THE RELATIONSHIP BETWEEN MORPHOLOGICAL AWARENESS AND LITERACY OUTCOMES OF ELEMENTARY STUDENTS: A META-ANALYSIS STUDY

by

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The *No Child Left Behind* Act of 2001 requires the US educational systems to provide effective instruction for all students to be successful in reading. It is generally accepted that there are five essential components for effective reading instruction: phonological awareness, alphabetic understanding, vocabulary, fluency, and reading comprehension. However, the role of morphological awareness is gaining greater attention. This study focused on understanding the role of morphological awareness in relation to the more commonly accepted aspects of literacy instruction.

The purpose of this study was to complete a meta-analysis on how specific aspects of morphological awareness relates to different components of literacy (i.e., word reading, reading comprehension, and spelling) in elementary-aged students of different grade levels and learner types. Specific procedures were used to identify relevant research that examined both morphological awareness and reading measures resulting in the identification of 44 studies. These studies were then coded for specific features and to capture and generate effect sizes for analysis.

Results indicated a positive, strong relationship between morphological awareness in general and each literacy skill (i.e., word reading, reading comprehension, and spelling) in elementary students. No significant difference in the mean relationship between morphological awareness and reading outcomes was found for each of the following variables: a) grade (lower versus upper elementary aged-students); b) learner type (typical versus struggling and mixed learners); and c) morphology type (derivational versus inflectional morphology). However, medium to large effects were found across each of these variables. Results were significantly impacted by a number of factors including the implemented coding procedures and features of the studies included in this meta-analysis (e.g., researcher developed measures, variation in defining student populations, etc.). However, a major factor that impacted addressing each specific research question was the limited number of effect sizes available for this meta-analysis. Suggestions for future research and general education implications are provided. Additional research in this area will improve the field by providing a better understanding of the role of morphological awareness within literacy instruction to potentially enable teachers to better meet the needs of all students.

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CHAPTER I

INTRODUCTION

Reading ability affects quality of life in a variety of ways, from academic achievement in school, to self-esteem and social relationships, and to opportunities for advanced education and successful employment. In addition to the wide, long-lasting effect of learning to read successfully, it is a general view that reading ability is not naturally acquired. Therefore, it is not surprising that debates on how to improve children's reading have continued for decades. In recent years, the importance of effective instruction for successful reading has been acknowledged among reading researchers, reading teachers, parents, and politicians. The National Reading Panel (NRP) (2000) conducted a comprehensive, evidence-based literature review of the findings from the past decades and reported a comprehensive summary on what to teach and how to teach for effective reading instruction. The *No Child Left Behind* (NCLB) Act of 2001 also reflects a strong governmental agenda for accountability systems in which effective reading instruction is implemented in school. This regulation holds a high expectation for reading excellence stressing that "all children should learn to read by third grade", and requires U.S. public school systems to meet the needs of all diverse learners, including children with learning disabilities (LD), children from families of low socioeconomic status (SES), and English language learners (ELL). Meeting this high standard may ensure that all children receive evidence-based, effective reading instruction for reading success.

Critical Components for Effective Reading Instruction

Acquiring foundational literacy skills during the elementary grades is more important than at any other time because early skills affect further reading development both independently and reciprocally (Snow, Burns, & Griffin, 1998). The NRP (2000) identified five critical components to teach children to read: (1) phonological awareness, (2) alphabetic understanding (or phonics), (3) fluency, (4) vocabulary, and (5) comprehension. Of the range of the components, research shows that phonological awareness is one of the major contributors to early reading development (i.e., word decoding), along with knowledge of the alphabetic system (Storch & Whitehurst, 2002). Furthermore, phonological awareness is correlated to later reading achievement (i.e., comprehension) (Hagtvet, 2003). In light of the current knowledge base, most early elementary reading programs have included phonological and phonemic awareness as an essential piece for transferring children's oral language ability to learning written language system (i.e., reading and spelling), as well as phonics skills corresponding letters (i.e., graphemes) to sounds (i.e., phonemes) for building further fluent word reading.

While many children benefit from these early reading approaches, some children still have difficulties in word decoding, especially in reading less common, more complex words that they encounter at grades two and beyond (Carlisle, 2000). The general consequences of difficulties in this late decoding stage are not limited to low rate and accuracy in word reading and low performance in passage reading, but also to slow rate in vocabulary acquisition which directly affects comprehension abilities. Particularly for children who have atypical developmental characteristics in language and reading in

English (e.g., ELLs, children from low SES) or who have some cognitive, language-based difficulties in learning processes (e.g., children with LD), word reading approaches based on phonological/phonemic awareness may not fully help them overcome the problems in word decoding or further develop their ability for constructing meaning from passage reading.

Current research-based knowledge, including the report of the NRP (2000), heavily emphasizes the components of phonological awareness and phonics in early grades for students who still need to develop their skills both in spoken language and literacy as part of effective instruction. However, this dominant instructional practice has not successfully worked for all elementary students. This reality implies other possible instructional components than phonological awareness that may help transfer children's language to reading development and capture the cognitive, language-based processes involved in reading. Therefore, it is important to consider the entire structure of the English language to better understand the mechanism of learning to read in English.

Importance of Morphological Awareness for Learning to Read in English

English orthography—the writing system—represents not only the units of sound structure (phonemes) but also the smallest unit of meaning (morphemes). Many theories regarding the acquisition of early reading have focused on the interaction between phonological and orthographical processes. Therefore, for the last several decades abundant research has been conducted on phonological and/or phonemic processes and learning to read in English (Adams, 1990). Meanwhile, the aspect of morphological and/or morphemic awareness in learning to read in the orthographic system of English

has not been understood well and its application to reading instruction has been less emphasized (Carlisle & Stone, 2005). The lack of understanding on morphological aspect in learning to read is mainly attributed to the fact that, compared to some other languages (e.g., Turkish, Korean, Italian, Hebrew, Chinese, etc.), English is not as morphologically rich as those languages in the formation of new words, particularly in inflection types. In other words, regular rules of inflections in English are limited to some syntactic information: tense (e.g., *look-looked*), number (e.g., *cat-cats*), third person singular in present tense (e.g., *meet-meets*), present particle (e.g., *walk-walking*), and comparative and superlative markers (e.g., *large-larger-largest*). Therefore, these types of words have been viewed as being able to be taught to young readers even by applying common phonological rules or simply by providing sufficient practice on word parts. In this context, the role of morphology in learning to read and write might be underestimated and, therefore, less attention might be given to full investigations of morphological awareness and knowledge as a critical component of effective reading instruction until recently.

Fortunately, for the last two decades research on morphological awareness and its relation with literacy has increasingly been conducted in multiple research fields (e.g., applied psycholinguistics, psychology, and education), thus accumulating supporting evidence on the importance of morphological skills in children's literacy development (e.g., word decoding, reading comprehension, spelling). Empowered by these findings, reading researchers have applied their understanding about the roles of morphological abilities to studies for specific effects of morphological abilities on literacy research with different characteristics of learners, such as students' learning disability (LD) status

(Siegel, 2008; Shankweiler, Crain, Katz, Fowler, Liberman, Brady et al., 1995; Elbro & Arnbak, 1996) and students of various grade levels (Carlisle, 2000; Carlisle & Stone, 2005; Ku & Anderson, 2003). In relation to grade levels, some of the studies reveal that morphological skills play an important role in reading morphologically complex words as well as reading comprehension even as early as the second or third grade (Carlisle, 2000). Carlisle (2000) asserted that morphological analysis skills greatly contributed to reading comprehension for the third graders, emphasizing that "they are presumably just beginning to learn to read and understand morphologically complex words" (p. 169). Carlisle and Stone (2005) also argued against Adams' (1990) suggestion for postponing instruction in morphology until the upper grades of elementary school. Instead, they recommended providing explicit elementary reading instruction linking the dimensions of phonology, syntax, morphology, semantics, and orthography together as early as second grade.

Recent studies suggest that many students with LD demonstrate lower morphological abilities than typical readers (Fowler & Liberman, 1995; Arnbak & Elbro, 2000). On one hand, it can be viewed that the low performance of students with LD in morphological tasks may be related to their deficits in phonological abilities (Fowler & Liberman, 1995; Casalis, Cole, & Sopo, 2004). On the other hand, there is some evidence showing that the difficulties in morphological processing of students with LD influence their weak reading and writing skills (Arnbak & Elbro, 2000; Bailet, 1990; Carlisle, 1987).

Along with increasing evidence supporting the important role of morphology in learning to read for both typically developing children and children with LD, there is

another body of research emerging on teaching morphological and morphemic analysis skills to investigate its instructional effect on word reading and reading comprehension (Baumann, Edwards, Font, Tereshinski, Kame'enui, & Olejnik, 2002; Egan & Ping, 2004; Elbro & Arnbak, 1996; Lyster, 2002; Nunes, Bryant, & Olsson, 2003; Wysocki & Jenkins, 1987). Unfortunately, not enough research evidence exists to make generalizations about the effect of morphology instruction on children's literacy performances, across different components of literacy, different characteristics of learners, and different types of morphology.

A Meta-analysis for the Relationship between Morphological Awareness and Literacy of Elementary Students

Despite the research studies supporting the importance of morphology for improving children's literacy, there is still much to understand regarding the sophisticated aspects of morphology in reading and spelling both conceptually and practically. A meta-analysis approach can systematically synthesize the research findings and examine specific features relevant to the studies synthesized.

Currently, researchers in the field of reading education have focused on addressing the Congressional request (i.e., *NCLB*) and political need for finding scientifically-based research evidence, which is viewed as evidence demonstrating a cause-effect relationship through experimental and/or quasi-experimental designs (Odom, Brantlinger, Gersten, Horner, Thompson, & Harris, 2005). The preference of experimental and quasi-experimental designs as important sources for evidence-based practices has been shown in research synthesis studies too (NRP, 2000; Reed, 2008). The

meta-analysis done by the NRP (2000) excluded studies using methods other than quasi-experimental and experimental designs in finding the cause-effect relationship for the effectiveness of reading instruction on literacy outcome measures. Another recent meta-analysis (Reed, 2008) also included only experimental and quasi-experimental studies to examine the effects of morphology intervention on reading outcomes. However, it is also important to include other types of studies (e.g., correlation studies) because including only the data of experimental and quasi-experimental intervention studies (e.g., *t*-value, *F*-value) in the meta-analysis and/or focusing on only narrow scopes of instructional features may lose any important information or factors that would be fundamental and, therefore, may not always provide a big picture of effective instruction through the synthesis.

Camilli, Vargas, and Yurecko (2003), in their examination of the meta-analysis of the NRP (2000), argued that the review process of the NRP was not accurate, particularly regarding phonics instruction. In particular, they pointed out that the NRP meta-analysis did not consider the effect of language activities incorporated with phonics instruction, which misled the interpretation and analysis of the effect of phonics instruction. That is, when considered the effect of systematic language activities (*d*=.29), the effect of phonics instruction was smaller than the NRP's result (*d*=.40), which was still significant (*d*=.24). Finally, they concluded that when phonics instruction would be combined with language activities, the effect of reading instruction may increase.

While current research in education has increasingly emphasized the role of experimental or quasi-experimental studies to accumulate scientific evidence for effective instruction, a meta-analysis including correlation data could be as valuable as

experimental studies or a meta-analysis based on the results of experimental and quasi-experimental studies. The correlation data in the meta-analysis can be used to examine the foundations and the sophistications of morphology in relation to literacy.

Indeed, the importance of insights gained by examining other types of empirical research such as correlation studies should not be discounted. Stanovich (2004) emphasizes the importance of combining findings from theory-driven studies as well as directly applied studies in relevant disciplines for obtaining converging evidence. While accumulated studies in experimental and quasi-experimental designs may be useful to generalize research findings to larger populations, the literature based solely on experimental and quasi-experimental designs may not be sensitive enough to fill in blank or blind spots (Wagner, 1993). Correlation studies (e.g., simple correlation, multiple regression, structural equation modeling, etc.), often used in theory-building, may have potential for more thoroughly investigating those research gaps of blank and/or blind spots (Stanovich, 2004). In recent years, experimental and quasi-experimental studies also have increasingly reported the relevant correlation data. Therefore, including correlation information in the process of finding scientifically-based evidence seems important for obtaining converging evidence on the role of morphological awareness to provide a more complete theoretical and conceptual framework, which will influence future educational research.

Among many theories of reading, a psycholinguistic view of reading provides the approach connecting linguistic knowledge and processes to the education-related behavior of reading. Many studies in the psycholinguistic field investigate the theoretical/conceptual associations between language and reading, providing correlation-

based values as part of the study results. To improve our understanding of the process of reading and spelling more complex words and its instructional application, it is important to include the correlation information, whether those are from the education field or from other relevant disciplines (e.g., psycholinguistics). Therefore, a critical consideration for this meta-analysis study is to incorporate correlation studies beyond the experimental and quasi-experimental studies to obtain a framework of more comprehensive aspects of language and literacy, particularly for the morphological aspects in reading and spelling.

Purpose of the Study

The primary purpose of this study was to provide a quantitative synthesis of studies of morphological awareness of elementary students and its relationships to reading and spelling using meta-analytic procedures. In particular, the synthesis examines how morphological awareness in elementary students is related to different components of literacy (i.e., word reading, reading comprehension, spelling), and with different types of morphology (i.e., derivational and inflectional morphology). The meta-analysis study also investigates how the relationships may vary as a function of grade level categories (i.e., lower elementary vs. upper elementary), and as a function of student learning characteristics (i.e., struggling students, typical students, and mixed). The results of this study will assist in understanding the reading and language relations in a comprehensive conceptual framework. This study will also expand the knowledge base in reading and spelling to guide future research for curricular and instructional decision making.

CHAPTER II

REVIEW OF RELATED LITERATURE

Literacy, including reading, is highly valued in our current society. In the light of the social value, acquiring foundational literacy skills in the early years is important. At an early period of literacy acquisition children's reading development is dependent on an interaction of language skills and basic knowledge of English orthography (Adams, 1990). Within early literacy development, most research in the field of education has focused on one exclusive aspect of language skills (i.e., phonological/phonemic awareness) for learning to read words (Blachman, Ball, Black, & Tangel, 1994; Cunningham, 1990; Stuart, 1999; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993) and has emphasized the effect of the phonological skills for word decoding (Tunmer & Hoover, 1993; Vandervelden & Siegel, 1997). This overemphasis ignores the overt morphophonemic nature of the English Language (Carlisle & Stone, 2005). Examining the role of morphology may provide critical insights in early reading instruction and intervention to best meet the needs of all students, including students with learning disabilities (LD). This chapter will provide a context for examining and understanding the role of morphology in literacy (e.g., reading, spelling). First, the theoretical and conceptual understandings of morphology from both linguistic and psychological perspectives will be provided. Then, research on the relationship between morphological awareness of elementary-aged children and literacy outcomes will be reviewed in relation to specific literacy, different grade levels, and different learner types such as children with LD, typical learners, and the mixture of those two types. The review focusing on

morphology and literacy skills will set the stage for this meta-analysis to address the posed research questions.

Backgrounds on Morphology and Literacy Development

Knowledge of linguistic structure is important for children's literacy development. In particular, the knowledge and awareness of the sound structure of language, which is phonological and phonemic awareness, is widely accepted as crucial knowledge required for developing word reading skills. Meanwhile, the knowledge and awareness of the morphological structure of language, which is morphological awareness, and its relation to early literacy has been less understood among educators in the area of literacy. The importance of morphological awareness in literacy development of young learners is a relatively recent understanding (Carlisle & Normanbhoy, 1993; Carlisle, 2000; Carlisle, 2003; Carlisle & Stone, 2005; Deacon & Kirby, 2004; Senechal, Basque, & LeClair, 2006; Singson, Mahony, & Mann, 2000) for both typical and struggling readers (Arnbak & Elbro, 2000; Carlisle, 1987; Casalis, Cole, & Sopo, 2004). However, we still have much to learn about the role of morphology in literacy development in order to embrace the aspect of morphology within the framework of literacy instruction and intervention. Before further discussing the combined issues of literacy and language, we will need to review the concept of morphology from the position of theoretical linguistics.

What Is Morphology?

Morphology is the study of the structure of words, particularly of the smallest 'meaningful' units that build the structure, *morphemes*, and of the regulations for word

formation (Dirven & Verspoor, 2004). The *morpheme* can be categorized into free or bound morphemes. The free morpheme, also referred to as a base or root (morpheme), is the unit that can stand alone (e.g., *teach*, *warm*) as a single word. On the other hand, the bound morpheme, which is also referred to as an affix, cannot function alone but should be part of a word (e.g., -*th* as in *warmth*, and -*ly* as in *lovely*). There would be little argument in that the *morpheme* is the basic unit of morphological analysis, either of spoken or of written words. However, perspectives on how to assign these units to analyze the structure of words could be different according to the models of morphological processing, which will be discussed later.

There are two types of morphology to be considered in understanding word structure and its formation: inflectional and derivational morphology. While these two types share commonalities of morphology (e.g., conveying meaning, parsing process, etc.), inflectional and derivational morphology have some distinctive features and regularities. The inflectional morphology determines the grammatical function of a word and links words in a larger syntactic (i.e., grammatical) unit such as a sentence. Morphemes in inflectional words have to do mainly with some grammatical features such as tense, person, and number (e.g., the present tense morpheme in relation to the 3rd person ending –*s* as in *she helps*; the past tense morpheme –*ed* as in *I smiled*; and number for regular plural –*s* as in *books*). Additionally, present particle (e.g., –*ing* as in *talking*) and comparative (e.g., –*er* as in *smaller*) and superlative markers (e.g., –*est* as in *smallest*) can be categorized as inflectional morphemes. In general, the inflectional regularity (e.g., *walk*/*walks*/*walked*), which a base word is followed by a suffix morpheme, does not change the word class and produces minimal or no change of the

meaning (Bybee, 1985). Therefore, the word formation based on the regulations of inflectional morphology may be less complex than that on derivational morphology.

On the other hand, derivational morphology has to do with forming a new word in reflecting similar features to lexical aspects. In a simplest way, the derivational word formation can be accomplished through combining a free morpheme with a bound morpheme, such as an affix (e.g., *joy* + *-ful*; *joyful*). Unlike the inflectional process of word formation of which regulations mostly reflect the syntactic features, derivational formation process often changes the meaning and concept of the base word (e.g., *happy/unhappy*) as well as the grammatical class (e.g., *grow*/*growth*). This point makes the derivational formation less regulated and its processes more complex. Furthermore, derivational formation is not limited to the combination of two morphemes but can combine more bound morphemes to form morphologically more complex words (e.g., *unbelievable*). As in the example *unbelievable*, more than one bound morpheme, the prefix *un-* and the suffix *–able*, are added to the base morpheme *believe*. The prefix and suffix in this derivational word formation both contribute to the change of the meaning and concept of the base word, while only the suffix *–able*, not the prefix *–un*, changes the grammatical class of the base word from verb to adjective (i.e., *believe* vs. *believable*).

On the one hand, as seen in the comparisons of two types of morphology, derivational morphology is far more complex than inflectional morphology in English because the word formation process is less regulated and has more variations. In addition, the type of derivational morphology has some complex issues related to the lexical processing such as transparency, frequency, and irregularity of the morphemic formations. On the other hand, derivational knowledge seems to expedite children's learning of new

words because the less regulated derivational process allows more words in a word family that vary in their meanings and concepts (Carlisle, 1995). For this reason, derivational morphology might be viewed as more important for children's literacy acquisition than inflectional morphology. This understanding, however, may not always be true in an absolute way when considering children's literacy acquisition within a course of a developmental continuum. Instead, we need to understand the relative importance of each morphology type in different phases of children's literacy development and the time required for children to approach the fluent level of using regulations for each morphology type. In the following section, some relevant theories of literacy development will be discussed in connection with linguistic aspects in reading processes.

Current Theories of Reading

Reading is a complex cognitive process requiring a variety of knowledge sources and their coordination (NRP, 2000). Beyond the cognitive demands of the reading process itself, learning to read during primary elementary years is particularly complex in relation to children's development. First, children need to have an appropriate level of spoken language ability as a prerequisite in order to develop a more advanced language level. Second, they are also acquiring knowledge of the English orthographic system and combining this knowledge with the linguistic knowledge and skills that they have acquired for word decoding. The knowledge and skills can be a base for further reading development and reading comprehension. In this section, two theories of reading from a developmental (Ehri, 1998) and a cognitive (Adams, 1990) perspectives will be discussed.

The main focus of these theories is on explaining the features of learning to read and spell, not necessarily on methods for instruction. However, each theory has influenced how we teach reading and spelling in different ways.

