MA intervention for MA tasks emphasizing word recognition and sentence level comprehension after accounting for pretest performance? Of these variables, which are the best predictors of MA intervention after accounting for pretest performance?

CHAPTER 2
REVIEW OF THE LITERATURE

The present study aims to determine which cognitive and language processing skills predict responsiveness to MA instruction among students' with reading disabilities and to examine effects of MA instruction. This review of literature includes three main bodies of research: (a) the importance of morphological knowledge and MA skills to develop children's reading skills, (b) intervention studies examining MA instruction for struggling readers, and (c) the cognitive and language variables that have been reported to be related to students' reading abilities.

The studies selected for review (a) were published in referred journals, (b) provided empirical evidence of the development of morphology, (c) targeted MA intervention for students with or without reading disabilities, (d) included students in grades K-12 with specific learning disabilities or dyslexia, (e) reported student achievement measures using descriptive statistics, (f) focused on the contribution of the cognitive and language variables to successful reading, and (g) included at least one dependent measure that assessed one or more aspects of reading in English, including spelling, writing, vocabulary, decoding, or reading comprehension. If the study did not have a reading related outcome or if reading performance was measured only by brain imaging it was not included in the literature review.

The overall search included several steps. First, an electronic database search was conducted using the Educational Resource Information Clearinghouse (ERIC), American Psychological Association (APA PsycNET), EBSCO HOST, PsyINFO, and Google Scholar using variations of the following search terms: morphological awareness, morphological knowledge, morphemes, morphology and reading, decoding, word study, reading, word part, affix, prefix, root word, base word, reading, dyslexia, disability, cognitive abilities, working memory, verbal intelligence, phonological awareness, rapid automatized naming, and oral language proficiency. Second, the references of selected papers to identify meaningful studies that did not appear in the first search step were reviewed. The specific criteria for inclusion in this review were that an article (a) included the participants who were students in grades K-12 and students with specific learning disabilities or dyslexia, (b) reported an intervention or a performance/comparison of groups design, (c) reported student achievement measures, (d) included at least one dependent measure which assessed one or more aspects of reading such as spelling, writing, vocabulary, decoding, or reading comprehension. If the study did not have a reading related outcome, the study was not included. When reading performance was measured only by brain imaging, the study was not included.

The Components and Roles of MA

Research on how students analyze monosyllabic or multisyllabic words and identify word level units in those words has focused on decoding as the process of translating written forms into language forms. The decoding process requires readers to use their phonological, orthographic, and semantic knowledge in learning to read (Reichle & Perfetti, 2003). This section includes a brief review of the types of morphemes, literature on the significance of morphology, and relationship between morphological knowledge and word recognition. Additionally, a description of how readers use their knowledge of morphographs when decoding complex words is provided. Further, this review will provide critical information to design MA interventions that are linguistically and developmentally appropriate for students with word analysis deficits.

Types of Morphemes

A morpheme is a main unit of analysis in morphology and refers to a combination of sounds that have a semantic meaning or grammatical function. Morphemes consist of phonemes (the smallest linguistic units of spoken language), and consist of graphemes (the smallest units of written language) in written language (Fromkin, 2013). A morpheme may or may not stand-alone. For example, the word “students” has two morphemes: student is a morpheme, and s is a morpheme. The word “student” is a morpheme that can stand on its own. Thus, it is a monomorphemic or simple word (i.e., words that have only one morpheme and have a unit of meaning). A morpheme can be either a base or an affix, and an affix can be categorized into two types: prefix (e.g., pre-, un-) and suffix (e.g., -able, -ish). For example, student is the base morpheme, and s is a suffix; whereas in the word “unhappy,” happy is the base morpheme, and un is a prefix. Words with more than one morpheme are called polymorphemic words. Polymorphemic words include bimorphemic (i.e., consisting of two morphemes as the words waiting and waited) or multimorphemic (i.e., consisting of more than two morphemes as the words reusable and unhappiness) words. Polymorphemic words are composed of two basic types of morphemes: free-standing, or unbound morphemes and bound morphemes. Free or unbound morphemes are morphemes that can stand alone in a sentence (e.g., student, learn, and etc.). Bound morphemes are morphemes that cannot stand alone; they are always part of a larger word and are attached to other unbound morphemes, such as prefixes and suffixes (e.g., -dict in dictation.). Bound morphemes also can be lexical morphemes (e.g., {com} as in combine, compose) or grammatical morphemes (e.g., --s in students means more than one). Bound grammatical morphemes are known as affixes and can be further divided into two types:

inflectional morphemes or affixes (e.g., -ed, -ing, -s) and derivational morphemes or affixes (e.g., -ly, -tion, pre-, un-) (Fromkin, 2013). In the following section, the way children decode bimorphemic or multimorphemic words and gain access to the meanings of such words will be addressed.

Roles of Morphemes When Learning to Read

Experimental evidence on morphological structure supports two opposing hypotheses regarding the processing of morphemes to gain access to the lexicon; the full-listing hypothesis and the decomposition hypothesis (Reed, 2008; Verhoeven & Perfetti, 2003). The full-listing hypothesis claims that students first recognize multisyllabic words in their entirety, often referred to as whole word processing procedures, and they begin to decompose words into their morphological units only after they have attained lexical access to the complex words. In contrast, the decomposition hypothesis has assumed that students read complex words (e.g., unhappiness) by first recognizing the individual morphemes and then automatically blending them to recognize the word (Verhoeven & Perfetti, 2003). Under the full-listing hypothesis, lexical entries are whole words or sight words; while for the decomposition hypothesis, lexical entries are roots, stems, or base words. Presently, research has not resolved which approach to decoding morphologically complex words is accurate--full-listing or decomposition procedures. Regardless of which approach students use when decoding multisyllabic words, it is clear that they must acquire knowledge about the different morpheme structures if they are to successfully decode and understand complex words.

Studies that investigate morphological development in children show that children first learn inflectional affixes (Reed, 2008) before learning derivational suffixes

(Carlisle & Stone, 2005; Carlisle & Katz, 2006; Reed, 2008; Vogel, 2001). This developmental pattern in learning may be due to the fact that there are only a limited number of inflectional affixes in English; whereas derivational affixes are more varied and complex. English has only eight inflectional affixes and all are suffixes (i.e., plural (e.g., students), possessive (e.g., student's), comparative (e.g., younger), superlative (e.g., youngest), present (e.g., learn), past (e.g., learned), past participle (given), and present participle (e.g., giving); whereas there are numerous derivational morphemes and derivational affixes that can be either suffixes (e.g., -ful, -ly, -al) or prefixes (e.g., un-, dis-, anti-). Furthermore, because many derivational affixes are adopted from Latin (e.g., basic meaning of co- is together as in coauthor and cohort), Greek (e.g., basic meaning of auto- is self or same as in automatic), Anglo-Saxon (e.g., root meaning of bind is tying or fastening as in bind and binder), or other languages, students need to learn the meaning origins of roots, prefixes, and suffixes to fully understand the meanings and uses of words that include these affixes and transfer their lexical knowledge to decode new words (Henry, 2010). Thus, acquiring fluency with derivational affixes is more challenging.

MA Skills and Reading and Spelling Proficiency

Written English is comprised of both phonemes (i.e., representations of sound) and morphemes (i.e., representations of meaning) (Carlise & Stone, 2005). Therefore, it is logical that both phonological and morphological knowledge contribute to students' reading ability. Cumulative evidence has shown that phonological awareness tasks are the best predictors of reading difficulty in early reading acquisition (Adams, 1990; Snow et al., 1998; Wagner, Torgeson, & Rashotte, 1994). Less attention, however, has been paid to children's ability to understand the morphemic structure of multisyllabic words.

Recently, studies of reading in English have demonstrated the relationship of MA and a variety of literacy skills (Carlisle, 1995; 2000; Deacon & Kirby, 2004; Kirby et al. 2012) for students in intermediate (Carlisle, 1995; 2000; Leong, 2000) and upper grades (Nagy & Scott, 1990).

Research has informed us that MA plays a key role in reading and spelling even when other language variables are controlled (Carlisle, 2000; Deacon & Kirby, 2004; Kirby et al. 2012; Treiman & Cassar, 1996). Additionally, MA predicts vocabulary growth (Bowers & Kirby, 2010). For example, in a 4-year longitudinal study investigating the roles of MA and phonological awareness on three aspects of reading development (i.e., pseudoword reading, single word reading, and reading comprehension) of students in Grades 2 through 5, Deacon and Kirby (2004) found that students' MA contributed uniquely to pseudoword reading, single word reading, and reading comprehension after controlling for phonological awareness. After controlling for verbal and nonverbal intelligence and phonological awareness, MA skills independently contributed to growth in pseudoword reading, single word reading, and reading comprehension in Grades 3 through 5. At Grades 4 and 5, MA made a greater contribution to pseudoword reading and reading comprehension than phonological awareness did after controlling for verbal and nonverbal intelligences of Grades 4 and 5; whereas phonological awareness made a stronger contribution to single word reading. Students' MA skills were significant predictors of their reading comprehension, implying that MA skills play a significant role in understanding text. From these findings, it was argued that MA skills may play a role in reading development that is comparable to or stronger than the role played by phonological awareness skills.

There is also evidence that supports the link between morphological knowledge and its use in understanding derived words and reading comprehension (Carlisle, 2000). Carlisle (2000) investigated the relationship between 3rd and 5th grade students' morphological knowledge and reading comprehension. Specifically, Carlisle assessed students' understandings of multisyllabic words that shifted in both their phonology and orthography when derivational affixes were added. For both 3rd and 5th graders, ability to read derived words accounted for a significant portion of the variance in reading comprehension, and this relationship was stronger for 5th graders (for 3rd, 43% ($F(3, 30) = 7.42$, $p < .001$, for 5th, 53%, $F(3, 21) = 8.03$, $p <.01$), showing that there is a meaningful link between students' knowledge on morphological structure of derived words and their reading comprehension ability.

In order to evaluate the contribution of students' knowledge of morphological structure to literacy outcomes, Nagy and his colleagues used structural equation modeling of covariance structures (Nagy et al.,2003, 2006). For example, they (2003) found that MA measured by three indicators (i.e., suffix choice, compound structure, and morphological relatedness) contributed uniquely to reading comprehension for the second-grade at-risk readers on the path analysis ($Z = 4.64$, where test statistic, $Z \geq 2.00$, $p < .05$). The correlation between MA and reading comprehension for fourth-grade at-risk writers was stronger ($r = .80$, $p < .05$) than the second-grade at-risk readers ($r = .69$, $p < .05$). Similarly, in a study investigating the contribution of MA to literacy outcomes (i.e., reading comprehension, reading vocabulary, spelling, and accuracy and rate of decoding morphologically complex words) for three groups of upper grade children (4th/5th, 6th/7$^{th/}$, and 8th/9th), Nagy, Beringer, and Abbott (2006) found that MA uniquely contributed to reading comprehension (Z = 5.02 for $4^{th}/5^{th,}$ $p < .001$; Z = 2.17 for $6^{th}/7^{th,}$ $p < .05$; Z = 3.56 for $8^{th}/9^{th,}$ $p < .001$), reading vocabulary (Z = 5.05 for $4^{th}/5^{th,}$ $p < .001$; Z = 2.30 for $6^{th}/7^{th,}$ $p < .05$; Z = 35.15 for $8^{th}/9^{th,}$ $p < .001$), and spelling (Z = 2.77 for $4^{th}/5^{th,}$ $p < .01$; Z = 2.63 for $6^{th}/7^{th,}$ $p < .01$; Z = 2.76 for $8^{th}/9^{th,}$ $p < .01$) for all three grade-level groups of students on the path analyses. Regarding the measures of accuracy and rate of decoding morphologically complex words, MA made a significant and unique contribution to all the measures of rate of decoding morphologically complex words (i.e., decoding inflected words, decoding prefixed and pseudoprefixed words, decoding prefixed irregular stems, decoding suffixed irregular stems, decoding sets of morphologically related words) for the 8th/9th-grade students, and to some measures of accuracy of decoding morphologically complex words for the 4th/5th-grade and 8th/9th-grade students (i.e., decoding inflected words, decoding prefixed and pseudoprefixed words, decoding prefixed irregular stems, decoding suffixed irregular stems, decoding suffixed irregular stems). In addition, MA is highly correlated with vocabulary knowledge in all three grade-level groups (r = .83 for $4^{th}/5^{th}$, r = .72 for $6^{th}/7^{th}$, r = .67 for $8^{th}/9^{th}$, $p < .001$).

Relationships among MA and literacy outcomes of students with disabilities. Several studies investigated the relationship between students with disabilities, MA, and reading and spelling development. Specifically, researchers examined how limited reading and spelling abilities of students with disabilities affected their understanding of morphological structure and use (e.g., Carlisle, 1987; Casalis et al., 2004; Champion, 1997; Siegel, 2008). Casalis, Cole and Sopo (2004) and Siegel (2008) examined the performance of dyslexic students on MA tasks and its relationship to students' proficiency in phonological awareness or oral language skills compared to children without reading disabilities who read at the same level. Casalis et al. (2004) examined how dyslexic French children performed on a series of MA tasks compared to a group of chronologically age matched peers and a group of peers matched on their reading achievement. Results showed that students with dyslexia scored significantly below students in the other two groups on all tasks ($F(2,96) = 77.94$, $p < .001$), and there was an interaction between MA tasks and the three groups ($F(6,288) = 8.46$, $p < .001$), showing that the difference among the three groups varied depending on the types of MA tasks (e.g., suffix deletion task, derivation in sentence completion task). For instance, children matched on chronological age showed highest scores on the suffix deletion task and the derivation in sentence context task, followed by scores of their peers matched on their reading achievement and dyslexia; however, there was no group difference between the group of peers matched on reading achievement and the dyslexia group on the derivation in sentence context task.

Siegel (2008) examined the relation of MA to reading and spelling skills for three groups of sixth grade children: those with dyslexia, those who were typical readers, and those who were English language learners (ELLs). She found that there were significant differences between two of the groups (i.e., dyslexic group vs. normally achieving students group) on the morphological tasks ($F(1,1060) = 254.30$, $p < .0001$), and the students with dyslexia scored lower on the word and pseudoword morphological tasks. The type of morphological tasks (i.e., word vs. pseudoword) also had a significant effect, $F(1, 1060)$ 200.96, $p < .0001$**),** resulting in both groups having lower scores on the pseudoword as opposed to the word morphological task. Dyslexic students' knowledge of multisyllabic words involving derivations was related to students' performance on reading (i.e., with pseudoword reading fluency, $r = .50$, $p < .001$) and spellings tasks ($r = .52$, $p < .001$). Additionally, MA made an independent contribution to reading comprehension and spelling achievement that was higher than the contribution made by phonological awareness and oral language skills. Furthermore, the links between MA and reading comprehension were stronger than these between phonological processing and reading comprehension. These findings show that MA is a skill that contributes independently to reading comprehension and spelling.

Hauerwas and Walker (2003) investigated morphological, phonological, and orthographic awareness skills of students with spelling deficits in 5^{th}, 7^{th} and 8^{th} grades and their abilities to spell inflectional morphology in writing tasks compared to students matched on spelling achievement and students of the same age. Comparisons of performance among the three groups showed that students with spelling deficits performed worse on all three spelling tasks (i.e., spelling of inflected verbs in sentence context, spelling of inflected verbs in list format, base word spelling) ($F(2, 85) = 65.27$, $p < .001$). In addition, the ability to spell inflected forms in sentence context of students with spelling deficits was significantly correlated with MA ($r = .40$, $p < .05$), phonological awareness ($r = .58$, $p < .01$), and orthographic awareness at ($r = .51$, $p < .01$). However, MA of students with spelling deficits was not related to base word and list form spelling tasks. Additionally, they found that the mistakes (e.g., omitting inflected endings) students with demonstrated spelling deficits made on an inflected verb task varied according to their understanding of how inflected endings can be used to show verb tense (e.g., the researcher stated, "Say damp" (student repeats). "Today the girl damps. What did she do yesterday? Yesterday she _____” (student says damp)); the mistakes spelling-matched students made on the same tasks varied according to their orthographic skills. These findings suggest that students’ understanding of spelling of inflected verbs is closely related to their MA skills.

Carlisle (1987) investigated the performance of learning disabled 9th graders on the morphological structure, spelling, and suffix addition tasks of derived forms and base forms compared to the performance of normally achieving 4th, 6th, and 8th graders on these same tasks. Results showed that the four groups displayed differences on derived forms ($F(3,78) = 18.91$, $p < .001$) and the base forms ($F(3,78) = 16.88$, $p < .001$). Interestingly, even though MA skills of 9th graders with learning disabilities fell between those of normal 6th and 9th graders, developmental patterns of learning orthographic and phonological rules were similar to those of normally achieving students. Findings from studies by Hauerwas and Walker (2003) and Carlisle (1987) demonstrated that students with specific learning disabilities had deficits in their morphological knowledge and exhibited difficulties in spelling that seemed to be associated with lack of MA skills.

Carlisle (1996) examined the morphological errors of students with learning disabilities during a creative writing activity. Twenty-six normally achieving students and 16 students with learning disabilities engaged in a picture story task. Students were presented with a picture and prompt and asked to write freely. Results showed that second grade students with learning disabilities made more errors than their nondisabled peers in the use of present tense ($t(41) = 2.82$, $p < .05$) (e.g., it *learn*, he *learn*, we *learns*), and the progressive form ($t(41) = 2.04$, $p < .05$) (e.g., he was *playing* and *read*); whereas no significant difference was found between third grade students with learning disabilities and their same age peers. She also found significant correlations between students' oral production of morphological tasks and accuracy in story writing ($r = .54$, $p < .001$) and spelling ($r = .35$, $p < .001$). Additionally, the frequency and accuracy of the use of morphological forms in their written stories varied based on students' grade and disability; 2nd graders had fewer uses of morphologically complex words than 3rd graders, and students with learning disabilities had fewer uses of morphologically complex words than non-learning disabled students in their writing.

Overall, research findings show that students who have deficits in reading and spelling tend to demonstrate difficulties using their morphological knowledge to analyze morphological structure in complex words. Poor MA has been shown to affect not only students' ability to decode words, but also negatively impacts their vocabulary, text comprehension, and spelling (Casalis et al., 2004; Carlisle, 1996; Hauerwas & Walker, 2003; Siegel, 2008). Moreover, MA skills of such students are related to lower scores on word recognition and writing tasks after taking into account the effects of other related factors such as phonological or orthographic awareness, suggesting that MA appears to be causally related to reading achievement.

Ways in which morphological awareness facilitates the learning of component reading skills such as spelling, vocabulary and reading comprehension are well documented (e.g., Bowers et al., 2010; Carlisle, 1995; 2000; Templeton, 2004) and suggest that morphological knowledge can be a predictor and facilitator of literacy skills. Thus, it seems reasonable that morphological instruction should be used to facilitate students' literacy proficiency, especially in the development of vocabulary knowledge for complex multisyllabic words (Bowers et al., 2010; Carlisle, 1995). Furthermore, researchers suggest that morphological awareness instruction is beneficial to struggling readers because morphological knowledge (i.e., use of orthographic structures to support meaning such as adding “ed” to indicated past tense) and orthographic knowledge (i.e., use of printed forms to convey meanings (i.e, using “ly” on beautifully in the context of “a beautifully written story”) are complimentary processes (e. g., Casalis et al., 2004). In the following section, studies on MA interventions focused on struggling readers will be reviewed to frame the effects of MA interventions on reading outcomes of students with reading disabilities.

MA Intervention for Students with Reading Disabilities

A large amount of research has demonstrated the significant contribution of MA to reading, spelling and vocabulary achievement (e.g., Arnbak & Elbro, 2000; Carlisle, 2000; Carlisle, 2007; Hauerwas & Walker, 2003; Nagy et al., 2006; Siegel, 2008). Any efforts to improve students MA skills also seem to improve important reading outcomes. Researchers who conducted intervention studies have provided evidence of causal links between deliberate morphological instruction and literacy development (Bowers et al., 2010). Researchers have also provided supportive evidence that teaching MA may be helpful for struggling readers (Abbott & Berninger, 1999; Carlisle, Stone, & Katz, 2001; Carlisle & Stone, 2006; Casalis et al., 2004; Elbro & Arnbak, 1996; Henry, 2003; Nunes & Bryant, 2006). The following review will present the findings of recent meta-analysis studies (Bowers et al., 2010; Reed, 2008), and morphological intervention studies that included students with disabilities.

In a meta-analysis using 22 intervention studies conducted by Bowers, Kirby, and Deacon (2010), they found that (a) morphological instruction focused on root words and affixes was more effective than instruction that emphasized affixes alone, (b) integrated morphological interventions (morphological instruction integrated with other instruction or literacy skills) (*Cohen's d* = 1.25 for sublexical linguistic outcomes or morpheme level) were more effective than isolated instruction (morphological instruction targeted only morphological content) (*Cohen's d* = 0.24 for sublexical linguistic outcomes), and (c) morphological instruction was helpful for learners at all ages even though the amount of gain differed based on the age of the students and whether the outcome measured involved morphemes or words. Additionally, the authors found that morphological instruction benefited students who struggled with reading, spelling, and vocabulary when they were taught in a small group or individual instruction. The authors concluded that both young and old students can profit from MA instruction if it is developmentally appropriate, including base words instruction, and "sublexical morphological knowledge is a tool for "strengthening learners' lexical representations" (p. 167). Interestingly, the authors identified 8 intervention studies (Abbott & Berninger, 1999; Arnbak & Elbro, 2000; Berninger, Nagy et al., 2003; Berninger, Winn et al., 2008; Kirk & Gillon, 2009; Tyler, Lewis, Haskill, & Tolbert, 2003; Vadasy, Sanders, & Peyton, 2006) that included less able children, and morphological content that targeted affixes, base or stems for word meaning, and oral and written morphology. Also, morphological analysis tasks were commonly used for assessing students' morphological knowledge in the 8 intervention studies. In these 8 studies, the selected words, instructional grouping (small group or individual), instructional time per session and number of sessions varied.

Reed (2008) qualitatively synthesized seven morphology intervention studies conducted between 1986 and 2006 involving students in grades K-12. The author selected 7 studies that focused on morphology instruction, in roots and affixes, and measured gains in one or more reading-related outcomes (e. g., word identification, spelling, vocabulary, reading comprehension). The research findings from studies in this review revealed that (a) morphological skill does not develop normally in children with reading and hearing disabilities, (b) stronger effects were associated with root word instruction in combination with affix instruction, and (c) morphology could successfully be combined with training in other skills without adding instructional time. According to the author, there has been little research conducted on the effect of explicit morphological instruction using an experimental design where the subjects are randomly assigned to treatment and control conditions with fidelity implementation. Moreover, there are only two experimental studies that included struggling readers (e.g., Abbott & Berninger, 1999; Vadasy et al., 2006).

A couple additional studies were identified that were not included in the Reed's review. Arnbak and Elbron (2000) investigated 33 fourth and fifth grade dyslexic students' response to 36 fifteen-minute lessons of MA training to investigate whether the students' MA skills in spoken language was causally related to dyslexic students' development of reading and spelling skills. A total of 540 minutes were dedicated to the intervention for the experimental group, and the training results were compared to a control group of same aged children. Students received isolated morphological training in small groups (3-4 students) with explicit instruction from the remedial teacher. The instruction targeted students' semantics of morphemes. Students were made familiar with semantically transparent and opaque morphemes. In addition, a significant portion of the instructional time was dedicated to increasing students' understanding of affixes using prefix and suffix families. Students' oral and linguistic abilities were assessed pre and post intervention. A series of 17 different tasks were employed. These tasks were similar to those used in correlational studies that demonstrated relationships between MA and reading and spelling skills. Both groups made equal gains on measures of phonological awareness, phoneme discrimination and picture naming. Consistent with other findings in the correlational literature, the dyslexic students' phonological skills predicted performance on the morpheme subtraction task (r = .28, p < .05), but were not associated with growth in MA. There was no support for links between phonological processing and MA. Importantly, these findings demonstrate that it is possible to improve morphological knowledge levels in students with dyslexia through targeted, explicit intervention regardless of their entering phonological awareness abilities.

