MORPHOLOGICAL INSTRUCTION IN THE ELEMENTARY CLASSROOM

by

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A dissertation submitted to the Faculty of Education

in conformity with the requirements for the

Degree of Doctor of Philosophy

Queen's University

Kingston, Ontario, Canada

Final submission December, 2012

An idea to consider:

Orthography is human thought made visible as text.

ABSTRACT

In recent years the role of morphology has gained a great deal of attention regarding research on vocabulary and literacy learning. An attendant literature investigating morphology as a potentially rich context for instructional innovation has grown as well. Chapter 1 of this dissertation presents a critical review of that research. Its focus is on ways that this growing interest in morphology builds on lessons from previous decades of research on the relative effectiveness of instruction which targeted phonological features of words (sub-lexical features) compared to those which targeted learning to read words from context. A detailed description of the linguistic account of how English orthography operates to represent morphology and phonology is also presented.

Two studies investigating the role of morphology and morphology instruction in relation to literacy learning and theories of reading are reported. The first study is an intervention using experimental and control classes (Grade 4 and 5) to investigate the effect of instruction about morphology on vocabulary learning. Hierarchical regression analyses controlling for initial vocabulary showed that the experimental group gained in measures of vocabulary compared to a control group and that the morphological treatment group made better use of existing vocabulary knowledge in learning new vocabulary.

The second study is a quantitative synthesis of instructional studies assessing the effects of morphological instruction on sub-lexical, lexical and supra-lexical outcomes. Positive effects were found for morphological treatments compared to the 10 studies that used typical classroom instruction controls and effects equal to alternative treatments that mostly used well-established research-based instruction. Less able students and younger students generally exhibited greater gains than undifferentiated and older students.

The results of these studies are discussed within the context of previous instructional research and established theories of reading and literacy instruction. It is suggested that the findings from these studies support the view that instruction should encourage learners to explicitly attend to the ordered lexical/sub-lexical morphological and phonological features of how oral and written words work as a means to foster generative word learning and greater literacy.

ACKNOWLEDGEMENTS

I would like to first acknowledge and thank John Kirby for the intensive and extensive support over the course of both my master's and doctoral work. I have been respected, challenged and supported as a student in need of guidance and as a colleague who has something of real value to offer in return. Not only have I had the benefit of expert guidance in making sense of the literature, research and writing process, but I have been able to go through this process with an implicit trust that my interests (including my family's interests) were always at the centre of this relationship. That level of trust was especially important given that our perspectives have always included large differences. John provided the support I needed to do my work without changing it to his work – all the while ensuring that I met his high standards of scientific research. A student couldn't ask for more in terms of doctoral supervision.

I owe my mother, Patricia Bowers, so much in so many ways. The fact that my mom was able to provide expert guide in academic thinking and writing over these years has been invaluable. I simply would not have made it without that support, let alone the heroic support in every other imaginable way. Thanks mom.

I also need to acknowledge my indebtedness to Real Spelling and the community of scholars that has grown to guide my thinking throughout this process. In particular Gina Cooke, Gail Venable Skot Caldwell, Lyn Anderson, Dan Allen, Ann Whiting and to the other teachers, administrators and students around the world for pushing this work forward in their own ways.

I would also like to acknowledge the work and the personal and academic support of Marcia K. Henry. Marcia published some of the most influential early work pointing researchers and educators to the importance of teaching about the morphological structure of the written word and the influence of etymology. Her 2003 book, "Unlocking Literacy" was also the first reference I have seen in the research literature to highlight the work of Real Spelling, including the morphological matrix. More personally, I was lucky that Marcia was the kind of academic who didn't think twice about reaching out to a young teacher who was just beginning to work with these tools from Real Spelling. Marcia went out of her way to support my work since before I had any interest in research, and that support and friendship has been crucial at each stage of my journey since. Marcia not only supports the work of those she mentors, she publically acknowledges how her thinking evolves by considering that work. I owe Marcia Henry a great deal, as does the field in general.

Finally, my love and appreciation to my amazing wife Sus and our kids, Jess & Skyler, for not only putting up with me so patiently, but actually supporting this too-often absent husband and father all these years!

STATEMENT OF CO-AUTHORSHIP

Study 1 was co-authored with John R. Kirby

Study 2 was co-authored with John R. Kirby and S. Hélène Deacon

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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

Introduction

As the Canadian Council on Learning (2008) argued in their document, *Reading the Future: Planning to meet Canada's future literacy needs*, basic literacy is a prerequisite for healthy, productive participation in our modern information age. Both children and society are harmed when children do not learn to read and write successfully. This dissertation critically reviews the success of current literacy education in English (with a focus on Canada and the US) and highlights an area of research that has received little attention until relatively recently -- that of morphological instruction. Morphology is the system by which bases and affixes combine to form words and to carry meaning to speakers of a language.

This dissertation comprises four chapters. Chapter 1 presents an extensive review of the relevant literature and is divided into five major sections. First, in order to provide a context for this relatively new focus on morphological instruction, an account is provided of the trajectory of literacy research that has led to the current research-based recommendations for literacy instruction. The second section provides a detailed description of how English orthography maps onto meaning via conventions for representing morphology and phonology. The third section is a review of the literature on the acquisition and use of morphological knowledge developed without explicit instruction. Fourth, research evidence of the effect of untaught and taught morphological knowledge on literacy learning is addressed. The fifth section reviews morphological intervention research and introduces the two studies.

Two studies on morphological instruction are presented in Chapters 2 and 3. The first is an experimental intervention exploring the effects of morphological instruction on vocabulary for Grade 4 and 5 students. The second is a quantitative synthesis using the principles of a

systematic review to investigate the effects of morphological instruction over a variety of outcome measures in the 22 studies that met inclusion criteria. Chapter 4 is a discussion of the results of the studies with a focus on the implications for educational practices.