Ehri's Developmental Phases of Word Recognition

For beginning readers, it is essential to understand language and orthographic systems and to recognize written words. Ehri's theory (1998) of word reading provides a good conceptualization of how children develop and apply their linguistic and orthographic knowledge to correspond appropriate linguistic and alphabetic units for word recognition in different phases of their literacy development. In her theory, Ehri (1998) has identified five phases of word reading development, differing from each other in the amount of involvement of alphabetic knowledge: *Pre-Alphabetic Phase, Partial-Alphabetic Phase, Full-Alphabetic Phase, Consolidated-Alphabetic Phase,* and *Automatic-Alphabetic Phase*.

During the *Pre-Alphabetic Phase,* word reading does not involve any process of alphabetic knowledge. Instead, a child reads the words which are familiar to the child in a spoken format, by connecting some salient visual cues of the words (e.g., mapping the shape of some letters in the word into the appearance of the object) with their linguistic representations (e.g., pronunciation and semantic representations). At the *Partial-Alphabetic Phase,* readers have acquired alphabetic knowledge of letter shapes, letter names, and typical sounds of the letters and use limited knowledge of letter-phoneme correspondences (e.g., salient partial letters in a printed word) to relate them to the word's pronunciation. As children have further experience with print, they move into the

Full-Alphabetic Phase. Children are now able to fully relate letters in a word to the most commonly used sounds for the letters more quickly and accurately than in the *Partial-Alphabetic Phase*. This may be one of the most important phases in learning to read because children begin to acquire full knowledge of the alphabetic system necessary for arriving at fluent reading and for shifting their attention from decoding to reading comprehension (Pikulski & Chard, 2005).

The *Consolidated-Alphabetic Phase*, most relevant to the current discussion on morphology, is characterized by the ability to use various orthographic units for word recognition. As we discussed the importance of analytic ability of words depending on different levels of linguistic units (e.g., syllables, onsets, rimes, phonemes, morphemes, etc) previously, in this phase children can speed up the process of word decoding, particularly using a larger size of chunks of letters (e.g., affixes) than single letters for more advanced level of reading. Ehri (1998) emphasized that once the unit *–est* has been stored in memory as a known spelling pattern, the word *nest* will be processed with only two units, *n* and *–est*, rather than four units of *n*, *e*, *s*, and *t*. As a result, the process with the larger units decreases the cognitive load and frees processing on fluency of connected text reading. Based on this theoretical viewpoint, children should be able to easily decode new words having the same patterns (e.g., *best*, *chest*). Finally, children at the *Automatic-Alphabetic Phase* identify words by sight, that is, immediately and effortlessly which allows a greater emphasis on vocabulary and reading comprehension.

Ehri's theory (1998) conceptualized children's word recognition as a developmental continuum and suggested the different phases progressing toward automatic sight word reading in relation to different written patterns. The theory,

however, did not distinguish the functions of written units. For example, the letter pattern *–est* as an affix (e.g., *-est* in *tallest*) is not necessarily distinguished from the letter pattern *–est* as a partial syllable (e.g., *-est* in *nest*). In other words, an affix is viewed as the same type of structural chunk as the *–est* in nest, not as a unique morphemic unit. Therefore, neither any specific need for morphemic skills nor different mechanisms may be assumed for decoding words with any chunk patterns, whether syllables or affixes. From an instructional perspective, this standpoint of Ehri's theory may imply that the need for differentiated instructional strategies for different types of patterns is not essential, as children should be able to acquire common patterns through sufficient exposure to and practice of the sounds of the patterns in a list of words.

An early study shows a similar standpoint to Ehri's theory. Hanson (1966) investigated the effect of teaching the use of variant word endings (i.e., *-s, -ing, -ed,* and *–er*) to first graders for 4 weeks. Teachers preliminarily presented the generalizations of the word endings and students practiced the word endings both orally and with the use of worksheet. The study found that teaching and practicing variant endings were effective in first grade. In fact, many of the practices in education, particularly for young children, had exclusively followed the exposure-and-practice approach to teach the letter patterns of affixes mostly using phonics-based strategies, not morphological strategies (e.g., morphemic identification, morphemic analogy, etc.).

Ehri's theory (1998) also indicates that the developmental phases in ability of using different orthographic units for word recognition are sequential, although some phases may overlap, particularly the fully-alphabetic phase and the consolidated-alphabetic phase (Ehri & McCormick, 2004). The feature of sequential phases might

imply that some letter patterns such as affixes should not be introduced in literacy instruction in early primary grades (e.g., first grade), or could be introduced but not necessarily in connection with grammatical categories and functions or meaning processes. This, however, seems incomplete based on the following reasons. First, there is evidence that even preschoolers have good morphological awareness at the implicit level (Berko, 1958, as cited in Carlisle & Stone, 2003). Second, one linguistic ability may take longer to acquire than the others (e.g., phonological awareness vs. morphological awareness) as some types of literacy-related knowledge and skills may need more time to master than the others (e.g., orthographic knowledge and decoding vs. reading comprehension, Paris, 2005). In light of this, the affixes would need to be understood as the morphemic units uniquely influencing the process of reading morphologically complex words, not just orthographic patterns corresponded to certain sounds as in Ehri's theory.

Adams' Theory of Reading

While Ehri (1998) focuses on the developmental changes of orthographic and phonological skills related to word recognition, Adams's theoretical framework of reading (1990) provides a broader scope on not only skills necessary for learning to read but also the cognitive processes of skillful reading. Similar to most reading theories, including the Ehri's theory, she views the print-sound correspondence skills based on orthographic and phonological knowledge as essential in learning to read. Adams, however, emphasizes the critical importance of semantic identification of word patterns and words as well. That is, for more advanced, effortless reading, a reader must

coordinate the interaction and interdependency of three types of knowledge: orthographical, phonological, and semantic knowledge. Adams also discusses a contextual processor that facilitates reading processes of difficult words and passage comprehension. Full consideration of the contextual processor is, however, beyond the scope of morphological discussion in this study.

In relation to morphological discussion at the word level, either in isolation or in a sentence as context, Adams' (1990) theory may better appreciate the morphological aspects in reading and writing than the Ehri's theory. Adams (1990) pointed out that the meaning processor and its interaction with the orthographic processor is responsible for "skilled readers' sensitivity to the roots or meaning-bearing fragments of polysyllabic words" (p. 151). According to this notion, the meaning processor might embrace morphemes, the smallest linguistic units conveying meanings, in the interactive reading process of complex and/or new words, particularly associated with the knowledge of the orthographic patterns of the words. The contextual processor may also increase the appropriateness of understanding word meanings, particularly in connection with the meaning processor. An example of a contextual clue for analyzing and processing a morphologically complex word could be the structure and meaning of a sentence given for the complex word.

Adams' theory, however, seems not to provide a theoretical framework optimizing for investigating converging evidence for the morphological aspects in literacy instruction. In her discussion on the instructional application of the phonological, orthographic, and meaning processors, Adams (1990) recommended the features of derivational morphology to be included in literacy instruction such as spelling and

vocabulary, but did not consider the features of inflectional morphology to be included. The recommendation may be based on the commonly accepted linguistic premise that inflectional rules are acquired as part of syntactic processes relatively early in childhood, and, therefore, have little influence on changing the semantic status (i.e., meanings) of base words and inflected words. According to this premise, there seems little need for inflectional morphology to be included in explicit literacy instruction for early primary students learning to read. In addition, Adams (1990) recommended introducing the derivational morphemes for older students, and postponing them for young, less skilled readers who still need to further develop their sensitivity to frequent orthographic (or spelling) patterns. Furthermore, the emphasis on the role of an orthographic processor for reading may not fully support the importance of oral practices of morphological awareness.

In summary, Ehri's (1998) and Adams' (1990) theories represent two important perspectives about learning to read: the developmental stages of word recognition and the cognitive, psychological processes of reading. These two theories cover the grapho-phonological aspect of English in learning to read, focusing on the correspondence of an orthographical unit (e.g., grapheme) to a phonological unit of language (e.g., phoneme). Furthermore, Adams' (1990) theory emphasizes the complex interaction of the phonological, orthographic, and meaning processes to identify words and to infer their meanings. However, both theories do not fully consider the grapho-morphological aspect of learning to read in English. Ehri's theory is not sensitive to the morphological knowledge and processes in word recognition. Adams' theory is too broad to support both grammatical (i.e., inflectional morphology) and semantic (i.e., derivational

morphology) functions of morphology in word reading and comprehension. Since English is a morphophonemic language, another theoretical view that embraces a full range of linguistic aspects in reading seems necessary in order to support the dual features of the English language and appreciate the role of morphology in learning to read.

A Psycholinguistic View of Reading

A psycholinguistic view of reading provides a foundation for understanding how critical overall language development and processes are for children learning to read. From a psycholinguistic perspective, reading is "a secondary language process, partly derivative of primary spoken language processes" (Perfetti, 1999, p. 167). The interpretation and application of the definition may vary in a subtle way depending on the study's focus and interests (e.g., word reading, reading comprehension). For elementary children learning to read and reading to learn, which is the focus and interest of this study, the psycholinguistic perspective may provide some important points: (1) overall development of spoken language is as important as knowledge of written codes (e.g., naming alphabetic letters, letter-sound correspondences) (Adams, 1990; Ehri, 1998; Perfetti, Landi, & Oakhill, 2005); (2) spoken language and reading can develop simultaneously and reciprocally influence their development (Carlisle, 2003); and (3) a reading process is similar to a spoken language process to some extent, that is, the procedures of learning to read should reflect the natural process of spoken language acquisition for its effectiveness (Perfetti, 1999).

The first point of the psycholinguistic perspective indicating the importance of spoken language development for reading development may be supported by most

theories of reading, including Ehri's (1998) and Adams' (1990). The main distinction between the theories is instead on dimensions of spoken language that each theory views as associated with early reading development and reading processes. Current educational studies of elementary students have a tendency to limit the critical dimensions of spoken language to phonological ability and exclusively focus on teaching phonological and phonemic awareness along with the knowledge of letters and letter patterns (Ehri, 1998). According to the psycholinguistic viewpoint, however, the dimensions of spoken language critical for learning to read may not necessarily be limited to phonology, but any other linguistic dimensions (e.g., morphology) can be considered within a whole linguistic system.

The second point of the psycholinguistic perspective is that there is the simultaneous development and reciprocal influence of spoken language and reading ability during early childhood, including the elementary years. This point may provide some rationale not only for including linguistic components in reading instruction earlier than is the common practice, but also for continuing to integrate the components in instruction throughout the elementary years during which children develop their use of spoken and written language. Of linguistic components, the phonological aspect of language has typically been integrated in reading instruction during the elementary years, either in an oral format (i.e., auditory practice of phonological awareness) or in conjunction with a written format (i.e., sounding out a word using the rules of letter-sound correspondences). Phonological awareness instruction in an oral format is common in practice for the first couple of elementary school years, and then the phonics-based approach focusing on letter-sound correspondence becomes dominant through the rest of

the primary grades increasing the grapheme sizes from letters to larger word parts. This common practice of phonological aspects of reading is consistent with the Ehri's (1998) and Adams' (1990) theories previously described. In terms of morphological aspects, an oral practice of morphological awareness has not been emphasized much for early readers, while written patterns of morphemes have been introduced in reading and writing instruction for older, intermediate level readers (Adams, 1990). The psycholinguistic view, however, considers the overall development of children's language within a continuum and allows dimensions of language other than phonology to be included in early reading instruction in an oral format. The introduction of the morphological dimension in a written format (i.e., morphemic analysis) can follow for upper grade students.

The last viewpoint that the reading process is similar to the spoken language process may be the most distinctive feature of the psycholinguistic perspective. We may agree that spoken language involves the interaction of different linguistic components (i.e., phonology, syntax, morphology, semantics, and lexicon) and the child's mind to construct the meaning of the language spoken. This feature is clearly shown in the processes of reading comprehension (Perfetti et al., 2005). Even for early reading, learning to read may share similar features to the process of spoken language acquisition in that knowledge on different linguistic components needs to be acquired and used in an integrative way to identify words and to make sense of the words written (Weaver, 1980). Therefore, instructional approaches on early reading should not be limited to teaching the rules of grapho-phoneme correspondences to transcode unfamiliar written words to sounds, but have to do with encouraging children to practice on linguistic entities related

to words and infer their meanings. The process of inferring meanings of words could be accomplished most effectively through providing similar conditions to those in which the natural linguistic process might occur and with which children learning to read might be familiar. The current practice has a tendency to focus on teaching explicit, teachable morphemic units to the intermediate level of students for the analysis of words either in isolation or within a sentence. However, the psycholinguistic perspective can embrace the learning process involving the interaction of the use of all aspects of language and the human mind. The interactive use of linguistic knowledge for word reading may be practiced in oral format the best for younger students (Singson, Mahony, & Mann, 2000), but possibly throughout the elementary years.

Summary

Current theories of reading have provided knowledge on the relationships between language and reading for children learning to read. As discussed previously, Ehri's (1998) theory focuses on the developmental continuum of knowledge on orthographic units and the correspondence skills of the orthographic units (i.e., graphemes) to linguistic units (i.e., phonemes) in word reading. Adams (1990) also supports the importance of the orthographic knowledge and processes but further emphasizes the interaction of the phonological, orthographic and meaning processes in word reading. The psycholinguistic view of reading seems to provide a broader and more unique foundation for the role of language in reading beyond the phonological level of a language system. Therefore, the psycholinguistic view of reading better covers the issue of linguistic sensitivity for learning to read and write. This aspect of the psycholinguistic

approach considers dimensions of language other than phonology to influence reading. In addition, this broader perspective encourages the inclusion of morphological components in literacy instruction earlier than typical practices, either in oral or written format.

While the definition of reading from the psycholinguistic perspective does not intend to specifically support the role of morphology in learning to read, it offers some insightful points for filling current gaps in our understanding of the morphological aspects of reading and reading instruction. Now the linguistic entity of morphology within a language system will be related to these specific reading theories for better understanding of the dual nature of English as a morphophonemic language. In the next section, an integrative theory of morphological processes of words and the lexical representations of morphologically complex words will be discussed to provide a foundation for the relevant sub-issues, such as morphology types, frequency, and transparency.

An Integrative Model of Multiple Linguistic Dimensions

While rooted into the psycholinguistic view, the theory of multiple linguistic dimensions (Carlisle, 2003) emphasizes the integrative processes in reading morphologically complex words. In her theory, Carlisle (2003) puts the morphological aspect of language at the center of discussion for understanding the role of morphology for reading and its integrative process with other language aspects and orthographic system. She also argues that morphology has its unique locus in a language system although the morphological processes of words involve the syntactic process (i.e., determining grammatical role) and the semantic process (i.e., deciding the appropriate

meaning). She emphasizes that the integrative processes of all different linguistic dimensions (i.e., phonological, syntactic, and semantic processing) along with the orthographic aspect are the most important features of the morphological process of words.

In comparison to Ehri's and Adams' theories, Carlisle's theory incorporates multiple linguistic dimensions, which can better explain the idea that the importance of morphology for elementary school-aged children is not limited to the derivational formation of words (Adams, 1990), but can be expanded to the process of inflected words. Inflectional morphology tends to be understood based on its syntactic function in text while derivational morphology is connected to its semantic role in word formations. Since this theory supports the concurrent role of the syntactic dimension in understanding the process of reading morphologically complex words, inflectional morphology can be as valued as derivational morphology for learning to read and write. This view can give some insight to future instructional research on what aspects of morphology should be considered and included in literacy instruction, in what order, to what extent, etc.

Carlisle (2003) viewed linguistic awareness as "a developmental phenomenon" (p. 291) that has a reciprocal relation with a child's cognitive development and ability. Unlike Adams (1990), she emphasized that the aspects of linguistic awareness other than phonemic awareness, such as morphological awareness and grammatical awareness, are also important parts of linguistic development and affect a child's word reading and reading comprehension as the child goes through the first few years in school. Within this theory, morphological awareness can be understood as a possible predictor of word reading, comprehension, and spelling, and, therefore, can be suggested for an inclusion in

literacy instruction for young readers. In fact, some studies reveal the relationship between morphological awareness skills of early elementary grade students and their word reading and spelling (Carlisle & Normanbhoy, 1993; Carlisle & Stone, 2005; Deacon & Kirby, 2003) and the effects of morphological awareness training in oral format on improving reading and spelling (Kemp, 2006). Instruction on the awareness of morphological structure of words does not need to be limited to a written format.

The consideration of the integrative process at the word level and beyond can also explain the subtle but critical features involved in the lexical processes of morphologically complex words: phonological, semantic, and orthographic transparency of word formations, and frequency of morphemic constituents of word structure. These influencing features will be discussed later in more detail. Adams' theory described previously may be able to explain the issue of frequency of morphemic components but not the transparency issue. The integrative theory of multiple linguistic dimensions can provide psychological and linguistic bases for educational researchers and practitioners to understand the needs for including the morphology in reading and spelling instruction during elementary years. More specifically, this theory will provide insights into instructional approaches such as the selection of morphologically complex words to teach (e.g., transparent vs. opaque words), the types of morphological tasks (e.g., decomposition, production, or analogy of derivational/inflected words), and the modality of tasks (e.g., oral vs. written). The instructional details could possibly depend on their grades for typically developing children or on their individual developmental profiles for children with difficulties in linguistic and cognitive learning areas.

Lexical Representation and Processing of Morphological Words

Feldman (1995) emphasizes that an overview on how morphologically complex words are represented in the mind of adults can provide an understanding of how children might store and access morphologically complex words in general, beyond the perceptual identification of the morphemes in morphologically complex words. There are three main classes of lexical representation and processing models of morphologically complex words: whole-word representation models, fully decomposed representation models, and dual-route processing models (Caramazza, Laudanna, & Romani, 1988).

Whole-word representation models assume that a word is recognized through a matching procedure between the orthographical input and the lexical representation. Therefore, there is no difference in processing a base word as a one-morpheme word (e.g., *want*) and a morphologically derived or inflected word (e.g., *wanted* or *wants*) separately stored in the lexicon. For a relatively frequent word in occurrence, the speed of the matching procedure increases. The class of the whole-word representation models, however, cannot clearly explain the recognition mechanism of new morphologically complex word forms and the rejection of non-words or irregular types within the morphological component (Chialant & Caramazza, 1995). Meanwhile, fully decomposed representation models view that morphologically complex words are accessed and represented necessarily in the decomposed units of bases and affixes. This hypothesis cannot account for the word formation in *hopped* and *saved* because simple parsers of the words do not correspond to morphemes stored in the lexicon. Finally, the dual-route processing model views that lexical access to morphologically complex words occurs either through whole-word access units for well known words or through morphemic

decomposed access units for unfamiliar words. This model can account for most issues related to psychological processing of complex words, such as non-word processing, frequency effect, and transparency effect.

Influencing Factors for Processing Morphologically Complex Words

There are at least two factors that influence the lexical processing and representation of morphologically complex words: (1) frequency of base and affix forms and/or words and (2) transparency of the word formation. These factors can influence the quality of the lexical representation of morphemes and words and, therefore, the recognition accuracy and fluency of processing complex words (Chialant & Caramazza, 1995; Fowler & Liberman, 1995; Stolz & Feldman, 1995).

Frequency of Base and Affix Forms

The frequency of the base forms and affixes of morphologically complex words is closely related to the degree to which the base forms, affixes, and whole words themselves are occurring redundantly and therefore familiar to readers. The frequently occurring forms are stored in long-term memory and retrieved from the memory with relative ease when the stimulus word is provided. The frequency feature is particularly important for processing morphologically complex words requiring decomposing processes. The familiarity of base forms and affixes can provide some clues for decoding words and inferring the meanings (Carlisle, 2003). There is some empirical evidence that the frequency of words affects the speed of recognition (New, Brysbaert, Segui, Ferrand, & Rastle, 2004). That is, the more frequent the word is in language use or in reading, the

faster the word is recognized. This frequency effect may be applied to the base forms in the same manner. Some studies support the positive effects of the base form frequency on the speed and/or accuracy of processing derived words (Carlisle, 1988; Carlisle & Stone, 2005; Carlisle & Katz, 2006) and inflected words (New et al., 2004). As with the frequency of whole words, the more frequently the base form occurs in different complex words, the faster the base form and the words with the base form are processed (Chialant & Caramazza, 1995). Therefore, it would be necessary to provide some instruction where children learning to read are systematically exposed to the structure of inflected and derived words, and have practice identifying the base morphemes and affix morphemes in the structure.