Morphological Content and Tasks

Several researchers have used different tasks to investigate children's representation of morphological knowledge and their use in oral and written language (Carlisle, 1987, 1996), and the descriptiveness of morphological tasks varied from study to study. Two scholars assessed students' morphological knowledge using derivational word tasks (Caslisle, 1987; Champion, 1997). Suffix addition tasks (e.g., dun + y = ___) (Carlisle, 1987) and deletion tasks (e.g., *sagesse/sage*) (Casalis, Cole, & Sopo, 2003) required students to isolate suffixes from base words. Several studies examined students' ability to produce (Carlisle, 1996; Casalis et al., 2003) and pronounce morphologically complex words (Casalis et al., 2003).

Teaching Prefix and Suffix Families

Based on existing empirical studies, researchers have recommended teaching students new or complex words by helping to cluster affixes into meaning based groups or families, which are called prefix or suffix families as a word-part clue, is effective (e.g., Baumann et al., 2003; Baumann, Font, Edwards, & Boland, 2005; Edwards, Font, Baumann, & Boland, 2004). Instruction in prefix families has also been combined with instruction in context clues as a way of helping students use their knowledge of prefixes and context to decode words.

In a study examining the impact of MA instruction on 5th grade students (Baumann et al., 2005), students were taught the following word families: not, number, below or part, again and remove, before and after, against, excess, and bad. Additionally, they were taught to use the appositive context clues that were set off by commas, dashes, or colons, as well as signal words such as or or a. Students were divided into groups where they received combined instruction in MA and contextual analysis, MA instruction alone, and contextual analysis instruction alone. Following the lessons, students were tested on their ability to recall meanings of words used to teach the morphemic and contextual analysis skills, infer unfamiliar words that contained morphemic elements that were embedded in text and included taught context clues (transfer words), and comprehend text including transfer words. Results indicated that (a) students of all ability levels benefited equally from the instruction in morphemic or contextual analysis, (b) there was an immediate and delayed impact of the morphemic and contextual analysis instruction, (c) there was an immediate impact of morphemic and contextual analysis instruction for transfer words, and (d) there was no evidence that instruction in morphemic or contextual analysis (in isolation, or combination) enhanced students' text comprehension; students were just as effective at inferring word meaning regardless of whether they received the intervention in isolation or combination. The treatment effects for the morphemic analysis instruction using prefix families were, in general, stronger than they were for contextual analysis instruction (mean effect size for morphemic analysis instruction was .78 and mean effect size for contextual analysis instruction was .60).

Similarly, Baumann and his colleagues (2003) investigated the effects of integrated instruction in morphemic and contextual analysis strategies embedded within subject matter lessons on 5th grade students' ability to learn new word meanings and on their text comprehension. A quasi-experimental design was used to compare the effects of morphemic and contextual analysis instruction with the effects of textbook vocabulary instruction during social students' lessons. General education teachers taught students how to derive word meanings through morphemic analysis using 8 affix families (i.e, not, before, excess, number, re, quality of, ward, ful), and asked students to infer meaning through contextual analysis. Results showed that students who received morphemic and contextual analysis instruction were better able to infer meanings of novel morphologically complex words (i. e., words with affixes) ($F(1, 6) = 54.840$, $p < .001$) and morphologically and contextually decipherable words on a delayed test ($F(1, 145) = 4.858$, p = < .05, but not on an immediate post-test. These findings suggest that (a) morphemic analysis instruction including high-frequency affixes organized by meaning-based families can help students decode and understand new, complex words independently, and (b) receiving MA instruction helps students expand learning word meanings beyond what they are taught.

The results of intervention studies indicated that there is evidence that students with disabilities would benefit from morphological instruction targeted at their instructional level. Also, studies support the use of targeted, explicit intervention to improve morphological knowledge levels in students with reading problems (Arnbak & Elbron, 2000; Vadasy et al., 2006). Less able readers seem to benefit from more explicit instruction (Bower et al., 2010). In addition, the morphological tasks used during intervention can influence the degree to which students profit from intervention. Which morphological tasks are used may lead to different outcomes of learning new, complex words (Baumann et al., 2002, 2003), suggesting the potential of using affix families to teach MA skills.

Clearly, research findings from these studies suggest that attention should be paid to how morphological awareness interventions are structured, in terms of the morphological processing of students with disabilities and their understanding of how affixes are related to a word's part of speech. What we don't understand is how changing features of an intervention will affect the learning of students with disabilities.

Language and Cognitive Variables Associated with Early Reading Achievement

Early cognitive and language skills are predictive of later reading achievement (Badian, 1995; 1998; O'Connor & Jenkins, 1999; Wilson & Lonigan, 2010). Numerous studies have examined relationships between component skills of reading (e.g., phonics, vocabulary) and reading achievement (e.g., Anthony & Lonigan, 2004; Hogan, Catts, & Little, 2005; Hoover & Gough, 1990; Storch & Whitehurst; 2002) using longitudinal data. Research has demonstrated that working memory, intelligence, phonological awareness, rapid naming, and oral language proficiency are related to important reading and spelling outcomes (e.g., Siegel, 2008) and may be related to MA.

Specific language and cognitive variables are likely to influence the response of students with disabilities to the MA intervention. Research has established a strong link between children's cognitive and language abilities and their word recognition and reading comprehension. Over the past years, however, the study of the roles of cognitive and language variables in developing students' morphology for learning to read has received little attention. The following review summarizes the literature on cognitive and language variables shown to predict children's reading abilities.

Phonological Awareness

One early reading skill that has been shown to be a strong predictor of later reading achievement for English speakers is phonological awareness (Wagner et al., 1994). Phonological awareness is "the ability to detect and manipulate the sounds of spoken language, independent of meaning" (Wilson & Lonigan, 2010, p. 63). Phonological processing involves access to the phonological structure of spoken language as well as processing written language (Jorm & Share, 1983; Wagner & Torgesen, 1987). Compared to other predictive variables, phonological awareness has been reported to be the most powerful predictor of reading skill development, particularly word-level reading skills (O'Connor & Jenkins, 1999; Scarborough, 1998). Also, phonological awareness is a strong and significant predictor of word reading skills in elementary children until around second grade (Torgesen et al., 1999; Ehri, 1992; Ehri et al., 2001; Storch & Whitehurst, 2002).

Its predictive value is diminished after this period when children are transitioning from the stage of "learning to read" into the stage of "reading to learn" (Hogan et al., 2005; Scarborough, 1998). For example, in a five-year longitudinal study of 216 children, Wagner and his colleagues (1997) assessed phonological awareness, word reading, and vocabulary skills from kindergarten through 4th grade. While individual differences in phonological awareness and vocabulary predicted later word reading skill, the amount of unique variance explained by phonological awareness in predicting later word reading skills declined from 23% kindergarten to second grade, 8% from first to third grade, and 4% from second to fourth grade. In a longitudinal study beginning in preschool, Storch and Whitehurst (2002) examined children’s knowledge in two domains, code-related skills (e.g., print concepts and phonological awareness) and oral language skills (e.g., receptive vocabulary, expressive vocabulary, and narrative recall) to determine which skills best predicted future reading achievement. Consistent with previous studies, the authors found a stronger relationship between the two domains during preschool than in the first and second grades, showing that the predictive strength of skills within these domains varies along a developmental continuum. Additionally, Catts and his colleagues (1999) found that second grade children with poor reading skills were four to five times more likely than good readers to demonstrate problems in both phonological awareness and oral language as early as kindergarten. Some studies have examined the degree to which phonological awareness skills are a moderator or mediator of the relationship between MA and selected reading abilities (e.g., Deacon & Kirby, 2004).

Rapid Automated Naming

Naming speed, which is called rapid automatized naming (RAN), has also proven to be a significant predictor of later reading skills. RAN is the result of lexical access (Badian, 1998; Kirby, Parrila, & Pfeiffer, 2003; Wolf & Bowers, 1999) since it requires the retrieval of phonological information from long-term memory in response to visual stimuli. In a longitudinal study, Kirby and his colleagues (2003) examined the extent to which early reading skills such as phonological awareness and rapid naming speed performance predicted reading development in children. Results of their study showed that phonological awareness was strongly related to reading ability during the first two years of school while rapid naming performance tended to be more related to reading ability in the later grades. Furthermore, children who performed poorly on the phonological awareness and rapid naming tasks in kindergarten were most likely to show reading difficulties in Grade 5, followed by the group of children who performed poorly on only the naming speed tasks in kindergarten (Kirby et al., 2003). Since RAN has been known as an important factor supporting children's word recognition abilities (NRP, 2000) and MA skills help readers recognize words (Carlisle, 2003), some researchers have been interested in the role of RAN in MA skills (e.g., McBride-Chang, Shu, Zhour, Wat, & Wagner, 2003; Plaza & Cohen, 2004).

Verbal Comprehension

Verbal comprehension or oral language proficiency refers to "vocabulary as well as the ability to use words to understand and convey meaning" (Wilson & Lonigan, 2010, p.63). Verbal comprehension is related to students' ability to listen to, understand, and remember information provided orally and use that information in novel tasks (McGrew, Schrank, & Woodcock, 2007).

While most studies have focused primarily on phonological awareness and/or rapid naming performance as predictors of children's risk for reading difficulties, some researchers have demonstrated that many children who have difficulties learning to read also have a history of oral proficiency deficits as well as phonological awareness deficits (e.g., Catts, Fey, Zhang, & Tomblin, 1999; Pearce & Gayle, 2009). Compared to their same-age peers, children with larger vocabularies tended to be more proficient readers than children with smaller vocabularies (e.g., Bishop & Adams, 1990; Catts et al., 1999; Pearce & Gayle, 2009; Scarborough, 1998). For example, Katz and Carlisle's (2009) found that students with higher verbal comprehension scores were more likely to profit from MA instruction and transfer their knowledge more easily to novel words presented in a passage. Kaye, Sternberg and Fonseca (1987) also found that students who have better verbal comprehension are more likely to use contextual information or cues to facilitate, thus, they can apply such ability to decode and infer the meaning of complex words. Similarly, Stage and his colleagues (Stage, Abbott, Jenkins, & Berninger, 2003) showed that students with higher verbal comprehension scores responded more rapidly to a set of early reading interventions involving alphabetic principle and reading first-grade books. Researchers have not established, however, the relationship between vocabulary and MA, though, given the meaning based aspect of MA, it would be surprising not to find a strong relationship between the two skills.

Executive Functions

Executive function refers to brain functions associated with "attention shifting, working memory, and inhibitory control cognitive processes that are utilized in planning, problem solving, and goal-directed activity" (Blair & Razza, 2007, pp. 647-648). Research has demonstrated that deficits in executive functions have been linked to dyslexia or reading disabilities (e.g., Berninger & O'Donnell, 2005; Purvis & Tannock, 2000; Reiter, Tucha, & Lange 2005). Reiter et al. (2005) examined a variety of aspects of executive functioning in two groups of children with a mean age of 10.8 years, one with dyslexia and another without dyslexia. According to their findings, children with dyslexia displayed impairments of both verbal and figural fluency functions, indicating that children with dyslexia demonstrate impairments in a variety of executive functions related to literacy outcomes. In a longitudinal study, Altemeier, Abbott, and Berninger (2008) investigated the development of executive functioning in grades 1 to 6 and its contribution to reading outcomes for children with and without dyslexia. Their findings showed that children tended to continue to develop their executive functions, and inhibition and rapid automatic switching tasks accounted for the amount of variance in later grades' reading measures that are timed (i.e., reading fluency). Also, inhibition consistently predicted timed literacy tasks for both children with and without dyslexia. Executive functions were more associated with literacy achievement in children without dyslexia than those with dyslexia, suggesting that children with dyslexia may not able to engage or use executive functions as effectively as normally achieving children.

Orthographic Processing or Knowledge

Orthographic knowledge refers to the knowledge of how sounds (phonemes) of spoken language are represented in written forms. Skilled readers are capable of understanding the conventions of orthographic aspects of sequentially printed letters and making use of such letters to recognize whole words (Levy, Gong, Hessels, Evans, & Jared, 2006). Further, skilled readers tend to read whole words as word chunks of associated letters, and they are able to recognize a visual pattern of word chunks or whole words (Adams, 1990).

There is considerable evidence that limited skill in orthographic knowledge is associated with lower level of performance on reading such as word recognition (Bowers, Golden, Kennedy, & Young, 1994). In a study by Leslie and Thimke (1986), they investigated the relationship between word recognition, orthographic knowledge, and use of orthographic knowledge in word recognition using fifty-six first and second graders. Results showed that children who scored below their grade level tended to have a lower score in word recognition, indicating that a child who has better orthographic knowledge may read words faster than a child who has poorer orthographic knowledge.

Manis, Doi and Bhadha (2000) investigated relationships among phonological awareness, orthographic skills and naming speed in second graders. Their findings revealed that (a) both phonemic awareness and naming speed in letter and digit naming tasks uniquely accounted for variance in orthographic skills, indicating that there might be intertwined connections among these variables, and (b) poor phonemic awareness or naming speed might negatively influence the acquisition of good orthographic processing skills. Nagy and his colleagues (2003) investigated the contribution of phonological, orthographic, morphological, and oral vocabulary factors to word reading, spelling, and reading comprehension outcomes in 98 second and fourth graders at risk. Phonological factor measured by the Rosner Auditory Analysis Test was correlated with orthographic factor measured by the Receptive Coding and Word Choice tasks from the Process Assessment of the Learner (PAL) (Berninger, 2001). For both second and fourth 4th graders, orthographic skills students have contributed to reading multisyllabic words.

Verbal or Non-Verbal Intelligence

Evidence from several sources shows a relationship between reading abilities and verbal or non-verbal Intelligence. For example, Foorman and her colleagues (Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998) examined the effects of four types of classroom reading instructions (i.e., direct code, embedded code, implicit code-research, implicit code-standard) on the growth of vocabulary, phonological processing, and word-reading skills of first and second grade children, and included covariates of verbal IQ, age, and ethnicity. In the analysis of growth using growth curve modeling, verbal intelligence was a significant predictor of expected performance for both phonological processing and word reading skills, meaning that children with higher intelligence tend to have higher phonological and word reading skills. Similarly, in a study examining reading growth of first grade students who are at-risk for reading disabilities, Stage, Abbott, Jenkins, and Berninger (2003) examined the impacts of verbal intelligence on the growth of word identification and word attack skills using growth curve analysis, they showed that verbal intelligence was significantly correlated with slope on word attack ($r = .21$, $p < .05$) and word identification ($r = .30$, $p < .01$).

Some studies have demonstrated the relationship between verbal intelligence and the acquisition of children's morphological knowledge (e.g., Deacon & Kirby, 2004). Deacon and Kirby (2004) used two subtests, figure memory and verbal-spatial relations, from the Das-Naglieri Cognitive Assessment System (Naglieri & Das, 1997) to measure verbal and nonverbal intelligence in second graders. The two measures of intelligence and their MA skills were moderately correlated (figure memory and MA $r = .30$, verbal-spatial relations and MA $r = .36$), suggesting that students with higher verbal IQ scores were more likely to demonstrate stronger growth and transfer of MA knowledge.

Working Memory

Working memory refers to the cognitive capacity to briefly store and manipulate information necessary for comprehension and reasoning (Alloway et al., 2008; Meyer et al., 2010). Working memory is "a resource that affects an individual's ability to carry out many of the processes associated with the construction of the text representation" (Cain, Oakhill, & Bryant, 2004, p. 32). A child's working memory capacity is not determined by learned skills through any formal or informal education or other environmental influences, which implies that it may be the purest indicator of his or her learning capacity. Hence, many researchers have tried to establish a link between measures of working memory and students' learning in schools (e.g., Cain, 2006; Gathercole, Brown, & Pickering, 2003; Meyer et al., 2010; Swanson, 2004).

According to the model of working memory developed by Baddeley and Hitch (Baddeley, 1996, 2000; Baddeley & Hitch, 1974), the function of working memory depends on the capacity of a central executive as a control mechanism and two slave systems, the phonological loop (also called the articulatory loop or phonetic loop) and the visuospatial sketchpad. The phonological loop processes spoken or written language, and it deals with sound or phonological information. The visuospatial sketchpad is responsible for visual and spatial processing of received stimuli and its retrieval from the long-term memory.

Many studies examining the properties of working memory and the three working memory systems have shown that each component of working memory differentially contributes to children's reading achievement (e.g., Meyer et al., 2010; Swanson, 2004; Swanson & Beebe-Frankerngerger, 2006). Research focusing on the capacity of the phonological loop has reported that it is related to young children's language acquisition, particularly vocabulary (Baddeley, Gathercole, & Papagno, 1998), but less is known about the relationship between the visuospatial sketchpad and literacy skills.

A relationship between children's reading abilities and the capacity of working memory skills has been supported by a number of studies (e.g., Cain et al., 2004; de Jong 1998; Seigneuric & Ehrlich, 2005; Swanson, 1994). Cain, Oakhill, and Bryant (2004) found that working memory capacity explained unique variance (i.e., ΔR^2= .69,

.55, .52 ($p < .05$) in reading comprehension scores in Time 1 (age 8-9), Time 2 (age 9-10), and Time 3 (age 10-11) respectively) after controlling the contribution made by verbal ability and word reading skill for students 8-11-years old. Similarly, working memory deficits for poor comprehenders at age 8 were related to word reading ability and resulted in lower SAT scores compared to the good comprehenders at 11 years old (Cain & Oakhill, 2006).

There is considerable evidence that children with reading disabilities have low working memory capacity that affects development of their decoding skills (De Jong, 1998). De Jong (1998) found that children with reading disabilities performed worse than their normal reading peers on both the language domain tasks (i.e., reproducing a sequence of three to eight high frequency CVC words) and numerical domain tasks (i.e., reproducing a sequence of three to eight digits). Gathercole and her colleagues (Gathercole, Lamont, & Alloway, 2006) investigated the contribution of working memory capacity of 46 students with reading disabilities to their reading and mathematics skills. Results showed that the severity of reading difficulties, as assessed by three subtests of the Wechsler Objective Reading Dimension (i.e., reading of letters and single words, spelling of letters and single words, and reading comprehension), among students with reading disabilities were significantly associated with working memory and language and phonological processing abilities. Further, working memory skill independently predicted the students' attainments in reading skills.

Although there are no studies correlating working memory abilities and MA skill in students with reading disabilities, it is likely that MA skill is affected by working memory. To decode and understand multisyllabic words based on knowledge of morphology, students are supposed to use language and phonological processing skills and these processing skills seem to be closely associated with students' working memory abilities. Moreover, the relation between children's working memory and their text comprehension would be different depending on whether verbal skills are controlled (Nation, Adams, Bowyer-Crane, & Snowling, 1999), whether number-based working memory tasks are used, or word- or sentence-based tasks are used (Oakhill, Cain, & Bryant, 2003). The findings of the meta-analysis conducted by Carretti and her colleagues (Carretti, Borella, Cornoldi, & De Beni, 2009) showed that the effect size for working memory measures and reading comprehension abilities varied depending on the characteristics of working memory task (i.e., tasks required verbal skills vs. visuospatial skills, tasks required storage skills vs. storage/processing skills). Thus, it is important for future research to improve its understanding of how working memory skills affect students' learning process of reading multisyllabic words and understanding such words.

Studies have demonstrated that reading-related cognitive and language-processing variables such as phonological awareness, RAN, and oral language proficiency are strong predictors early reading skills. Less is known, however, about the relationship among these variables and MA, or its development. Previously, MA has been treated as a language skill that predicts reading ability. Researchers have not, however, examined those variables that predict MA and its development.

Cognitive and Language Characteristics of Struggling Readers and Their Influences on Responsiveness to Morphological Intervention

Cognitive and language abilities predict students' reading abilities. Thus, researchers have attempted to examine how these skills predict students' responsiveness to intervention (e.g., Biemiller & Siegel, 1997; Foorman et al., 1998; Torgesen et al., 1997; Vandervelden & Siegel, 1997).

Biemiller and Siegel (1997) examined the relationship among language and cognitive variables and students' response to two different interventions (i.e., Bridge vs. Whole Language). Specifically, they used longitudinal data collected over a two-year period to determine the predictive ability of reading-related measures (i.e., recognition-discrimination, rapid naming, phoneme analysis) and language-related measures (i.e., working memory, oral cloze, vocabulary development, oral comprehension). The students in the Bridge reading program outperformed the students in the Whole Language program in word identification. Further, the significance of predictive variables was different according to each reading program. That is, the letter-naming, phoneme analysis, and oral cloze were effective predictors of word identification gains in the group of children who received Whole Language instruction; whereas these predictive variables were not predictors of word identification outcomes in the Bridge program. These findings imply that the influence of students' reading specific or language related characteristics may vary and have different roles in responding to reading instruction according to which reading program is used.

Stage, Abbott, Jenkins, and Berninger (2003) examined the impact of verbal intelligence, language abilities (phonological, rapid naming, and orthographic), and attention ratings on at-risk first graders' responsiveness to an early reading tutoring intervention. Bivariate correlations between verbal intelligence and other cognitive and linguistic variables and reading scores on word identification and word attack showed that verbal intelligence was significantly correlated with slope on word attack ($r = .21$, p

< .05), word identification (r = .30, p < .01), phonological skill (r = .39, p < .01), and RAN (r = -.19, p < .05), accounting for 4%, 9%, 16% and 4% of the variance, respectively. Verbal intelligence was not predictive of orthographic skill or tutors' attention ratings of students. Both phonological and RAN skills were correlated with gains in word attack (r = .30 with phonological skill, r = .39 with RAN skill, p < .01) and word identification (r = -.35 with phonological skill, r = -.55 with RAN skill, p < .01). Moreover, students with double or triple deficits in language skills (RAN, phonological, and orthographic processing) responded more slowly to early intervention than students without language deficits, implying that students' cognitive and language processing variables may differentially influence students' responsiveness to reading intervention, and the degree to which students respond to reading intervention may differ according to what types of deficits in reading-related language processes students have.

Defining Students Responsiveness

Researchers have measured and defined students' responsiveness to varying reading instructions such as phonological awareness, letter-sound recognition, and word recognition (Fuchs, Fuchs, & Compton, 2004). For example, researchers have suggested universal screening for early literacy skills at the beginning of each semester and combining it with short-term progress monitoring to identify student responsiveness (Compton et al., 2006; Fuchs & Deshler, 2007; Speece & Case, 2001). For instance, Speece and Case (2001) evaluated the performance of a novel method of identifying early reading difficulty, compared to the identification based on the IQ-reading achievement discrepancy model. The authors found that students' responses on single-point measures of reading fluency and phonological awareness were not valid to identify students with reading problems, implying that ongoing progress monitoring is necessary to identify whether or not they have disabilities. In most cases of such studies, normalized pre- or post- tests based on the reference groups and standard assessment protocols (e.g., the Woodcock Reading Mastery Test, the Dynamic Indicators of Basic Literacy Skills) were used to monitor students' growth and final outcome status and to determine students' responsiveness.

Unfortunately, little research has explored students' responsiveness to morphological instruction, and no standard treatment protocols that have explicitly scripted morphological activities are available. Moreover, there is neither a norm-referenced cutoff point regarding MA skills nor performance benchmarks that can provide evidence showing whether the student have failed to respond to morphological instruction. Some studies have shown how to estimate students' responsiveness to reading intervention based on their growth on targeted reading outcomes and how to examine the effects of students' deficits in cognitive and language abilities on their ability to respond to reading instruction. For example, Foorman and her colleagues (1998) used growth curve modeling to examine the effects of four types of classroom reading instructions (i.e., direct code, embedded code, implicit code-research, implicit code-standard) on the growth of vocabulary, phonological processing, and word-reading skills assessed by standardized measures. Similarly, Stage and his colleagues (2003) applied growth curve modeling to examine varying students' language processing abilities and verbal intelligence and their influences on the degree of reading growth in word identification and word attack abilities as a consequence of early reading instruction.

Implications for Research

The findings from this literature review provide an empirical foundation for the present study. Repeated studies have established that skill in MA is a key predictor of both vocabulary knowledge and reading comprehension (Casalis et al., 2004; Carlisle, 1996; Hauerwas & Walker, 2003; Siegel, 2008). Further, a limited amount of research has demonstrated that when you intervene in students' MA, you can improve their skill in that area, their ability to apply their learning to novel and pseudo words, and their reading comprehension and vocabulary knowledge (Bowers, Kirby, & Deacon 2010). Students with reading disabilities, however, have underlying cognitive and language deficits that may hamper their ability to learn MA skills, even when presented with explicit, systematic instruction. Additionally, the research examining instruction in MA for students with reading disabilities is small compared to the research examining the development of these students' early decoding skills. Therefore, it is important to identify those MA skills that students with reading disabilities can learn and the degree to which learning those skills will influence these students performance on broader reading outcomes. In particular, the roles of students' underlying cognitive and linguistic abilities that might help them respond to morphological instruction need to be established. Understanding skill in MA and how it can be developed provides researchers the foundation for creating curriculum and other educational materials that can help students with reading disabilities make important decoding and meaning connections.

CHAPTER 3
METHODS

This study aims to identify those cognitive and language problems that best predict the performance of students with reading problems on MA skills before and following a brief intervention. The following two questions will be answered: (a) What cognitive and language variables predict responsiveness to MA intervention on tasks emphasizing word recognition, after accounting for pretest performance? Of these variables, which are the best predictors of MA intervention after accounting for pretest performance? And (b) What cognitive and language variables predict responsiveness to MA intervention for MA tasks emphasizing word recognition and sentence level comprehension, after accounting for pretest performance? Of these variables, which are the best predictors of MA intervention after accounting for pretest performance?

Participants and Setting

This section is to describe the participants that were involved in this study, including selection process and criteria according to the five specific steps. First, after the approval of the University of Florida Institutional Review Board (IRB) and the Department of Research, Assessment and Student Information in Alachua County, the Alachua County Public Schools Office of Research distributed the research protocol to public school principals at Alachua County public schools (For copies of IRB documentation, including the study protocol, parental consent letter, and student assent form, see Appendix A). This study was also advertised in the publication “North Florida School Days”, a newspaper that targets parents of school-aged children. Second, the investigator informed school personnel and parents about this study and recruiting potential participants who were third grade students who had standard scores below the

25th percentile on the Word Reading subtest of the Florida Assessment for Instruction in Reading (FAIR). Also, the investigator provided third grade teachers with a brief description of this study and the benefits of participating in this study. Third, school personnel (i.e., principal, reading coach, and teachers) referred the students who met the criteria based on the FAIR scores. For those students who were recruited by the advertisement and did not have FAIR scores, the Word Attack subtest of the Woodcock Johnson Achievement or the Phonological Awareness subtest of the Comprehensive Test of Phonological Processing was administered by two trained research assistants with parents' permission. Students scoring below the 25th percentile on these measures were also potential participants. Fourth, the school principals distributed consent forms to the parents of these students asking their permission to participate in the study as required by the University of Florida Institutional Review Board (IRB). Finally, from the students who returned parent consent forms as well as child assent forms, 42 were randomly selected to participate in the study. Students with word decoding skills above the 25th percentile, those with behavioral or emotional concerns and those with a cognitive delay or severe communication or speech deficits were excluded from the study.

One student was dropped from the study because the student's other tutoring program conflicted with the assessment and intervention schedule. Out of 41 students, two students left the study due to the health or family issues. Therefore, the final pool of participants consisted of 39 students. A summary of demographic information for all subjects is provided in Chapter 4 (Table 4-1).

Research assistants (instructors) contacted the parents of the participating students and found out whether or not the student was enrolled in the after school program. If the student was enrolled in the after school program, we informed the parent that a researcher was meeting with the student during the week. For students enrolled in the after school program, we contacted the after school coordinator to meet with the participating students. If the student was not enrolled in the after school program, we requested to set up an appointment with the parent.

Cognitive and Language Measures

There were seven cognitive and language measures administered to the participants: (a) phonological awareness (PA), (b) rapid automatized naming (RAN), (c) working memory, (d) executive function, (e) verbal comprehension, (f) non-verbal intelligence, and (g) orthographic knowledge. The following sections contain a description of each of the cognitive and language measures. All cognitive and language assessments were administered prior to beginning the intervention portion of the study.

Phonological Awareness (PA) and Rapid Automatized Naming (RAN)

PA and RAN measures used in this study included subtests from the Comprehensive Test of Phonological Processing (CTOPP: Wagner, Torgesen, & Rashotte, 1999). This norm-referenced test is designed to (a) assess and document an individual’s skills in phonological processing, and (b) to identify those with phonological processing difficulties. The CTOPP includes three indicators of phonological abilities: (a) Phonological Awareness Quotient (PAQ) that measures an individual's awareness of and ability to access the phonological structure of oral language; (b) Phonological Memory Quotient (PMQ) that measures an individual's ability to code information phonologically for temporary storage in working or short-term memory; and (c) Rapid

Naming Quotient (RNQ) that measures the individual's efficient retrieval of phonological information from long-term or permanent memory, as well as the ability to execute a sequence of operations quickly and repeatedly. Internal consistency or alternate forms reliability coefficients exceed .80 in magnitude. The test-retest coefficients range from .70 to .92. Predictive validity of the CTOPP composites with the Woodcock Reading Mastery Tests-Revised one year later was .71 for Phonological Awareness, .42 for Phonological Memory, and .66 for Rapid Naming (Wagner, Torgesen, & Rashotte, 1999).

Phonological awareness (PA)

In this study, the composite score consisting of the standard scores of two PA subtests (Elision and Blending words), which are called Phonological Awareness Composite Score (PACS), were used to represent students' PA ability as suggested in the CTOPP examiner's manual (Wagner et al.,1999). The PACS measures an individual's awareness of and access to the phonological structure of oral language.

Elision. This 20-item subtest measures the ability to separate the sounds of the word and remove phonological segments from spoken words to form other words. The examiner requires a student to say a word, and then say the word after a specific sound has been dropped. For example, the student is instructed to "Say cold." After repeating "cold," the student is told, "Now say cold without saying /k/" The correct answer is "old". The test is stopped after five consecutive errors in a row.

Blending words. This 20-item subtest measures an individual's ability to use the speech sounds to form words. The child listens to a series of audiocassette-recorded separate sounds and then is asked to blend these separate sounds together to make a whole word. For example, the student is asked, "What word do these sounds make? /k/

/a/ /t/." The correct answer is "cat". The test is stopped after five consecutive errors in a row.

For Elision and Blending words tasks, the total score is the number of correct test items up to the ceiling. The composite score in accordance with the sum of standard scores of these two tasks was used for data analysis.

Rapid automatized naming (RAN)

For students' RAN ability, the composite score combining the standard scores of two RAN subtests (Rapid Digit Naming and Rapid Letter Naming), which is called Rapid Naming Composite Score (RNCS), was used as suggested in the CTOPP examiner's manual (Wagner et al.,1999). The abilities measured by the RNCS include efficient retrieval of phonological information from long-term or permanent memory and executing a sequence of operations quickly and repeatedly. Efficient retrieval of phonological information and execution of sequences of operations are required when readers attempt to decode unfamiliar words.

Rapid digit naming. This is a timed task that measures the ability to quickly and orally name aloud digits. CTOPP has two versions, Form A and B on each page. Each form has 6 randomly arranged digits (i.e., 2, 7, 4, 5, 3, 8) in nine columns by three rows.

Rapid letter naming. This is a timed task that measures the ability to quickly and orally name aloud letters. CTOPP has two versions, Form A and B on each page. Each form has 6 randomly arranged letters (i.e., a, t, s, k, c, n) in nine columns by three rows.

For rapid digit and letter naming, the number of seconds the examinee takes to name all of the letters on Form A and Form B were calculated. The composite score in accordance with the sum of standard scores of these two tasks was used for data analysis.

Working Memory

Automated Working Memory Assessment (AWMA: Alloway, 2007) was used to examine the students' working memory ability. The AWMA is a computer-based assessment and the "first standardized tool for non-specialist assessors such as classroom teachers to use for screening their pupils for significant working memory problems quickly and effectively" (Alloway et al., 2008, p. 726). This test has been used mostly as an experimental measure in studies. The AWMA scores of 128 students in England randomly selected across schools and age ranges had few changes between the first testing time and the second time, establishing test-retest reliability (Alloway, 2007). Concurrent validity of the AWMA was established by comparing student scores on the AWMA to their scores on the Wechsler Intelligence Scale for Children, 4th UK Edition (WISC-IV); Alloway (2007) reported that 75% of children identified as having a poor working memory by the AWMA also obtained standard scores of 85 or less on the WISC-IV Memory Index" (p. 60). In this study, the composite standard scores of three subtests of Verbal Working Memory (i.e., Listening Recall, Counting Recall, and Backwards Digit Recall) automatically calculated by the software was used to represent the individuals' working memory ability.

For the Listening Recall test, participants listened to a series of individual sentences and were asked to judge if each sentence is true or false. At the end of each trial, the examiner prompted participants for recall of the final word (e.g., 'water' in a sentence 'Bananas live in water') once they had answered true or false. They received scores for (a) responding true or false correctly to each sentence, and (b) recalling the final word in each sentence correctly. For the Counting Recall test, participants were asked to count the number of red circles in an array of circles and triangles and then attempted to recall the tally of numbers in sequence. They received scores for (a) counting the correct number of circles in the array, and (b) recalling the tallies correctly in sequence. For the Backwards Digit Recall test, participants listened to a sequence of digits and were asked to recall each sequence in backwards order. They received a correct score when they recalled each number in the correct backwards order for each trial. The composite scores summed up by the standard scores of all three tests were used for data analysis.

Executive Function

Delis-Kaplan Executive Function System (D-KEFS, Delis, Kaplan, & Kramer, 2001) was used to examine the students' executive function skills. The D-KEFS is the first nationally standardized set of tests to evaluate higher level cognitive functions in both children and adults. The D-KEFS comprises nine tests that were designed to stand alone. Therefore, there are no aggregate measures or composite scores for an examinee's performance. Nine subtests include: Trail Making, Verbal Fluency, Design Fluency, Color-Word Interference, Sorting, Twenty Questions, Word Context, Tower, and Proverb Test. All nine subtests are scaled to the subject's age with a mean of 10 and a standard deviation of 3. Evidence of reliability and validity for each subtest has been well documented (Swanson, 2005). Elis, Kramer, Kaplan, and Holdnack (2004) reported the construct validity of D-KEFS has been established across numerous clinical populations. The internal consistency coefficients of 9 subtests range from .43 to .90. In this study, only the Color-Word Interference Inhibition task was administered; it has been considered to be most related to successful literacy skills (Altemeier et al., 2008). Participants were given 50 items and were asked to read the color names printed in a different-colored ink. For example, the word red is printed in green ink, and the participants needed to name the color of the ink (i.e., green) that the letters are printed and not read the word red. The scaled scores in accordance with the total completion time to name 50 items were used.

Verbal Comprehension

In this study, the Verbal Comprehension test from Woodcock-Johnson III Normative Update Complete (WJNUC: Woodcock, McGrew, Schrank, & Mather, 2007) was used to measure children's word-level verbal comprehension ability. The Verbal Comprehension test includes four subtests: Picture vocabulary (test 1A), synonyms (test 1B), antonyms (test 1C), and verbal analogies (test 1D). This test is a co-normed set of subtests in the WJNUC battery for measuring general intellectual ability, specific cognitive abilities, oral language, and academic achievement. The Verbal Comprehension subtest is used to measure lexical (vocabulary) knowledge and language development (general development in spoken English language skills). The test-retest reliability of the Verbal Comprehension subtest ranges from .68 to .87. Participants were asked to identify pictures of familiar and unfamiliar objects (test 1A), provide synonyms (test 1B), provide antonyms (test 1C), and complete an analogy with an appropriate word (test 1D). The standard scores in accordance with the sum of the number of correct answers of four subtests were used for data analysis.

Non-Verbal Intelligence

The Raven's Standard Progressive Matrices (RSPM: Raven, Raven, & Court, 1998) is a nonverbal assessment tool designed to measure an individual's ability to perceive and think clearly, make meaning out of confusion, and formulate new concepts when faced with novel information. This test includes 60 questions. Evidence of convergent validity has been established with subtests of other batteries. The correlations are as follows for the following tests and subtests of the Wechsler Adult Intelligence Scale III: (a) *r* = .64 for the Full Scale score, *r* = .79 for the Performance Scale score, (c) *r* = .49 for the Verbal Scale score, and *r* = .81 for the Matrix Reasoning subtest. (i.e., high correlations have been established based on subtests of the Wechsler Adult Intelligence Scale III (i.e., Matrix Reasoning (*r* = .81), Performance IQ (*r* = .79), Full Scale IQ (*r* = .64), and Verbal IQ (*r* = .49) (Wechsler, 1997). The SPM is also correlated with the Watson-Glaser Critical Thinking Appraisal-Short Form (*r* = .43) (Watson & Glaser, 2006). With the standardization sample of 793 people, the internal consistency reliability estimate for the Standard Progressive Matrices (SPM) total raw score was .88, indicating high internal consistency (Raven, Raven, & Court, 1998). In this study, participants were given 40 minutes and were asked to identify the missing element that completes a pattern. They were asked to use a one-page open-ended answer sheet to mark their answer. The examiner marked each answer as right or wrong. The total number of correct responses was used.

Orthographic Knowledge

The Orthographic Coding Task (Olson, Forsberg, Wise, and Rack, 1994) used to measure children's orthographic knowledge ability. For a sample consisting of 92 participants (33 in fourth grade, 33 in sixth grade, and 26 in eighth grade), the split-half reliability of the sample was .97 (Roman et al., 2009). Participants were presented with 50 pairs of phonologically matched words in each column, where only one is a real word (e.g., room vs. rume). Thirty-five word pairs were selected from the Orthographic Coding task employed in a study by Olson and colleagues (1994). Fifteen additional items were included at the beginning of the task to make it more approachable for less able children (e.g., cup and kup; cat and kat). Participants were presented on paper with

50 pairs of phonologically matched words with alternate spellings in two columns, with only one spelling representing the correct spelling of the word (e.g., hert vs. hurt). Participants circled the correctly spelled word for each pair and were given 60 seconds to complete as many items as they could. They were told that accuracy was more important than speed.

Summary of Assessment Procedures

Each student was individually administered subtests that comprised of two composites from the Comprehensive Test of Phonological Processing. These subtests are designed to assess students’ level of phonological awareness and rapid naming abilities: (a) Phonological Awareness Quotient and (b) Rapid Naming Quotient. The Automated Working Memory Assessment was used to provide a measure of working memory, and the Delis-Kaplan Executive Function System was used to assess students’ executive functioning abilities. Verbal comprehension was assessed using the Verbal Aptitude Composite of the Woodcock Johnson Cognitive Abilities Battery. Non-verbal intelligence was assessed using the Raven’s Standard Progressive Matrices (RSPM). Orthographic awareness was assessed using a researcher-developed measure employed in previous studies and the spelling subtest of the Woodcock Johnson Achievement Battery. The table 3-1 shows the instruments and target 7 measures that will be used in this study.

Table 3-1. Instruments and measures of cognitive and language abilities

Instrument	Target ability to measure in this study	Time spent per individual student
Comprehensive Test of Phonological Processing	Phonological awareness Rapid naming	15-30 mins
Automated Working Memory Assessment	Working memory	30-45 mins
Delis-Kaplan Executive Function System	Executive function	15-20 mins
Woodcock-Johnson III Normative Update Complete	Verbal comprehension	30-45 mins
Raven's Standard Progressive Matrices (RSPM)	Non-verbal intelligence	40 mins
Orthographic Coding Task	Orthographic knowledge	1 min

Intervention and Test Design

Pre-Posttest Design

This study employed a pretest-posttest design. These designs are often employed in studies that examine response to intervention. In Response to Intervention studies, the amount of change from pre- to posttest is used as an indicator of responsiveness. In order to examine the reliability of pre- and posttest items and scores on MA assessment tasks and how stable student performance was without intervention, two pretests with the same items were administered prior to MA intervention. The two pretests were averaged and used as covariate of students' initial MA performance. Two additional posttests were provided to estimate students' growth in morphological knowledge after 5 intervention sessions and then again after 10 intervention sessions; (a) first posttest after sessions 1-5, and (b) second posttest after sessions 6-10. In order to control psychometric properties (i.e., item equivalence and difficulty across pretest and posttests) of test items, the same morphological items were used for the three morphological tasks (i.e., base word recognition task, prefix and base word recognition task, and sentence level comprehension task). As such, students were administered 7 cognitive and language predictor variables (i.e., phonological awareness, rapid naming, verbal comprehension, working memory, executive function, non-verbal intelligence, and orthographic awareness) prior to two pretests and morphological intervention.

Intervention Design

After being assessed on the seven predictor measures, students participated in the 10 intervention sessions in a small group (2-3 students). In order to design appropriate MA intervention for students with decoding deficits, interventions previously established as effective were considered (e.g., Abbott & Berninger, 1999; Arnbak & Elbro, 2000; Baumann et al., 2002, 2003; Berninger et al., 2003, 2008; Bowers et al., 2010; Hurry et al., 2005; Kirk & Gillon, 2009; Nunes, Bryant, & Olson, 2003). How morphological knowledge is expressed in written or spoken language varies at different ages or grades (e.g., children use inflections and simple derivations earlier than more complex derivational relations involving phonological or orthographical shifts) (Anglin, 1993; Carlisle, 1987). Research on the acquisition of developmentally appropriate morphological tasks was considered when designing the MA intervention used in this study.

MA intervention session content

Prefix families. The MA intervention in this study focused on simple prefixes and base words. Latin and Anglo-Saxon root words were selected for the base words. Several researchers have recommended teaching students new or complex words using prefix families, as this approach requires less cognitive effort (e.g., Baumann et al., 2005; Edwards et al., 2004; Vadasy et al., 2006). The intervention sessions included the most frequent, common prefixes for lower graders and their families (Baumann et al., 2002, 2003; Edwards et al., 2004; Grave, 2004), and each morphological task and practice was designed to incorporate examples that are developmentally appropriate (Bear, Invernizzi, Templeton, & Johnston, 2004; Nunes & Bryant, 2006; Katz & Carlisle, 2009). The target words used in each session were from the most frequent word lists of lower elementary grades (Carroll, Davies, & Richman, 1971; Zeno, Ivens, Millard, & Duvvuri, 1995). To allow for differences in cognitive and language abilities of each student, a number of fairly easy MA tasks were added to the material (Arnbak & Elbro, 2000). The author and scholars who have expertise in reading intervention for students with reading disabilities developed an intervention protocol.

Table 3-2 shows the types of prefix families that were used in each session in this study. The prefix families listed below are chosen based on both an analysis of common words in print and research findings on common affixes (Baumann et al., 2002; O'Connor, 2007; Pike, 2011).

Table 3-2. Target Prefixes Families

Session	Family	Prefixes
1	Not (1)	un-, dis-, in-
2	Not (2)	im-, il-, ir-
3	Position	pre-, post-, mid-,
4	Bad	mis-, mal-
5	All prefixes in lessons 1-4	
6	Over or Under	over-, super-, sub-
7	Against, opposite of	anti-, non-, de-
8	Again and Cause	re-, en-
9	Number	uni-, mono-, bi-
10	All prefixes in lessons 6-9	

Target word selection. The target words used in each intervention session were chosen from lists of most frequently used words, including: (a) the Educator's Word Frequency Guide (Zeno et al. 1995), (b) the 4,000 word families of Hiebert's Word Zones corpus (Hiebert, 2005), and (c) The American Heritage Word Frequency Book (Carroll et al., 1971). According to the Word Frequency Book, frequencies are determined in terms of how many times they occur in written language. For example, a value of 90 indicates a word that appears once in 10 words of text, and a value of 50 means a word appears once in 100,000 words, and so on. According to Carroll et al. (1971), high-frequency words refer to the words that have a value of 50 or higher, and low-frequency indicates the words that having a value of 37 or lower. Initially, a total of 200 base words were chosen based on these frequency lists. After reviewing these words with reading experts, a total of 96 target base words were selected for 10 MA intervention sessions. For the review session, 10 to 15 target words were chosen based on students' performance on previous sessions. The selected target words for each intervention session are presented in the Appendix B.

MA Intervention Procedures

Students received MA intervention for 40-50 minutes, two to three times a week (based on after school program and parents schedule) for a total of 10 sessions in a small group (2 or 3 students). Each intervention session was structured to provide explicit instruction; first, the instructor explained the concepts of prefixes and base words; second, the students were presented familiar words with targeted prefixes. Students were most likely to determine the prefix's meaning if it was used with words they already knew (e.g., unhappy, dislike, incorrect for Not prefix families such as un-, dis-, in-); third, they were presented with the meaning of base words and how they are combined with targeted prefixes families. For each intervention session, two evidence-based instructional activities were used to practice and improve students' understanding of morpheme units in words: (a) Blending and segmenting (Ghaemi, 2009; Goodwin & Ahn, 2010; Nunes et al., 2003; O'Connor, Jenkins, & Slocum, 1995; Savage, 2012), and (b) word mapping (Harris, Schumaker, & Deshler, 2011). At the end of each session, students reviewed their knowledge on morphology using new words as transfer stimuli (Arnbak & Elbro, 2000). An intervention transcript of the first intervention session is presented in the Appendix C.

Intervention session structure

Intervention sessions were conducted with two to three students. When conducting an intervention session, students were provided a corresponding packet (e.g., pencils, student sheets) and the instructor briefly introduced the topic to the group. For example, "Today, we will be talking about prefixes." After discussing the topic, the instructor provided an example using the whiteboard, such as "unhappy". Then, the instructor prompted the students to predict the prefix and circle the prefix on the whiteboard. Then, students were asked and prompted to predict the base word and underline it. The students were asked to give their definition of what the base word (i.e., "happy") means. The instructor suggested a more correct definition if needed. Then, the students were asked to define the words with prefixes (i.e., "unhappy"). The students compared the two definitions to deduce a definition for the prefix (i.e., "not"). The instructor provided a summary for the student to clarify and reiterate the concept that was introduced. For example, "'un-' is the prefix and it means 'not,' and 'happy' is the base word which means 'feeling good.' Therefore, unhappy means you are not feeling good." At this point, the instructor asked individual students or the group to circle the prefixes and underline the base words for the corresponding row on their packets. Once completed, they worked through each word in the row, predicting the prefix and its meaning, predicting the base word and its meaning, and deducing the overall meaning of the word. Then, the instructor repeated the process of using the whiteboard to introduce a new prefix and provide an example, using the worksheet to circle prefixes and underline base words, and working through each word in the row.

After working through the examples, the instructor used word mapping activities and work sheets to break down the target morphemes and practice words provided. If necessary, one or two practice words per each target prefix were discussed. The students wrote the practice word in the first box. In the next row, instead of circling and underlining, the students wrote the prefix in one box and the base word in another. The students then proceeded to the next row of boxes to define the meaning of the prefix and base word. The instructors then prompted the student to define the practice word overall. Once all target and practice words were discussed, the group proceeded to the conclusion of the intervention. As a group, the instructor and students read each word on the list and used their hands to tap the table at the beginning of each word (See Appendix C).

Training of instructors

Four graduate student research assistants who have experience teaching reading were trained by the author and reading expert to administer interventions and assessments for a total of 20 hours. During this training, research assistants (instructors) were introduced to the purpose of this study and the specific goals of morphological intervention. Also, they were introduced to the materials contained in the intervention, and how they should be implemented within a small group. The research assistants observed a model implementing the first and second intervention session as well. They simulated the first intervention session in varying contexts (e.g., one-to-one intervention, small group intervention, providing feedback, prompting response). After each training session lasting 2 to 3 hours, the research assitants discussed their intervention simulation and provided feedback to each other.