Transparency of Word Formations

The transparency of morphological word formation plays an important role in word reading and comprehension. The formation of morphological words is often complex phonologically, semantically, and/or orthographically. Regarding the issue of phonological transparency, the derivational word *growth* is phonologically transparent because the pronunciation of the base morpheme *grow* does not change due to the formation process. In contrast, the word *preference* is not phonologically transparent because the pronunciation of the base form (i.e., *prefer*) changes after the formation. In relation to orthographic transparency, the word *decision* is not orthographically transparent because the spelling of the base morpheme *decide* has changed. These transparencies affect the awareness of morphemic structure recognition, and therefore affect the speed and accuracy of reading the word. Readers who are just learning to read

may have difficulties reading some morphologically complex words when the word formation is complex orthographically and phonologically (Carlisle, 2000; Carlisle, Stone, & Katz, 2001). It is known that the transparency of orthographic and phonological transformations between base and derived forms affects children's ability to generate and spell derived words (Carlisle, 1988).

With regard to semantic transparency, if the meaning of the base form retains the original meaning after morphological transformation, the base morpheme word is defined as semantically transparent. Whether the base morpheme is semantically transparent or not also may affect understanding the meaning of morphologically complex words, rather than just the speed or accuracy of the word processing. According to Stolz and Feldman (1995), the semantic transparency affects the morphological processing, but the magnitude of its contribution is not large.

In short, the transparency features of word formations influence morphological processing in word recognition along with the frequency of morpheme constituents (Stolz & Feldman, 1995). Therefore, the levels of phonological, orthographical, and semantic transparency of words in literacy instruction for elementary students would need to be differently considered according to their overall linguistic and literacy developments.

Evidences on Morphological Awareness in Reading and Spelling

So far we have discussed the features of morphological word formation (e.g., frequency of morphemes, and transparency of word formation) that contribute to the level of complexity and difficulties for processing and representing the word structure. Along with these structural features of words, a learner factor such as individual differences in

linguistic abilities (e.g., phonological and morphological awareness) can influence their learning to read and write (Carlisle, 1995; Carlisle & Normanbhoy, 1993; Deacon & Kirby, 2004; Fowler & Liberman, 1995; Juel & Minden-Cupp, 2006; Schreuder & Baayen, 1995). This chapter reviews how children's morphological awareness contributes differently to specific components of literacy outcomes (e.g., word reading, comprehension, and spelling). In light of the point that morphemes are meaning-bearing linguistic units, reading models have tended to focus on the relationship between morphological awareness and reading comprehension rather than decoding, particularly of upper grade students (Adams, 1990). However, the association of children's morphological awareness with literacy is not limited to reading comprehension for older students but extends to word reading and analysis for early grade students. The extent to which morphological awareness of children is further associated with specific literacy components (i.e., word reading, reading comprehension, and spelling) may vary depending on other factors such as the developmental level of the children (e.g., grades). Often, the variation in the morphological awareness and its contribution to reading and spelling is related to the children's chronological difference (e.g., ages or grades) and cognitive and linguistic abilities (e.g., LD, ELLs). Therefore, learner differences such as grade levels and learning disabilities will also be reviewed in relation to different literacy components.

Morphological Awareness and Word Reading

The number of morphologically complex words included in a curriculum increases throughout the elementary school years. Therefore, contributions of

morphological ability to accurate and rapid decoding may increase. Morphological awareness is significantly correlated with word reading for early elementary students, even once phonological awareness is statistically controlled (Carlisle, 1995; Deacon & Kirby, 2004; Fowler & Liberman, 1995). Some other research (Carlisle & Normanbhoy, 1993; Carlisle, 2000; Mahony, Singson, & Mann, 2000; Singson et al., 2000) provides additional evidence of the relationship between morphological awareness and word reading, specifying details of some morphological and developmental features contributing to word reading (e.g., type of morphological tasks, grades, complexity of word forms, etc.). Carlisle and Normanbhoy (1993) investigated the extent to which morphological awareness contributes to word reading, with and without consideration of phonological awareness. The participants of 101 first grade children were assessed on two receptive and expressive morphological awareness measures (Judgment of Word Relations; Production of Word Forms), a measure of phonological awareness (Test of Auditory Analysis Skills (TAAS)), Picture Identification Test, and Word Reading Test. The results revealed that phonological and morphological awareness together contributed to word reading of the first grade students. Morphological awareness alone contributed to a small portion of the variance to word reading (4%), but its contribution was still statistically significant, which reflects the unique role of morphological awareness in first grade children's word reading. Interestingly, Carlisle and Normanbhoy (1993) found that word reading was significantly related to the performance on the expressive morphological awareness, but not on the receptive morphological awareness. They interpreted this to indicate the importance of promoting children's active use of morphological rules for improving their word reading.

Mahony and his colleagues (2000) studied the relationship between morphological sensitivity to derivational structures of words and word reading ability of elementary students in different grades. In order to assess morphological sensitivity, 98 students in third (n=25), fourth (n=27), fifth (n=24), and sixth (n=22) grade were asked to respond either to the Morphological Relatedness Test that consists of 40 word items in pairs, of which 20 pairs were administered in ”Written” version and 20 other pairs in “Oral plus written” version. Each version of the test consists of 15 morphologically related pairs and 5 morphologically unrelated pairs. The Word Identification (WI) and Word Attack (WA) subtests of the Woodcock Reading Mastery Test (Woodcock, 1973) were also administered to assess the students’ word reading. Consistent with the findings by Carlisle and Normanbhoy (1993), the results indicated that performance on the Morphological Relatedness test was significantly associated with word reading of the elementary students in third through sixth grade. The contribution of morphological ability to word reading was small (5%) but still significant at the level of $p < .001$, even after controlling the effect of vocabulary and phonological awareness. The results also revealed that reading ability of morphologically complex words increased with grade level and did not differ for both “Written” and “Oral plus written” formats.

In the same line of study, Singson and her colleagues (2000) investigated the relation between morphological skills and word decoding ability of students in grades 3 to 6. To assess morphological skills, the Derivational Suffix Test (DST) was used with a sentence completion task in which the participants were asked to select one from four possible word choices and fill in the blank of a sentence. The task was presented in one of the four conditions that combined presentation type (i.e., written vs. oral plus written) and

item type (i.e., real words vs. nonsense words). As in Mahony et al. (2000), the word reading ability of the participants was assessed with the WI and WA. Results of the study revealed that the participants' performance on the subtests of the Derivational Suffix test is correlated with the two reading measures and increases by grade. Most importantly morphological skills of the participants contributed an additional portion (5%) of the variance of word reading outcome, even after controlling the short term memory variable. Singson et al. (2000) also found that the real word items were recognized more easily than nonsense words and that the "oral plus written" condition had advantage over the "written only" condition. However, the effects of these word types and the presentation conditions became less profound as children's grades increased.

Carlisle and Stone (2005) investigated the role of morphemes in elementary students' reading speed and accuracy of derived words with two different groups of elementary students: one is 39 lower elementary students (i.e., 2nd and 3rd) and the other is 33 upper elementary students (i.e., 5th and 6th). They compared the morphological sensitivity of those students to two-syllable, high-frequency derived words (e.g., *dirty*) and high-frequency pseudo-derived words (e.g., *empty*) as well as two-syllable, low-frequency words (e.g., *queendom*). They also examined the effect of the frequency of words on reading speed and accuracy of the words (i.e., high-frequency derived words vs. low-frequency derived words), particularly when the base-word frequency is high. The words selected for this study were all phonologically and orthographically transparent.

Results indicated that the upper elementary group was faster and more accurate at reading transparently derived words and pseudo-derived words than the lower elementary group, and that both the upper and the lower elementary groups were more accurate at

reading the derived words than the pseudo-derived words. This result reflects that the sensitivity to morphemic structure would facilitate word reading and that syllables and morphemes are distinctive features contributing differently to word reading. For speed of reading, the lower elementary group was faster at reading the derived words than the pseudo-derived words. Meanwhile, the upper elementary students did not differ significantly in the reading of derived and pseudo-derived words, indicating the possible existence of a ceiling effect. This developmental growth over time and the ceiling effect in the upper grades may be consistent with the finding of Deacon and Kirby (2004) that morphological awareness predicts pseudo-word reading in 4th and 5th grades but not in 3rd grade. Carlisle and Stone (2005) also found that, for both groups, reading low-frequency derived words with familiar base forms was less automatic than high-frequency derived words. This result indicates that high-frequency of the base words may not be the main contributor to reading unfamiliar derived words, especially for the lower elementary grade students. In conclusion, Carlisle and Stone (2005) suggest significant relationships between reading derived words and word reading for elementary students.

Morphological Awareness and Reading Comprehension

Morphological ability of elementary students is related to not only their understanding of word meanings at the vocabulary level (McBride-Chang, Wagner, Muse, Chow, & Shu, 2005) but also their reading comprehension in connection with the text (Carlisle, 1995; Carlisle, 2000; Carlisle & Fleming, 2003; Deacon & Kirby, 2004). Carlisle (2000) examined whether there was a relationship between morphological awareness and abilities to define words and passage comprehension. She also examined

how differently the level of frequency and transparency of morphological words influenced the relationship between reading those words and morphological awareness at different grades. The participants of 34 third and 25 fifth graders were given a word reading test (WRT), a test of morphological structure (TMS), and a Definition test in the winter term. The WRT was administered with three different groups of words: high-frequency transparent derived words (e.g., *powerful*), high-frequency shifted derived words (e.g., *explanation*), and low-frequency derived words with high-frequency base forms (*puzzlement*). The TMS was given to assess the participants' awareness of the constitutional relations of base and derived forms with the formats of either decomposing a derived word to finish a sentence (e.g., *Driver*, Children are too young to _____), or producing a derived word to finish a sentence (e.g., *Farm*, My uncle is a _____). Finally, the participants' ability of defining morphological words (Definition) was assessed using a word interview. The participants were asked to provide the meanings of morphologically complex words, to use the meanings in sentences, and to select appropriate meanings from multiple-choice items. In the spring term, two other predicted measures of Vocabulary and Reading Comprehension from the Comprehensive Testing Program (CTP) were administered. In the Reading Comprehension subtest of the CTP, the participants were asked to read short passages and choose the best answers for comprehension questions.

The results showed that the awareness of morphological structure on the TMS was significantly correlated with reading comprehension for fifth graders, while significantly correlated with the ability to read morphologically complex words for both third and fifth graders. This indicates that children's awareness of morphological

structures and reading may have different relationships according to grade levels. The study also showed that the level of frequency and transparency of word items tested had a different influence on the performance of the third and fifth graders.

Many other studies support the contribution of morphological awareness to reading comprehension for elementary students (Carlisle & Fleming, 2003; Deacon & Kirby, 2004; Jarmulowicz, Hay, Taran, & Ethington, 2008; Kieffer & Lesaux, 2007; Nagy, Berninger, & Abbott, 2006; Nagy, Beninger, Abbott, Vaughn, & Vermeulen, 2003). Carlisle and Fleming's (2003) 3-year longitudinal study found that the morphological skills of the groups of both the third and fifth graders did significantly contribute to reading comprehension after two years, indicating that morphological ability emerges in early elementary years, or even before, and continues developing. Deacon and Kirby (2004) found that morphological awareness was more likely to contribute to reading comprehension than to single word reading, supporting the idea that the role of morphological awareness might be mainly constructing meaning. Particularly, the contribution was more obvious for the fourth and fifth graders than the third graders.

With respect to grade differences, other studies provide similar findings. In a study applying a path analysis with data from 76 third graders, Jarmulowicz et al. (2008) found that morphological awareness had only indirect influence on reading comprehension for the third graders. In another study using a structural equation modeling, Nagy et al. (2006) found that morphological awareness had a significant, unique contribution to vocabulary and reading comprehension for three different groups of elementary grades: 4^{th} and 5^{th} graders, 6^{th} and 7^{th} graders, and 8^{th} and 9^{th} graders. These differences may reflect that morphological awareness is either a developmental

continuum and increasingly contributes to reading comprehension or more relevant to more complex tasks which students in higher grades engage in more frequently.

Morphological Awareness and Spelling

Fowler and Liberman (1995) emphasized the possible relation between children's awareness of morphemic structure of words and their orthographical knowledge, mentioning that "morphophonemic representations are more fully specified only after an introduction to literacy" (p. 165). They explored the relationship between knowledge of derivational morphology and spelling of students in ages 7.5 to 9.5. Results from the study indicated that students' spelling was related to their performance on all morphological production tasks that varied according to task type (base target vs. derived target) and the condition of phonological change (phonologically neutral vs. phonologically complex).

Some other studies focused on the relationship between spelling and inflectional morphology in younger children, including emerging spellers in kindergarten and first grade (Rubin, 1988) and early elementary children in first to third grades (Nunes, Bryant, & Bidman, 1997; Walker & Hauerwas, 2006). Walker and Hauerwas (2006) investigated the influence of phonological, morphological, and orthographic awareness skills in first, second, and third graders on spelling of the words with inflected morphemes. In particular, the spelling items consisted of the inflected past with the ending of *-ed* and progressive tense verbs with the ending of *–ing*. Results indicated that for first and second graders both phonological and morphological awareness were related to spelling ability, whereas for third graders morphological awareness was an independent predictor

of spelling ability. With regard to the relationship with sub-components of spelling inflected verbs, performance of first graders was significantly different from that of second and third graders. In first graders either phonological or orthographic awareness or both predicted performance on the sup-components of *–ed* and *–ing*. In second and third grades, morphological awareness predicted performance on the spelling components, specifically *-ing* in second grade and both *–ing* and *–ed* in third grade. The results of this study suggest a developmental relationship between early elementary children's phonological, morphological, and orthographic awareness and learning to spell. That is, once children are systematically introduced to literacy in kindergarten to first grade and acquire more solid skills of mapping their phonological knowledge to basic orthographic knowledge, the relation of morphological awareness to spelling seems to increase through the following years (i.e., 2nd and 3rd grades).

Kemp (2006) investigated the use of base words to spell derived words in young children ranging in ages from 5- to 9-year-olds. Similar to the findings by Walker and Hauerwas (2006), Kemp found that young children's morphological awareness was related to their spelling of morphological words, both inflected and derived words, and that their ability to transfer the morphological knowledge to spelling increased with age. This study also showed that different morphological tasks (e.g., sentence analogy and base-extraction tasks) require different levels of explicitness in morphological awareness and that the level of sentence analogy would be easier to reach than that of base-extraction. The study found that children's ability to transfer their morphological formation knowledge to spelling words is not limited to real-word, derived forms.

The relationship between morphological awareness and spelling seems stronger in upper grades than in younger grades. For older students, the complexity of words they encounter increases. Therefore, studies with participants of upper elementary students have often involved other relevant features (e.g., transparency) in understanding the relationship between morphological awareness and spelling. Leon (2000) examined the aspects of morphological processing and its relationship with spelling. In his study, he investigated the role of speed and accuracy of morphological processing in spelling performance of 226 fourth, fifth, and sixth graders. The participants were asked to respond to four different derivational conditions (i.e., No change, Orthographic change, Phonological change, and Orthographic and Phonological change), each of which contained either 10 source base words or 10 source derived words to be used to complete short sentences. For each condition, the speed on reaction time of spelling and the accuracy on frequency occurrences of appropriate spelling were calculated. Results indicated that accurate and rapid processing of the source base forms of derivational words had a larger effect on spelling performance than of the source derived forms. This effect was evident for all derivational conditions but the "No change" condition. In relation to grade differences, there was no difference between 4^{th} and 5^{th}grades, while there was significant difference between 4^{th} and 6^{th} grades and between 5^{th} and 6^{th} grades. These results indicate that the effect of the accuracy and speed of morphological processing on spelling performance would be the largest for the 6^{th} graders. These results also demonstrate a developmental aspect to morphological awareness.

Carlisle (1988) investigated the relationship between knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth grade. She examined whether

there were any developmental trends in reading and spelling derived words between students in the different grade levels. Sixty-five students in fourth (N=22), sixth (N=22), and eighth (N=21) grade were assessed with the Spelling subtest of Wide Range Achievement Test (Jastak & Jastak, 1978, as cited in Carlisle, 1988), a morphological test with derived words selected to represent the different phonological and orthographic complexity of transformations between derived forms and base forms, a spelling test dictated with the same base words and derived words of the morphological test, and a suffix test with nonsense forms. Results of this study indicated that students' knowledge of derivational morphology and their use of the knowledge for spelling derived words increased by grade, consistent with the findings of the study previously reviewed. This study also supports that the developmental relationships between knowledge of derivational morphology and spelling ability depend on the relative complexity of the morphological transformation related to orthographic and phonological changes.

Purpose of the Study and Research Questions

The purpose of this meta-analysis study is to synthesize studies on morphological awareness and literacy to examine how morphological awareness is related with reading and spelling of elementary school students and to determine moderator variables (e.g., types of morphology, learner types, and grade level categories) that may alter the magnitude of the relationship. This study employs meta-analytic procedures in order to achieve the purpose and address the following questions:

1. What is the relationship between elementary aged students' morphological awareness and three literacy outcome measures (i.e., word reading, reading comprehension, and spelling)?

1a. Is the average effect size representing each relationship significantly different from zero? (analyzed with a one group t-test and the 95% confidence interval around the average effect size)

1b. How variable are the effect sizes representing the relationship between morphological awareness and each literacy outcome? Is there a significant variability in the distribution of the effect sizes for each relationship? (analyzed with the Q statistic)

2. Are the average effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by morphology type (i.e., derivational vs. inflectional)?

3. Are the average effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by learner type (i.e., typical, struggling, mixed)?

4. Are the average effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different when comparing lower and upper elementary grades (i.e., K-3 vs. 4-6th)?

CHAPTER III

METHODOLOGY

To address the research questions posed, meta-analytic procedures were used. Meta-analysis is a systematic, quantitative synthesis of the findings of a body of studies. That is, the unit of analysis in meta-analysis is not a human subject but an individual research report or an effect size. Meta-analysis has some strength in that the steps of the procedures are documented and scrutinized so that readers can assess the quality of the research and the validity of the conclusion(s) drawn in the meta-analysis study (Lipsey & Wilson, 2000). This section presents the methods and procedures for meta-analysis. The procedures of this meta-analysis involve: (1) defining operational concepts of the two main variables (i.e., morphological awareness and literacy), (2) determining inclusion and exclusion criteria for eligible studies, (3) searching and determining eligible studies, (4) developing a coding form, (5) coding research reports, and (6) calculating effect sizes and analyzing the data collected.

Operational Definitions and Categories

For a meta-analysis of the relationship between morphological awareness and literacy outcomes of elementary-aged children, the operational definition of morphological awareness was specified as well as the categories of literacy outcomes.

Definition and Measures of Morphological Awareness

As discussed in a previous section, morphology is the study of word structures consisting of the smallest linguistic units that involve meaning and grammatical functions

(i.e., morphemes). In light of this, the term *morphological awareness* refers to "children's conscious awareness of morphemic structure of words and their ability to reflect on and manipulate that structure" (Carlisle, 1995, p. 195). Therefore, children's morphological awareness can include both their understanding of the linguistic structure of words and their ability to produce/explain morphologically complex words and the word relationship (Carlisle & Normanbhoy, 1993). The various examples of the morphological awareness tasks with a brief description of each of the tasks are listed in Table 1.

Table 1

Descriptions and Examples of Morphological Awareness Tasks

Descriptions	Examples
Identify constituent morphemes of an inflection or a derivational word in a receptive or an expressive way	(ex) Is there a little word in *teacher* that means something like *teach*? (ex) "Comes from" test: Does the word *knowledge* come from the word *know*? (ex) "Comes from" test: Does the word *knowledge* come from any other words that you can think of?
Discriminate the differences between morphemic words and mono-morphemic words looking similar in orthography or in phonology	(ex) sunny vs. silly
Decomposition of an inflectional or derivational word : Supply the appropriate base form, given the inflected or derived form and a short sentence	(ex1) Farmer. My uncle has a _____. (ex2) Growth. She wanted the plant to _____.

Table 1 *(Continued)*

Descriptions	Examples
Production of an inflected or derivational word : Provide the appropriate derived form, given the relevant base form and a short sentence	(ex1) Warm. He chose the jacket for its _____.
Morphological analogy—Word analogy : Apply analogy skills to produce or decompose an inflectional or derivational word given a sentence	(ex) There is a wug. There are two ____ (ex) Reading relates to read as writing relates to ____?
Morphological Analogy—Sentence Analogy : Apply analogy skills to create a sentence that contains an appropriate inflectional or derivational word.	(ex) Present a pair of sentences: "Tom held the puppy"; "Tom holds the puppy." Give another sentence to make the same kind of change: "Tom fed the fish"; _____
Suffix Addition/Deletion :Combine or decompose a base word and a suffix, following the rules that govern the addition/deletion of suffixes to/from inflectional or derivational words	(ex) The first item is as follows: dun + y = _____ (ex) What is left in football if you take away ball?
Morphological fluency on inflectional or derivational words	(ex) Given a word, ask to produce words that contain the "same little piece of the word" as many as possible
Define the meaning of an inflectional or derivational word	(ex) Tell (or write) the meaning of the derived (or inflected) word given (ex) What does the word teacher mean to you?