Pretest-Posttest Measures of Students' Morphological Knowledge

The purpose of this set of assessments was to examine the participants' understanding of morphologically complex words encountered during their intervention sessions and to determine whether students were able to apply the same strategies for word learning to new words. Morphological tasks that have been widely used in previous research were selected to assess the children's morphological knowledge (e.g., Arnbak & Elbron, 2000; Calisle, 1987; 1996; Casalis et al., 2004; Vadasy et al., 2006). Most of these tasks do not have documented psychometric properties or norms.

Students were assessed on the three types of morphological assessment tasks: (a) base word recognition task, (b) prefix and base word recognition task, and (c) a sentence comprehension task. All the items in each task were developed and validated by a team of reading experts and scholars from the University of Florida, and all of the items were thoroughly examined by reading teachers as well as researchers. For all the three tasks, an internal consistency alpha was calculated. The first task on each test was a practice item, which was not scored. The purpose of this item was to ensure that the all students understood and became familiar with the test process. Feedback was given for the practice item. Assessors were provided a script for administering the assessment and scoring procedures. The MA assessment script is presented in the Appendix D.

Base Word Recognition Task

This task was to measure student' ability to recognize written words and their forms correctly. Four words were shown, and students were asked to circle the word that the instructor provided orally. If the student could check the word the instructor assigned, the student earned 1 point. For example, "I am going to show you four words. You will circle the word that I say. Are you ready? Look at the words (Instructor points to it) Circle the word that says happy." If the student could circle the word happy, the student earned 1 point. If not, the student earned 0. This test was administered four times, twice as pretests, and twice as posttests. This task included a total of 30 items, with 15 target words taught during intervention sessions and 15 novel words. Students could earn one point per item according to their verbal answers on an answer key, thus the highest possible total score in this task is 30 (See Appendices D and E).

Prefix and Base Word Recognition Task

This task was developed to measure students' ability to recognize and pronounce multisyllabic words involving prefixes and base words. Through this task, students demonstrated how to combine prefixes and base words and how to read them correctly. Students were asked to read the word involving prefixes and base words. For example, "Look at this word 'happy' (Instructor points to it). Now I am going to put this small word part un- (Don't read it out) in front of 'happy' (Use a prefix un- card with the word happy and place the un- in front of happy). Now what word do we have? Can you read it out for me?" If the student could read the word without any assistance, the student earned 2 points and moved to next item. If the student could not say the word, the assessor provided assistance. For example, “Watch me. If you put the “un” (Read it out) in front of “happy”, what word do you have? (Show the child the word unhappy.” If the student could say it correctly with assistance, the student earned 1 point. If the student could not read the word with assistance, the student earned 0. The words with prefixes did not require orthographical and phonological changes in the base words. The score was determined by the number of correct verbal responses. This task included 30 items, with 15 of target word items and 15 novel words items to assess the ability to transfer their knowledge to novel tasks, thus the highest possible total score in this task is 60. This test was administered four times, twice as pretests, and twice as posttests (See Appendices D and E).

Sentence Comprehension Task

This task measures students’ ability to identify the meaning of the word in a sentence when a prefix has been appended. The assessor read a sentence involving a prefix and base word to the student, and the student was asked to look at the sentence as the assessor read it. Then, the student was asked to answer which sentence represented the meaning of the prefix and base word correctly. For example, “Now, I will read a sentence to you. You can look at the sentence as I read it. Then I will ask you a question about the word that is in bold. (Read the sentence) “The girl is unhappy with her cat” Can you tell me what the word unhappy means in this sentence? Ready? I will give you three choices to pick from. Select the choice that means unhappy. (a) She feels joyful with her cat. (b) She is not pleased with her cat. (c) She feels that her cat is smart.” The students earned 1 point for a correct response or a 0 for an incorrect response. This task included a total of 30 items, with 15 target words and 15 novel words. The assessor presented each item visually and orally. The total score was the number of correct items, with higher scores indicating greater level of understanding the meaning of prefixes and base words. Thus, the highest possible total score in this task is 30. This test was administered four times, as two pretests, and two times as a posttest (See Appendices D and E).

The following figure (Figure 3-1) represents procedures for administering the pretest, intervention, and posttest.

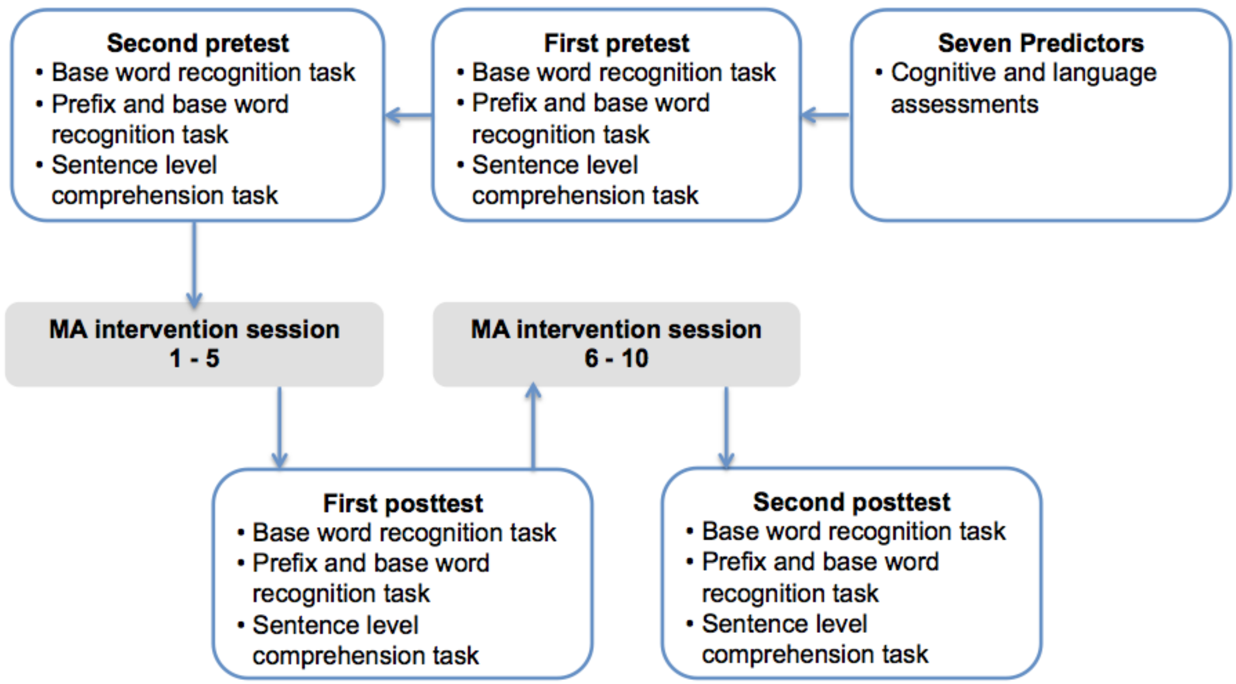

Figure 3-1. Procedures for cognitive and language assessments, pre- and posttests, intervention

Pilot Study

A pilot study was conducted prior to the implementations of both MA pre- and posttests and MA interventions with the purpose of evaluating the feasibility of the MA tasks and intervention scripts. In the pilot study, the three types of MA tasks and the first intervention session were implemented with a total of three students (i.e., one reading at third grade level and two reading below third grade level and having word reading deficits determined by CTOPP and WJ). The administration procedures were similar to the ones described in this study.

As a result of the pilot study, a few modifications were made to the MA tasks and intervention script to ensure that the base words were not too difficult for students and that test and intervention administration could be implemented with fidelity. First, a few words not understood by students were removed (e.g., freeze and anti-freeze). Second, the intervention script was developed further to promote intervention fidelity across 4 instructors. Third, the assessor's script for assessing MA was revised in a way to easily score student' performance without wasting time between each task (e.g., scoring along with each test administration script)

Intervention Fidelity

All 4 instructors participated in a total of 20 hours of intervention training. For each intervention training session, two instructors were paired and delivered the instruction to each other using the intervention script. They were supervised by the author who provided feedback on their performance after the role play. During the intervention and data collection, 10 Intervention sessions and 4 MA assessment sessions were randomly selected to assess treatment fidelity. The author of the study assessed treatment fidelity by observing the interventions in real time while checking to ensure that targeted activities were implemented according to the intervention script and used appropriate error correction and feedback.

Data Analysis

The data analysis for this study was designed to address the research questions, and statistical calculations were performed using the Statistical Package for Social

Sciences (SPSS) version 21.0. All statistical tests were evaluated using an alpha level of .05, unless otherwise stated.

Descriptive data were computed for all measures associated with students' cognitive and language abilities as well as three MA tasks scores. Pearson product-moment correlation coefficients were used to determine relationships among the: (a) seven cognitive and language variables, (b) pretest scores of the three MA tasks, and (c) posttest scores of the three MA tasks. In order to determine if there is a statistically significant difference between the means of the two pretests (second pretest two weeks after the first pretest), a dependent samples *t* test was used.

To examine how students responded to the MA intervention over three time points (i.e., pretest, first posttest, and second posttest), a repeated measures of ANOVA and paired samples *t* test were conducted. The chi square value of Mauchly's test was used to evaluate the assumption of sphericity. If the assumption was violated, the Huynh-Feldt correction was applied and the degrees of freedom was corrected. Simple and multiple regression analyses were conducted to examine if single or multiple cognitive and language variables predicted student performance on the three MA tasks after accounting for student performance on the pretest.

CHAPTER 4
RESULTS

The purpose of this study was to examine the roles of cognitive and language abilities, and pretest performance on the MA tasks in predicting responsiveness to MA intervention for third grade students with decoding deficits. Specifically, I was interested in answering the following research questions:

1. What cognitive and language variables predict responsiveness to MA intervention on tasks emphasizing word recognition, after accounting for pretest performance? Of these variables, which are the best predictors of MA intervention after accounting for pretest performance?
2. What cognitive and language variables predict responsiveness to MA intervention for MA tasks emphasizing word recognition and sentence level comprehension, after accounting for pretest performance? Of these variables, which are the best predictors of MA intervention after accounting for pretest performance?

In order to answer the research questions, a pre- and posttest design was employed. After being assessed on the seven predictor measures (i.e., PA, RAN, verbal comprehension, executive function, orthographic knowledge, non-verbal intelligence, and verbal working memory), participants were provided with a total of 10 MA intervention sessions that involved learning about prefix families and understanding the role that target prefixes play in changing a word's meaning. Student performance was assessed four times (two pretests prior to MA intervention, first posttest after five interventions sessions, and second posttest after 10 intervention sessions) using three MA tasks; (a) base word recognition, (b) prefix and base word recognition, and (c) sentence level comprehension.

The goal of this chapter is to present the results obtained from the various analyses. This chapter is divided in the following sections: (a) demographic characteristics of the sample, (b) descriptive statistics, (c) equivalence of pretest means by time, (d) correlations among cognitive and language variables and pre- and posttests, (e) responsiveness to the MA intervention, (f) cognitive and language variables that predict responsiveness to MA intervention, and (g) the roles of initial performance as a predictor. These sections are organized in a way to sequentially answer two research questions.

Demographic Characteristics of the Sample

The final sample of students contained 39 third grade students from 4 schools in Alachua County, FL. Of the 39 study participants used for the analysis, 19 (48.7%) were female and 20 (51.3%) were male. The children ranged from 8 years, 5 months of age to 10 years, 7 months of age (M = 9 years, 5 months, SD = 6.9 months). All students were identified as native English speakers by their teachers and parents; 14 (35.9%) were African American, 2 (5.1%) were Asian, 15 (38.4%) were Caucasian, 4 (10.3%) were Hispanic, and 4 (10.3 %) were designated as other or unknown.

Table 4-1. Demographic characteristics of the sample

		Frequency	Percent of Sample
Gender	Female	19	48.7%
	Male	20	51.3%
Ethnicity	African American	14	35.9%
	Asian	2	5.1%
	Caucasian	15	38.4%
	Hispanic	4	10.3%
	Unknown	4	10.3%
Lunch-status	Free or Reduced	12	30.8%
	Regular	27	69.2%
Primary language	English	39	100.0%
	Non-English	0	0%

As a proxy for socioeconomic status (SES), the percentage of students who received free or reduced lunch was used, and 12 (30.8%) students qualified for free or reduced lunch programs. Students with severe behavior disorders, speech and language impairment, or more significant cognitive disabilities were not included. Table 4-1 summarizes demographic information for the complete sample.

Descriptive Statistics

Table 4-2 represents each of the cognitive and language assessments as well as MA pre- and posttests along with an abbreviation used throughout the paper.

Table 4-2. Variables and corresponding abbreviations

Variable	Abbreviation
Cognitive and Language Variables	
CTOPP Phonological Awareness Composite Scores	PA
CTOPP Rapid Automatized Naming Composite Scores	RAN
WJNUC Verbal Comprehension	VC
DKEF Executive Function Color-Word Inference Inhibition	EF
Orthographic Knowledge/Coding Task	OK
RSPM Non-Verbal Intelligence	NVIQ
AWMA Verbal Working Memory	VWM
MA Tasks	
Task1: Base Word Recognition Task, 1st and 2nd pretests	BR-Pre1, BR-Pre2
Task1: Base Word Recognition Task, 1st and 2nd posttests	BR-Post1, BR-Post2
Task2: Prefix + Base Word Recognition Task, pretest	PBR-Pre1, PBR-Pre2
Task2: Prefix + Base Word Recognition Task, posttest	PBR-Post1, PBR-Post2
Task3: Sentence Level Comprehension Task, pretest	SC-Pre1, SC-Pre2
Task3: Sentence Level Comprehension Task, posttest	SC-Post1, SC-Post2

Descriptive statistics for all measures associated with students' cognitive and language abilities as well as three MA tasks scores were calculated. The seven cognitive and language variables used in this study are shown in Table 4-3 with their means (M), standard deviations (SD), percentile ranks of the mean for the case that the standard and normal distribution is provided, and SD of the norm group provided by assessment technical manuals.

Table 4-3. Descriptive statistics for cognitive and language variables

Variables/Tests	M	SD	Min	Max	Norm group M (SD)
PA*	78.93	11.62	64	103	100 (15)
RAN*	87.33	7.58	76	106	100 (15)
VC*	89.08	13.00	68	116	100 (15)
NVIQ	20.30	4.59	10	28	29 (8)
VWM*	87.95	5.73	77	98	100 (15)
EF*	5.26	1.39	3	8	10 (3)
OK	22.60	5.50	10	42	

Note. * denotes M and SD based on standard score; Percentile ranks indicate the percentage of scores that fall at or below a given score in a standardized test; Norm group M (SD) indicates the mean and standard deviation for the normative group; N = 39.

Also, the means and standard deviations of two pretests and two posttests are presented in the Table 4-4.

Table 4-4. Descriptive statistics for MA pretests and posttests

Variables	First					Second				
	M	SD	Min	Max	α	M	SD	Min	Max	α
Pretest										
BR	26.90	3.34	17	30	.83	26.49	3.16	19	30	.77
PBR	51.95	4.94	43	59	.79	51.44	4.71	41	59	.76
SC	19.05	5.16	8	29	.77	18.79	5.31	9	28	.79
Posttest										
BR	27.36	3.34	19	30	.82	27.51	2.64	20	30	.70
PBR	54.03	5.45	40	60	.87	54.10	5.56	39	60	.88
SC	20.64	5.58	6	29	.78	22.77	4.75	13	30	.82

Note. The total score for BR is 30; the total score for PBR is 60; the total score for SC is 30; α indicates Cronbach's alpha reliability coefficient.

In addition Cronbach's alpha coefficients are reported for two pretests and two posttests for each task of BR, PBR, and SC. According to the Table 4-4, the values of alpha coefficients of MA pretests and posttests ranged from .70 to .88, showing acceptable to good degree of internal consistency reliability.

Figure 4-1 displays the means of pre- and two posttest scores for three MA tasks (i.e., BR, PBR, and SC)

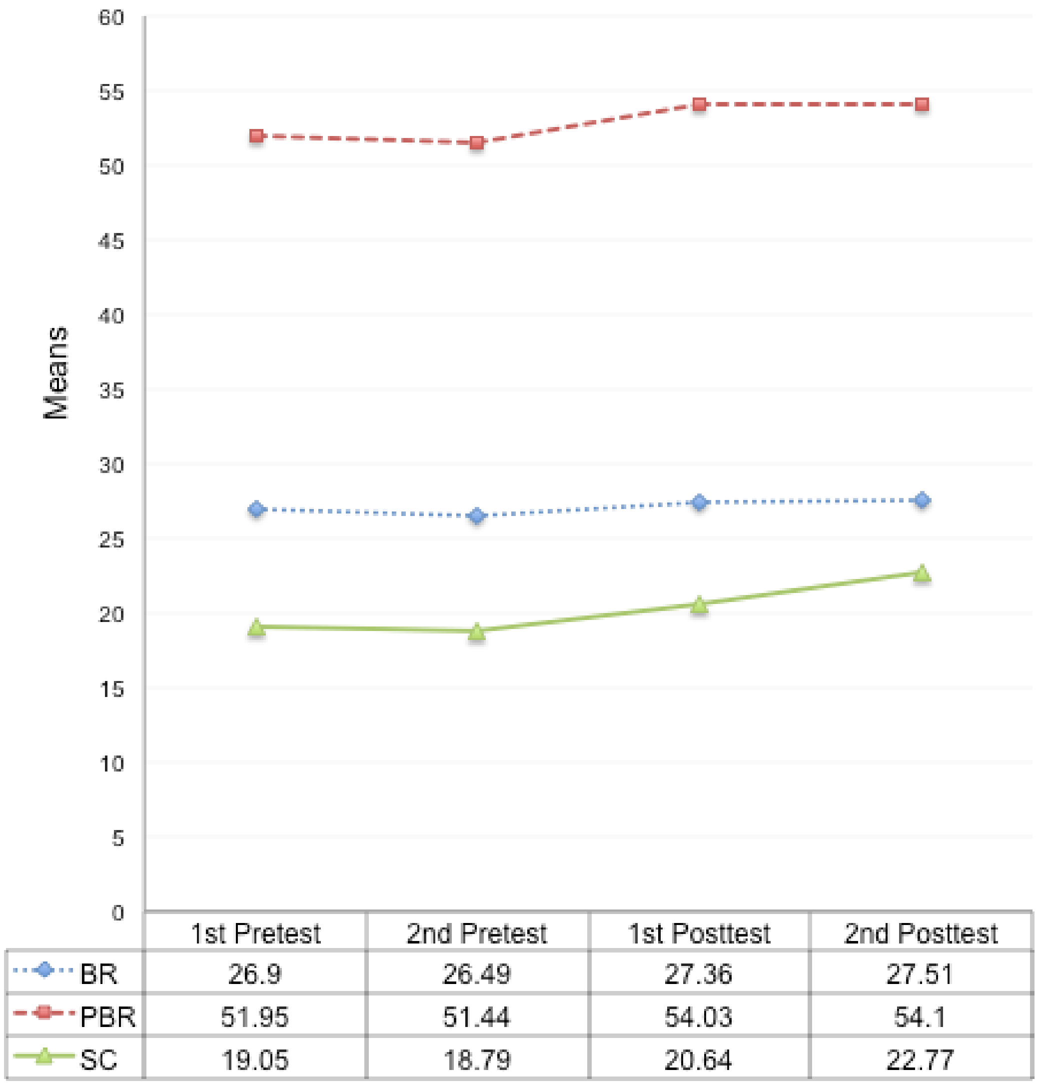

Figure 4-1. Means of three MA tasks over time

Equivalence of Pretest Means by Time

In order to determine if there is a statistically significant difference between the means of the two pretests (second pretest after two week later of first pretest), a dependent samples *t* test was used. On the pretest, each task included both target words and new words, *t* tests were conducted separately (i.e., BR-Pre1 with target words vs. BR-Pre2 with target words, and BR-Pre1 with new words vs. BR-Pre2 with new words) to see if there was any difference between target word items and new word items. Descriptive statistics are reported in Table 4-5 by week for each of BR, PBR, and SC. In addition the mean difference between the two weeks, Cohen's *d*, and the dependent samples *t* statistic are reported for each variable. The mean differences are small as are the values for Cohen's *d*.

Table 4-5. Summary of *t* test for two pretests

Task	First		Second		Mean Difference	*d*	*t*	*df*	*p*
	M	SD	M	SD					
BR									
Target words	13.41	1.73	13.21	1.61	-.21	-.13	-1.75	38	.088
New words	13.49	2.01	13.28	1.69	-.21	-.11	-1.16	38	.253
PBR									
Target words	25.74	2.60	25.46	2.45	-.28	-.11	-1.54	38	.133
New words	26.21	2.67	25.97	2.51	-.23	-.09	-1.06	38	.298
SC									
Target words	9.97	2.89	9.69	2.84	-.28	-.10	-1.36	38	.18
New words	9.08	2.49	9.10	2.60	.03	.01	.13	38	.89

Note. The total score for Task 1 (BR) target words is 15; The total score for Task 1 (BR) new words is 15; the total score for Task 2 (PBR) target words is 30; the total score for Task 2 (PBR) new words is 30; the total score for Task 3 (SC) target words is 15; the total score for Task 3 (SC) new words is 15.

Results of the *t* tests showed that the mean differences between the 1st and 2nd pretest scores for each task were not significant and the effect sizes were very small. In sum there is little or no evidence of change in performance over the two weeks.

Based on the results of the *t* tests, the two pretests were averaged to represent one pretest score administered prior to the start of MA interventions. Means, standard deviations, and minimum and maximum scores of collapsed pretests are presented in Table 4-6. Coefficient alpha was .90, .89, and .89 for BR-Pre, PBR-Pre, and SC-Pre, respectively.

Table 4-6. Means and standard deviations of collapsed pretest

Variables/Tests	Pretest				
	M	SD	Min	Max	*A*
BR-Pre	26.69	3.34	18	30	.90
PBR-Pre	51.69	4.73	43	59	.89
SC-Pre	18.92	5.11	8.5	28.5	.89

Correlations among Cognitive and Language Variables and Pre- and Posttests

In order to examine the relationship among cognitive and language variables as well as MA assessment scores of three tasks (i.e., BR, PBR, and SC), Pearson product-moment correlation coefficients were calculated to determine relationships among the: (a) seven cognitive and language variables, (b) pretest scores of three MA tasks, and (c) posttest scores of the three MA tasks. Cohen's (1988) conventions were used to determine the strength of the relationship between two variables (i.e., small ≥ .10, medium ≥ .30, large ≥ .50).

Correlations among Cognitive and Language Variables

Table 4-7 displays a correlation matrix showing intercorrelations among the 7 cognitive and language variables. As expected, significant intercorrelations were found among cognitive and language variables. The highest significant correlation was found between OK and VWM, $r = .57$, $p < .01$, followed by between VC and OK, $r = .52$, $p < .01$; the lowest significant correlation was found between PA and OK, $r = 31$, $p < .05$, preceded by the correlation between PA and VWM, $r = .34$, $p < .05$. RAN was moderately correlated with OK ($r = .39$, $p < .05$) and with VWM ($r = .38$, $p < .05$), and there was a high correlation with PA ($r = .49$, $p < .01$). Also, VC was strongly correlated with VWM ($r = .49$, $p < .01$). There were moderate to high correlations between OK and PA, RAN, VC, NVIQ and VWM, $r = .31$, $r = .39$, $r = .52$, $r = .42$, and $r = .57$ respectively.

Table 4-7. Intercorrelations among cognitive and language variables

Measures	1	2	3	4	5	6	7
1. PA		.49**	.27	.29	.31*	.17	.34*
2. RAN			.40*	.22	.39*	-.04	.38*
3. VC				.34*	.52**	.30	.49**
4. EF					.17	.30	.35*
5. OK						.42**	.57**
6. NVIQ							.37*
7. VWM							

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

Correlations of Pretest and Two Posttest Sores

Table 4-8 displays a correlation matrix showing intercorrelations among pretest and two posttest scores of three MA tasks (i.e., BR, PBR, and SC). For BR task, high correlations were established for BR-Pre and BR-Post1 ($r = .94$), BR-Pre and BR-Post2 ($r = .85$), and BR-Post1and BR-Post2 ($r = .87$), $p < .01$. For PBR task, there were high correlations between PBR-Pre and PBR-Post1 ($r = .85$), PBR-Pre and PBR-Post2 ($r = .70$), and PBR-Post1 and PBR-Post2 ($r = .86$), $p < .01$. Similarly, for SC task, high correlations were found between SC-Pre and SC-Post1($r = .92$), SC-Pre and SC-Post2 (*r* = .78), and SC-Post1 and SC-Post2 (*r* = .86), *p* < .01. Also, there were moderate to high correlations across three tasks (i.e., BR, PBR, and SC): BR-Pre and PBR-Pre (*r* = .77), BR-Pre and SC-Pre (*r* = .57), BR-Pre and PBR-Post1 (*r* = .83), BR-Pre and SC-Post1 (*r* = .52), BR-Pre and PBR-Post2 (*r* = .79), and BR-Pre and SC-Post2 (*r* = .47), *p* < .01. It should be noted that for all three MA tasks, correlations between pretest scores and first posttest scores were higher than the correlations between pretest scores and second posttest scores.

Table 4-8. Intercorrelations of pre- and posttests

Measures	1	2	3	4	5	6	7	8	9
1. BR-Pre		.94**¤	.85**¤	.77**	.83**	.79**	.57**	.52**	.47**
2. BR-Post1			.87**¤	.71**	.85**	.84**	.52**	.48**	.42**
3. BR-Post2				.52**	.69**	.81**	.43**	.44**	.39*
4. PBR-Pre					.85**¤	.70**¤	.58**	.49**	.43**
5. PBR-Post1						.86**¤	.49**	.48**	.45**
6. PBR-Post2							.35*	.37*	.39*
7. SC-Pre								.92**¤	.78**¤
8. SC-Post1									.86**¤
9. SC-Post2									

Note. ¤ denotes coefficients for the same variable at different time points; **p* < .05. ***p* <.01.

Correlations of Gain Scores from Pretest to First and Second Posttests

Table 4-9 displays a correlation matrix showing intercorrelations among gain scores from pretest to first posttest, from pretest to second posttest, and from first posttest to second posttest for three MA tasks (i.e., BR, PBR, and SC). For initial progress (pretest to first posttest), moderate correlations were established between BR-Post1-Pre and PBR-Post1-Pre(*r* = .39, *p* < .05) and PBR-Post1-Pre and SC-Post1-Pre, but negative between BR-Post1-Pre and SC-Post1-Pre. Similarly, for gain scores from pretest to second posttest, there was moderate correlation between BR-Post1-Pre and PBR-Post2-Pre (r = .40, p < .05), but not between PBR-Post1-Pre and SC-Post1-Pre and between BR-Post1-Pre and SC-Post1-Pre. For gain scores from first posttest to second posttest, moderate correlation was found between BR-Post2-Post1 and PBR-Post2-Post1 (r = .37, p < .05), but not between PBR-Post2-Post1 and SC-Post2-Post1 and between BR-Post2-Post1 and SC-Post2-Post1.

Table 4-9. Intercorrelations of gain scores

Measures	1	2	3	4	5	6	7	8	9
1. BR-Post1-Pre		.40*	-.29	.39*	.40*	.17	-.04	.03	.04
2. BR-Post2-Pre			.76**	.09	.40*	.46*	.18	.24	.14
3. BR-Post2-Post1				-.18	.14	.37*	.19	.23	.12
4. PBR-Post1-Pre					.69**	-.02	.32*	.23	.03
5. PBR-Post2-Pre						.70**	.28	.31	.15
6. PBR-Post2-Post1							.07	.20	.18
7. SC-Post1-Pre								.53**	-.15
8. SC-Post2-Pre									.76**
9. SC-Post2-Post1									

Note. Gain scores were computed by subtracting pretest scores from first posttest (i.e., BR-Post1-Pre, PBR-Post1-Pre, and SC-Post1-Pre), pretest scores from second posttest (BR-Post2-Pre, PBR-Post2-Pre, and SC-Post2-Pre), and first posttest from second posttest ((BR-Post2-Post1, PBR-Post2-Post1, and SC-Post2-Post1); *p < .05. **p <.01.

Correlations of Cognitive and Language Variables with Pretest Scores

Table 4-10 presents a correlation matrix showing correlations between cognitive and language variables with pretest scores for the three MA tasks (i.e., BR-Pre, PBR-Pre, and SC-Pre). BR-Pre scores were significantly and moderately to highly correlated with PA (r = .42), RAN (r = .47), VC (r = .53), EF (r = .34), OK (r = .38), and VWM (r = .37). PBR-Pre scores were also significantly and moderately correlated with PA (r = .32), RAN (r = .40), and OK (r = .32). There was no significant correlation found between pretest scores of sentence level comprehension and cognitive and language variables.

Table 4-10. Correlations of cognitive and language variables with pretest scores

Measures	PA	RAN	VC	EF	OK	NVIQ	VWM
BR-Pre	.42**	.47**	.53**	.34*	.38*	.05	.37*
PBR-Pre	.32*	.40*	.24	.09	.32*	-.02	.15
SC-Pre	.20	.27	.29	.27	.12	.11	.10

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

Cognitive and Language Variables with First Posttest Scores

Table 4-11 presents a correlation matrix showing correlations of cognitive and language variables with the first posttest scores across three MA tasks. The first posttest scores of the BR task were moderately to highly correlated with PA (r = .39), RAN (r = .46), VC (r = .55), EF (r = .33), OK (r = .37), and VWM (r = .36). The posttest scores involving prefixes and base words were also moderately correlated with PA (r = .33), RAN (r = .53), VC (r = .44), and OK (r = .32). Posttest scores related to sentence level comprehension were moderately correlated with VC (r = .39) and EF (r = .38).

Table 4-11. Correlations of cognitive and language variables with first posttest scores

Measures	PA	RAN	VC	EF	OK	NVIQ	VWM
BR-Post1	.39*	.46*	.55**	.33*	.37*	.10	.36*
PBR-Post1	.33*	.53**	.44**	.23	.32*	-.05	.28
SC-Post1	.21	.26	.39*	.38*	.18	.27	.15

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

Cognitive and Language Variables with Second Posttest Scores

Table 4-12 shows a correlation matrix displaying correlations of cognitive and language variables with the first posttest scores across three MA tasks (i.e., BR-Post2, PBR-Post2, and SC-Post2). The second posttest scores of the base word recognition task were moderately to highly correlated with PA (r = .43), RAN (r = .47), VC (r = .59), EF (r = .36), OK (r = .45), and VWM (r = .40). Posttest scores involving prefix and base words were also moderately correlated with PA (r = .40) and OK (r = .48) and highly correlated with RAN (r = .53), VC (r = .57), and VWM (r = .51). Posttest scores related to sentence level comprehension were strongly correlated with VC (r = .54) and moderately correlated with EF (r = .37).

Table 4-12. Correlations of cognitive and language variables with second posttest scores

Measures	PA	RAN	VC	EF	OK	NVIQ	VWM
BR-Post2	.43**	.47**	.60**	.36*	.45**	.04	.40*
PBR-Post2	.40*	.53**	.57**	.28	.48**	.05	.51**
SC-Post2	.13	.28	.54**	.37*	.13	.25	.22

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

Responsiveness to the MA intervention

In order to examine how students responded to the MA intervention, a repeated measures ANOVA and paired samples t-tests were conducted. Participants were assessed over three time points (i.e., pretest, first posttest, and second posttest) and changes in mean scores for the three MA tasks were compared over the three time points to assess students' responsiveness to the MA intervention.

For the BR task, Mauchly's test indicated that the assumption of sphericity had been violated, $X^2(2) = 7.56$, $p = .02$, therefore, the Huynh-Feldt correction was applied and the degrees of freedom was corrected. According to the results after the Huynh-Feldt epsilon correction, there was a significant main effect of the time on the BR task, $F(1.76, 66.80) = 6.10$, $p = .005$.

For the PBR task, Mauchly's test indicated that the assumption of sphericity had been violated, $X^2(2) = 9.85$, $p = .007$, therefore, the Huynh-Feldt correction was applied and degrees of freedom was corrected. According to the results after the Huynh-Feldt epsilon correction, there was a significant main effect of the time on the BPR task, $F(1.68, 63.96) = 13.33$, $p = .000$. This result indicated that the MA intervention had a positive effect on student ability to recognize multisyllabic words involving prefixes and base words.

For the SC task, Mauchly's test indicated that the assumption of sphericity had been violated, $X^2(2) = 8.34$, $p = .015$, therefore, the Huynh-Feldt correction was applied and the degrees of freedom was corrected. According to the results after the Huynh-Feldt epsilon correction, there was a significant main effect of the time on the sentence level comprehension task, $F(1.73, 65.79) = 36.06$, $p = .000$. This result indicated that the MA intervention had a positive effect on student ability to understand the meaning of multisyllabic words involving prefixes and base words at the sentence level.

Table 4-13. Repeated measures analysis of variance

Source	SS	*df*	MS	F	*p*
BR					
Time	14.84	1.76	8.44	6.10	.005
Error (Time)	92.50	66.80	1.39		
PBR					
Time	146.38	1.68	86.97	13.33	.000
Error (Time)	417.29	63.96	6.53		
SC					
Time	289.56	1.73	167.25	36.06	.000
Error (Time)	305.111	65.79	4.64		

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

Overall, there were significant mean changes in all three MA tasks involving word recognition as well as meaning over three time points. Table 4-13 summarizes the results of repeated measures ANOVA analysis for the three MA Tasks.

Mean differences between pretest and two posttests. Paired samples t-tests were conducted in order to investigate if the differences in mean scores of the three MA tasks over three time points (i.e., pretest, first posttest, and second posttest) are significant, and also where the differences in the main effects are between two time points. Table 4-14, Table 4-15, and Table 4-16 summarize the results of paired samples t-tests for three comparisons (i.e., pretest vs. first posttest, pretest vs. second posttest, and first posttest vs. second posttest).

Table 4-14. Difference between pretest and first posttest

Task	Time				Mean Difference	*d*	*t*	*df*	*p*
	Pretest		First posttest						
	M	SD	M	SD					
BR	26.69	3.34	27.36	3.34	.67	.20	3.52	38	.001**
PBR	51.69	4.73	54.03	5.45	2.34	.46	5.08	38	.000**
SC	18.92	5.12	20.64	5.58	1.72	.32	4.88	38	.000**

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

As shown in Table 4-14, the first posttest scores were significantly higher than pretest scores for all three MA tasks. To be more specific, BR-Post1 (M = 27.36, SD = 3.34) was significantly higher than BR-Pre (M = 26.69, SD = 3.34), $t(38) = -3.52$, p = .001. PBR-Post1 (M = 54.03, SD = 5.45) was significantly higher than PBR-Pre (M = 51.69, SD = 4.73), $t(38) = -5.08$, p = .000. Similarly, SC-Post1 (M = 20.64, SD = 5.58) was significantly higher than SC-Pre (M = 18.92, SD = 5.12), $t(38) = -4.88$, p = .000.

Pretest scores were also compared to the second posttest scores for all three MA tasks. As presented in Table 4-15, the first posttest scores were significantly higher than pretest scores for all three MA tasks. More specifically, BR-Post2 (M = 27.51, SD = 2.64) was significantly higher than BR-Pre (M = 26.69, SD = 3.34), $t(38) = -2.92$, p = .006. PBR-Post2 (M = 54.10, SD = 5.56) was significantly higher than PBR-Pre (M = 51.69, SD = 4.73), $t(38) = -3.73$, $p = .001$. Likewise, SC-Post2 (M = 22.77, SD = 4.75) was significantly higher than SC-Pre (M = 18.92, SD = 5.12), $t(38) = -7.22$, p = .000.

Table 4-15. Difference between pretest and second posttest

Task	Time				Mean Difference	*d*	*t*	*df*	*p*
	Pretest		Second posttest						
	M	SD	M	SD					
BR	26.69	3.34	27.51	2.64	.82	.27	2.92	38	.006**
PBR	51.69	4.73	54.10	5.56	2.41	.47	3.73	38	.001**
SC	18.92	5.12	22.77	4.75	3.85	.78	7.22	38	.000**

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

Table 4-16 displays the comparison of first posttest scores and second posttest scores for all three MA tasks.

Table 4-16. Difference between first posttest and second posttest

Task	Time				Mean Difference	*d*	*t*	*df*	*p*
	First posttest		Second posttest						
	M	SD	M	SD					
BR	27.36	3.34	27.51	2.64	.15	.05	.57	38	.570
PBR	54.03	5.45	54.10	5.56	.07	.01	.17	38	.870
SC	20.64	5.58	22.77	4.75	2.13	.41	4.65	38	.000**

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

As shown in Table 4-16, The BR-Post2 (M = 27.51, SD = 2.64) was not significantly higher than BR-Post1 (M = 27.36, SD = 3.34), $t(38) = -.57$, $p = .570$. Similarly, PBR-Post2 (M = 54.10, SD = 5.56) was not significantly higher than PBR-Post1 (M = 54.03, SD = 5.45), *t*(38) = -.17, *p* = .870. However, SC-Post2 (M = 22.77, SD = 4.75) was significantly higher than SC-Post 1 (M = 18.92, SD = 5.12), *t*(38) = -4.65, *p* = .000.

Cognitive and Language Variables that Predict Responsiveness to MA Intervention

Simple and Multiple regression analyses were conducted to examine if single or multiple cognitive and language variables predicted student performance on three MA tasks after accounting for student performance on the pretest. This section is organized according to two research questions: (a) What cognitive and language variables best predict student performance on the MA tasks that involve primarily word recognition, and (b) What cognitive and language variables best predict performance on the MA tasks that involve word recognition and sentence level comprehension. For each research question, gain scores on the three MA tasks served as the dependent variable. For the first dependent variable, gain scores for the three MA tasks were computed by subtracting the students' average pretest scores from their first posttest scores (i.e., BR-Post1 minus BR-Pre, PBR-Post1 minus PBR-Pre, SC-Post1 minus SC-pre). For the second dependent variable, gain scores for the three MA tasks were computed by subtracting the students' pretest scores from their second posttest scores (i.e., BR-Post2 minus BR-Pre, PBR-Post2 minus PBR-Pre, SC-Post2 minus SC-Pre).

Research Question 1: Cognitive and Language Variables and Student Performance on Word Recognition Task

Multiple regression analyses were conducted in order to investigate whether single or multiple cognitive and language variables predicted unique variance in gain from the pretest to the first posttest scores, after controlling for pretest scores. In the first multiple regression analysis the pretest and one cognitive or language variable was included in the analysis; in the second the pretest and the seven cognitive and language variables were included.

Student performance on BR task over time

In the first set of regression models, cognitive and language variables did not predict gains from the pretest to first posttest on the BR task after accounting for average scores on the pretest. Similar findings held for predicting gains from the pretest to second posttest on the BR task, with one exception. VC was the only variable that added significant predictive power in predicting gains from the pretest to second posttest on the BR task after controlling for average pretest scores ($\beta = .30$, $p < .05$).

In the second set of regression models, there was no cognitive or language variable that could add significant predictive power in predicting gains from pretest to BR-Post1 on the BR task after accounting for average scores on the pretest. Similar findings held for predicting gains from the pretest to BR-Post2 on the BR task after controlling average scores on the pretest.

Table 4-17. Results of multiple regression analyses for BR task

Cognitive/ Language Variables	Dependent Variable							
	Post1 – Pre[a]				Post2 - Pre[b]			
	First		Second		First		Second	
	β	*p*	*β*	*p*	*β*	*p*	*β*	*p*
PA	-.04	.983	-.11	.607	.14	.336	.10	.551
RAN	.06	.759	.24	.337	.13	.369	-.01	.970
VC	.21	.267	.12	.612	.30	.045*	.25	.178
EF	.02	.910	-.06	-.286	.13	.370	.12	.447
OK	.05	.786	-.10	.700	.22	.119	.20	.293
NVIQ	.14	.383	.12	.550	.03	.984	-.21	.201
VWM	.07	.695	.01	.056	.16	.276	.01	.961

Note: [a]Dependent variable is first posttest minus pretest; [b]Dependent variable is second posttest minus pretest; *$p < .05$. **$p < .01$

Table 4-17 summarizes the results of the first and second sets of multiple regression analyses where dependent variables are BR-Post1 minus BR-Pre and BR-Post2 minus BR-Pre.

Student performance on PBR task over time

In the first set of regression models, cognitive and language variables did predict gains from the pretest to PBR-Post1. RAN ($\beta = .43$, $p < .05$) and VC ($\beta = .47$, $p < .01$) added significant predictive power in predicting gains from the pretest to PBR-Post1 after controlling for BR-Pre. Results from the simple regression analyses using gains on the PBR-Post2 showed that RAN ($\beta = .41$, $p < .05$), VC ($\beta = .58$, $p < .01$), OK ($\beta = .39$, $p < .05$), and VWM ($\beta = .56$, $p < .01$) added significant predictive power after controlling PBR-Pre. Of the significant variables, VC was the best predictor of PBR-Post2 gains.

Table 4-18. Results of simple and multiple regression analyses for PBR task

Cognitive/ Language Variables	Dependent Variable							
	Post1 – Pre[a]				Post2 - Pre[b]			
	First		Second		First		Second	
	β	*p*	*β*	*p*	*β*	*p*	*B*	*P*
PA	.13	.449	-.10	.583	.19	.264	-.12	.423
RAN	.43	.014**	.30	.159	.41	.017*	.22	.215
VC	.47	.004**	.39	.050	.58	.000**	.30	.074
EF	.29	.078	.15	.367	.30	.063	.10	.532
OK	.10	.568	-.20	.353	.39	.018*	.06	.748
NVIQ	-.06	.742	-.20	.282	.08	.612	-.25	.111
VWM	.30	.079	.17	.389	.56	.000**	.42	.017*

Note: [a]Dependent variable is first posttest minus pretest; [b]Dependent variable is second posttest minus pretest; *$p < .05$. **$p < .01$

In the second set of regression models, there were no significant predictors of gains from the pretest to PBR-Post1 after controlling PBR-Pre. As with the simple regression analysis, VWM ($\beta = .42$, $p < .05$) added significant predictive power in predicting gains from PBR-Pre to PBR-Post2 after controlling PBR-Pre. Table 4-18 summarizes the results of the first and second sets of multiple regression analyses for the PBR task.

Table 4-19 displays a summary of results for the BR and PBR tasks that primarily involve word recognition.

Table 4-19. Summary of results for BR and PBR tasks

	Dependent Variable			
	Post1 – Pre[a]		Post2 - Pre[b]	
	First	Second	First	Second
Significant predictive variables[c]	RAN (PBR) VC (PBR)		VC (BR, PBR) RAN (PBR) OK (PBR) VWM (PBR)	VWM (PBR)

Note: [a]Dependent variable is first posttest minus pretest; [b]Dependent variable is second posttest minus pretest; [c]Cognitive and language variables that had significant *β* values

Research Question 2: Cognitive and Language Variables and Student Performance on Sentence Comprehension Task

Single and multiple regression analyses were conducted in order to test whether single or multiple cognitive and language variables in combination with pretest scores predicted unique variance in the first posttest scores on the MA tasks involving sentence level comprehension, after accounting for average pretest scores. For research question 2, students' pre- and posttest scores on the SC task were used.

Student performance on SC task over time

In the first set of regression models, VC (β = .34, p < .05) and EF (β = .38, p < .01) added significant predictive power in predicting gains from SC-Pre to SC-Post1 after accounting for average scores on SC-Pre. VC (β = .50, p < .01), however, was the only variable that added significant predictive power in predicting gains from SC-Pre to SC-Post2 after accounting for average SC-Pre scores.

In the second set of regression models, there were no significant predictors of gain scores from SC-Pre to SC-Post 1 after accounting for average scores on the pretest. VC (β = .58, p < .01) and OK (β = .37, p < .01), however, added significant predictive power in predicting SC-Post2 after controlling SC-Pre. Table 4-20 summarizes the results of the first and second sets of multiple regression analyses for the SC tasks.

Table 4-20. Results of simple and multiple regression analyses for SC task

Cognitive/ Language Variables	Dependent Variable							
	Post1 – Pre[a]				Post2 - Pre[b]			
	First		Second		First		Second	
	β	p	β	p	β	p	B	p
PA	.06	.709	-.01	.950	-.04	.783	-.17	.283
RAN	.05	.775	-.08	.731	.12	.774	.09	.605
VC	.34	.047*	.31	.151	.50	.001**	.58	.001**
EF	.38	.025**	.30	.118	.25	.107	.08	.571
OK	.17	.309	-.01	.998	.04	.798	.37	.040*
NVIQ	.30	.066	.20	.314	.23	.118	.22	.161
VWM	.17	.332	-.20	.588	.22	.155	.07	.681

Note: [a]Dependent variable is first posttest minus pretest; [b]Dependent variable is second posttest minus pretest; *p < .05. **p < .01

Table 4-21 shows the summary of results for the SC task that primarily involves sentence level reading comprehension.

Table 4-21. Summary of results for SC task

	Dependent Variable			
	Post1 – Pre[a]		Post2 - Pre[b]	
	First	Second	First	Second
Significant predictive variables[c]	VC EF		VC	VC OK

Note: [a]Dependent variable is first posttest minus pretest; [b]Dependent variable is second posttest minus pretest; [c]Cognitive and language variables that had significant β values; *p <.05. **p < .01

Summary of Results for Research Questions

Simple and multiple regression models were employed to test which cognitive and language variables best predict performance on the MA tasks that involve word recognition (i.e., BR and PBR) and sentence level comprehension (SC). In simple regressions, cognitive and language variables didn't predict gains from BR-Pre to BR-Post1, and VC was the only variable that predicted gains from BR-Pre to BR-Post2; whereas RAN and VC significantly predicted gains from PBR-Pre to PBR-Post1 as well as gains from PBR-Pre to PBR-Post2. Additionally, OK and VWM significantly predicted gains from PBR-Pre to PBR-Post2. VWM is the only variable that predicted gains from PBR-Pre to PBR-Post2. In short, for the BR task which only included base words, both students' initial progress (pretest to first posttest) and overall progress (pretest to second posttest) did not seem to be predicted by cognitive and language variables, with one exception (VC). However, for the PBR task that involved prefixes and base words, student performance was predicted by their cognitive and language variables. For the SC task, VC predicted both gains from SC-Pre to SC-Post1 and SC-Pre to SC-Post2. Overall, it was found that pretest performance accounted for all of the variance in performance on some tasks, but not others. For the SC task and PBR task other variables combined with the pretest account for a significant portion of the variance in performance.

The Roles of Initial Performance as a Predictor

It was observed that (a) there were moderate to strong correlations between initial performance variables (i.e., MA score changes from pretest to first posttest) (See Table 4-9) and (b) changes in scores in the three MA tasks were identified as significant (see Table 4-14, 4-15, and 4-16). These findings are consistent with previous studies (e.g., Al Otaiba & Fuchs, 2006; Stage, Abbott, Jenkins & Berninger, 2003). Thus, single and multiple regression analyses, where initial performance was added as one of the variables, were conducted to see if students' initial performance played a role in predicting overall changes in the pretest to second posttest.

Student performance on MA tasks with initial performance as a predictor. Single and multiple regression analyses were conducted in order to investigate whether cognitive and language variables as well as initial performance can predict unique variance in the second posttest scores, after controlling for pretest scores. For each task, results from the simple regression are reported first followed by results from multiple regressions. Table 4-22, 4-23, and 4-24 shows the results of simple and multiple regression analyses for the BR, PBR, and SC tasks.