Each task in Table 1 assesses some aspect of morphological awareness. In this study, the term *morphological awareness* was operationalized as the numerical scales of performance on any measure of the morphological awareness. The morphological awareness tasks which involve derivational or inflectional morphology are tested with varying levels of transparency in either oral or written format, and can also be independent of (e.g., list of words) or incorporated with context (e.g., embedded in a sentence).

Literacy Categories and Measures

Based on the review of previous literature, literacy outcomes are summarized into three categories: word reading, reading comprehension, and spelling. These literacy outcomes can be tested using either standardized or unstandardized experimental measures. Some examples of standardized literacy measures are shown in Table 2.

Word Reading Measures

In general, word reading is measured with the following tasks: (1) general identification of single words in a word reading list (Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004; Deacon, Wade-Woolley, & Kirby, 2007; Fowler & Liberman, 1995; Joanniesse, Manis, Keating, & Seidenberg, 2000; Mahony et al., 2000; McBride-Chang et al., 2005; Nagy et al., 2003; Schwiebert, Green, & McCutchen, 2002; Shankweiler et al., 1995); (2) decoding pseudowords or nonsense words requiring word attack skills (Deacon & Kirby, 2004; Fowler & Liberman, 1995; Jarmulowicz et al., 2008; McBride-Chang et al., 2005; Nagy et al., 2003; Shankweiler et al., 1995); (3)

Table 2

Examples of Standardized Literacy Measures

Word Reading
• Woodcock Reading Mastery Test-Revised (1987): Word Identification, Word Attack • WJ Psycho-Educational Battery (1977): Letter-Word Identification, Word Attack • WJ III Test of Achievement (2001): Word Identification, Word Attack • Wide Range Achievement Test-Revised (1984) • Decoding Skills Test, Words and Nonwords subtests (1986) • Test of Word Reading Efficiency (1999): Pseudoword
Reading Comprehension
• Stanford Diagnostic Reading Test (1994): Vocabulary/Passage Comprehension subtests • Gates-MacGinitie Reading Test (1989): Vocabulary/Passage Comprehension subtests • Woodcock Reading Mastery Test-Revised (1998): Passage Comprehension subtest • Metropolitan Achievement Test: Reading Comprehension subtest • Woodcock Johnson, WJ-15 • Wide Range Achievement Test (2001): Reading Comprehension subtest • Gray Oral Reading Test, Paragraphs (1967) • Formal Reading Inventory (1986)
Spelling
• The Spelling subtest of Wechsler Individual Achievement Test (1991) • The Spelling subtest of the Wide Range Achievement Test (2001) • The Spelling pseudoword of the Wide Range Achievement Test (2001) • Test of Written Spelling (1976)

reading morphologically complex words (Carlisle, 2000; Nagy et al., 2006); and (4) timed word and pseudoword reading rate or accuracy (Siegel, 2008; Nagy et al., 2003).

Reading Comprehension Measures

Reading comprehension measures can include the following tasks: (1) reading a short passage and choosing correct answers to questions (Carlisle, 1995; Carlisle, 2000; Green, McCutchen, Schwiebert, Quinlan, Eva-Wood, & Juelis, 2003; Jarmulowicz et al., 2008; Keiffer & Lesaux, 2007; Ku & Anderson, 2003; Schwiebert et al., 2002; Shankweiler et al. 1995; Siegel, 2008); (2) reading a short passage and identifying a key missing word, which is also called cloze task (Deacon & Kirby, 2004; Keiffer & Lesaux, 2007); and (3) reading a word either isolated or in a short passage and selecting the best meaning of the word from multiple-choice options, which could be part of a vocabulary task (Carlisle, 2000).

Spelling Measures

Typically, spelling is measured with the examiner dictating words and the student writing the words. The spelling tasks can be administered with a series of words of increasing difficulty (Green et al., 2003; Nagy et al., 2006; Schwiebert et al., 2002). Spelling items tested can be real words (Schwiebert et al., 2003) or pseudowords (Siegel, 2008). Spelling tasks with a list of words can also target certain features such as base words, affixes, or the inflected/derived words (Kemp, 2006; Walker & Hauerwas, 2006). Spelling measures can be either standardized or unstandardized.

Inclusion and Exclusion Criteria

Studies for the meta-analysis were selected based on the following criteria:

1. Studies should include morphological awareness as one variable and specific literacy domains (i.e., word reading, reading comprehension, and spelling) as another variable.

2. Morphological awareness should be measured in any of the categories listed in Table 1. The measures can be either standardized or unstandardized experimental measures.

3. The literacy outcomes should be measured in any of the following composite areas: word reading, reading comprehension, and spelling. The measures can be either standardized or unstandardized experimental measures.

4. Regardless of participants' native language, the measures of morphological awareness and literacy outcomes should be assessed in English.

5. Studies should include elementary-aged children (i.e., grades K-6). If both elementary-aged and older children are included in a study, only the studies that provide separate effect size data for the elementary-aged group are included. Studies that provide only aggregated data for both groups are excluded.

6. Studies can include typical learners, struggling learners, or both typical and struggling learners. Struggling learners refer to children with learning disabilities (LD) and at-risk children. Children with LD include those who attend a special education classroom or a remedial session in reading and/or writing, and/or those who are diagnosed with LD. At-risk children include those who attend a general education classroom and receive a supplemental session in reading and/or writing. Struggling

learners also cover any children who are below average, often called poor readers, poor spellers, or struggling readers/spellers in the research literature. Typical learners are normally achieving children and/or those who attend a general education classroom. They are average to above average in reading and/or writing. Studies that include subjects with disabilities other than LD (e.g., behavior disorder) are excluded.

7. Studies should report effect sizes (e.g., correlation coefficient *r* between morphological awareness and any literacy outcomes) or provide sufficient quantitative information to permit calculation of effect sizes (e.g., means and standard deviations, sample sizes, *F*, *t*, etc.). The type of research design is not initially specified as eligibility criteria.

8. Studies should be published (or reported) no earlier than 1980 or currently in press.

9. Studies should be included only if reported in English.

Literature Search and Retrieval

To obtain potentially eligible studies, three main procedures were used: (a) systematic computer searches, (b) a hand-search for specified journals, and (c) a review of the reference lists of studies searched. For the computer searches, multiple bibliographic databases and Google Scholar were used. Educational Resources Information Center (ERIC), PsycINFO, Linguistics and Language Behavior Abstract (LLBA), Dissertation Abstracts International databases, Google Scholar and Article First search engines were systematically scanned from 1980 to 2009. The two topic categories that key words describe are (1) morphological aspect and (2) literacy outcomes. For the

morphological aspect, the following key words were used: *morphological awareness, morphology, morphemic, morpheme, derivation, derivational, inflection, inflectional, inflected, derived, affix, suffix,* and *prefix*. Key words for literacy outcomes include *literacy, reading, decoding, word identification, fluency (rate or accuracy) vocabulary, comprehension,* and *spelling*. The keywords from each category were used in various combinations to find studies on the relationship between morphological awareness and literacy of elementary children. The feature of the wildcard "*" was also used for certain keywords (e.g., morphemic and morpheme, inflection and inflectional, derivation and derivational) when the database has the wildcard function (e.g., ERIC). The studies initially scanned through the databases were checked with the titles, the abstracts, and relevant descriptors to identify the studies that might meet some of the inclusion criteria described previously (e.g., morphological awareness, literacy, grade levels, characteristics of participants). For the Google Scholar search the content of the linked materials were reviewed.

The manual search of relevant journals was also planned to include studies possibly omitted from the computer searches when any journal article within the range of relevant publication year criteria was not electronically accessible but appeared to be relevant. In that case, the relevant articles were attempted to be obtained from the shelf in the University library or through interlibrary loans. The following journals were checked when needed: *Journal of Educational Psychology, Educational Psychologist, Journal of Experimental Child Psychology, Developmental Psychology, Brain and Cognition, Cognition, Applied Linguistics, Applied Psycholinguistics, Journal of Linguistics, Language and Speech, Language, Speech, and Hearing Services in Schools, Journal of*

Speech, Language and Hearing Research, Reading and Writing: An Interdisciplinary Journal, Reading Psychology, Scientific Studies of Reading, Reading Research Quarterly, Journal of Educational Research, Journal of Research in Reading, Journal of Reading Behavior, Reading Improvement, The Reading Teacher, Educational Studies in Language and Literature, Annals of Dyslexia, Journal of Learning Disabilities, Learning Disability Quarterly, Learning Disabilities Research & Practice, Journal of Remedial and Special Education, Journal of Special Education, and *Exceptional Children*.

Reference lists of the eligible studies obtained through the computer search and the hand-search were also reviewed to not leave out any potentially eligible studies. Once a list of candidate studies was developed through the searching procedures, copies of the studies were obtained and carefully reviewed to make decisions on its eligibility for inclusion. While the procedures of searching candidate studies using key words were not very much restrictive in order to not miss any potentially eligible studies, the review of the candidate studies had been done more thoroughly to narrow down the candidate studies to those meeting the other relevant inclusion criteria (e.g., elementary, effect size types, etc.). The decision check sheet was incorporated at the final stage of the decision-making on study inclusion (see APPENDIX A).

Along with the three main procedures described above, 16 selected scholars in the relevant topic area were contacted through emails and asked to share any unpublished research works to address a file-drawer problem. The scholars were selected based on the frequency of appearances of those names in the references of eligible studies. The search using Google Scholar also provided some scholars who contributed to the topic area. Of the 16 scholars contacted, 8 responded to the contact. They mostly reported that their

studies were all published and/or recommended contacting some other researchers, who were initially in the selected contact list, to find any potentially unpublished works. Through the personal contacts and the review of suggested studies, one more unpublished study was further included in this meta-analysis.

Forty-seven eligible studies were initially identified and located through the above search and retrieval procedures. Of the studies, two studies (Jarmulowicz, Taran, & Hay, 2007; Singson, Mahony, & Mann, 2000) were excluded because the data sets used were the duplications of the same authors' studies (Jarmulowicz, Hay, Taran, & Ethington, 2007; Mahony, Singson, & Mann, 2000) included in this meta-analysis, which were published in different journals. Three of the initially identified studies were excluded in the later stages because the researcher found that the studies were based on the relationship between morphological awareness and literacy in French, reported partial correlations, or did not report sufficient information for calculating an effect size. Therefore, the total of forty-two studies was finally used for this meta-analysis. The studies are listed in the reference section with an asterisk sign (*) beside each study.

Coding Procedures

Developing a Coding Protocol

The coding protocol for meta-analysis was developed as shown in APPENDIX B. The eligible studies for this meta-analysis were coded in two general categories of information: information of study characteristics and effect size information. Except for the items about actual values relevant to effect sizes and some identification items, all the coding items in the coding protocol were closed-ended so that the transition to next

procedure (e.g., database creation) would be easier. To assist consistent and accurate coding, a coding manual was also developed. The coding manual includes the definition/description of each item and detailed decision-making guidelines for coding. The coding manual is attached in APPENDIX C.

Coding of Study Characteristics

Information of the study characteristics is the general picture of the entire studies included. This information for the set of eligible studies can be used for descriptive analyses of the studies, which may also provide some explanation for the results of effect size analyses. The study characteristic information was organized as follows: (1) identification of study, (2) general characteristics of subjects, and (3) general features of measures.

The basic information of the study identification includes study identification number, publication year, and type of publication sources (e.g., journal, book, book chapter, technical report, conference paper, or dissertation).

Information about general characteristics of the subjects is coded with total study size, predominant sex, and English speaking status of subjects. Specifically, total study size is coded into four categories: (1) less than 10, (2) 10 to 25, (3) 26 to 100, and (4) more than 100, which are conceptually representing small, medium, large, and very large, respectively. The predominant sex is coded in the five categories representing the different proportions of different sex and another category for “not specified”. Finally, the English speaking status of subjects in the study is coded as native English speakers only, English language learners (ELL) only, or both native English speakers and ELLs

either in separate groups or in a mixed group. If the study did not specify it, the code "not specified" is selected.

General measurement information such as whether multiple measures are used and whether the measures include standardized or experimental or both are coded for each of the morphological awareness and literacy areas.

Coding of Effect Size Level Information

Along with the repetition of the study identification number and the assignment of an effect size sequence number for a specific effect size value, this section includes the following schemes that specifically correspond to the quantitative values for an effect size: (1) features of the literacy variable, (2) features of the morphological awareness variable, (3) sample descriptors, and (4) effect size data.

As for the features of the literacy variable, the main category of the literacy variable is coded in one of the following categories: word reading, reading comprehension, or spelling. This category information, along with the information of the effect size value and the sample size, is later used to calculate the mean effect size between morphological awareness for each of the literacy outcomes. The specific literacy tasks that correspond to the literacy category are further coded in one or more of the following categories: (1) word attack or pseudo-word reading, (2) word identification or single word reading in a list, (3) reading rate or fluency, (4) answering questions about stories, (5) identifying a key missing word in a sentence or short passage, (6) dictation of given words, (7) spelling a target word to complete a sentence, and/or (8) spelling words while writing a story. If the study does not provide

enough specification of the tasks in relation to the effect size, the code "cannot tell" is marked. Finally, the type of the literacy measure specific to the effect size value is coded in two categories, which are standardized and experimental measures.

Some features of morphological awareness were determined by the researcher as important to code under this scheme. The coding items corresponding to each effect size value are as follows: (1) the type of morphology (i.e., derivational morphology, inflectional morphology, or mixed), (2) the type of morphological awareness measures (i.e., standardized or experimental measure), (3) the format of morphological awareness measures used (i.e., single words in a list or words in context) (4) the modality of morphological tasks required (i.e., oral, written, both oral and written, or not clear), (5) the equivalence of frequency of bases and affixes involved in the tasks (i.e., yes, no, or not clear), and (6) the transparency of the morphological items (i.e., transparent only, shift only, both transparent and shift, and not clear).

Sample information specifically corresponding to the effect size data also needs to be coded to analyze the different effect of the specific variable on the relationships between morphological awareness and each of literacy categories. The grade levels of samples are categorized in lower elementary and upper elementary categories. The learning characteristics of the samples are categorized into three learner types: struggling learner, typical learner, and mixed learner which stands for a mixed group of the two learner types.

As for the effect size data, reference information is coded on the items such as the page number(s) and/or the table number(s) where effect size data are found. Most importantly, statistical information about the effect size values and other relevant

information necessary for answering the research questions of the study and/or for conducting statistical adjustments in later analysis are coded. First, if an effect size is directly reported, the type of the calculated effect size is coded along with the effect size value. If the relevant information reported is based on a significant tests (e.g., *t*-test, *F*-test, chi-square, etc.), the type of significant test is coded along with the significant test value and *p*-value, if available. Sample sizes and descriptive statistics (i.e., mean and standard deviation) for each of the accompanying groups also need to be coded whenever available. In particular, the sample size is essential for the inverse variance calculation.

Multiple Effect Sizes

While it is not uncommon for a study to report results on more than one effect size value, there is a concern about using more than one effect size from a single study for a meta-analysis because it is often complicated to establish the independency of the effect size information for analysis (Lipsey & Wilson, 2001). However, for unique and independent constructs or subgroups of samples in a study, it is defensible to include multiple effect sizes from the study for a meta-analysis (Lipsey & Wilson, 2001).

The primary interest and the main purpose of this meta-analysis study was to examine whether there would be a significant relationship between two variables, morphological awareness and literacy, and to see whether the magnitude of the relationships would be different by some other factors (i.e., type of morphology, grade categories, and learner types). In order not to lose any important information at the beginning stage of coding, this study coded information on multiple effect sizes per study. In particular, multiple measures of the literacy variable in three different, critical

categories (i.e., word reading, reading comprehension, and spelling) were considered and coded further information about the specific features relevant. For the morphological awareness variable, a broad range of morphological awareness measures was embraced to define the morphological awareness construct while intending to further code the specific features for each measure (e.g., modality, format, frequency, transparency, etc.). In fact, most of the eligible studies reported more than one effect sizes on different combinations of morphological awareness and any of the literacy measures, which were averaged into an effect size per each literacy category at the later stages before data analyses.

In some studies, effect sizes were presented for different sub-samples of study participants, which can determine the coding of more than one effect sizes (Lipsey & Wilson, 2001, p. 79). This meta-analysis study coded effect sizes separately reported for the sub-samples by grade level category (i.e., lower elementary and upper elementary) and by learner type (i.e., struggling students, typical students, and mixed).

Coding Studies

Once an initial coding form was developed, the procedures for coding the eligible studies were followed. The procedures included recruiting coder(s), training the coders, practicing on coding studies and doing inter-coder reliability checks with selected study samples, and independently coding the rest of the eligible studies.

Recruiting and Training Coders

The main researcher of this study served as one of the coders of this meta-analysis. To find the second coder, a recruiting flyer was distributed to graduate students who are in the College of Education through email. Some graduate students were also contacted

personally. Ideally, the coders were expected to be knowledgeable about the content areas (i.e., language and literacy, students with LD), research designs, and methodologies for social and behavioral sciences. Finally, a graduate student who has knowledge on the literacy measures and has plenty of research assistant experience in the area of early literacy was recruited as a second coder and received the coding training.

The coder received initial training as well as on-going training and discussion sessions. The initial training was mainly focused on understanding the rationale and general procedure of the meta-analysis and the role of coders. In the following training sessions, the coding protocol and the accompanying coding manual were thoroughly reviewed. The main researcher (a coder herself) and the other coder reviewed the concepts/definitions of the coding items in the coding form one by one, defined some examples for better understanding of the relevant concepts, and discussed any possible exceptions in the way of coding. During the training period, the coders practiced coding some selected coding items and a couple of studies to check whether they were following the coding manual well and whether any definitions would need to be further clarified. When any coding items were found still ambiguous, they further discussed and/or defined the concepts to refine the coding rules. The refined definitions and coding rules were included in the coding manual (See APPENDIX C) to reflect the decisions made.

Inter-Coder Reliability

Once clearly understood and agreed upon what and how to code through the trainings and practices, the next step was to independently code the studies in a reliable way. To establish reliability of the coding procedures, 2 out of 42 study reports (Or, 3 of

the 44 studies) were randomly selected and coded by the two coders, and the coded items were compared. Inter-coder agreement rate was calculated by the number of coding items on agreement divided by the number of items on agreement plus the number of items on disagreement. Out of 230 items, 213 items were on agreement, and therefore the inter-coder agreement was 93%.

The inter-coder reliability for each coding item was also calculated using Cohen's kappa (K). The formula for the estimate of K is as follows.

$$K = \frac{P_o - P_e}{1 - P_e}$$

where P_o and P_e are the observed and expected agreement probability rates, respectively. The kappa values were all high (>.70) except for one item, the modality of morphological awareness tasks (=.55). In particular, the kappa values for some important coding items were as follows: literacy category (=1.00), type of morphology (=.87), grade category (=.97), learner type (=.77), and effect size value (=1.00). The relatively low inter-coder reliability for the modality of morphological awareness tasks may be because studies often do not explicitly describe the features of morphological awareness tasks.

Meta-Analytic Data Analysis

Effect size statistics of correlation coefficients were used in this meta-analysis study because the interest of this study was in examining the relationship between the two variables of morphological awareness and literacy. The correlation coefficients can be obtained from correlation research findings on the two continuous variables or converted

from the findings of group experimental comparisons on a dichotomous variable and a continuous variable, or on two dichotomous variables.

Meta-Analysis of Correlation Data

Pearson Product-Moment Correlation Coefficient

The studies included in this meta-analysis directly reported the Pearson product-moment correlation coefficient between morphological awareness and literacy variables. Because the correlation coefficient is a standardized value, the coefficient reported can be used as an effect size index as it is (Lipsey & Wilson, 2001, p. 72):

$$ES_r = r$$

The distributions of the coefficients were also examined using visual graphs such as bar graphs to examine the normality of the distributions and any potential extreme outlier.

Fisher's Zr Coefficient

While the correlation coefficient itself is an effect size statistic that can be interpreted for meta-analysis, the sampling distribution of the correlation coefficients, which is also called the standard error of the mean, is not normally distributed but skewed because the correlation is bound by +1 and -1. The skewed sampling distribution of the effect sizes can hardly be used for testing hypotheses that require a normal distribution and could be problematic in meta-analysis. More importantly, the standard error is used to determine the confidence intervals around the mean effect size as well as to obtain the weight of the inverse variance for adjusting the bias due to the sample sizes.

To better address the normal distribution condition, the correlation coefficients were transformed to Fisher's *Zr* coefficients. This Fisher's *Zr* transformation can be done for the effect size from each individual study before averaging the effect sizes of eligible studies or for the averaged effect size of the product-moment correlation coefficient. The effect size formula of the Fisher's *Zr* correlation, ES_{Zr}, is as follows (Lipsey & Wilson, 2001, p. 64):

$$ES_{Zr} = Z_r = .5 \log_e \left[\frac{1+r}{1-r}\right]$$

$$SE_{Zr} = \frac{1}{\sqrt{n-3}}$$

$$w_{Z_r} = \frac{1}{SE_{Z_r}^2} = n - 3$$

where *r* is the individual correlation, $\log_e$ is the natural logarithm, SE_{Zr} is the standard error of the Fisher *Zr*, *n* is the total number of samples, and w_{Zr}, is the inverse variance.

For the purpose of interpretation, the individual or mean Fisher's *Zr* transformed correlations are converted back into regular correlation coefficient *r* using the following formula.

$$r = \frac{e^{2ES_{Z_r}} - 1}{e^{2ES_{Z_r}} + 1}$$

Meta-Analysis of Group Comparison Data

In this study, group comparison data was not intended to be excluded for coding and analysis. Group comparison study findings can be similarly represented as the

relationship between two variables in certain situations. One possible situations is to view that either morphological awareness or literacy variable is the dichotomized independent variable (e.g., low vs. high morphological awareness groups) and the other variable becomes the continuous dependent variable.

The relationship between the dichotomous and continuous variables can be estimated using the point-biserial correlation coefficient. When descriptive statistics such as means, standard deviations, and sample sizes for each group were reported in a study, the point-biserial correlation coefficient r_{pb} can be calculated as follows (Lipsey & Wilson, 2000, p. 62, p. 201).

$$r_{pb} = \frac{ES_{sm}}{\sqrt{\frac{1}{p(1-p)} + ES_{sm}^2}}$$

$$ES_{sm} = \frac{\bar{X}_1 - \bar{X}_2}{s_{\text{pooled}}}$$

$$s_{\text{pooled}} = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

Where ES_{sm} is the standardized mean difference effect size, p is the proportion of total sample sizes in one of the two groups, $\bar{X}_1$ and $\bar{X}_2$are the means of the groups 1 (e.g., low spelling ability) and 2 (e.g., high spelling abilities) on the dependent variable (e.g., morphological awareness), s_{pooled} is the pooled standard deviation for the dependent measure, s_1 and s_2 are the standard deviations for the two groups, and n_1 and n_2 are the sample sizes for each of the groups.

The group comparison studies often reported the values of an independent group *t*-test (*t*-value) or a one-way analysis of variance (*F*-value) test for the two or more group comparisons along with the sample sizes for each group. In this meta-analysis, however, if studies reported both descriptive statistics (i.e., means and standard deviations) and the statistic values from those tests, the descriptive values were used to calculate the corresponding point-biserial correlation coefficients. Similar to the product-moment correlations, the point-biserial correlations were transformed to Fisher's Zr prior to analysis.

Calculating Mean Effect Sizes

Assuming that the number of subject *n* is the same across studies, the mean effect size estimate $\bar{Z}_r$ of *k* studies can simply be averaged. However, in most situations the sample sizes of studies that are combined for a meta-analysis are different. As mentioned previously, the Fisher *Zr* coefficients converted should be weighted by the sample size (*n*) of each study. The inverse variance weight corresponding to each study is as follows (Lipsey & Wilson, 2001, p. 64):

$$w_{Zr} = n - 3 \quad = df$$

Given the weights for the studies with different number of samples, weighted mean of the effect sizes of the Fisher *Zr*, $Z_{r\_weighted}$, is obtained using the following formula (Rosenthal, 1991, p. 74, p. 87):

$$\bar{Z}_{r\_\text{weighted}} = \frac{\sum_j w_j Z_{rj}}{\sum_j w_j} = \frac{\sum_j (n_j - 3) Z_{r_j}}{\sum_j (n_j - 3)} = \frac{\sum_j df_j Z_{rj}}{\sum_j df_j}$$

The standard error of the mean effect size, the *z*-test, and 95% confidence intervals around the mean effect sizes were also calculated using the following formulas (Lipsey & Wilson, 2000, p. 114):

$$SE_{\bar{z}_{r\_w}} = \sqrt{\frac{1}{\sum w_i}}$$

$$Z = \frac{\bar{Z}_{r\_w}}{SE_{\bar{z}_{r\_w}}}$$

$$95\ \%\ \text{CI}: \ \bar{Z}_{r\_w} \pm 1.96\ (SE_{\bar{z}_{r\_w}})$$

When necessary, graphs such as box plot charts would also be provided for visual analysis of the distribution of the effect sizes.

Homogeneity Analysis

The test of heterogeneity is conducted to determine whether or not the variation in effect sizes could be accounted for by sampling error alone. The statistical significance of the heterogeneity of the mean effect size $\bar{Z}_r$s can be obtained from a chi-square statistic (χ^2) using the following formulas (Rosenthal, 1991, p. 74):

$$\sum (n_j - 3)\left(Z_{r_j} - \bar{Z}_r\right)^2 \text{ is distributed as } \chi^2 \text{ with K-1 } df$$

or

$$Q = \sum \left(w_j \text{ x } {Z_{r_j}}^2\right) - \frac{\left[\sum (w_j \text{ x } Z_{r_j})\right]^2}{\sum w_j}$$

The statistic Q is tested against a chi-square distribution with k-1 degrees of freedom, where $w_j = n_j$ - 3 and k equals the number of effect sizes included.

If the test result is significant, the effect sizes in the distribution are assumed to be heterogeneous, which indicate that there is more variance across the effect sizes than expected due to sampling error alone. Therefore, combining individual effect sizes and interpreting the combined effect size estimates should be done with caution. There may be some distinctly different groups within the aggregated distribution of effect sizes, or exist extreme values in effect sizes.

Analyses of Effect Sizes and Moderator Variables

For the studies that reported multiple effect sizes, the effect sizes were first aggregated into one effect size per each literacy category per study, and averaged for each literacy category to examine the overall relationship between morphological awareness and literacy of elementary children. The homogeneity among the aggregated effect sizes within each category (Q_w) and the differences between the categories (Q_B) were tested to examine the variability of the effect sizes (Lipsey & Wilson, 2001).

This study hypothesized that there would be significant variability among the effect sizes beyond sampling errors for the relationship between morphological awareness and each literacy category. Therefore, the influence of moderating variables on mean effect size estimates was further examined with fixed-effect models. The priori moderators hypothesized were (1) morphology types, (2) learner types, and (3) grade categories. Effect sizes into each moderator variable were averaged to obtain a mean effect size. Based on the assumption that the distribution of effect sizes within each

category of the corresponding variable is homogeneous, the data analyses on the variables of interest such as different grade levels, different student types, and morphology types were done using either independent groups *t*-tests or analyses of variance (ANOVA).

CHAPTER IV

RESULTS

The current study attempted to answer the following questions:

1. What is the relationship between elementary aged students' morphological awareness and each of the three different literacy outcome measures (i.e., word reading, reading comprehension, and spelling)?
   1a. Is the mean effect size representing each relationship significantly different from zero (analyzed with a one group *t*-test and the 95% confidence interval around the mean effect size)?
   1b. How variable are the effect sizes representing the relationship between morphological awareness and each literacy outcome? Is there a significant variability in the distribution of the effect sizes for each relationship (analyzed with the *Q* statistic)?
2. Are the mean effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by morphology type (i.e., derivational vs. inflectional)?
3. Are the mean effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by learner type (i.e., typical, struggling, mixed)?
4. Are the mean effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by grade category (i.e., lower grade: K-3rd vs. upper grade: 4-6th)?

Before addressing the specific questions, descriptive information will be provided on the studies found to meet the eligibility criteria discussed in Chapter 3. After this general description of studies, analyses addressing the research questions will be presented.

Descriptive Characteristics of Eligible Studies

The literature search from 1980 to current (2009) yielded a total of 42 publications. Of the 42 eligible publications, two included two independent studies in a single study report. Therefore, the total number of studies included for analysis was 44 studies.

Study Information

Of the 44 studies, 6 were published before 2000, 37 were published between 2000 and 2009, and one was not published but in press at the time of study retrieval. The majority of the studies were from journal articles (36 counts or 81.8 %), and the remaining 28.2 % included two book chapters, five dissertations (including one masters' thesis), and one ERIC research document.

General Characteristics of Study Subjects

Table 3 shows the frequency and percent of the studies regarding subject characteristics including the total sample size, the predominant sex, and the English speaking status of students participated. Nineteen studies (56.8 %) reported a total sample

size more than 100, and 25 studies (43.2 %) had between 26 and 100 subjects. No study had a total sample size less than 25 subjects.

Table 3

Characteristics of Subjects at the Study Level

Characteristics of study subjects	Frequency	Percent (%)
Total sample size		
Less than 10	--	--
10 to 25	--	--
26 to 100	25	56.8
More than 100	19	43.2
Predominant sex		
Less than 10% male students	--	--
10-49% male students	15	34.1
50 % male students	2	4.5
51-90% male students	15	34.1
More than 10% male students	--	--
Not specified	12	27.3
English speaking status		
Native speaking students only	22	50.0
English language learners (ELLs) only	2	4.5
Both native speakers and ELLs	4	9.1
Not specified	16	36.4

Boys were predominant in 15 studies, girls were predominant in 15 studies, and only two studies reported an equal number of boys and girls. Twelve studies (27.3 %) did not provide information on the predominant sex of the study subjects, or if they did, it was reported as a proportion and the actual number could not be determined.

The majority of the studies used native English speaking students only, which constituted 50% (22 counts) of the studies. Two studies used English language learners only. Not surprisingly, both the ELL studies were published more recently, 2007, and captures the changing demographics in the field of education. Four studies included both English language learners and English speaking students, and were published between 2006 and 2009. Of the 44 studies, 16 studies (36.4%) did not specify the English speaking status of the study subjects, possibly because the main interest of the study was not in examining differences in English speaking status.

General Characteristics of Measures

Table 4 describes the type (e.g., standardized, experimental) and the number of morphological awareness and literacy measures employed in the 44 studies. In terms of the measures used to assess morphological awareness, the majority of the studies (42 counts or 95.5 %) used at least one experimental measure (i.e., only experimental or both experimental and standardized measures). Of those 42 studies, 26 employed a single morphological awareness measure and 16 employed multiple measures. Of the three studies that employed at least one standardized measure (i.e., only standardized, or both experimental and standardized measures), two studies used only standardized measures

and one study used one standardized measure, and the other used multiple standardized measures.

Table 4

General Characteristics of Measures at the Study Level

Characteristics of measures	Frequency	Percent (%)
Morphological awareness measures		
Single measure, standardized	1	2.3
Single measure, experimental	26	59.1
Multiple measures, standardized only	1	2.3
Multiple measures, experimental only	15	34.1
Multiple measures, both standardized and experimental	1	2.3
Literacy measures		
Single measure, standardized	6	13.6
Single measure, experimental	3	6.8
Multiple measures, standardized only	20	45.5
Multiple measures, both standardized and experimental	15	34.1

The measures used to assess literacy were a bit different with the majority of studies (41 counts or 93.2 %) using at least one standardized measure. Of the 41 studies that used standardized measures, 20 used multiple standardized measures, 6 used one standardized measure, and 15 employed both standardized and experimental literacy measures. Three studies used an experimental literacy measure only.

While each study employed at least one measure of both morphological awareness and literacy, it was not the case that all the combinations of morphological awareness (i.e., derivational and inflectional) and literacy measures (i.e., reading, spelling, and comprehension) were found in each study. Depending on the focus of the research project, some studies examined the relation of morphological awareness to spelling, while others examined the relation of morphological awareness and word reading, comprehension, and spelling. There were many variations across the studies which account for the varying numbers of effect sizes by study as well as by independent variable reported here.

Effect Size Data across Studies

This section presents descriptive information on the number of effect sizes from the 44 eligible studies. Pearson product-moment correlation coefficients were used in this study as the reported metric of effect size. A total of 337 effect sizes that were correlation coefficients were identified in the 44 studies. As seen in Figure 1, the distribution of the effect sizes was negatively skewed. That is, a greater number of effect sizes were distributed on the right of the mean than on the left. In this negatively skewed distribution, one effect size showed a negative relationship (r = - .20), while all the other effect sizes were positive. The mean of the 337 effect sizes was .43 with a standard deviation of .17. The standard error of the mean was .01, and the 95 % confidence interval for the mean was .41 to .44.

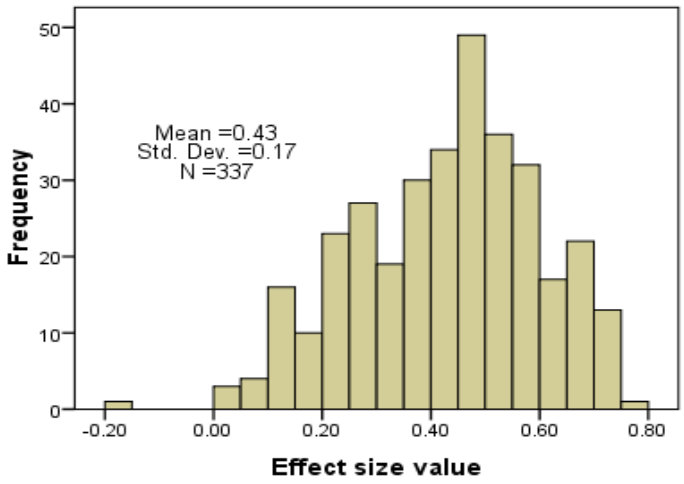

Figure 1. Histogram showing the distribution of 337 effect sizes.

It is common in meta-analysis research that more than one effect size is reported per study. As shown in Figure 2, 5 of the 44 studies provided only one effect size, and the rest of the studies had more than one effect size. While a majority of the studies with multiple effect sizes reported a small to medium number of effect sizes (i.e., 2 to 8 effect sizes each), the other eight studies reported a relatively large number of effect sizes (i.e., 9 to 56 effect sizes).

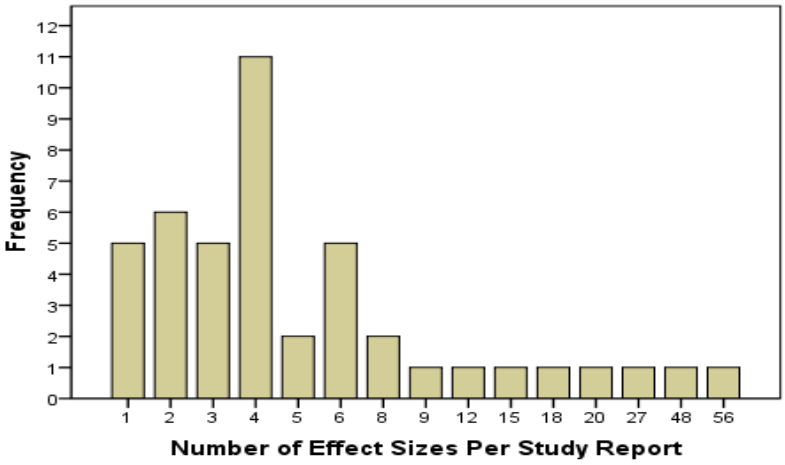

Figure 2. Histogram displaying the number of effect sizes per study.

Common approaches of dealing with multiple effect sizes within a study are to either select a single effect size from the study, or to average all of the study effect sizes into a single mean value (Lipsey & Wilson, 2001). For this study, effect sizes were averaged within each study for each category of the independent variable being investigated. Table 5 summarizes the number of effect sizes by independent variable to address each research question as well as the *a priori* analytic approach. After gathering the effect sizes, a number of the research questions needed modification due to the limited number of effect sizes. These modifications are also presented in table 5. For each independent variable the effect sizes in each category of the variable were based on different groups of subjects in the original studies and are, therefore, independent of each other in the analyses.

Fisher's Z Transformations

As previously mentioned, the distribution of Pearson product moment correlations is skewed for different true population values of the correlations. This complicates comparisons of correlations since they are based on different sampling distributions. In order to facilitate comparisons on a common scale, Pearson correlation coefficients were transformed into Fisher's *Z* values but are reported in the original metric for purposes of interpretation.

Table 5

Data Set Used and Number of Effect Sizes Across Research Questions by Literacy Category

Research question	Data set (Analysis)	By	Literacy category		
			WR	RC	SP
• Is there a significant relationship between elementary aged students' morphological awareness and each of the three different literacy outcome measures?	89 ES (One group *t*-tests)		*n* = 38	*n* = 31	*n* = 20
		Morphology	WR	RC	SP
• Are the mean effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by morphology type?	82 ES (Two-way ANOVA)	Derivational	*n* = 27	*n* = 25	*n* = 12
		Inferential	*n* = 9	*n* = 3	*n* =6
			Literacy category collapsed:		
	[a] 50 ES (Indep. group *t*-test)	Derivational	*n* = 37		
		Inferential	*n* = 13		

Table 5 *(continued)*

Research question	Data set (Analysis)	By Learner	Literacy category WR	RC	SP
• Are the mean effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by learner type?	89 ES (Two-way ANOVA)	Struggling	*n* = 4	*n* = 3	*n* = 2
		Typical	*n* = 25	*n* = 21	*n* = 15
		Mixed	*n* = 9	*n* = 7	*n* = 3
	[a] 69 ES (Two-way ANOVA)	Typical	*n* = 25	*n* = 21	Excluded
		Collapsed	*n*=13	*n*=10	
		Grade	WR	RC	SP
• Are the mean effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by grade category?	89 ES ([b] 77 ES) (Two-way ANOVA)	K-3rd	*n* = 19	*n* = 12	*n* = 11
		4th-6th	*n* = 12	*n* = 16	*n* = 7
	89 ES ([c] 59 ES) (Two-way ANOVA)	K-3rd	*n* = 19	*n* = 12	Excluded
		4th-6th	*n* = 12	*n* = 16	

Note. ES=effect sizes. WR=word reading. RC=reading comprehension. SP=spelling. Collapsed= Struggling+Mixed learners.

a. Modified analysis. b. Mixed grade category was filtered out. c. Mixed grade and spelling categories were not considered.

Unweighted and Weighted Mean Effect Sizes

The distribution of the effect sizes presented above was based on mean effect sizes without any consideration of the sample size on which each effect size was based. However, this meta-analysis study also used inverse variance weighting as a strategy to make sure that there would be no bias due to different sample sizes. The weighted mean effect size (WES) for the correlation coefficients was calculated by using the inverse variance weight, which adjusts the within-sampling error by the number of study participants contributing to the effect size (i.e., $w = n - 3$). The unweighted and weighted mean effect sizes as well as the confidence interval around the weighted mean effect sizes were examined, particularly regarding research question 1 that examined the mean relationship between each literacy category and morphological awareness.

Relationship between MA and Each Literacy Category

One of the research interests in this study was to find whether the mean effect size representing the relationship between each of the literacy categories and morphological awareness was significantly different from zero, and, if so, how variable the effect sizes were for each relationship. The relevant research questions were:

1. What are the relationships between elementary aged students' morphological awareness and each of the three different literacy outcome measures (i.e., word reading, reading comprehension, and spelling)?

1a. Is the mean effect size representing each relationship significantly different from zero (analyzed with a one group *t*-test and the 95% confidence interval around the mean effect size)?

1b. How variable are the effect sizes representing the relationship between morphological awareness and each literacy outcome? Is there significant variability in the distribution of the effect sizes for each relationship (analyzed with the *Q* statistic)?

To address this research question, the set of 89 effect sizes from the 44 studies that reported one or more effect sizes was used, which resulted in 38 effect sizes for word reading, 31 for reading comprehension, and 20 for spelling (see Table 5). Because the research question of interest was whether each individual relationship was significantly different than zero, three separate one sample *t*-tests were conducted.