Table 4-22. Results of regression analyses for BR task with initial performance as a predictor

Cognitive/ Language Variables & Initial Performance	Dependent Variable Post2 – Pre[a]			
	Single		Multiple	
	β	*p*	*β*	*p*
Post1-Pre	.30	.020*	.30	.031*
PA	.14	.336	.13	.397
RAN	.13	.369	-.08	.659
VC	.30	.045*	.21	.221
EF	.13	.370	.14	.353
OK	.22	.119	.23	.202
NVIQ	.03	.684	-.25	.115
VWM	.16	.276	.01	.678

Note: [a]Dependent variable is second posttest minus pretest; *$p < .05$. **$p < .01$

Table 4-23. Results of regression analysis for PBR task with initial performance as a predictor

Cognitive/ Language Variables & Initial Performance	Dependent Variable Post2 – Pre[a]			
	Single		Multiple	
	β	*p*	*β*	*p*
Post1-Pre	.69	.000**	.50	.000**
PA	.19	.264	-.07	.562
RAN	.41	.017*	.07	.635
VC	.58	.000**	.10	.476
EF	.30	.063	.01	.918
OK	.39	.018*	.16	.293
NVIQ	.08	.612	-.15	.245
VWM	.56	.000**	.34	.022

Note: [a]Dependent variable is second posttest minus pretest; *p < .05. **p < .01

Table 4-24. Results of single and multiple regression analysis for SC task with initial performance as a predictor

Cognitive/ Language Variables & Initial Performance	Dependent Variable Post2 – Pre[a]			
	Single		Multiple	
	β	*p*	*β*	*p*
Post1-Pre	.53	.000**	.40	.003**
PA	-.04	.793	-.16	.233
RAN	.12	.444	.12	.427
VC	.50	.001**	.40	.005**
EF	.25	.107	-.04	.777
OK	.04	.798	.37	.020*
NVIQ	.23	.118	.14	.431
VWM	.22	.155	.46	.003**

Note: [a]Dependent variable is second posttest minus pretest; *p < .05. **p < .01

For all of the three MA tasks (BR, PBR, and SC), initial performance added significant predictive power in predicting gains from the pretest to BR-Post2 (β = 30, p = .020 for simple regression; β = 30, p = .031 for multiple regression), PBR-Post2 (β = 69, p = .000 for simple regression; β = 50, p = .000), and SC-Post2 (β = .53, p = .000 for simple regression; β = 46, p = .000 for multiple regression) after controlling pretest scores. Also, students' initial performance was the best predictor for overall gains in the three MA Tasks.

CHAPTER 5
DISCUSSION

The purpose of this study was to examine the predictive ability of students' entering language and cognitive variables in their responsiveness to an intervention designed to improve MA skills, specifically students' ability to use prefixes to recognize and understand words. The aim of this chapter is to summarize and interpret results obtained in this study in light of previous research, and provide implications for educational practice and future research. The chapter is organized in the following sections: (a) overview of the study, (b) summary of findings, (c) interpretation of findings in light of previous research, (d) limitations, and (e) implications for future research.

Overview of the Study

Thirty-nine 3rd grade students scoring below the 25th percentile on the FAIR's word analysis scores participated in this study. The average age of participants was 9.5 years old, and 12 students received free/reduced school meals. The participants were assessed on seven independent variables prior to starting the intervention. These variables included: (a) phonological awareness (PA), (b) rapid automatized naming (RAN), (c) verbal comprehension, (d) executive function, (e) orthographical knowledge, (f) non-verbal intelligence, and (g) verbal working memory. Each of these variables has been linked to various reading skills in previous research (Badian, 1995; 1998; O'Connor & Jenkins, 1999; Wilson & Lonigan, 2010). After being assessed on the independent variables, students participated in the MA intervention twice a week, for a total of 10 sessions. An intervention protocol was developed by the author and other researchers who have expertise in reading assessment and intervention for students with reading disabilities. All target words used in each intervention session were selected based on high frequency words for lower elementary grades. Four research assistants with teaching experience in reading were trained for about 20 hours and provided MA instruction.

The purpose of this study was to examine the predictive ability of cognitive and language abilities on students' response to the MA intervention. Students' MA skills were measured by assessing their recognition of base words (BR), recognition of prefixes and base words combined (PBR), and their understanding of words with prefixes in a sentence (SC). Data were collected through two pretests and two posttests. Items used for the three MA tasks were the same across both pretests and posttests.

A comparison of students' performance on the two pretest sessions indicated that there was no significant change between the two pretests. Thus, average pretest scores for each of the three MA tasks were used in the analyses. Gains from average pretest scores to first posttest were used to determine how students' initial ability to respond to instruction, in combination with the language and cognitive variables, predicted responsiveness to MA instruction on the second posttest.

Summary of Findings

This section summarizes study results according to the major research questions.

Predictors of Student Responsiveness to MA Instruction in Recognizing Base Words and Prefixes

The first research question focused on those cognitive and language variables that predicted responsiveness to the MA intervention in recognizing base words and prefixes, after accounting for pretest performance. Results of repeated measures

ANOVAs for BR and PBR tasks showed significant gains from average pretest score to second posttest score. Changes in students' abilities from pretest to the first posttest were larger than those from the first posttest to the second posttest, meaning that students made little improvement on word recognition tasks after the second set of MA intervention sessions (i.e., sessions 6-10).

Simple regression analysis showed that verbal comprehension was the only significant predictor of PBR; whereas, simple regression analyses showed that gains made from average pretest score to second PBR posttest score were predicted by verbal comprehension, verbal working memory, RAN, and orthographic knowledge. Although performance on PA and RAN were significantly correlated with performance on the two pre- and posttests, RAN was the only predictor of students' gains from average pretest score to the first PBR posttest score.

In the multiple regression analyses, only verbal working memory predicted gains from pretest scores to second PBR posttest scores. Further, multiple regression analysis showed that gains from the average BR and PBR pretest scores to the first BR and PBR posttest scores were the best predictors of second BR and PBR posttest scores. Thus, initial response to intervention was the best predictor of later performance.

Predictors for Student Responsiveness to MA Instruction in Understanding Multisyllabic Words in Sentences

The second research question examined the predictive ability of cognitive and language variables in responsiveness to MA intervention for the SC task. Analyses of data gathered from cognitive and language assessments as well as student performance on the SC task revealed several key findings.

Overall, students showed significant gains from average SC pretest to second SC posttest, indicating that students improved in their ability to identify the meaning of multisyllabic words in sentences. Changes in students' abilities from average SC pretest to first SC posttest were smaller than those from first SC posttest to second SC posttest, meaning that students made more improvement in the SC task after the second set of the MA intervention sessions.

Simple regression analyses showed that students' executive function scores and verbal comprehension scores were significant predictors of students' gains from average SC pretest score to first SC posttest score, and verbal comprehension was the only significant predictor of students' gains from average SC pretest score to second SC posttest score.

Multiple regression analyses showed that verbal comprehension and orthographic knowledge were the only language and cognitive variables that significantly predicted students' gains on average SC pretest score to second SC posttest score after controlling for average SC pretest score. Students' gains from average SC pretest score to first SC posttest score, however, were the strongest predictor of the second SC posttest score, showing that initial performance is the best predictor of responsiveness to intervention on SC tasks.

Summary of Findings

Results from this study show that students' cognitive and language abilities likely underlie students' ability to acquire MA skills; however, the influence of these skills seems to vary depending on the demands of the task. When students are required to recognize multisyllabic words in isolation, they seem most disadvantaged by poor verbal comprehension scores. However, when they are asked to recognize multisyllabic words in the context of a sentence (i.e., the sentence comprehension task), they seem disadvantaged by both their verbal comprehension scores and their orthographic knowledge. Further, the amount of student response to MA intervention is the best predictor of how students with reading difficulties will respond to future instruction.

Interpretation of Findings in Light of Previous Research

Findings from this study add to a body of evidence demonstrating the role that cognitive and language variables play in the development of students' MA skills and their ability to respond to instruction in this area.

Cognitive and Language Abilities and Reading Multisyllabic Words

Past research has found strong evidence for the cognitive and language processes underlying students' reading performance (Evans, Floyd, & McCrew, 2002; McCrew & Wendling, 2010). Numerous researchers have documented the contribution that cognitive and language variables make to students' achievement on specific reading skills (e.g., word recognition, reading fluency, vocabulary, or reading comprehension) (e.g., Adams, 1990; Badian, 1994; Catts et al., 2001; Catts & Kamhi, 2005; Compton, Fuchs, Fuchs, & Bryant, 2006; Elbro, Borstrom, & Petersen, 1998; Scarborough, 1998). To date, however, there has been little research examining how such variables are related to students' learning of MA skills. Findings from this study suggest that cognitive and language variables identified as underlying many students' overall poor reading achievement also may influence their ability to acquire MA skills. The following section addresses the cognitive and language variables that were observed as predictors of students' response to the MA intervention with regard to the existing literature.

Verbal comprehension

Findings from this study showed that, after initial response to intervention, verbal comprehension was the best predictor of improvements in both recognizing and understanding words with prefixes in isolation and in sentences. This finding is consistent with previous research studies demonstrating linkages between verbal comprehension and word learning. Specifically, Katz and Carlisle's (2009) found students with higher verbal comprehension scores were more likely to profit from MA instruction and transfer their knowledge more easily to novel words presented in a passage. Similarly, Stage and his colleagues (2003) showed that students who had higher verbal comprehension scores responded quicker to a set of early reading interventions involving the alphabetic principle and reading first-grade books.

Orthographic knowledge

In this study, students' orthographic knowledge was correlated with pretest and posttest BR and PBR scores, and multiple regression analysis showed that orthographic knowledge was a significant predictor of gains on the SC task. These findings are supported in other studies where researchers established the relationship between orthographic knowledge and students' MA skills. Specifically, in a study of upper elementary aged students (i.e., grades 4, 6, and 8), Roman and colleagues (2009) found that orthographic skill was correlated with students' ability to add suffixes to words in a production task (e.g., "Teach. She is a _____?"). Berninger et al. (2003) also found that orthographic awareness of typically developing fifth graders was highly correlated with MA measured by MA decomposition and derivation tasks. The current study extends these findings by showing that students with stronger orthographic knowledge are able to better understand multisyllabic words in sentences. Thus, students with weaker orthographic skills may need more support during MA intervention.

Verbal working memory

In this study, verbal working memory did not play the same strong role that it has in previous studies. Verbal working memory was not a significant predictor of gain scores from the first PBR posttest to the pretest average. However, verbal working memory was a significant predictor in only one of the multiple regression analyses; the analysis involving the second PBR score. Findings from this study were surprising given the strong role that working memory has played in reading or language processing disabilities in previous studies (e.g., Cain et al., 2004; de Jong, 1998; Gathercole et al., 2006; Seigneuric & Ehrlich, 2005; Swanson, 1994).

PA and RAN

PA and RAN skills also did not play a role in predicting responsiveness to intervention on MA skills in this study. The results of this study showed that students' PA and RAN skills were significantly correlated with BR pretest and posttest scores and PBR pretest and posttest scores. Students' RAN scores predicted gains from average PBR pretest to first BPR posttest. However, students' PA score did not predict students' gain scores as a consequence of MA intervention.

These findings are somewhat at odds with a substantive research base that has shown that PA and RAN independently contribute to early reading skills (Compton, 2000; Cutting, 1997; Schatschneider et al., 2002). For example, PA has been considered to be the most significant variable in the development of proficient reading in lower grades (Badian, 2001; Shaywitz & Shaywitz, 2005). Specifically, PA skill was strongly correlated with basic reading skills such as word recognition, pseudoword decoding (Swanson et al., 2003), and dividing syllables into phonemes (Yap & Balota, 2009). Similarly, weak RAN ability has been shown to be related to weak reading skills (Swanson et al., 2003; Wolf, 1984; Wolf & Bowers, 1999). Results of this study, however, are consistent with findings from the correlational study conducted by Casalis et al (2004). Casalis and colleagues found evidence that phonological processing was unrelated to students' MA for students with reading disabilities. These results can be also supported by recent studies in brain research that has indicated that the brain seems to use separate parts when processing PA verses MA (Richards et al., 2006). This might be why many advocate for MA as a viable alternative decoding strategy for students with poor PA skills (e.g., Casalis et al., 2004; Richards et al., 2006).

Overall Conclusions

Although there has been a considerable amount of research published on the contribution of MA to the development of reading and spelling skills, there is limited research examining how children's cognitive and language abilities affect the acquisition of morphological skill. Also, little research evidence has been provided in terms of what cognitive and language variables determine the extent to which children with decoding deficits benefit from MA reading intervention. Thus, this study was conducted to advance the literature on the roles that cognitive and language abilities play in students' responsiveness to the MA reading intervention.

Findings from this study demonstrate that cognitive and language variables likely play a role in the acquisition of MA skill; however, deficits in verbal comprehension, and to a lesser extent orthographic knowledge, seem to play a more important role in students' initial ability to respond to intervention and seem to be more important in predicting how they will respond to intervention.

Limitations

The current study attempted to provide information about how selected cognitive and language abilities of students with word decoding deficits are likely to be associated with their progress and learning in MA measured by three types of MA tasks (i.e., BR, PBR, and SC). Although a variety of techniques were employed to ensure that the MA measures were reliable and that the intervention was delivered with fidelity, there were some limitations to this study. The following section describes these limitations.

Limited number of student participants. The first limitation pertains to the small sample size. Although attempts were made to recruit an adequate sample, there were a limited number of students that met the inclusion criteria and were available to join an additional program after school (i.e., MA intervention). Also, there were three students who were chronically absent or dropped out after cognitive and language assessments. Thus, the overall sample available for analysis was 39. This small sample might impact the results of the study and limit the generalizability of its findings.

Measures of MA skills. One goal of this study was to assess the students' response to MA instruction based on their scores obtained from three types of MA tasks. Currently, there are no standardized measures of MA abilities available to use; thus, the study relied on researcher-generated measures for both pretests and posttests. Although the tasks were generated and revised according to feedback from two experts and the pilot study, weaknesses in the design of these measures may have resulted in an underestimation or overestimation of the intervention's effect.

Use of composite scores. In the current study composite scores were used to improve power and increase reliability of three individual measures: PA, RAN, and verbal working memory (Rosenberg et al., 2012; Hoeft et al., 2011). In this study, PA composite scores were calculated based on combined standard scores of CTOPP Elision and Blending words. Although Elision and Blending words skills are types of PA and these subtests can be combined to represent PA skill, research has shown that each measure is related to different aspects of reading (Plaza & Cohen, 2003; Katzir, 2006). In future studies with larger sample sizes, it might be useful to include performance on individual subtest scores (e.g., Elision, Blending words) to investigate different aspects of PA and their relation to students' response to MA instruction.

Verbal comprehension measure. In the current study, the Verbal Comprehension subtest from the Cognitive Test battery of the Woodcock-Johnson III Normative Update Complete (Woodcock, McGrew, & Mother, 2007) was used. This test is standardized and includes four subtests (i.e., Picture Vocabulary, "What is this called"; Synonyms, "Tell me another word for *big*"; Antonyms, "Tell me the opposite of *yes*"; and Verbal Analogies, "Finish what I say-mother is to father, as sister is to …") to measure ability to use word knowledge and to reason based on acquired word knowledge. This measure only involves a single word or picture without any additional context to support student comprehension, such as using words in sentences or text. The opportunity to access context helps students to understand vocabulary and concepts (Miller & Veatch, 2010). Therefore, a verbal comprehension measure that is presented in expository or narrative text, that requires the examinee to use their existing word knowledge or experience within the context of connected text, might be more reliable.

Multiple measures involving multiple events. The results of the current study showed that predictors changed depending on whether it is the first posttest or the second even though the same MA tasks (i.e., BR, PBR, and SC) were used across two pretests and posttests. There might two reasons why the significant predictors could differ depending on whether change to the first or second posttest is predicted. First, it could be an unfortunate combination of Type I and Type II errors as (a) relatively small sample of data was used and (b) relatively many variables and tests were run for the regression models. Second, it could reflect the fact that the first and second posttests measure different aspects of achievement and/or that there were different instructional events and a different time span intervening between pretest, the first posttest, and the second posttest.

Implications for Future Research

Many researchers have identified students' background characteristics as well as cognitive and language variables that impact different reading skills for students with reading difficulties. Previous studies demonstrate that students' demographic and socioeconomic status influences their current or future reading performance (e.g., Ramani & Siegler, 2011; Scarborough, Dobrich, & Hager, 1991; Scarborough & Dobrich, 1994). Researchers have also established relationships among cognitive and language abilities and students' reading skills in word recognition (e.g., Bowers et al., 1994; Georgiou, Parrila, & Papadopoulos, 2008; Leslie & Thimke, 1986; Manis et al., 2000), reading fluency (e.g., Georgiou et al., 2008; Good III, Simmons, & Kame'enui, 2001; Speece & Case, 2001) and reading comprehension (e.g., Cain et al., 2004; Cutting & Scarborough, 2006). Although MA skills are essential to becoming a proficient reader, there has been little research examining the cognitive and language variables that impact students' ability to acquire and use MA skills in comprehending multisyllabic words. Findings from this study help to identify those cognitive and linguistic abilities that underlie the acquisition of MA skills in students with reading disabilities. Additionally, findings from this study show that students' initial learning gains might be useful in predicting future learning. Clearly, future research is needed to determine if findings from this study can be replicated and extended.

Implications for future research. This study provided evidence that can be used to measure students' MA abilities, however, there is still a need to develop standardized MA measures. The development of such measures would allow researchers access to assess students' MA ability in a valid way and may ensure more reliable findings from the next. Items included in this study might be used to guide and generate items that could be included in the development of such standardized assessments. Also, further studies must include additional items involving prefixes and suffixes to establish a set of MA measures that capture students' skill more broadly in this area.

Additionally, information from this study can provide the foundation for conducting large scale and longitudinal studies that assess the role that language and cognition play in determining responsiveness of students with reading disabilities to MA intervention over a one or two year period. Such studies would provide information about the degree to which students with different entering cognitive and language abilities can profit from MA interventions over time. For instance, by longitudinally tracking student's progress in MA skills, students with similar language and cognitive deficits could be clustered and compared to each other to better determine their growth trajectories. In addition, intervention studies might target a set of prefix and suffix families, or only suffix families, for a longer period and through more sessions.

Information from these studies could guide how MA interventions are developed and implemented for students at different age levels, children with language impairments, or English language learners. Specifically, researchers could investigate the relationship between different cognitive and language profiles and the duration and intensity of instruction needed to improve students' MA skills and maintain those skills over time.

Additional research is also needed to inform potential approaches for individualizing MA intervention. In this study, responsiveness to MA intervention was dependent on individual students' cognitive and language profiles. For example, students with poor verbal comprehension experienced greater difficulties during multisyllabic decoding at the word level, and students with poor verbal comprehension and orthographic skills were most likely to struggle with sentence level comprehension task. Future studies examining the extent to which research on the cognitive and language variables influence responsiveness to intervention can be used to develop reading interventions in ways that reflect an individual's cognitive strengths and weaknesses. For instance, students with deficits in verbal comprehension may learn to recognize multisyllabic words more easily in text when they are also taught context clues for recognizing vocabulary.

Research from the current study and others demonstrate that cognitive and language abilities in combination with initial MA skill acquisition influence students' responsiveness to intervention. Thus, researchers need to conduct more research aimed at better understanding the development of MA in students with reading disabilities and how knowledge of these students cognitive and language abilities can be used to design interventions for them and predict who will have difficulty responding to intervention. Such research is essential to better understanding the processing deficits underlying the challenges students with reading disabilities face in acquiring MA skills and how they might be supported through carefully designed MA interventions.

APPENDIX A
IRB DOCUMENTATION

<table>
<tr><th colspan="4">UFIRB 02 – Social & Behavioral Research
Protocol Submission Form</th></tr>
<tr><td>Title of Protocol:</td><td colspan="3">Cognitive and language predictors of response to morphological awareness instruction in third grade students with decoding deficits</td></tr>
<tr><td>Principal Investigator:</td><td colspan="2">Mary T. Brownell</td><td>UFID #: 0622-6400</td></tr>
<tr><td>Degree / Title:</td><td>Professor</td><td rowspan="2">Mailing Address: (If on campus include PO Box address):
PO Box 117050
Gainesville, FL 32611-7050</td><td>Email:
mbrownell@coe.ufl.edu</td></tr>
<tr><td>Department:</td><td>School of Special Education, School Psychology, & Early Childhood Studies</td><td>Telephone #:
352-273-4261</td></tr>
<tr><td>Co-Investigator(s):</td><td>Yujeong Park</td><td>UFID#: 1457-3908</td><td>Email: yjparksped@ufl.edu</td></tr>
<tr><td>Supervisor (If PI is student):</td><td></td><td colspan="2">UFID#:</td></tr>
<tr><td>Degree / Title:</td><td></td><td rowspan="2">Mailing Address: (If on campus include PO Box address):</td><td>Email:</td></tr>
<tr><td>Department:</td><td></td><td>Telephone #:</td></tr>
<tr><td>Date of Proposed Research:</td><td colspan="3">10/01/12 – 01/31/12</td></tr>
<tr><td colspan="2">Source of Funding (A copy of the grant proposal must be submitted with this protocol if funding is involved):</td><td colspan="2">College of Education College Research Incentive Fund (CRIF)</td></tr>
<tr><td colspan="4">Scientific Purpose of the Study:

The purposes of this study is (1) to examine how students with word analysis deficits respond to a previously researched morphological awareness (MA) instruction that involves learning about affixes (prefixes and suffixes) and (2) to identify cognitive and language processing variables that predict students' early decoding skills</td></tr>
<tr><td colspan="4">Describe the Research Methodology in Non-Technical Language: (Explain what will be done with or to the research participant.)

Participants will be 40 students who are from the Alachua County schools and are scoring below the 25th percentile on the word analysis subtest of the Florida Assessment for Instruction in Reading (FAIR). Students will be individually assessed on 6 independent cognitive and language predictor variables (i.e., phonological awareness, rapid naming, working memory, executive function, verbal intelligence, and orthographic awareness) prior to staring the MA intervention. Each student will be individually administered subtests that comprise two composites from the Comprehensive Test of Phonological Processing designed to assess students' level of phonological awareness and rapid naming abilities: (a) Phonological Awareness Quotient and (b) Rapid Naming Quotient. The Automated Working</td></tr>
</table>

Memory Assessment will be used to provide a measure of working memory, and the Delis-Kaplan Executive Function System will be used to assess students' executive functioning abilities. Verbal Intelligence will be assessed using the Verbal Aptitude Composite of the Woodcock Johnson Cognitive Abilities Battery. Orthographic awareness will be assessed using a researcher-developed measure employed in previous studies and the spelling subtest of the Woodcock Johnson Achievement Battery. After being assessed on the predictor measures, students will participate in the treatment (intervention with twice a week sessions for two months (November-December 2012), and two experts who have teaching experiences in teaching reading will provide the treatment. An intervention protocol will be developed by principal investigators and other doctoral students who have expertise in reading intervention for students with reading disabilities. The dependent measure will be the number of prompts needed to secure correct responses on learning tasks and pseudo word tasks. The total number of prompts will be used to determine students' level of responsiveness to intervention.
Describe Potential Benefits: The research examining instruction in MA for students with reading disabilities is small. Therefore, this study will add to the understanding of the roles of cognitive and language deficits play in students' ability to learn and transfer MA skills to pseudo words. Additionally, the findings from this study can inform professional development opportunities that might be needed to prepare teachers more effectively to teach students with reading disabilities to read and understand multi-syllabic words.
Describe Potential Risks: (*If risk of physical, psychological or economic harm may be involved, describe the steps taken to protect participant.*) No more than minimum risks are anticipated.
Describe How Participant(s) Will Be Recruited: To select the potential participants, we will contact third grade teachers once we have secured approval to conduct research through the UF Institutional Review Board and through the Alachua County School Board. Forty 3rd grade students from the Alachua County schools will be selected using the word analysis scores on the FAIR. Since the FAIR is a state mandated reading test, it is expected that most students would have their FAIR scores. In case students have no FAIR scores, 15-minutes phonics/decoding screening test (e.g., Read nonsense words as *plurp* and *fronkett* aloud or which word starts with the same sound as *pan*? *Pig, hat, or cone*?) will be used as a substitute for FAIR scores, and children will be given the screening test by the school as part of their regular practice Also, we are going to advertise this study in the publication "North Florida School Days" to see if there are any parents who are willing to participate in this study. All students scoring below the 25th percentile will be asked to participate in my study and provided with an informed consent letter. From the students who return parent consent forms, 40 will be randomly selected to participate in the study.