The assumptions of normality and independence of residuals on the dependent variable (i.e., effect sizes) for the one sample *t*-tests were also checked. The normality tests (i.e., Kolmogorov-Smirnov D test, Shapiro-Wilk's W test) showed no significant results, the skewness and kurtosis of the distributions were between -1.0 and +1.0, and there were no outliers in the box plots. For each one sample *t*-test, the standardized residuals of the effect sizes were evenly scattered above and below the horizontal line of the standardized residual of 0. These results indicate that the assumption of normality and the independence of residuals were met for each of the one-group *t*-tests.

Table 6 shows the results of the three one-group *t*-tests for the relationships between the literacy categories and morphological awareness. As shown in Table 6, the

mean relationship between each literacy category and morphological awareness was significantly different from zero: word reading $t(37) = 14.40$, $p < .001$; reading comprehension $t(30) = 15.65$, $p < .001$; and spelling $t(19) = 13.39$, $p < .001$. The results of the one-group *t*-tests confirmed that there was a significant, non-zero positive relationship between elementary children's abilities/performances on the literacy categories and their morphological awareness.

Table 6

Results of the Three One-group t-tests for the Mean Relationships

Relationship	*M*	*SD*	*df*	*t*	*p*
Word reading and MA	.45	.19	37	14.40	<.001
Reading comprehension and MA	.55	.20	30	15.65	<.001
Spelling and MA	.46	.15	19	13.39	<.001

Note. MA refers to morphological awareness.

The three separate one sample *t*-tests for the mean relationships were based on the mean effect sizes unweighted by the number of samples. Table 7 summarizes the unweighted mean effect size between each literacy category and morphological awareness in the third column. The unweighted mean relationships of morphological awareness with the literacy categories were all positive and relatively large. Specifically, the relationship of morphological awareness with word reading was .45, reading comprehension was .55, and spelling was .46. Table 7 also shows weighted mean effect size (WES) between each literacy category and morphological awareness and the 95%

confidence interval (CI) around each of the weighted means along with the standard errors (SE). As can be seen in Table 7, the weighted mean relationships by the inverse variance weight (w=n-3) ranged from .46 to .56 (WES=.50 for word reading, WES=.56 for reading comprehension, and WES=.46 for spelling). There was little difference between the unweighted and weighted effect size estimates except for word reading (.45 versus .50).

Table 7

The Mean Relationship Between MA and Each Literacy Category

				SE of the	95% CI for the WES			
Lit. category	*m*	UWES	WES	WES	Lower	Upper	*Q*	Q_B
								18.14***
Word reading	38	.45	.50	.02	.47	.53	154.30***	
Comp	31	.55	.56	.02	.53	.59	118.62***	
Spelling	20	.46	.46	.02	.42	.50	41.96**	

**p < .01. ***p<.001.

The 95% CI around the WES for each of the literacy categories were relatively narrow indicating that the estimation of the magnitude of the relationship was relatively precise (Lipsey & Wilson, 2001). The mean *Z*-transformed values were converted back to Pearson's correlations for better interpretation of the magnitude of each relationship. After transformation, the mean relationships were .46 for word reading, .51 for reading

comprehension, and .43 for spelling, respectively. Same as with the unweighted mean relationships, the magnitudes of the weighted mean relationships were large according to Cohen's rules of thumb (Cohen, 1988).

The heterogeneity of the effect sizes for each relationship (Q) and the heterogeneity of the effect sizes between literacy categories (Q_B) were also examined to determine whether the variability within each relationship or between the relationships was greater than would be expected as a result of sampling error (see the last two columns of Table 7). As noted in Table 7, the tests for each of the literacy categories were statistically significant: word reading $Q(37)=154.30$, $p < .001$; reading comprehension $Q(30)=118.62$, $p < .001$; and spelling $Q(19)=41.96$, $p < .01$. The results showed that there was variability of effect sizes for each relationship. These results suggest that further analyses within each literacy category would be useful to determine whether other variables can account for the observed differences in effect sizes (Lipsey & Wilson, 2001).

The between-level homogeneity test was also statistically significant, Q_B (2) =18.14, p<.001, indicating that there was significant variation of the distributions of effect sizes among the three literacy categories. This significant homogeneity test result implies that there are differences in the mean relationships between literacy and morphological awareness by literacy category.

Relationships between MA and Literacy by Morphology Type

This study hypothesized that morphology type is a potential variable contributing to the heterogeneous variability of the distribution of the effect sizes for each literacy category. To examine the hypothesis, the second research question was:

2. Are the mean effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by morphology type (i.e., derivational vs. inflectional)?

To address this research question, the set of 89 effect sizes from the 44 studies that reported one or more effect sizes was first used for analysis (i.e., two-way ANOVA), which relates a) derivational morphology to word reading (*n*=27), reading comprehension (*n*=25), and spelling (*n*=12); and b) inflectional morphology to word reading (*n*=9), reading comprehension (*n*=3), and spelling (*n*=6) (see Table 5). Because the numbers of effect sizes relating inflectional morphology to specific literacy categories were very small, the decision was made to collapse across literacy type for analysis. As shown in Table 5, the set of 50 effect sizes was used for the modified analysis (i.e., an independent groups *t*-test by morphology type), with derivational (*n*=37) and inflectional (*n*=13) morphology. As previously mentioned, the 50 effect sizes were obtained by collapsing the three literacy categories within a study and, therefore, are independent by the independent group levels and morphology construct level. This modification allowed the examination of the relationship of derivational and inflectional morphology to an overall

literacy outcome (combined word reading, spelling, and reading comprehension) using an independent samples *t*-test.

For the independent sample *t*-test, the assumptions of independence, normality, and homogeneity of variances were examined. According to the plot of standardized residuals versus standardized predicted values of the effect sizes, the distribution of the standardized residuals had slightly more spread in the points for the larger predicted values than for the smaller predicted values. However, the number of values outside the general distribution was minimal. Therefore, it is possible to conclude that the scatter of the residuals was evenly balanced and the assumption of independence was met.

The assumption of normality was also checked with tests of normality (i.e., Kolmogorov-Smirnov, Shapiro-Wilk's), graphical methods (i.e., histogram and box plot), and review of skewness and kurtosis. For derivational morphology, the normality tests were not significant ($p > .05$), the distribution of the dependent variables (i.e., effect sizes) was approximately normal, and the distribution of skewness and kurtosis was between -1 and 1. For inflectional morphology, the Kolmogorov-Smirnov test was significant at the $p < .05$, the examination of the box plot identified a single outlier, and skewness (1.05) of the distribution was slightly beyond the range of -1.0 to +1.0. However, the Shapiro-Wilk's test was not significant ($p > .05$) and skewness was not severe. Therefore, it can be concluded that the distribution of the effect sizes was approximately normal. Levene's test for homogeneity of variance was not significant ($p > .05$). Overall, the assumptions of independence, normality, and homogeneity of variance for the independent samples *t*-test were met.

Table 8 shows the result of the independent samples *t*-test on the 50 effect sizes. The means for derivational morphology and for inflectional morphology were .51 and .44, respectively. Considering the respective standard deviations (i.e., .19 and .16) and the sample sizes (i.e., 37 and 13), the difference of the means (i.e., 0.07) was not large. The result of the independent groups *t*-test by morphology type was not significant, $t(48) = 1.11$, $p > .05$.

Table 8

Group Statistics and Results of an Independent Groups t-test by Morphology Type

	Group statistics			*t*-test for equality of means		
Type of morphology	*n*	*M*	*SD*	*T*	*df*	*p*
Derivational	37	.51	.19	1.11	48	.27
Inflectional	13	.44	.16			

The omega squared for the independent samples *t*-test ($\omega^2 = .005$) showed a small association (Cohen, 1988; Kirk, 1995), indicating that only 0.5% of the variance in the relationships between literacy and morphological awareness was accounted for by morphology type. Statistical power of .19 was observed for this independent samples *t*-test.

Relationships between MA and Literacy by Learner Type

Another hypothesis in this study was that the type of learner is a potential variable that contributes to the heterogeneous variability of the distribution of the effect sizes.

3. Are the mean effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by learner type (i.e., typical, struggling, mixed)?

To address this research question, the set of 89 effect sizes from the 44 studies that reported one or more effect sizes was used for analysis (i.e., a two-way ANOVA by three different literacy categories and three different learner types). As seen in Table 5, the gathered data set resulted in the following number of effect sizes by learner type and literacy category: a) struggling learner to word reading = 4, reading comprehension = 3, and spelling = 2; b) typical learner to word reading = 25, reading comprehension = 21, and spelling = 15; and, c) mixed learner to word reading = 9, reading comprehension = 7, and spelling = 3. Because of the small number of effect sizes for the struggling and mixed learner types as well as the spelling measure, the decision was made to exclude the spelling category and collapse the categories of struggling and mixed learners. This revision then examined the differences by learner type of typical type versus a collapsed type of mixed and struggling learners on word reading and comprehension.

As shown in Table 5, this modification resulted in a set of 69 effect sizes for the modified analysis (i.e., a two-way ANOVA by two levels of learner type and two levels of literacy). By collapsing the struggling and mixed learner categories and excluding the spelling category, the data set resulted in the following number of effect sizes for analysis: (a) typical learner for word reading = 25 and for reading comprehension = 21; and (b) collapsed learner for word reading = 13 and for reading comprehension = 10.

The assumptions of independence, normality, and homogeneity of variances for the two-way ANOVA were examined and all the assumptions were met. In the plot of standardized residuals versus standardized predicted values of the effect sizes for the literacy and learner type factors the standardized residuals were evenly distributed. Therefore, the assumption of independence was met. Tests of normality and examination of the normal *Q-Q* plots by learner type and literacy indicated that the distributions of the effect sizes were approximately normal. Levene's test of homogeneity of variance was not significant ($p > .05$).

Table 9 presents the means and standard deviations related to the ANOVA by literacy and learner type. The difference between the means for the levels of the learner type factor across the levels of the literacy factor (.49 vs. .51) was small, and the difference between the means for the levels of the literacy factor across the levels of the learner type factor was slightly larger (.45 vs. .55). The standard deviations for the learner type and literacy factors ranged from .19 to .20.

Table 9

Descriptive Statistics for the Literacy and Learner Type Factors with 69 Effect Sizes

	Word reading	Reading comprehension	Total
Learner type	*M (SD)*	*M (SD)*	*M (SD)*
Typical	.44 (.20)	.54 (.19)	.49 (.20)
Collapsed	.47 (.19)	.56 (.20)	.51 (.20)
Total	.45 (.19)	.55 (.20)	.50 (.20)

Differences among these means were examined using two-way ANOVA by literacy and learner type. As shown in Table 10, there was no significant main effect of the literacy factor, $F(1, 68)= 3.45$, $p= .07$, no significant main effect of the learner type factor $F(1, 68)=.25$, $p=.62$, and no significant interaction effect of the two factors, $F(1, 68) =.01$, $p=.93$.

Table 10

Results of a Two Way ANOVA by Literacy and Learner Type

	SS	*df*	*MS*	*F*	*p*
Literacy	.14	1	.14	3.45	.07
Learner type	.01	1	.01	.25	.62
Literacy x Learner type	.00	1	.00	.01	.93
Within	2.54	65	.04		
Total	2.71	68			

Omega squared (ω^2) was $\omega^2=.036$ for the main effect of the literacy factor; $\omega^2 =.0$ for the main effect of the learner type factor; and $\omega^2 =0$ for the interaction of the literacy and learner type factors. These results indicate that the relationship between literacy and morphological awareness was not accounted for by learner type or by the interaction of the literacy and learner type factors. About 4% of the variation in the relationship between literacy and morphological awareness was accounted for by the literacy categories (Cohen, 1988; Kirk, 1995). Statistical power for the ANOVA tests on the main

effect of the literacy factor, the main effect of the learner type factor, and the interaction of the two factors was .45, .08, and .05, respectively.

Relationships between MA and Literacy by Grade Category

Another hypothesis was that the grade level of the student contributed to the heterogeneous variability of the distribution of the effect sizes. Therefore, the following question was addressed in this study.

4. Are the mean effect sizes representing the relationship between morphological awareness and each literacy outcome significantly different by grade category (i.e., lower grade: K-3 vs. upper grade: 4-6th)?

To address this question, the set of 89 effect sizes from the 44 studies that reported one or more effect sizes was first used for a two-way ANOVA by grade level and literacy category factors (see Table 3). Because the mixed grade level was filtered out during the data analysis process, a total of 77 effect sizes was used in the final analysis. As seen in Table 5, the number of effect sizes for lower elementary level (i.e., K-3rd) was 19 for word reading, 12 for reading comprehension and 11 for spelling. For the upper elementary level (i.e., 4th -6th) the numbers of effect sizes were 12 for word reading, 16 for reading comprehension, and 7 for spelling. The number of effect sizes for spelling was relatively small for both grade categories (n=11 for lower elementary, n= 7 for upper elementary). Therefore, the decision was made to exclude the spelling category. As presented in Table 5, the modification resulted in using a set of 59 effect sizes for a

two-way ANOVA. By excluding the spelling category, the data set had the following number of effect sizes for analysis: (a) lower elementary: word reading=19 and comprehension=12; (b) upper elementary: word reading =12 and comprehension=16.

The assumptions of independence, normality, and homogeneity of variances for the two-way ANOVA were examined. The plot of standardized residuals versus standardized predicted values of the effect sizes for the literacy and grade factors showed that the distribution of the standardized residuals was evenly distributed above and below the standardized residual of 0. The tests of normality and the examination of the normal *Q-Q* plots by grade and literacy indicated that the distribution of the effect sizes was approximately normal. Finally, Levene's test of homogeneity of variance was not significant ($p > .05$). Therefore, it can be concluded that all the assumptions were met for the ANOVA analysis.

Table 11 shows the means and standard deviations related to the two-way ANOVA by grade level and literacy category factors.

Table 11

Descriptive Statistics for the Literacy and Grade Factors with 59 Effect Sizes

	Word reading	Reading comprehension	Total
Grade	*M (SD)*	*M (SD)*	*M (SD)*
Lower (K-3rd)	.42 (.21)	.55 (.26)	.47 (.23)
Upper (4th-6th)	.46 (.15)	.54 (.16)	.50 (.16)
Total	.44 (.19)	.54 (.20)	.49 (.20)

According to Table 11, inspection of the means revealed that there was little difference between the means for different levels of the grade category across literacy types (.47 vs. .50).

Table 12 presents the results of the two-way ANOVA examining literacy and grade factors. There was no significant main effect for the: (a) literacy factor, $F(1, 55)= 3.73$, $p= .06$; (b) grade factor $F(1, 55)=.07$, $p=.79$; or (c) interaction effect of the two factors, $F(1, 55) =.21$, $p= .65$.

Table 12

Results of a Two Way ANOVA by Literacy and Grade When Excluded Spelling Category

	SS	*df*	*MS*	*F*	*p*
Literacy	.15	1	.15	3.73	.06
Grade	.00	1	.00	.07	.79
Literacy X Grade	.01	1	.01	.21	.65
Within	2.15	55	.04		
Total	2.32	58			

The omega squared (ω^2) obtained for the two-way ANOVA tests was $\omega^2 =.047$ for the main effect of the literacy factor; $\omega^2 = 04$ for the main effect of the grade factor; and $\omega^2 =.05$ for the interaction of the literacy and grade factors. These results indicate that a small portion (i.e., 4.7%) of the variance accounted for by the literacy factor (Kirk, 1995). The relationship was not accounted for by the grade factor or by the interaction of the literacy and grade factors. Statistical power for the ANOVA tests on the main effect

of the literacy factor, the main effect of the grade factor, and the interaction of the two factors were .48, .06, and .07, respectively.

CHAPTER V

DISCUSSION

Overview

One of the greatest educational challenges in the United States is to ensure all students have sufficient language and literacy skills to support more advanced educational pursuits. An example of a commitment to address this challenge is in the federal government's support of *No Child Left Behind* (2001). Within this initiative is a commitment to the use of evidenced-based practices in the provision of instruction. The National Reading Panel (2000) has summarized the critical components of reading instruction as addressing phonemic awareness, phonics, fluency, vocabulary and reading comprehension. Therefore, much of the research completed in early reading development focused on the linkage of phonological awareness to language and print. However, this approach has a limited focus on the phonological aspect of literacy development. Recent views of language and literacy development emphasize the importance of other linguistic aspects, beyond phonological awareness, to include morphology. Researchers with this lens emphasize the importance of developing morphological awareness to facilitate the mutual process of learning to read and write (Perfetti, 1999; Carlisle, 2003).

The present meta-analysis synthesized the research conducted over the last 29 years to better understand the linkage between literacy and morphological awareness in elementary-age students. Three hundred thirty-seven correlation coefficients were retrieved from the 44 studies and aggregated to address the research questions. In the remainder of this chapter, findings of the meta-analysis are discussed in relation to each

research question. In addition, the limitations of the current study are presented and followed by implications for practice, theory, and further research.

Discussion of Study Findings

Positive and Strong Relationships between MA and Literacy

The first goal of this study was to examine the overall relationship between morphological awareness and literacy outcomes of elementary students. Morphological awareness was broadly defined as a child's understanding of the morphological structure of words and ability to produce morphologically complex words (Carlisle, 1995). The specific literacy outcomes considered were word reading, spelling, and comprehension. A significant relationship was found indicating that morphological awareness and essential literacy outcomes are strongly related in elementary children. This result is consistent with the growing view from educational and psychological research literature regarding the importance of morphological awareness for word reading (Carlisle & Normanbhoy, 1993; Carlisle, 2000; Mahony et al., 2000), reading comprehension (Carlisle, 2000; Carlisle & Fleming, 2003; Deacon & Kirby, 2004; Jarmulowicz et al., 2008; Nagy et al., 2006), and spelling (Kemp, 2006; Walker & Hauerwas, 2006) during the elementary years. The relationship between morphological awareness and word reading was .51, spelling was .43, and comprehension was .43, which were relatively large effects (Cohen, 1988). This finding is consistent with previous research documenting the unique relationship between morphological awareness and literacy (Carlisle & Normanbhoy, 1993) after considering the possible intercorrelation between morphological awareness

and phonological awareness (Fowler & Liberman, 1995; Mahony et al., 2000; McCutchen, Green, & Abbott, 2008).

This study did not directly compare the varying relationship between morphological awareness and literacy across word reading, reading comprehension and spelling categories. However, the significant level of heterogeneity of the relationships across literacy categories implies that there may be varying relationships depending on other variables. In a study completed by Deacon and Kirby (2004), they found a larger effect of children's morphological awareness on a meaning-based reading performance (e.g., comprehension) than a code-based reading performance (e.g., word reading). It is also known that, while phonological awareness of elementary students is more likely to contribute to their word reading at early grades (Carlisle, 1995; Fowler & Liberman, 1995), morphological awareness of elementary students is more directly related to reading comprehension in upper elementary students (Deacon & Kirby, 2004). Considering that a morpheme is the smallest meaning-bearing linguistic unit (Dirven & Verspoor, 2004), it would be interesting in future research to directly examine the relationship of morphological awareness across specific literacy categories to determine its varying influence.

This study also found significant heterogeneity of the effect sizes within each literacy category, supporting the rationale for posing additional research questions to explain the variance. The factors that this study hypothesized were morphology type, learner type, and grade category. The significant variability might also provide support for most of the current theories emphasizing the complex nature of reading and language development and processes in the phases of reading development (Adams, 1990; Carlisle,

2003; Ehri, 1998; NRP, 2000; Perfetti, 1998). As discussed previously, developing literacy skills takes practice and requires different lengths of time to master depending on literacy components (Ehri, 1998; Paris, 2005). Overall, the first goal of this study was successfully achieved in finding a strong relationship between morphological awareness and literacy of elementary children. This provides some initial evidence that literacy instruction in elementary school years should include morphological awareness as a core component. Also, the significant within- and between-levels of heterogeneity support further examination to determine how other specific factors may explain the relationship of morphological awareness to reading and spelling.

Morphology Type and the Relationship between MA and Literacy

The analysis on the overall relationship between morphological awareness and literacy revealed that there was substantial variability of the correlations within each literacy category (i.e., word reading, comprehension, and spelling). Another goal of this meta-analysis was to identify factors contributing to this variability. One of the potential factors hypothesized was the type of morphology (i.e., derivational and inflectional). Unfortunately, there were an insufficient number of effect sizes to address each literacy category separately so the correlations were aggregated. The mean relationship of the overall combined literacy component to derivational morphology was .51 while inflectional morphology was .44, demonstrating the expected strong, positive relationship. Considering the magnitude of the mean relationships obtained, the difference according to morphology type was not large. The non-significant result of the independent samples *t*-test by morphology type supports this observation, providing no evidence of any

difference by morphology type. That is, the non-significant results failed to support current theoretical standpoints such as Adams' (2000), which states that derivational morphology has a more direct role in literacy development than inflectional morphology.