Maximum Number of Participants (to be approached with consent)	**40**	**Age Range of Participants:**	**Beginning 3rd grade at age 8, and turn 9 during the school year**	**Amount of Compensation/ course credit:**	**Gift cards for teachers and students: $550**

Describe the Informed Consent Process. (Attach a Copy of the Informed Consent Document. See http://irb.ufl.edu/irb02/samples.html for examples of consent.) An informed consent form will be provided to participants prior to the interviews. Participation is completely voluntary.

(SIGNATURE SECTION)		
Principal Investigator(s) Signature:		**Date:**
Co-Investigator(s) Signature(s):		**Date:**
Supervisor's Signature (if PI is a student):		**Date:**
Department Chair Signature:		**Date:**

UF | **Institutional Review Board**
UNIVERSITY *of* FLORIDA

PO Box 112250
Gainesville, FL 32611-2250
352-392-0433 (Phone)
352-392-9234 (Fax)
irb2@ufl.edu

September 12, 2012

TO:	Mary T. Brownell, PhD; Yujeong Park PO Box 117050 Campus
FROM:	Ira S. Fischler, PhD; Chair ISF/dl University of Florida Institutional Review Board 02
SUBJECT:	**Approval of Protocol #2012-U-882**
TITLE:	Cognitive and Language Predictors of Response to Morphological Awareness Instruction in Third Grade Students with Decoding Deficits
SPONSOR:	College of Education College Research Incentive Fund

I am pleased to advise you that the University of Florida Institutional Review Board has recommended approval of this protocol. Based on its review, the UFIRB determined that this research presents no more than minimal risk to participants. Your protocol was approved as an expedited study under category 7: *Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.* Given your protocol, it is essential that you obtain signed documentation of informed consent from the parent or legal guardian of each participant. Enclosed is the dated, IRB-approved informed consent to be used when recruiting participants for the research.

> It is essential that the parents/guardians of your minor participants sign a copy of your approved informed consent that bears the IRB approval stamp and expiration date.

If you wish to make any changes to this protocol, ***including the need to increase the number of participants authorized***, you must disclose your plans before you implement them so that the Board can assess their impact on your protocol. In addition, you must report to the Board any unexpected complications that affect your participants.

The approval of this study is valid through **August 24, 2013**. If you have not completed the study by this date, please telephone our office (392-0433), and we will discuss the renewal process with you. **Additionally, should you complete the study before the expiration date, please submit the study closure report to our office.** The form can be located at http://irb.ufl.edu/irb02/Continuing_Review.html. It is important that you keep your Department Chair informed about the status of this research protocol.

ISF:dl

UF | Institutional Review Board
UNIVERSITY *of* FLORIDA

PO Box 112250
Gainesville, FL 32611-2250
352-392-0433 (Phone)
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irb2@ufl.edu

November 2, 2012

TO: Mary T. Brownell, PhD; Yujeong Park
PO Box 117050
Campus

FROM: Ira S. Fischler, PhD; Chair
University of Florida
Institutional Review Board

SUBJECT: **Revision of Protocol #2012-U-0882**
Cognitive and Language Predictors of Response to Morphological Awareness Instruction in Third Grade Students with Decoding Deficits

SPONSOR: College of Education College Research Incentive Fund

The request to revise the above referenced protocol has been reviewed and approved. Approval of this study is valid through August 24, 2013.

The Board must review any further revisions to this protocol, including the need to increase the number of participants authorized prior to implementation.

IF:dl

- Added two sentences to specify recruitment and screening methods of research participants

UF UNIVERSITY of FLORIDA

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2012-U-0882
For Use Through 08-24-2013

College of Education
School of Special Education, School Psychology, and Early Childhood Studies
1403 Norman Hall, PO Box 117050
Gainesville, FL 32611-7050
352-273-4279
352-392-2655 Fax

Consent Form for Parents of ________________________ Date: ______________
Student name

Dear Parent or Guardian,

I am a professor in School of Special Education, School Psychology, and Early Childhood Studies at the University of Florida and we would like your help with our research study, *Cognitive and language predictors of response to morphological awareness (MA) instruction in third grade students with decoding deficits* that involves your child.

The purpose of this study is to better understand key variables that predict students' ability to read and understand long, complex words. Specifically, this study is proposed (1) to examine how students who struggle to decode words respond to a multisyllabic reading instruction that involves learning about prefixes (e.g., *re-* in the words 'review' and 'redo') and suffixes (e.g., -er in the words 'swimmer' and 'helper') and (2) to identify cognitive and language processing variables that predict students' skill in this area. The information obtained by this study will provide researchers a foundation for creating curriculum and other educational materials that can help students with reading problems.

We would like to invite you and your child to take part in this study. It will not interrupt your child's learning and this study involves no risks or discomforts of any kind. Children involved in our study will receive a $10 gift card to be used locally as compensation, and by offering multisyllabic (e.g., artist as 2-syllable, bar-be-cue as 3-syllable, par-ti-cu-lar as 4-syllable) reading instruction, our study should help your child in reading.

If you give permission for your child to participate in the study, (1) prior to staring the multisyllabic reading intervention, your child will be individually assessed on 6 independent cognitive and language predictor variables as follows: Phonological awareness (refers to a child's understanding that spoken words are made up of sounds), rapid letter naming (refers to the ability of how quickly a child can name a letter), working memory (refers to the ability to manipulate and use information), executive function (refers to the cognitive abilities used to plan, organize, strategize, and pay attention), verbal intelligence (refers to intelligence in the use and comprehension of language), and orthographic awareness (refers to the knowledge of how the sounds of a language are spelled out); (2) your child will participate in the multisyllabic reading instruction provided by reading experts; and (3) after the sessions, the number of prompts needed to secure correct responses on learning and pseudo word tasks will be used to determine students' level of responsiveness to intervention. Multisyllabic reading instruction for your child will last 8 weeks, twice a week after school, up to 30-40 minutes per session.

There might direct benefit to the participant in this research because each participant will be provided the multisyllabic instruction by reading experts. Also, the information we obtain from the study will help researchers develop or modify curriculum for students with reading problems.

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Results of this study are confidential to the extent provided by law. No one's name will be used or appear in any written work. In addition, your child's participation in the study will not affect his or her grades or treatment at school. Please note that you or your child may withdraw from the research study at any time without penalty. Your child also does not have to answer any questions that he/she doesn't want to answer.

If you would like to give permission for your child to participate, please put your child's name on the attached from and sign it. If you wish to refuse participation there is also a space to sign. If you have any questions, please contact the co-investigator, Yujeong Park at 360 Norman Hall, Gainesville, FL 32608. You may also call (352) 275-2687 or email yjparksped@ufl.edu. Questions or concerns about participants' rights may be directed to UF IRB02 Office, Box 112250, University of Florida, Gainesville, FL 32611-2250, (352) 392-0433.

Sincerely,

Dr. Mary Brownell and Yujeong Park

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2012-U-0882
For Use Through 08-24-2013

Agreement:

I have read the procedure described above. I voluntarily give my consent for my child, ___________________, to participate in this study and have received a copy of this description.

Disagreement:

I have read the procedure described above. I DO NOT want my child, ___________________, to take part in this research study.

______________________________ ________________
Signature of Study Participant Date

______________________________ ________________
Signature of Principle Investigator Date

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STUDENT ASSENT FORM FOR RESEARCH

ASSENT TO PARTICIPATE IN RESEARCH

1. My name is Dr. Mary Brownell. I am a college professor and researcher at the University of Florida.

2. I am asking you to take part in a research study because I am trying to learn about the best way to help students learn long, complex words that are difficult to sound out and to understand what those words mean. I will help you understand the prefix (e.g., un- in 'un happy) by using the base word (e.g., -happy in 'un happy') and then the base word plus the prefix in the sentence. We are asking you read for us because we want to see what kinds of your ability has helped you learn. You can participate in this work twice a week after school.

3. As a teacher at the college, I have had much experience and training in working with students and want you to know that no one but me will be looking at your work. Also, other people will not know if you are in my study. I will put things I learn about you together with things I learn about other children, so no one can tell what things came from you. When I tell other people about my research, I will not use your name, so no one can tell who I am talking about.

4. The benefits of working with us include opportunities to learn new ways to read difficult words in your class. Also, we will provide you with a $10 gift card to be used locally.

5. Please talk this over with your parents before you decide whether or not to participate. We will also ask your parents to give their permission for you to take part in this study. But even if your parents say "yes" you can still decide not to do this. If you don't want to be in this study, you don't have to participate. Remember, being in this study is up to you and no one will be upset if you don't want to participate or even if you change your mind later and want to stop.

6. You can ask any questions that you have about the study. If you have a question later that you didn't think of now, you can call me, Mary Brownell 352-273-4261. I will give you a copy of this form in case you want to ask questions later. Signing on the next page means you agree to be in the study.

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2012-U-0882
For Use Through 08-24-2013

Agreement:

I have decided to be in the study even though I know that I don't have to do it. [Name of researcher] has answered all my questions.

Signature of Study Participant	Date
Signature of Principle Investigator	Date

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2012-U-0882
For Use Through 08-24-2013

APPENDIX B
TARGET PREFIXES AND SELECTED WORDS USED IN MA INTERVENTION

Session	Prefixes	Target words
1	un-, dis-, in-	unkind, unfair, uneasy, unhappy, unsafe displace, dislike, disable, disorder, dishonest inactive, indirect, inexact, incorrect, independent
2	im-, il-, ir-	impatient, impure, immoral, imbalance, improper irregular, irrelevant, irresponsible illegal, illiberal, illogical
3	pre-, post-, mid-	prejudge, pretest, prepay, preheat, preschool postwar, postdate, postact, postflight, postgraduate midterm, midwinter, midtown, Mideast, midway
4	mis-, mal-	misunderstand, misbehave, misplace, miscast, miscall malodor, maldevelop, maladapted, maladjusted, malpractice
5	REVIEW	(chosen based on student performance during sessions 1-4)
6	over-, super-sub-	overeat, overprice, oversleep, overheat, overwork superfast, superbusy, supersafe, superbright, supercute subocean, subtitle, submarine, subsoil, suburban
7	anti-, non-, de-	antismoking, antiwar, antisocial, anticrime, antinoise nonfat, nondairy, nonsense, nonprofit, nondrinker decompose, devalue, degrade, defog, deform
8	re-, en-	refreeze, rejoin, react, replay, recall enlarge, enable, ensure, enact, enclose
9	uni-, mono-, bi-	unicorn, uniform, unisex, unicycle, unicore monorail, monotone, monoline, monoaxial, monoski bicycle, bicolor, bimonthly, bifold, biannual
10	REVIEW	(chosen based on student performance during sessions 6-9)

APPENDIX C
SESSION 1 INTERVENTION SCRIPT

<u>Intervention Materials</u>: whiteboard, color boxes, blue and read pens, word cards

1. **Introduction to Prefixes and base words**

[Prefix]

- Today we are going to be learning about prefixes.
- Prefixes are small parts of words that help us to change the meaning of a word. Let's take the following word (Show "safe" on a white board).
- Do you know what this word is? Yes, it is ***safe***. What does it mean to be ***safe***?
- Now, I am going to change the word ***safe*** by putting "***un-***" in front of it (Say ***un-***).
- Now, what word do I have? (Children say ***unsafe***). Yes, it is ***unsafe***.
- Does anyone know what it means to be ***unsafe***? (Get student responses. If they cannot define, use it in a sentence—The girl was very ***unsafe*** when she rode her bike on the slippery street. Once you use unsafe in a sentence, get the students to tell you what it means).
- Is ***unsafe*** the same as ***safe***? No, it is not. ***Unsafe*** is the opposite of ***safe*** because the word part "***un-***" means not. So ***unsafe*** means not ***safe***.
- We have a special name for word parts that come at the beginning of a words and that change the meaning of words. These word parts are called prefixes. Can you say the word prefix? Yes, that is correct, prefixes.

[Base word]

- Also, we have another part of the word to learn— it's called the base word. Base words are words like ***safe***. I can change the meaning of the word ***safe*** by adding a prefix to it. So we can change ***safe*** to ***unsafe***. Now we have two different words. One word is safe as in ***The girl feels safe when she rides her bike on the dry street***. The other word is unsafe as in ***The girl feels unsafe when she rides her like on the slippery street***. We used the prefix "***un***" to change ***safe*** to ***unsafe***.
- Today, we are going to be learning about three different prefixes that mean not. Those prefixes are "***un-***", "***dis-***" and "***in-***" (Write the prefixes on the board).

2. Instructional activity 1: Blending and segmenting multisyllabic words

[Prefix *un*-]

- First, we are going to work with the prefix "***un-***".
- Okay, let's get ready to work with the prefix ***un-***.
- What word is this? (Show and point to the word ***happy***). Yes, it is ***happy***. What does ***happy*** mean? (Student response).
- Yes, ***happy*** means that you feel good about something. ***Happy*** is the base word. Now, put the prefix "***un-***" in front of ***happy***. What word do you have now? Now, what does the word mean?
- If you know base words and their prefixes, you can read the word and understand it.
- Okay, let's practice with this word list. (Show ***unkind***, ***unfair***, ***undo***, ***unhappy***, ***unsafe***)
- Now, we are going to see if we can break the words apart, say the base and what it means and say the prefix.
- What is the first word on the list? (Show and point to the word ***unkind***) Yes, it is ***unkind***. What is the prefix in ***unkind***? Yes, it is ***un-***.
- Could you circle the prefix? Yes, ***un-*** is the prefix. What is the base word? Yes it is **kind**. Can you underline the base word?
- Now, try to find the prefix and base word in the next two words and then we will talk about it (Provide the words ***undo*** and ***unfair***).
- Okay, now that we understand the prefix "***un-***". We are going to work with two more prefixes: "***dis-***" and "***in-***"

[Prefix *dis*-]

- What is this word? (Student says dislike)
- Can you find the base word in this word? Yes, it is "***like***"
- What is the prefix? Yes, it is "***dis-***"
- What does the word ***like*** mean? (If they struggle ask them to tell you a word that means the same as like).
- What happens when you put ***dis-*** in front of ***like***, yes it means that you do not like it. So "***dis-***" also means not.

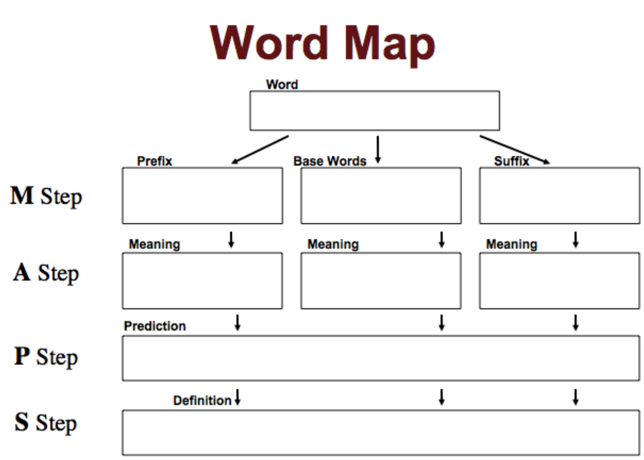
- Okay, let's get ready to work with the prefix ***dis-***. What word is this? (Show the word ***able***).
- Yes, it is ***able***. What does ***able*** mean? (Student response).
- Yes, ***able*** means that you feel you can do something. **Able** is the base word. Now, put the prefix "***dis-***" in front of able. What word do you have now? (Student response; If they struggle ask them to put two words together by modeling). Now, what does the word mean?
- If you know base words and their prefixes, you can read the word and understand it. For example, you know base word ***able*** (Point to ***able***) and prefix ***dis-*** which means not (Point to ***dis-***). Then, you can predict what this word means.
- Okay, let's practice with this word list. (Show ***displace***, ***dislike***, ***disable***, ***disorder***, ***dishonest***)
- Now, we are going to see if we can break the words apart, say the base and what it means and say the prefix.
- What is the first word on the list? Yes, it is ***dislike***. What is the prefix in ***dislike***? Yes, it is ***dis-***.
- Could you circle the prefix? Yes, ***dis-*** is the prefix. What is the base word? Yes it is ***like***. Can you underline the base word?
- Now, try to find the prefix and base word in the next three words (Show and point to ***disorder***, ***dishonest***, and ***displace***) and then we will talk about it.
- Okay, now that we understand the prefix "***dis-***". Now, we are going to work with one more prefixes "***in-***"

[Prefix *in-*]

- What is this word? (Student says incorrect; If they struggles or hesitates to say then read out incorrect and ask them to repeat after you)
- Can you find the base word in this word? Yes, it is "***correct***"
- What is the prefix? Yes, it is "***in-***"
- What does the word correct mean? (If they struggle ask them to tell you a word that means the same as correct).
- What happens when you put ***in-*** in front of correct? Yes, it means that it is not correct. So "***in-***" also means not.

- Okay, let's get ready to work with the prefix ***in-***. What word is this? (Show the word ***direct***).
- Yes, it is ***direct***. What does ***direct*** mean? (Student response).
- Yes, ***direct*** means that there is no one or nothing in between.
- Is ***Direct*** the base word or prefix? Yes, it is base word.
- Now, put the prefix "***in-***" in front of ***direct***. What word do you have now? (Student response). Now, what does the word mean?
- If you know base words and their prefixes, you can read the word and understand it.
- Okay, let's practice with this word list. **(**Show ***inactive***, ***indirect***, ***inexact***, ***incorrect***, ***independent***)
- Now, we are going to see if we can break the words apart, say the base and what it means and say the prefix.
- What is the first word on the list? Yes, it is ***inactive***. What is the prefix in ***inactive***? Yes, it is ***in-***.
- Could you circle the prefix? Yes, ***in-*** is the prefix. What is the base word? Yes it is ***active***. Can you underline the base word?
- Now, try to find the prefix and base word in the next two words (Shows and point to inexact and independent) and then we will talk about it.
- Okay, now that we understand the prefixes "***un-***, ***dis-***, and ***in-***", and all these prefixes means not.

3. Instructional activity 2: Word Mapping



- Now, we are going to play with words that have ***un-***, ***dis-***, and ***in-*** in them.
- Here are the first three words (Show ***unclean***, ***disgrace***, ***insufficient***).
- Let's break each word into prefix and base word to guess the meaning of a new word.
- (Model how to complete Word Mapping task) First, map the words by breaking it down into its words parts. For the word ***unclean***, for example, write **un-** in the prefix box and write **clean** in the base word box after breaking down.
- Second, guess the meaning of the word ***unclean*** using the meaning of prefix and the meaning of base word. For example, the prefix **un-** means *not*, and the base word clean means it is free from dirt, marks, or stains.
- Third, guess the meaning of the word ***unclean*** by putting the word part meaning together. For example, you can say "unclean" means "not clean"
- Fourth, if you are done with your map, and raise your hand silently. I will see if your answer is correct.

4. Review

- Now, we are going to read this list of prefix and base words together accurately and quickly.
- Here are the words to read (Provide a worksheet with a list of words).
- I am going to tap the table for you to read aloud (Show how to read each word with tapping).
- Are you ready? Go.

APPENDIX D

MA WORD RECOGNTNION AND DECODING TEST

For the assessor: The tasks on this pretest involve three skills. Task 1 involves word recognition of a base word. Task 2 involves word recognition of a prefix and base word together. Task 3 involves identifying the meaning of the word when a prefix is appended. There is one practice item. Please follow the student instructions when training students on how to complete the task. You will not assign points for the practice item.

Instructions to student: We are going to spend time working with words. I am going to ask you to do three different things with many different words. First, we are going to practice, so that you will understand what to do. When we are done, I have a surprise for you. Are you ready?

#. Practice: ***unhappy***

Task	Test Instruction	Point
(1) Recognition of base word	I am going to show you four words. You will circle the word that I say. Are you ready? Look at the words (Instructor points to it) Circle the word that says ***happy***. (Give a 1 if the child can check ***happy***)	1 0
(2) Recognition of prefix + base word	Look at this word "***happy***" (Instructor points to it). Now I am going to put this small word part ***un-*** (Don't read it out) in front of "***happy***" (Use a prefix ***un-*** card with the word ***happy*** and place the ***un-*** in front of ***happy***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. Then, move to first test item. If the child cannot do it, say) Watch me. If you put the "***un***" (Read it out) in front of "***happy***", what word do you have? (Show the child the word ***unhappy***. Give a 1 if the child can say correctly with your assistance). (If the child cannot read, model it for the child). This word is ***unhappy***. Say "***unhappy***" Nice work! Let's do this with some more words.	0 2 1
(3) Meaning of prefix + base word	Now, I will read a sentence to you. You can look at the sentence as I read it. Then I will ask you a question about the word that is in bold. (Read the sentence) "The girl is ***unhappy*** with her cat" Can you tell me what the word ***unhappy*** means in this sentence? Ready? I will give you three choices to pick from. Select the choice that means ***unhappy***. a. She feels joyful with her cat. b. She is not pleased with her cat. c. She feels that her cat is smart.	1 0

#1. ***unable***

Test Instruction	Point
Look at the words (Instructor points to it). Circle the word ***able***.	1 0
Look at this word "***able***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***able***" (Use a prefix ***un-*** card with the word ***able*** and place the ***un-*** in front of ***able***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***un***" (Read it out) in front of "***able***", what word do you have? (Show the child the word ***unable***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The boy is ***unable*** to skate." Can you tell me what the word ***unable*** means in this sentence? I will give you three choices to pick from. Pick the best answer among them (Read out three choices). a. The boy doesn't know how to skate. b. The boy wants to skate again. c. The boy hates to skate outside.	1 0

#2. ***preview***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***view***.	1 0
Look at this word "***view***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***view***" (Use a prefix ***pre-*** card with the word ***view*** and place the ***pre-*** in front of ***view***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***pre***" (Read it out) in front of "***view***", what word do you have? (Show the child the word ***preview***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The girls ***preview*** the homework in class." Can you tell me what the word ***preview*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices) a. The girls read the homework again in class. b. The girls complete the homework in class. c. The girls look through the homework before class.	1 0

#3. ***superfast***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***fast***.	1 0
Look at this word "***fast***" (Instructor points to it). Now I am going to put this word part (Don't read it out) in front of "***fast***" (Use a prefix ***super-*** card with the word ***fast*** and place the ***super-*** in front of ***fast***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***super-***" (Read it out) in front of "***fast***", what word do you have? (Show the child the word ***superfast***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "My dog can run ***superfast***." Can you tell me what the word ***superfast*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices) a. My dog can run very fast. b. My dog can run very far. c. My dog has difficulty running.	1 0

#4. ***inexact***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***exact***.	1 0
Look at this word "***exact***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***exact***" (Use a prefix ***in-*** card with the word ***exact*** and place the ***in-*** in front of ***exact***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***in-***" (Read it out) in front of "***exact***", what word do you have? (Show the child the word ***inexact***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "She used an ***inexact*** way to solve the math question." Can you tell me what the word ***inexact*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. She answered the math question correctly. b. She was unable to solve the math question correctly. c. She solved the math question quickly.	1 0

#5. ***rejoin***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***join***.	1 0
Look at this word "***join***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***join***" (Use a prefix ***re-*** card with the word ***join*** and place the ***re-*** in front of ***join***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***re-***" (Read it out) in front of "***join***", what word do you have? (Show the child the word ***rejoin***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "We can ***rejoin*** the dance club." Can you tell me what the word ***rejoin*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. We are able to join the dance club again. b. We cannot join the dance club. c. We hate to join the dance club.	1 0

#6. ***midnight***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***night***.	1 0
Look at this word "***night***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***night***" (Use a prefix ***mid-*** card with the word ***night*** and place the ***mid-*** in front of ***night***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***mid-***" (Read it out) in front of "***night***", what word do you have? (Show the child the word ***midnight***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "They have to leave at ***midnight***." Can you tell me what the word ***midnight*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. They have to leave after night. b. They have to leave around 9 o'clock at night. c. They have to leave at 12 o'clock at night.	1 0

#7. ***impure***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***pure***.	1 0
Look at this word "***pure***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***pure***" (Use a prefix ***im-*** card with the word ***pure*** and place the ***im-*** in front of ***pure***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***im-***" (Read it out) in front of "***pure***", what word do you have? (Show the child the word ***impure***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "His sickness is caused by drinking ***impure*** water" Can you tell me what the word ***impure*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices) a. He is sick because he didn't drink water. b. He is sick because he drank unclean water. c. He is sick because he drank too much water.	1 0

#8. ***overeat***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***eat***.	1 0
Look at this word "***eat***" (Instructor points to it). Now I am going to put this word part (Don't read it out) in front of "***eat***" (Use a prefix ***over-*** card with the word ***eat*** and place the ***over-*** in front of ***eat***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***over-***" (Read it out) in front of "***eat***", what word do you have? (Show the child the word ***overeat***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The boy tried not to ***overeat*** due to his weight." Can you tell me what the word ***overeat*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The boy tried to stop eating too much. b. The boy tried to eat fast. c. The boy tried to eat more than usual.	1 0

#9. ***bicycle***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***cycle***.	1 0
Look at this word "***cycle***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***cycle***" (Use a prefix ***bi-*** card with the word ***cycle*** and place the ***bi-*** in front of ***cycle***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***bi-***" (Read it out) in front of "***cycle***", what word do you have? (Show the child the word ***bicycle***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The boy doesn't have a front wheel for his ***bicycle***." Can you tell me what the word ***bicycle*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The boy's bicycle has only one wheel. b. The boy's bicycle has both wheels. c. The boy's bicycle doesn't need any wheels.	1 0

#10. ***misuse***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***use***.	0 1
Look at this word "***use***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***use***" (Use a prefix ***mis-*** card with the word ***use*** and place the ***mis-*** in front of ***use***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***mis-***" (Read it out) in front of "***use***", what word do you have? (Show the child the word ***misuse***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "She can ***misuse*** her money when she goes shopping." Can you tell me what the word ***misuse*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices) a. She can spend too much money when she goes shopping. b. She knows how to use her money when she goes shopping. c. She can bring her money when she goes shopping.	1 0

#11. ***dislike***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***like***.	1 0
Look at this word "***like***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***like***" (Use a prefix ***dis-*** card with the word ***like*** and place the ***dis-*** in front of ***like***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***dis-***" (Read it out) in front of "***like***", what word do you have? (Show the child the word ***dislike***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The students ***dislike*** going to the gym." Can you tell me what the word ***dislike*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The students want to go to the gym as soon as possible. b. The students are ready to go to the gym. c. The students don't want to go to the gym.	1 0

#12. ***mistreat***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***treat***.	1 0
Look at this word "***treat***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***treat***" (Use a prefix ***mis-*** card with the word ***treat*** and place the ***mis-*** in front of ***treat***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***mis-***" (Read it out) in front of "***treat***", what word do you have? (Show the child the word ***treat***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The boy seems to ***mistreat*** his dog." Can you tell me what the word ***mistreat*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The boy seems to play with his dog. b. The boy seems to feel very happy with his dog. c. The boy seems to behave badly with his dog.	0 1

#13. ***antiwar***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***war***.	0 1
Look at this word "***war***" (Instructor points to it). Now I am going to put this word part (Don't read it out) in front of "***war***" (Use a prefix ***anti-*** card with the word ***war*** and place the ***anti-*** in front of ***war***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***anti-***" (Read it out) in front of "***war***", what word do you have? (Show the child the word ***antiwar***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "He is writing an ***antiwar*** book." Can you tell me what the word ***antiwar*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. He is writing a book against war. b. He is writing a book during a war. c. He is writing a book about a war	1 0

#14. ***illegal***

Test Instruction	Scoring point
Look at the words (Instructor points to it) Circle the word ***legal***.	1 0
Look at this word "***legal***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***legal***" (Use a prefix ***il-*** card with the word ***legal*** and place the ***il-*** in front of ***legal***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***il-***" (Read it out) in front of "***legal***", what word do you have? (Show the child the word ***illegal***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "Crossing the street at a red light is ***illegal***." Can you tell me what the word ***illegal*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. We can cross the street when a red light appears. b. We need to cross the street when a red light appears. c. We are not allowed to cross the street when a red light appears.	1 0

#15. ***depart***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***part***.	1 0
Look at this word "***part***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***part***" (Use a prefix ***de-*** card with the word ***part*** and place the ***de-*** in front of ***part***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***de-***" (Read it out) in front of "***part***", what word do you have? (Show the child the word ***depart***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "She is scheduled to ***depart*** at 8:00am." Can you tell me what the word ***depart*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. She is going to arrive earlier than 8:00am. b. She is going to arrive later than 8:00am. c. She is going to leave at 8:00am.	1 0

#16. ***distrust***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***trust***.	1 0
Look at this word "***trust***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***trust***" (Use a prefix ***dis-*** card with the word ***trust*** and place the ***dis-*** in front of ***trust***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***dis-***" (Read it out) in front of "***trust***", what word do you have? (Show the child the word ***distrust***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The students ***distrust*** what the stranger told them." Can you tell me what the word ***distrust*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The students are disappointed by what the stranger told them. b. The students are excited about what the stranger told them. c. The students have doubts about what the stranger told them.	1 0

#17. ***irregular***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***regular***.	1 0
Look at this word "***regular***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***regular***" (Use a prefix ***ir-*** card with the word ***regular*** and place the ***ir-*** in front of ***regular***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***ir-***" (Read it out) in front of "***regular***", what word do you have? (Show the child the word ***irregular***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "She is worried about her ***irregular*** sleep habits." Can you tell me what the word ***irregular*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. She sleeps very well at night. b. She has trouble sleeping at night. c. She sleeps at the same time every night.	1 0

#18. ***impossible***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***possible***.	1 0
Look at this word "***possible***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***possible***" (Use a prefix ***im-*** card with the word ***possible*** and place the ***im-*** in front of ***possible***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***im-***" (Read it out) in front of "***possible***", what word do you have? (Show the child the word ***impossible***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "It is ***impossible*** for her to score high enough on the final exam." Can you tell me what the word ***impossible*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. She is capable of scoring well on the final exam. b. She is unable to score well on the final exam. c. She feels good about her score on the final exam.	1 0

#19. ***antismoking***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***smoking***.	1 0
Look at this word "***smoking***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***smoking***" (Use a prefix ***anti-*** card with the word ***smoking*** and place the ***anti-*** in front of ***smoking***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***anti-***" (Read it out) in front of "***smoking***", what word do you have? (Show the child the word ***antismoking***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The people belong to an ***antismoking*** group." Can you tell me what the word ***antismoking*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The people in the room smoke a lot. b. The people in the room want to start smoking. c. The people in the room are against smoking.	1 0

#20. ***subgroup***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***group***.	1 0
Look at this word "***group***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***group***" (Use a prefix ***sub-*** card with the word ***group*** and place the ***sub-*** in front of ***group***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***sub-***" (Read it out) in front of "***group***", what word do you have? (Show the child the word ***subgroup***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The kids get into ***subgroups*** to complete their class project." Can you tell me what the word ***subgroup*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The kids are divided into smaller groups in the class to do their work. b. The kids work in groups that involve students from other classes. c. The kids form smaller groups outside the class to do their work.	1 0

#21. ***prejudge***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***judge***.	1 0
Look at this word "***judge***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***judge***" (Use a prefix ***pre-*** card with the word ***judge*** and place the ***pre-*** in front of ***judge***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***pre-***" (Read it out) in front of "***judge***", what word do you have? (Show the child the word ***prejudge***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "Don't ***prejudge*** what this new candy will taste like". Can you tell me what the word ***prejudge*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. Don't eat the candy too quickly. b. Don't tell me if you like the candy until you eat it. c. Don't ask for another piece of candy until you finish the first one.	1 0

#22. ***reproduce***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***produce***.	1 0
Look at this word "***produce***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***produce***" (Use a prefix ***re-*** card with the word ***produce*** and place the ***re-*** in front of ***produce***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***re-***" (Read it out) in front of "***produce***", what word do you have? (Show the child the word ***reproduce***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "John will ***reproduce*** the letter his mother wrote long ago." Can you tell me what the word ***reproduce*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. John will write a letter just like the one his mother once wrote. b. John will not be able to make a copy of the letter his mother once wrote. c. John will work fast to write a letter for his mother.	1 0

#23. ***misbehave***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***behave***.	1 0
Look at this word "***behave***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***behave***" (Use a prefix ***mis-*** card with the word ***behave*** and place the ***mis-*** in front of ***behave***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***mis-***" (Read it out) in front of "***behave***", what word do you have? (Show the child the word ***misbehave***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The children ***misbehave*** at school when the teacher doesn't show up." Can you tell me what the word ***misbehave*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The children are very obedient when the teacher doesn't show up. b. The children are sad when the teacher doesn't show up. c. The children are not very obedient when the teacher doesn't show up.	1 0

#24. ***unaware***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***aware***.	1 0
Look at this word "***aware***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***aware***" (Use a prefix ***un-*** card with the word ***aware*** and place the ***un-*** in front of ***aware***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***un-***" (Read it out) in front of "***aware***", what word do you have? (Show the child the word ***unaware***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "She was ***unaware*** of the hurricane alert until she saw it on TV." Can you tell me what the word ***unaware*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. She was not informed about the hurricane alert until she saw it on TV. b. She was surprised by the hurricane alert on TV. c. She was informed about the hurricane alert before she saw it on TV.	1 0

#25. ***refreeze***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***freeze***.	1 0
Look at this word "***freeze***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***freeze***" (Use a prefix ***re-*** card with the word ***freeze*** and place the ***re-*** in front of ***freeze***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***re-***" (Read it out) in front of "***freeze***", what word do you have? (Show the child the word ***refreeze***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "He didn't ***refreeze*** the ice cream after the party" Can you tell me what the word ***refreeze*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. He didn't put the ice cream in the freezer after the party. b. He didn't get the ice cream out of the freezer. c. He forgot to get the ice cream before the party.	1 0

#26. ***prearrange***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***arrange***.	1 0
Look at this word "***arrange***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***arrange***" (Use a prefix ***pre-*** card with the word ***arrange*** and place the ***pre-*** in front of ***arrange***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***pre-***" (Read it out) in front of "***arrange***", what word do you have? (Show the child the word ***arrange***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "We were able to ***prearrange*** tables for the guests." Can you tell me what the word ***prearrange*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. We were able to prepare tables before the guests arrived. b. We were unable to prepare tables before the guests arrived. c. We forgot to prepare the tables before the guests arrived.	1 0

#27. ***decompose***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***compose***.	1 0
Look at this word "***compose***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***compose***" (Use a prefix ***de-*** card with the word ***compose*** and place the ***de-*** in front of ***compose***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***de-***" (Read it out) in front of "***compose***", what word do you have? (Show the child the word ***decompose***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The scientist is able to **decompose** water into two parts." Can you tell me what the word ***decompose*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The scientist knows how to combine two parts to make water. b. The scientist knows how to break down water into two parts. c. The scientist knows how to use many parts to make water.	1 0

#28. ***incomplete***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***complete***.	1 0
Look at this word "***complete***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***complete***" (Use a prefix ***in-*** card with the word ***complete*** and place the ***in-*** in front of ***complete***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***in-***" (Read it out) in front of "***complete***", what word do you have? (Show the child the word ***incomplete***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The boy turned in ***incomplete*** homework on the due date." Can you tell me what the word ***incomplete*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The boy turned in his homework earlier than the due date. b. The boy turned in his homework later than the due date. c. The boy didn't finish his homework but turned it in on the due date.	0 1

#29. ***impatient***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***patient***.	1 0
Look at this word "***patient***" (Instructor points to it). Now I am going to put this small word part (Don't read it out) in front of "***patient***" (Use a prefix ***im-*** card with the word ***patient*** and place the ***im-*** in front of ***patient***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***im-***" (Read it out) in front of "***patient***", what word do you have? (Show the child the word ***impatient***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The woman is ***impatient*** to get her mail." Can you tell me what the word ***impatient*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. It is hard for the woman to wait for her mail to come. b. It is very exciting for the woman to wait for her mail to come. c. It is fun for the woman to wait for her mail to come.	1 0

#30. ***counteract***

Test Instruction	Point
Look at the words (Instructor points to it) Circle the word ***act***.	1 0
Look at this word "***act***" (Instructor points to it). Now I am going to put this word part (Don't read it out) in front of "***act***" (Use a prefix ***counter-*** card with the word ***act*** and place the ***counter-*** in front of ***act***). Now what word do we have? Can you read it out for me? (Give a 2 if the child can read the word without any assistance. If the child cannot then say) Watch me. If you put the "***counter-***" (Read it out) in front of "***act***", what word do you have? (Show the child the word ***counteract***). (Give a 1 if the child can say correctly with your assistance).	0 2 1
(Read the sentence) "The boy participated in a campaign to ***counteract*** school bullying." Can you tell me what the word ***counteract*** means in this sentence? I will give you three choices. Pick the best answer among them (Read out three choices). a. The boy participated in a campaign to support school bullying. b. The boy participated in a campaign that is against school bullying. c. The boy participated in a campaign on school bullying.	1 0

MA Word Recognition and Decoding Task

Scoring Sheet

Student Name: Assessor:

School: Date:

Pre1 ( ) Pre2 ( ) Post1 ( ) Post2 ( )

#. Words	(1)		(2)			(3)		#. Words	(1)		(2)			(3)	
1. unable	1	0	2	1	0	1	0	2. preview	1	0	2	1	0	1	0
3. superfast	1	0	2	1	0	1	0	4. inexact	1	0	2	1	0	1	0
5. rejoin	1	0	2	1	0	1	0	6. midnight	1	0	2	1	0	1	0
7. impure	1	0	2	1	0	1	0	8. overeat	1	0	2	1	0	1	0
9. bicycle	1	0	2	1	0	1	0	10. misuse	1	0	2	1	0	1	0
11. dislike	1	0	2	1	0	1	0	12. mistreat	1	0	2	1	0	1	0
13. antiwar	1	0	2	1	0	1	0	14. illegal	1	0	2	1	0	1	0
15. depart	1	0	2	1	0	1	0	16. distrust	1	0	2	1	0	1	0
17. irregular	1	0	2	1	0	1	0	18. impossible	1	0	2	1	0	1	0
19. antismoking	1	0	2	1	0	1	0	20. subgroup	1	0	2	1	0	1	0
21. prejudge	1	0	2	1	0	1	0	22. reproduce	1	0	2	1	0	1	0
23. misbehave	1	0	2	1	0	1	0	24. unaware	1	0	2	1	0	1	0
25. refreeze	1	0	2	1	0	1	0	26. prearrange	1	0	2	1	0	1	0
27. decompose	1	0	2	1	0	1	0	28. incomplete	1	0	2	1	0	1	0
29. impatient	1	0	2	1	0	1	0	30. counteract	1	0	2	1	0	1	0
Total								Total							

(1) Recognition of base word		(2) Recognition of prefix + base word		(3) Meaning of prefix + base word	
Target words (odd#):	/15	Target words (odd#):	/30	Target words (odd#):	/15
New words (even#):	/15	New words (even#):	/30	New words (even#):	/15

APPENDIX E
MA TEST STUDENT SHEET

Student Name:

School:

Date:

Pre 1 (   )   Pre 2 (   )   Post 1 (   )   Post 2 (   )

#. Practice

happen   **haptic**   **habit**   **happy**

The girl is ***unhappy*** with her cat.

a. She feels joyful with her cat.
b. She is not pleased with her cat.
c. She feels that her cat is smart.

#. 1

above **able** **abuse** **above**

The boy is ***unable*** to skate.

a. The boy doesn't know how to skate.
b. The boy wants to skate again.
c. The boy hates to skate outside.

#. 2

view **value** **visit** **virtue**

The girls ***preview*** the homework in class.

a. The girls read the homework again in class.
b. The girls complete the homework in class.
c. The girls look through the homework before class.

#. 3

feast **fast** **face** **fade**

My dog can run ***superfast***.

a. My dog can run very fast
b. My dog can run very far.
c. My dog has difficulty running.

#. 4

exact **excel** **expert** **expect**

She used an ***inexact*** way to solve the math question.

a. She answered the math question correctly.
b. She was unable to solve the math question correctly.
c. She solved the math question quickly.

#. 5

joint **join** **joy** **joke**

We can ***rejoin*** the dance club.

a. We are able to join the dance club again.
b. We cannot join the dance club.
c. We hate to join the dance club.

#. 6

nine **light** **night** **neigh**

They have to leave at ***midnight***.

a. They have to leave after night.
b. They have to leave around 9 o’clock at night.
c. They have to leave at 12 o’clock at night.

#. 7

push **pure** **purse** **pool**

His sickness is caused by drinking ***impure*** water

a. He is sick because he didn’t drink water.
b. He is sick because he drank unclean water.
c. He is sick because he drank too much water.

#. 8

eat **eel** **each** **ease**

The boy tried not to ***overeat*** due to his weight.

a. The boy tried to stop eating too much.
b. The boy tried to eat fast.
c. The boy tried to eat more than usual.

#.9

circle **certain** **cycle** **child**

The boy doesn’t have a front wheel for his ***bicycle***.

a. The boy’s bicycle has only one wheel.
b. The boy’s bicycle has both wheels.
c. The boy’s bicycle doesn’t need any wheels.

#. 10

use **huge** **upon** **urban**

She can ***misuse*** her money when she goes shopping.

a. She can spend too much money when she goes shopping.
b. She knows how to use her money when she goes shopping.
c. She can bring her money when she goes shopping.

#. 11

like **light** **lime** **lake**

The students ***dislike*** going to the gym.

a. The students want to go to the gym as soon as possible.
b. The students are ready to go to the gym.
c. The students don’t want to go to the gym.

#. 12

trees **trick** **treat** **threat**

The boy seems to ***mistreat*** his dog.

a. The boy seems to play with his dog.
b. The boy seems to feel very happy with his dog.
c. The boy seems to behave badly with his dog.

#. 13

wall **will** **well** **war**

He is writing an ***antiwar*** book.

a. He is writing a book against war.
b. He is writing a book during a war.
c. He is writing a book about a war

#. 14

legal **level** **lean** **lagan**

Crossing the street at a red light is ***illegal***.

a. We can cross the street when a red light appears.
b. We need to cross the street when a red light appears.
c. We are not allowed to cross the street when a red light appears.

#. 15

port **potter** **part** **pals**

She is scheduled to ***depart*** at 8:00am.

a. She is going to arrive earlier than 8:00am.
b. She is going to arrive later than 8:00am.
c. She is going to leave at 8:00am.

#. 16

truth **trust** **treat** **true**

The students ***distrust*** what the stranger told them.

a. The students are disappointed by what the stranger told them.
b. The students are excited about what the stranger told them.
c. The students have doubts about what the stranger told them.

#. 17

reflect **regard** **regret** **regular**

She is worried about her ***irregular*** sleep habits.

a. She sleeps very well at night.
b. She has trouble sleeping at night.
c. She sleeps at the same time every night.

#. 18

possess **possible** **posture** **positive**

It is ***impossible*** for her to score high enough on the final exam.

a. She is capable of scoring well on the final exam.
b. She is unable to score well on the final exam.
c. She feels good about her score on the final exam.

#. 19

smoking **smoothing** **smuggling** **smashing**

The people belong to an ***antismoking*** group.

a. The people in the room smoke a lot.
b. The people in the room want to start smoking.
c. The people in the room are against smoking.

#. 20

group **growth** **growl** **ground**

The kids get into ***subgroups*** to complete their class project.

a. The kids are divided into smaller groups in the class to do their work.
b. The kids work in groups that involve students from other classes.
c. The kids form smaller groups outside the class to do their work.

#. 21

just **juicy** **junior** **judge**

Don’t ***prejudge*** what this new candy will taste like.

a. Don’t eat the candy too quickly.
b. Don’t tell me if you like the candy until you eat it.
c. Don’t ask for another piece of candy until you finish the first one.

#. 22

product **propose** **promise** **produce**

John will ***reproduce*** the letter his mother wrote long ago.

a. John will write a letter just like the one his mother once wrote.
b. John will not be able to make a copy of the letter his mother once wrote.
c. John will work fast to write a letter for his mother.

#. 23

behave **belove** **belong** **become**

The children ***misbehave*** at school when the teacher doesn't show up.

a. The children are very obedient when the teacher doesn't show up.
b. The children are sad when the teacher doesn't show up.
c. The children are not very obedient when the teacher doesn't show up.

#. 24

award **aware** **awake** **awful**

She was ***unaware*** of the hurricane alert until she saw it on TV.

a. She was not informed about the hurricane alert until she saw it on TV.
b. She was surprised by the hurricane alert on TV.
c. She was informed about the hurricane alert before she saw it on TV.

#. 25

freeze **freedom** **fresh** **french**

He didn't ***refreeze*** the ice cream after the party.

a. He didn't put the ice cream in the freezer after the party.
b. He didn't get the ice cream out of the freezer.
c. He forgot to get the ice cream before the party.

#. 26

arrange **arrest** **arrival** **array**

We were able to ***prearrange*** tables for the guests.

a. We were able to prepare tables before the guests arrived.
b. We were unable to prepare tables before the guests arrived.
c. We forgot to prepare the tables before the guests arrived.

#. 27

compass **composite** **compose** **comprise**

The scientist is able to ***decompose*** water into two parts.

a. The scientist knows how to combine two parts to make water.
b. The scientist knows how to break down water into two parts.
c. The scientist knows how to use many parts to make water.

#. 28

complete **compile** **compete** **compute**

The boy turned in ***incomplete*** homework on the due date.

a. The boy turned in his homework earlier than the due date.
b. The boy turned in his homework later than the due date.
c. The boy didn’t finish his homework but turned it in on the due date.

#. 29

patent **patrol** **pattern** **patient**

The woman is ***impatient*** to get her mail.

a. It is hard for the woman to wait for her mail to come.
b. It is very exciting for the woman to wait for her mail to come.
c. It is fun for the woman to wait for her mail to come.

#. 30

ant **act** **alt** **art**

The boy participated in a campaign to ***counteract*** school bullying.

a. The boy participated in a campaign to support school bullying.
b. The boy participated in a campaign that is against school bullying.
c. The boy participated in a campaign on school bullying.

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BIOGRAPHICAL SKETCH

Yujeong Park received her bachelor's degree in special education with a minor in Korean language and literature from Pusan National University in Pusan, S. Korea where she graduated with honors (*Summa Cum Laude*). She taught students with severe/multiple disabilities literacy and communication skills at a public special education school in Seoul, S. Korea. She received her master's degree in exceptional children, with a learning disabilities concentration from Seoul National University.

Since she was accepted into the special education doctoral program at the University of Florida in 2009, her work has focused on conducting research on effective instructional practices and reading assessment for students with disabilities. She has collaborated with faculty and graduate students on several interdisciplinary research projects to (1) assess the effectiveness of reading interventions and strategies for students with special needs, and (2) develop a reliable and valid assessment system in reading for K-12 SLDs as well as English language learners. Since 2009, she has served as a research assistant in the Literacy Learning Cohorts (LLC) project to study the influence of professional development and coaching on literacy instruction of special education teachers. She also served as a research assistant in the National Center to Inform Policy and Practice in Special Education (NCIPP)

She has delivered more than 20 presentations at national and international conferences, including: AERA, CEC, IRA, and TED and is an author on 10 peer-reviewed publications. Honors include the University of Florida's College of Education's Fien Dissertation Award in 2012 and Korean Honor Scholarship from the Korean Embassy of the United States in 2011. Other awards received include the Outstanding International Student Award for the College of Education, Qualitative Research Award by the Council for Exceptional Children Teacher Education Division, and Rosser Family Graduate Scholarship. She has been selected by the Council for Exceptional Children's Division for Research (CEC-DR) through a national competition to participate in the 2012-2013 cohort of Doctoral Student Scholars in Special Education Research.

In 2013, she graduated with a Ph.D. in special education with a minor in research and evaluation methodology at the University of Florida. Her professional goals include delving deeper into research on effective literacy intervention and assessment for students with high incidence disabilities and supporting general and special education teachers to better design and implement their reading instructions in inclusive classroom settings.