Learner Type and the Relationship between MA and Literacy

Another possible factor that may be important in understanding the relationship between morphological awareness and literacy is variation in the type of student (i.e., struggling learner, typical learner, and mixed learner). However, the studies were not consistent in how they specified their student populations so the categories of struggling and mixed learners had to be collapsed and compared to the typical learner category. Additionally, there were an insufficient number of effect sizes with the spelling outcome so it was eliminated from this analysis. The mean relationships between morphological awareness and literacy by the literacy categories and learner types were all positive and strong.

However, results showed no significant difference between the mean relationships for the two levels of literacy (i.e., word reading=.45 vs. reading comprehension=.55), no significant difference between the mean relationships for the two levels of learner type (i.e., typical=.49 vs. collapsed=.51), and no significant interaction in the effect of learner type on the relationship of morphological awareness to word reading or reading comprehension (i.e., typical and word reading=.44, typical and reading comprehension=.54, collapsed and word reading=.47, and collapsed and reading comprehension=.56). The power to reject each of the hypotheses tested was only 45%, 8%, or 5 %. If the number of studies included for analysis were larger, the power would

have increased and the results may have been different. Additional and future studies will be more helpful in understanding any differences in the relationship between morphological awareness and literacy by variation in learner types.

Grade Category and the Relationship between MA and Literacy

Another possible factor contributing to the variability between morphological awareness and literacy examined in this study was grade level (i.e., lower elementary—k-3rd and upper elementary—4th-6th). When examining this issue, there were a limited number of studies that included the spelling category so it was removed from the analysis. The analysis found no significant difference when examining the relationship of morphological awareness to the overall literacy by grade category (i.e., lower= .47 vs. upper=.50). This non-significant result failed to support Adam's (1990) viewpoint of postponing teaching morphological awareness until upper elementary. The non-significant result by grade category may have been impacted by the low statistical power (i.e., .06) due to the small number of studies included.

This study also found no significant difference in the effect of grade category on the relationship of morphological awareness to word reading and comprehension (i.e., lower and word reading= .42, lower and reading comprehension= .55, upper and word reading= .46, upper and reading comprehension= .54). The relationships for both grade categories appear to show a similar pattern (i.e., lower relationship for word reading than reading comprehension). Unfortunately, this result failed to support prior research findings that the relationship for word reading was smaller than that for reading comprehension for both lower (Carlisle & Stone, 2005) and upper elementary students

(Carlisle & Fleming, 2003). This finding also failed to support prior research (Carlisle & Fleming, 2003; Carlisle & Stone, 2005; Deacon & Kirby, 2004; Singson et al., 2000) that found the relationship between morphological awareness and word reading and reading comprehension became stronger and stabilized as students get older. Again, the non-significant result may have been impacted by the low statistical power (i.e., .07) due to the small number of studies included for analysis.

Summary

In summary, the first goal of this meta-analysis study was to examine the relationship between morphological awareness and literacy skills of elementary students. Results demonstrated a strong and significant relationship between morphological awareness and literacy which provides support for including it within literacy instruction. Unfortunately, the other goals of the study to explain this relationship by specific factors (i.e., morphology type, learner type, or grade category) were not supported. However, the analyses were constrained by the limited number of studies that included informational aspects under investigation. Therefore, many variables had to be aggregated (i.e., literacy levels for morphology type and learner type factors) or dropped (i.e., level of spelling for grade factor and for learner type factor). There was no significant effect found by morphology type, learner type, nor grade category on literacy outcomes. The results of this study may not be applied to different writing systems but limited to the English language. In the next section, the limitations due to the limited numbers of effect sizes will be discussed.

Limitations

The results from this meta-analysis were impacted by a number of factors which impacted how research questions were addressed, but also elucidated areas for the field to address in future research. The primary limitations in this study included the following: (1) small sample sizes, (2) broad operationalization of the morphological awareness variable, (3) study selection bias, (4) coding procedures, and (5) quality of studies and measures (e.g., correlational nature of results, measurement quality issues in original studies).

Small Sample Sizes for Analysis

Although the total number of effect sizes retrieved (n=337) was not small, the number of effect sizes used for analysis was based on aggregated mean effect sizes per independent variable per study to establish the independency of the effect sizes. Consequently, this limited the number of effect sizes considerably and impacted the way the research questions were addressed. In general, the small numbers influence the power to reject the hypothesized tests. To minimize the power issues, specific categories were clustered or excluded for analysis. Even with these modifications, most of the analyses of this study were not significant. The main effect of literacy factor was not statistically significant. The power (i.e., .45 to .48) would have been stronger if the sample size included for analysis was larger and, therefore, the results may have been different.

Because small sample sizes were expected when planning the study, other potentially important or relevant features coded (e.g., frequency, transparency, modality, regularity, etc.) were not analyzed in this study. Therefore, this meta-analysis study was

limited in scope due to the relatively few studies that have been conducted to provide clear understandings on other morphological awareness features that haven't been as frequently investigated.

Broad Conceptualization of the Morphological Awareness Variable

In this study morphological awareness was broadly operationalized. Performance on any morphological awareness measure was included in the study, and was primarily determined by researcher-developed measures (i.e., 93.2% of the measures were researcher developed). This broad conceptualization thereby combined measures that varied by task type (e.g., analogy, morpheme discrimination, decomposition/production, etc.), task formats (e.g., in isolated list or in context), test modality (e.g., oral, oral plus written, or written only), and difficulty levels of task items (e.g., frequency, transparency, etc.). Research findings based on this broadly operationalized concept have some advantages in initial exploratory analysis; however, it also documents a huge challenge in the field to come to consensus on a definition to improve measurement and research. In the meantime, the broadly conceptualized variable of morphological awareness in this study has simplified features (e.g., frequency, transparency, modality, format, etc.) and therefore the interpretation of the results should be generalized only within the breath of the concept of morphological awareness as operationalized in this study. For more specific guidance to future educational practices, the field needs to reach an agreement on a set of specifically defined concepts of morphological awareness and replicate research studies, including a meta-analysis, based on those definitions.

Sampling Bias

One of the strengths of a meta-analysis is its comprehensiveness and completeness of data sources (Rosenthal & DeMatteo, 2001). A meta-analysis should include all studies that are built on similar hypotheses. However, the reality is that relevant studies are often missed due to reasons such as selection and publication bias. The current study used multiple bibliographic databases (i.e., ERIC, PsycINFO, LLBA, and Article First) and Google Search to include as many relevant research studies as possible. The key words related to the morphological awareness and literacy variables were also carefully selected to identify all possible studies. However, this approach focuses primarily on reviewing the titles, abstracts, and bibliographic descriptors of the study so there may be other studies available that were not reviewed through this process. However, when a manual search was completed within relevant journals, additional articles were not identified so the selected articles appear to be relatively complete.

This meta-analysis study also made an effort to avoid publication bias and minimize issues related to the "file drawer problem" by contacting scholars in the fields of morphology and literacy instruction. These efforts resulted in adding only one additional article. Although only 50% of the scholars (8 out of 16) contacted responded, it is unclear if there were additional articles available or if scholars simply didn't respond.

Coding Procedures

Threats to reliability and validity (generalizability) can arise in the implemented coding procedures used when conducting a meta-analysis. While steps and procedures were developed a priori to ensure consistency, a certain aspect of subjectivity and use of

judgment calls was used. For example, during the training in how to use the developed coding procedure for this study, the coders had opportunities to discuss specific coding items, refine the details, and practice on some selected articles. This process may have created some dependencies between coders due to this process.

This meta-analysis made an effort to use categorized, close-ended coding items as much as possible to make the coding simple and efficient and increase reliability (Lipsey & Wilson, 2001). The inter-coder agreement of the coding items based on the percent agreement approach was strong (93%) and the kappa values for coding items were all high (i.e., >.70). Although the number of studies selected for the initial inter-coder reliability check (i.e., 3 studies) and the number of coders involved (i.e., 2 coders) were reasonable considering this study was a small size meta-analysis study (i.e., 44 studies), the number of studies and coders used could have been larger to improve the reliability and the generalizability of the study results (Lipsey & Wilson, 2001).

Even though the inter-coder agreement was reasonable, in retrospect, mistakes were made in developing the coding protocol. Best practices in meta-analytic coding procedures recommend providing a thoughtfully generated rationale for groupings to support meaningful coding, analysis, and interpretation (Lipsey & Wilson, 2001). While most of the coding items were clear, the implemented and contrived categorization for some items was not best practice and made interpretation unclear and difficult. For example, the study size variable was categorized into (1) less than 10, (2) 10 to 25, (3) 26 to 100, and (4) more than 100. One end point of the scale “less than 10” may appropriately represent an under-sized study that is likely to miss any statistical effect present and the other end point of the scale “more than 100” may represent an oversized-

study that is likely to falsely detect an effect, of which scientific importance of the results would be doubtful. In designing a study, the sample size of the study is determined based on not only statistical criteria but also contextual criteria such as budgetary and ethical issues (Lenth, 2001). Not created a priori to fit a general category of subjects (i.e., 10-25, etc) the appropriateness of this categorization (e.g., why split at *n*=25) is not a recommended practice (Lipsey & Wilson, 2001) and negatively impacted how findings were interpreted. Rather, an open-ended item should have been used to code the actual value of the study size. Using the actual value would have aided in providing more meaningful and accurate study descriptives that then may have been categorized into size groupings for general discussion.

Similar mistakes were made in categorizing the demographic variable of sex into the following (1) less than 10 % male, (2) 10 to 49% male, (3) 50% male, (4) 51 to 90% male, and (5) more than 90% male. The categories "less than 10% male" and "more than 90% male" seem to appropriately represent the predominance of female and male students, respectively. However, the appropriateness of the middle-point categories (2) to (4) was not supported. That is, it was not clear how 50% male would be different from either 49% male or 51% in terms of the predominance of one gender type over the other. In addition, the scale for this coding variable has missed a certain range of percent values (i.e., more than 49% and less than 50%, more than 50% and less than 51% male). For example, if the participants of a study are 101 boys and 99 girls, the percent of male students is 50.5%, which does not belong to any of the categories (1) through (5). These mistakes impacted the accuracy and meaningfulness of some of the data. Similar to how the sample size variable was coded, the actual

percent of males and females should have been coded to enable more accurate and meaningful study-level information (Lipsey & Wilson, 2001). Fortunately, these items (i.e., study size, predominant sex) were not variables under investigation in this study but did make the descriptive statistics on the studies gathered confusing to interpret.

Quality of Studies and Measures

The quality of original studies included in this analysis may have impacted the results obtained. The type of research design of the studies or/and the data from the studies used for this meta-analysis was correlational by nature which does not imply/indicate causal relationships due to the possibility of multiple compounding factors. Therefore, the presence of a strong, positive relationship between morphological awareness and literacy obtained does not necessarily mean that successful literacy development of elementary children is attributed to their morphological awareness. Rather, morphological awareness and literacy development may go hand in hand. The strength of the relationship between morphological awareness and literacy obtained in this study, therefore, should be interpreted in the way that provides insights on the importance of morphological awareness for children's literacy development, but not imply any causal inference.

The quality of studies is not necessarily limited to the type of research design (e.g., correlation study vs. randomized group design), but also can reflect the validation process of the study quality (e.g., peer-reviewed). A majority of the studies (78.3%) included in this meta-analysis were from peer-reviewed journals, which are considered higher quality

than articles from non-peer reviewed journals (Lipsey & Wilson, 2001). However, it is unclear what role other study types (primarily dissertations) had on the obtained findings.

The quality even within peer-reviewed studies can vary. For this study, the nature of the measures used could have heavily impacted the obtained results. Across the publications, the range of measures used to measure the same variable (i.e., word reading) varied considerably. In addition, many of the articles did not report the reliability and validity of the measures used. However, the most significant observation related to the measures used was that the vast majority (93.2%) of the morphological awareness measures were non-standardized or experimenter-developed. These measures were the primary construct of interest for the current study and the articles provided no or limited information on their reliability and validity. Therefore, how this may have impacted the obtained results (either inflating or deflating effect sizes) is unclear (Hunter & Schmidt, 2004).

Despite these limitations, this study has yielded some useful findings for informing educational practices, theory, and further research. These limitations will need to be addressed in the future by researchers, practitioners, and theorists.

Implications for Practice, Theories, and Future Research

Implications for Educational Practice

As discussed in the previous chapters, the important role of morphological awareness has increasingly been recognized among teachers, administrators, and researchers. The findings of the current study have added support for the importance of morphological awareness for children's reading performance. However, there seems to be

a gap between the increased recognition and research interest and current educational practices. That is to say, while there is an increased number of research studies investigating specific literacy components and language development during the elementary years, morphological awareness in research and educational practices still tends to be focused more on one aspect of morphological awareness (i.e., derivational morphology) for older children (Larsen & Nippold, 2007; Wysocki & Jenkinson, 1987), particularly as vocabulary building skills (Anglin, 1993; Carlisle, 2000; McBride-Chang, et al., 2005; Wysocki & Jenkinson, 1987), rather than developing comprehensive literacy and language skills. As discussed previously, having an agreed upon definition of morphological awareness which is sophisticated enough to cover the developmental aspects of younger children is essential for supporting future research and inform improved educational practice.

Increasing the amount and quality of the research on morphological awareness in early reading development may assist in improving educational practices and outcomes for students. As a field we have increased expectations for all students to be successful while, simultaneously, having increased variability in the linguistic skills of our ever-increasing diverse student population, focused lines of research in this area may provide unique insights to meeting the needs of all students, including ELLs. Results of these research findings could improve teacher professional development, both pre-service and in-service, and improve practices in schools and outcomes for students.

Implications for Theories

The different theories reviewed in the previous chapters have provided a useful foundation for examining the role of morphological awareness for elementary children's literacy. Current theories could be refined to build a new conceptual model and assist in understanding relevant instructional components in promoting its development. Ideally, a skills-based model, such as Ehri's (1998) theory, or a components-based model, such as Carlisle's (2003) integrative model of multiple linguistic dimensions of reading, could be interwoven with other cognitive processes-based models, such as Adams' (1990) theory, or a psycholinguistic framework, such as Perfetti's (1999). For example, Carlisle's integrative model of multiple linguistic dimensions mapped out the multiple linguistic components including the morphological dimension to relate orthographic components as contributing components to reading and spelling. Therefore, expanding the model in combination with the other models compensating the procedural aspects (e.g., Adams', Perfetti's models) could potentially provide greater clarity on a range of important instructional issues, which may include the following: (1) modality (i.e., examining how written or spoken processes of language impact the development of morphological awareness and literacy), (2) language status (i.e., how does a student's language skills (i.e., ELL, LD, language impaired) impact how to direct intervention), and, (3) interactions and reciprocal relationships (i.e., examining how specific linguistic features may interact with literacy development).

Implications for Future Research

More Research Is Needed

As previously mentioned, one of the limitations of this meta-analysis study is the small number of studies included for analysis. Although research in morphological awareness and literacy of elementary students has been increasing, the number of studies is still not large enough to provide clear direction for research and to inform educational practice. Systematic replication and new research studies in this area will provide the data necessary for future meta-analyses to provide a more clear understanding on this topic.

More Research Controlling Specific Features

While this study focused on logical factors to study (morphology type, grade, learner type), there are other features of morphology that need further investigation. Some examples that initial research indicate promise include phonological awareness (Fowler & Liberman, 1995; Walker & Hauerwas, 2006), levels of word complexity related to transparency (Carlisle, 2000; Stolz & Feldman, 1995) and frequency (Carlisle & Stone, 2005), modality (Mahony et al., 2000, written vs. oral plus written), task format (e.g., in isolation or in context), and/or even specific types of literacy (e.g., word identification, oral reading fluency) or morphological awareness tasks (e.g., sentence analogy, suffix deletion). If there were a sufficient number of research studies specifically targeting each of these factors, the meta-analysis could better examine the components and procedures of language and literacy development of elementary children and how they do or do not interact with other factors (i.e., grade level, learner type, morphology type) to better inform instruction.

There is also a need for longitudinal studies examining the general developmental process of morphological awareness in relation to other reading measures for typically developing readers at different points in time (e.g., grade). Having a more specific understanding of this process would inform researchers as to where to target their interventions as well as inform teachers about when and how to better instruct their students. Once the field has a better sense of the role of morphological awareness on typical reading development, it will inform the field of when and how to identify students with deficiencies earlier to provide more targeted remediation and intervention.

More Research on Students from a Wider Demographic Range

More research specifically targeting lower elementary children (e.g., K-3rd) is necessary. Current theories and research, in general, focus on the relevance and importance of morphological awareness more for upper elementary students and beyond (i.e., middle school students). Therefore, the common instructional practices for lower elementary students are, at best, to teach inflectional morphemes embedded in context, neither explicitly nor systematically (Nunes et al., 1997; Rubin, 1988). For upper elementary students, the research and practices tend to emphasize derivational morphemes to investigate and teach. Often derivational morphemes are dealt with as part of vocabulary instruction on decomposing unfamiliar words into roots and affixes (Anglin, 1993; Wysocki & Jenkins, 1987). More research on lower elementary children with an emphasis on the unique role of both inflectional and derivational aspects of morphological awareness could provide great insight on how to promote not only morphological awareness but also reading development more efficiently.

There is also a need for more research targeting ELL students. Some studies show that the role of morphological awareness for literacy development of elementary children is similar across different languages and cultures (Ku & Anderson, 2003; McBride-Chang, et al., 2005). However, morphological awareness and reading of an ELL student in his/her native language system may not be transferred to the English language system in a similar way. Therefore, ELL students may have atypical developmental characteristics of language and reading in English. The current study did not include an analysis for the different relationship with the English speaking status (e.g., ELL students vs. English speaking students) due to the small number of studies including ELL students. Considering the increasing number of students in schools being ELL and increased expectations for all students to be proficient readers, understanding the role of morphological awareness for this population is critical.

The current study identified only a small number of studies that focused exclusively on struggling learners, such as students with learning disabilities. Arnbak and Elbro (2000) found that morphological awareness instruction potentially has an influence on struggling learners' reading and spelling. Similarly, Elbro and Arnbak (1997) showed that Danish adolescents with dyslexia were more dependent on morphological structures of words for word reading than reading-age matched normal readers. There is also a study (Casalis, Cole, & Sopo, 2004) showing that students with reading disabilities compensate their poor phonological skills using morphological awareness strategies. Therefore, more studies specifically focusing on struggling learners in the future will be helpful to better examine any similar and different developmental features of struggling and typical learners in their morphological awareness and reading (e.g., any moderator

factors differentially contributing to the relationship between morphological awareness and literacy according to different learner types).

Use of Standard Morphological Awareness Measures

As discussed in the limitation section, the quality of the measures used in a study is one of the factors determining the quality of the study (Lipsey & Wilson, 2000). While there are many cases using standardized morphological awareness measures for clinical purposes, a majority of the morphological awareness measures currently used in reading research are experimental, non-standardized measures. Non-standardized measures have questionable reliability and validity and make generalization of findings and conclusions very tenuous. If researchers were more consistent in using standardized measures then findings could be interpreted across studies using common measures and increase our confidence in the outcomes. Therefore, the field needs to develop a reliable and valid, standardized measure of morphological awareness that can be used across a wide age-range of developing readers. Additionally, due to the multi-faceted nature of morphological awareness, the use of multiple measures would also provide a greater depth of understanding. By having information regarding the reliability and validity information on the measures, it would be possible to determine whether any future meta-analysis study should apply any adjustment for low or high reliability as well (Hunter & Schmidt, 2004).

Conclusion

This study confirmed the positive, strong relationship between morphological awareness and literacy performance of children in elementary school, suggesting morphological awareness as a potential core instructional component for elementary literacy instruction. The study also found significant variability in the relationships within each literacy category as well as between the categories. This finding suggests that there may be some moderator factors contributing to the strengths of the relationship between morphological awareness and literacy of elementary children. Interestingly, the analyses on the hypothesized moderator factors (i.e., morphology type, learner type, and grade category) did not show any statistically significant differences in the relationship between morphological awareness and literacy development in elementary-aged children. There were many methodological limitations (e.g., few studies, lack of agreed upon definitions, limited use of standardized measures, etc.) noted that may have minimized this study's ability to truly understand these relationships. Additional research in this area has the potential to provide greater insight on the role of this multidimensional construct to improve the educational practices of the future.

APPENDIX A

CODING DECISION CHECK SHEET

Coding Decision Check

Decision point: If answer to question 1, 2, 3, 4, 5, 6, 7, or 8 is "No", stop reviewing the study.

1. Did the study include a specific domain of literacy (i.e., reading, spelling) as a variable?
   Yes ( ) No ( ) NC ( )

2. Did the study include morphological awareness as a variable?
   Yes ( ) No ( ) NC ( )

3. Did the study include the participants of K to 6th grade children?
   Yes ( ) No ( ) NC ( )

4. Did the study separately report data for typical children, children struggling in reading and spelling, or the mixed group of both?
   Yes ( ) No ( ) NC ( )

5. Did the study report effect sizes (i.e., *r*) or provide appropriate quantitative information to permit calculation of effect sizes (e.g., means, standard deviations, *F*, *t*, etc.)?
   Yes ( ) No ( ) NC ( )

6. Were literacy and morphological awareness measured in English?
   Yes ( ) No ( ) NC ( )

7. Was the study published or reported no earlier than 1980?
   Yes ( ) No ( ) NC ( )

8. Was the study reported in English?

   Yes ( ) No ( ) NC ( )

APPENDIX B

CODING FORM

CODING FORM

Coder:_____
Bibliographic Reference (in APA):_____
_____

STUDY LEVEL CODING

Identification of Study

1. Study ID [STUDYID]: _____
2. Type of Source [PUBTYPE]:
   1)____ Journal 2) _____ Book 3)_____ Book chapter
   4) ____ Technical report 5) ____ Conference paper
   6) ____Doctoral dissertation 7) ___ Other (Specify):_____
3. Publication Year [PUBYEAR]:_____

General Characteristics of Study Subjects

4. Total Study size [STUDYSIZE]
   1) _____ less than 10
   2) _____ 10 to 25
   3) _____ 26 to 100
   4) _____ more than 100

5. Predominant sex [SEX]
   1) _____ less than 10 % male 2) _____ 10-49% male
   3) _____ 50% male 4) _____ 51-90 % male
   5) _____ more than 90 % male 9) _____ not specified

6. English speaking status of subjects targeted [ENGLISH]
   1) _____ native English speakers (or English as an L1) only
   2) _____ English language learners (or English as an L2) only
   3) _____ both native English speakers (English as an L1) and English language learners (English as L2)
   9) _____ not specified

General Characteristics of Measures

7. Morphological awareness measures employed [MEAS_MA]
   1) _____ single measure: standardized
   2) _____ single measure: experimental
   3) _____ multiple measures: standardized only
   4) _____ multiple measures: experimental only
   5) _____ multiple measures: both standardized and experimental
   9) _____ not specified

8. Literacy outcome measures employed [MEAS_LIT]
   1) _____ single measure: standardized
   2) _____ single measure: experimental
   3) _____ multiple measures: standardized only
   4) _____ multiple measures: experimental only
   5) _____ multiple measures: both standardized and experimental
   9) _____ not specified

EFFECT SIZE LEVEL CODING

1. Study ID [STUDYID]: _____

2. Effect size sequence ID [ES_ID]: _____

Features of Literacy Variable

3. Category of literacy measures corresponding to the effect size [CATEG_LIT]
   1) _____ word reading
   2) _____ reading comprehension
   3) _____ spelling

4. What specific literacy tasks were corresponding to the effect size? [LIT_TASK] (check all)
   1) _____ word attack, or pseudo-word reading
   2) _____ word identification, or single word reading in a list
   3) _____ reading rate or fluency
   4) _____ answering questions about stories
   5) _____ identifying a key missing word in a sentence or short passage
   6) _____ dictation of given words, or spelling a word to complete a sentence
   7) _____ spelling words in writing a story
   9) _____ cannot tell

5. Type of the literacy outcome measure corresponding to the effect size [LIT_MESRTYPE]
   1) _____ standardized 2) _____ experimental

Features of Morphological Awareness Variable

6. Type of Morphology involved in task items corresponding to the effect size [MOR_TYPE]

   1) _____ derivational 2) _____ inflectional 3) _____ mixed

7. Type of the morphological awareness measure corresponding to the effect size [MA_MEASRTYPE]
   1) _____ standardized 2) _____ experimental

8. Format of the morphological awareness measures corresponding to the effect size [FMT_MA]
    1) _____ single words in a list 2) _____ words in context

9. Modality of morphological tasks required [MODALITY]
    1) ____ Oral 2)____ Written 3) ___ oral plus written 9) ____ not clear

10. Was frequency of the morphemes involved in the tasks equivalent? [FREQUENCY]
    1) _____ yes 2) _____ no 9) _____ not clear

11. Transparency of the items of morphological awareness measure corresponding to the effect size [TRNSPR]
    1) _____ transparent only 2) _____ shift only
    3) _____ both transparent and shift 9) _____ not clear

Sample Descriptors

12. The grade Level of the participants corresponding to the effect size data [SUB_GRD]
    1) _____ lower elementary: Kindergarten through 3rd grade
    2) _____ upper elementary: 4th through 6th grade
    3) _____ mixed: Kindergarten through 6th grade

13. Learning characteristics of the participants corresponding to the effect size data [SUB_LC]
    1) _____ struggling students
    2) _____ typical students
    3) _____ mixed

Effect Size Data

14. Page number(s) where effect size data found [PGNUB]:_____
15. Table number(s) where effect size data found [TBNUB]:_____

Calculated Effect Size	Type of Effect size: __ *r* __ *d* __ *g* __ ω^2 ___ η^2 __ other (specify): _____ Effect size value (ES): _____				
Significance Tests	Type of significance test: __ Pearson *r* __ *t*-test __ *F*-test __ chi-square __ other (specify):_____ Significance test value: _____ *p*-value: _____				
		G1	G2	G3	G4
Sample Size (N)					
Descriptive Statistics	Mean (M)				
	Standard Deviation (SD)				

APPENDIX C

CODING MANUAL

CODING MANUAL

Coder: Write your name (e.g., initials of your name).

Bibliographic reference: Write a citation in APA format. The last names and initials of the first names of all authors should be written at the minimum in order to be able to correctly locate the study. (cf. Kemp, N. (2006) vs. Kemp, S.C. (2006)).

STUDY LEVEL CODING FORM

Identification of Study

1. Study ID [STUDYID]. Assign a unique identification number to each study.

   If the study report includes more than one study (or experiment), add decimals after the study IDs for each experiment (e.g., 1.1., 1.2, 1.3). When only one of the experiments provides relevant effect size data, do not assign any decimal.

2. Type of Source [SOURCETYPE]. Select the type of the report.

   1 Journal article 2 Book 3 Book chapter 4 Technical report
   5 Conference paper 6 Doctoral dissertation 7 Other (specify)

   For a published study, select the type of the publication of the study. If "other" is chosen, specify the type (e.g., monograph, document).

   For an "in press" study, select the source where the study will be published (e.g., journal, book chapter in a book, etc). If "other" is chosen, specify the type.

   For an unpublished study, select "Other" and specify the type as best as you can (e.g., unpublished dissertation, unpublished manuscript, etc.).

3. Publication year [PUBYEAR]. Write the four digits of the publication year.

   If the study has not been published but has been accepted in a journal (e.g., in press), write "in press". If the study has not been published and not been accepted (e.g., submitted), write "submitted". If the study has not been published and no plan for publication (e.g., unpublished works), write the year of the report with "unpublished" (e.g., 1998 unpublished).

General Characteristics of Study Subjects

4. Total study size [STUDYSIZE]. Select the code that best describes the range of the subject size of the study. For a longitudinal study, select the number at the start of the study.

   1 less than 10 2 10 to 25 3 26 to 100 4 more than 100

5. Predominant sex [SEX]. Select the code that best describes the proportion of males to the females in the sample. For a longitudinal study, select the proportion at the start of the study.

   1 less than 10 % male 2 10-49% male 3 50% male

   4 51-90 % male 5 more than 90 % male 9 not specified

6. English speaking status of study subjects [ENGLISH] Select the code that best describe the English speaking characteristic of the study subjects.

   1 native English speakers only (English as an L1; English as a primary language; mono-lingual English speakers)
   2 English language learners only (English as an L2)
   3 both native English speaking and English language learners (mixed group of 1 and 2)
   9 not specified

General Characteristics of Measures

The information about measures is often found in the Methods and Procedures sections of the study.

7. Morphological awareness measures employed [MEAS_MA]. Select the code that best describes whether the study employed multiple measures of morphological awareness and whether the measure(s) employed are standardized or experimental.

    1 single measure: standardized
    2 single measure: experimental
    3 multiple measures: standardized only
    4 multiple measures: experimental only
    5 multiple measures: both standardized and experimental
    9 not specified

    If morphological awareness was assessed in two different languages (e.g., English and Hebrew), code "single measure" when there was only one English measure used, "multiple measures" when there were more than one English measures used.

8. Literacy outcome measures employed [MEAS_LIT]. Select the code that best describes whether the study employed multiple literacy measures and whether the measure(s) employed are standardized or experimental.

    1 single measure: standardized
    2 single measure: experimental
    3 multiple measures: standardized only
    4 multiple measures: experimental only
    5 multiple measures: both standardized and experimental
    9 not specified

    If literacy was measured in two different languages (e.g., English and Hebrew), code "single measure" when there was only one English measure used, "multiple measures" when there were more than one English measures used.

EFFECT SIZE LEVEL CODING

1. STUDY ID [STUDYID]: Write the study ID corresponding to the effect size sequence ID that is assigned below.

2. Effect size sequence ID [ES_ID]: Assign a unique sequence ID number to each effect size in the study (e.g., 1, 2, 3…).

   If multiple effect sizes are reported based on different morphological awareness or literacy measures, assign different effect size ID for each.

   For longitudinal studies that report effect sizes at different years (e.g., Year 1, Year 2, and Year 3; Grade 1, Grade 2, and Grade 3), when the effect size data is based on the measures assessed within one year or so (e.g., MA in fall of first grade and reading comprehension in fall of second grade), include the data for an effect size. When the relationship is based on the measures assessed beyond one-year (e.g., MA in Year 1 and literacy outcome in Year 3), do not assign an effect size sequence number to the data.

Features of Literacy Variable

3. Categories of literacy measures corresponding to the effect size [CATEG_LIT]. Select the code that describes the categories of literacy measures.

   1 word reading
   2 reading comprehension
   3 spelling

   Reading words which are morphologically complex is considered as "word reading"
   Spelling dictated sentences or words that include morphological forms is considered as "spelling".

   Reading irregular words that cannot be decodable using decoding rules or that can only partially decodable so that lexical units should be used is not considered as word reading.

Teachers rating of children reading or spelling ability is not considered as a literacy outcome.

4. What specific literacy tasks were corresponding to the effect size? [LIT_TASK] (check all). Select the code that best describes the tasks related to the effect size data.
   When only the names of standardized measures are provided (e.g., Gates-MacGinitie Comprehension subtest), refer to the general description of the test to determine the specific tasks related to the effect size.

   1 word attack or pseudo-word reading
   2 word identification or single word reading in a list
   3 reading rate or fluency (the accuracy and speed with which children could decode words; counting the number of words that children read accurately per minute)
   4 answering questions about stories (e.g., multiple choice questions, choose a correct word related to the story, etc.)
   5 identifying key missing word in a sentence or short passage (e.g., Cloze test)
   6 dictation of given words or spelling of a word to complete a sentence
   7 spelling words in writing a story
   9 cannot tell

   If the accuracy (the number of words read correctly) is not based on timed reading, code it as "word reading".

5. Type of literacy outcome awareness measures [MEAS_LIT]

   1 standardized (administered standardize type of measure)
   2 non-standardized experimental (administered non-standardized experimental type of measure)

Features of Morphological Awareness Variable

6. Type of Morphology involved in task items [MOR_TYPE]. Select the code that best describes the morphology type with which task items are

related. Refer to the definitions and categories of the morphological awareness tasks described in the study.

1 derivational (only derivational type is involved)

2 inflectional (only inflectional type is involved)

3 mixed (both derivational and inflectional types are involved)

When the study did not use the terminology such as "derivational" or "inflectional", pick up one of the categories that best relates to the morphological features described in the study. Also check with the word list attached in Appendix, whenever available, and/or examples in text to determine the type of morphology.

Inflectional morphology can be named as grammatical morphology, and its tasks can be based on any measures assessing the grammatical relations (e.g., past tense completion, production of plural endings, comparative, superlative).

According to the categorization of morphology type in this coding, the examples of compounding (e.g., cowboy) can be best described as derivational type.

7. Type of morphological awareness measures [MEAS_MA]. Select the code that best describes the type of morphological awareness measures used in the study. Norm-referenced measures are categorized as standardized, whereas criterion-referenced measures are not.

   1 standardized (administered only standardized type of measure)
   2 non-standardized experimental (administered non-standardized, experimental type of measure)

8. Format of morphological awareness measures corresponding to the effect size [MEAS_FMT]. Select the code that best describes how the morphological awareness was measured. If the study simply cited the MA measure used in another study without detailed description of the format, refer to the study. Also see the Appendix if the measure was specified in Appendix.

1 single words in a list (e.g., give a word to judge or produce an inflected/derived form or vice versa; give pairs of base and inflected/derived forms for word analogy – A:B::C:D; ask to indicate whether each word in the list was morphologically complex; given base and affixes, ask to form a morphologically complex word, etc.)

2 words in context (e.g., give a base word and ask to derive or inflect the word to finish a sentence; ask to either decompose or produce a morphological word to finish a sentence; whenever words are presented in sentence contexts)

9. Modality of morphological tasks required [MODALITY]. Select the code that best describes the modality of the morphological awareness tasks required. If the study simply cited the MA measure used in another study without detailed description of the modality, refer to the study. Also see Appendix, if available, to determine the modality.

    1 oral (tasks are verbally presented and require verbal responses)
    2 written (tasks are presented in print and require written responses)
    3 oral plus written (tasks are presented verbally and require written responses; presented in print and require verbal responses; presented verbally and require both written and verbal responses; or presented both verbally and in print and require either verbal or written responses or both)
    9 not clear

    If students were given a written copy of the tasks and only the instructions of the tasks are orally presented by an examiner at the beginning, select 2 "written".

    If the study specified the task is to assess children's oral morphological skills, code it as "oral".

10. Was frequency of the morphemes involved in the tasks equivalent? [FREQUENCY].

    1 yes 2 no 9 not clear

If the study specifies that the frequency of base or affix forms of task items were equivalent, choose “yes”. If the study specifies that the frequency across task items were not equivalent, choose “no”. If the study does not mention the equivalence of the frequency, choose “not clear”.

Sometimes, the equivalence of the frequency is tested using a statistical analysis (e.g., ANOVA, t-test). If the test result is not significant, select “yes”. If significant, select “no”.

If the study calculated or reported Standard Frequency Index (SFI) for groups of morphological words and mentioned that the SFI for the groups are comparable, select “yes”. If the study statistically compared the SFIs and found it significantly different, select “yes”.

If the study simply describes that the task items are similar or comparable in frequency, select “yes”.

If the frequency of morphological awareness items has not been mentioned while the frequency of morphologically complex words involved in literacy tasks, select “not clear”.

11. Transparency of the items of morphological awareness measure corresponding to the effect size [TRNSPR]

    1 transparent only
    2 shift only
    3 both transparent and shift
    9 not clear

    The term “transparent” refers to the condition in which the phonological feature (i.e., sound production) and/or the orthographical structure (i.e., spelling) of the base word are maintained (e.g., warm-warmth, ill-illness, etc.). Terms such as “no phonological/orthographic change” and “phonologically/orthographically neutral” are comparable to “transparent”.

    The term “shift” refers to the condition in which the phonological and orthographical features of the base word are altered (e.g., decide-decision, happy-happily, etc.) The terms “phonological/orthographic change”,

"opaque", and "phonologically/orthographically not neutral" are comparable to "shift".

If the tasks of the morphological awareness include transparent items only, select 1. If the tasks include shift items only, select 2. If the tasks include both transparent and shift items, select 3. If the study did not specify the transparency of the task items, select 9 "unclear".

The case of inflectional morphology (e.g., Irregular production of the past tense forms) is coded as "not clear".

Sample Descriptors

12. Grade Levels of the participants corresponding to the effect size data [SUB_GRADE]. Select the code that describes the grade level of the group related to the effect size. Write the actual grades beside the category selected whenever possible.

    1 lower elementary: Kindergarten through 3rd grade
    2 upper elementary: 4th through 6th grade
    3 mixed: Kindergarten through 6th grade

    Years 1, 2, 3, 4 … at schools in England correspond to K, 1st, 2nd, 3rd grades… at schools in the US.

    If only ages of the participants are specified, not grades, make a decision to relate the students' age ranges to grades (e.g., aged 7.5 to 9.5 years—2nd to 3rd grades or lower elementary) (Fraser et al., 2008).

    If the study did not specify the grade but described the participants as students in early elementary, then code the participants as "lower elementary".

    If the study did not specify the grade but described the participants as students in upper or intermediate elementary, code the participants as "upper elementary".

Do not consider the group of mixed grades beyond 6th (e.g., group consisted of 6th, 7th, and 8th) for coding this item. The information for this mixed group will be excluded for effect size level coding overall

13. Learning characteristics of the participants corresponding to the effect size data [SUB_LC]. Select the code that best describes the learning characteristics of the participants related to the effect size.

    1 struggling students (students with LD, at-risk students, poor reader/speller, struggling reader/speller, any students who are provided with special help, below average, etc.)
    2 typical students (normally achieving students, students who attend regular classes or general classroom, students who do not need or do not receive special education services, average and above average students, etc.)
    3 mixed (mixed group of 1 and 2)

    If the study is conducted using children in regular classes and does not specifically mention whether there are any children who have difficulties in reading and spelling, code them as "typical students".

    If the study used the terminology "poorer" or "better" to describe chronological age is relatively "young" or "old", don't consider the "poorer" group as struggling student group.
    If the study did not specify for an inclusion of struggling learners, code as "typical students".
    For younger children (e.g., kindergarteners), if there is not specific notification of any risk for reading in the study, consider them as "typical".
    If a study names a group of children as those with LD, code them as LD even though they might have some language difficulties as well as reading difficulties.

Effect Size Data

14. Page number(s) where the effect size data found [PGNUB]. Write the page number(s) where effect size data were found in the study. If effect sizes are found in multiple pages, write each page number in order.

15. Table number(s) where effect size data found [TBNUB]. Write the table number(s) where the effect sizes were found. If effect sizes were found in

multiple tables, write each table number in order. If effect sizes are not found in a table, code this item as “0”.

Fill out the table for calculated effect size, significance tests, sample size, and/or descriptive statistics.

Calculated Effect Size

Choose the type of effect size index and write the corresponding value of the effect size (ES).

For the effect size based on the correlation *r*, if both simple and partial correlations are reported in a study, select and code the simple correlations. If a study reports only partial correlations, code the partial correlations.

In the case that two sets of correlations are reported, if one is for the entire sample and the other is the subsample of the entire sample, code the correlations for the entire sample only.

For a longitudinal study, if the correlation *r*s between morphological awareness and literacy are reported for multiple years (e.g., Grade 1, Grade 2, and grade 3; Year 1, Year 2, and Year 3) and are based on the same MA and literacy measures each year, code *r*s once, possibly for the starting year of the study (e.g., Grade 1, or Year 1). If the MA and literacy were measured in different times, code only the correlations based on the data within one year period (e.g., MA in fall of first grade and reading comprehension in fall of second grade). When the relationship is going beyond the one-year period (e.g., MA in Year 1 and literacy outcome in Year 3), do not include the coefficient as an effect size.

For a cross-sectional study, the effect sizes for each grade (or year) should be coded as a separate data.

Significance Tests

Choose the type of significance test and write the corresponding value of the significance test. Also write the corresponding p-value testing the significance if available (e.g., $p<.05$, $p=.09$).

The significance test should compare different ability groups based on the scores on either MA or literacy measures. The group assignment can use neutral break or equal intervals in score distribution of the scores on the measures.

For a significance test value, also write the degrees of freedom (e.g., $F(2, 67) = 2.73$).

Sample Size (N)

Write the number of samples corresponding to calculated effect sizes, significant tests, and/or descriptive statistics.

When the number of study participants is different from the entire sample size, write the number exactly corresponding to the specific effect size. For example, when the correlation reported is based on the number of students from whom complete data was available, code the number of students included for calculating the coefficient, not the number of the study participants. When the effect size data is based on any subgroup of the entire study samples, write the number of the subgroup.

Descriptive Statistics

Write the means (M) and Standard deviation (SD) for the relevant group(s) (G1, G2, etc.). The group assignment should be based on the scores on either MA measures or Literacy measures.

If sufficient information has not been provided (e.g., missing the size of each group) so that a relevant effect size can be calculated, don't write the descriptive statistic values.

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