The Current State of Word Level and Sub-Lexical Literacy Instruction

In Ontario, the Education Quality and Accountability Office (EQAO) offers a means to assess current literacy learning. EQAO's 2009-2010 report examined progress in reading and writing achievement in students who took the EQAO Primary Reading Assessment and Primary Writing Assessment in third grade in 2007 and then the Junior Reading and Writing Assessments in sixth grade in 2010. Only 56% of these students met the provincial standard at both testing periods for both reading and writing. Including those who never reached provincial standards at either grade, 28% of sixth grade students were below provincial standards in reading and 29% were below standards in writing. Too many Ontario students enter the intermediate grades with substandard literacy skills that are likely to severely impede their scholastic and lifelong success.

Results from the National Assessment of Educational Progress (NAEP) show a similarly challenging situation for literacy in the United States. *The Nation's Report Card: Reading 2009* shows that 33% of fourth and 25% of eighth-grade public school students were below the basic achievement-level level for reading (see Figure 3 and Figure 14 of *National Center for Education Statistics*, 2010, for complete data). The basic level is defined as denoting "...partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each grade" (NAEP, 2009, p. 5). *The Carnegie Council on Advancing Adolescent Literacy* (2010) found that relative to other nations, American students scored poorly on reading comprehension, with tenth-grade American students among the worst in developed countries. *The National Commission on Writing* (2004) calculated that poor writing skills cost US businesses $3.1 billion

annually. With results such as these, it is not surprising that the search for improved literacy instruction remains a prime focus of educational research.

Instructional Focus: Lexical or Sub-Lexical?

A wide variety of factors related to literacy learning and instruction have been addressed over the last thirty or forty years. However, as Snow and Juel (2005) pointed out, a great deal of this work relates to two questions. First, what unit of language should be addressed by instruction: whole word or sub-lexical (especially phonemes and letter-sound correspondences) features? Second, "to what degree can we trust children to induce an adequate understanding of the system themselves, without explicit instruction about its character?" (Snow & Juel, 2005, p. 505). Broadly speaking, whole language instruction de-emphasizes explicit instruction about sub-lexical aspects of oral and written words (Adams, 1990, Rayner et al., 2001). Instead, this approach targets a sight vocabulary of high-frequency words to help young children get started with books and then exposes learners to written words in the context of stories in a print-rich and supportive environment. Some influential proponents of this instruction argued that because children learn to speak through exposure to rich, meaningful language experiences without explicit instruction about how speech works, a similar engaging exposure to print would result in efficient literacy learning (Smith & Elley, 1994; Smith, 1971, 2003; Smith & Goodman, 1971; Weaver, 1994). Frank Smith, an important figure establishing the basis for whole language, argued, "Reading print is no more complex than reading faces and other things in the world. Making sense of print can't be more complicated than making sense of speech, which begins much earlier" (Smith, 2001, p. 12). This view from whole language is in direct contrast with recommendations to provide phonics and phonemic awareness instruction, which explicitly and systematically target sub-lexical features of oral and written words (e.g., National Reading Panel

2000; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg et al., 2001). Phonemic awareness instruction helps students identify and manipulate individual phonemes within spoken words without reference to letters. Phonics targets graphemes (letters or combinations of letters within words) and the phonemes with which they are associated. A vast amount of research evidence was gathered to test the effectiveness of these contrasting approaches. Results overwhelmingly showed that practices associated with phonics were more effective at promoting literacy success than those associated with whole language (Adams, 1990; National Reading Panel 2000; Rayner et al., 2001; Snow, Burns, & Griffin, 1998).

Scientific inquiry into the effects of instructional practices on literacy learning resolved an important question. Students who receive explicit, systematic instruction about phonemic awareness and letter-sound correspondences are more likely to achieve higher literacy success than those who receive instruction that does not emphasize the substructures of oral and written words. Based on these findings some researchers described the instruction such as that which is supported by the National Reading Panel (2000) as "best practice" (e.g., Al Otaiba & Fuchs, 2006, p. 414). However, this achievement should be seen as one step (albeit an important one) in an on-going process of using research to guide educators in the design of ever more effective instructional practices. The fact remains that controlled experiments using careful implementation of the practices recommended by this research still leave too many children struggling with literacy (Vellutino et al., 1996; Fuchs & Fuchs, 2006).

Limits of Sub-lexical Phonological Instruction

The seminal study by Vellutino et al. (1996) provides a useful illustration of both the clear benefits and apparent limitations of careful, sustained implementation of phonemic awareness and grapheme-phoneme instruction as recommended by Adams (1990) and the

National Reading Panel (2000) for students struggling with literacy. Vellutino et al. gave individualized one-on-one tutoring sessions (30 minutes per session) for at least 15 weeks (typically 70 to 80 sessions) to first grade students who were identified as performing below grade level. The instruction focused on phonemic awareness, decoding, sight-word practice, comprehension strategies and reading connected text. Two thirds of the students who had been struggling with reading caught up to their regularly achieving classmates in one semester with this intensive intervention. Vellutino et al. commented that that these results suggested that "reading difficulties in most children from middle- to upper middle-class backgrounds are quite likely caused by experiential and instructional deficits" (p. 633).

Despite such important progress for so many students, Vellutino et. al (1996) found that there were limits to its success for a third of the struggling readers they tested. They found that phonological coding deficits were a likely important factor in the substantial number of students who persisted with reading difficulties despite their intervention. It is plausible that there are instructional strategies not used in their study that might allow children with phonological coding deficits, or perhaps other as yet unidentified deficits, to achieve grade level literacy scores.

In line with the findings of Vellutino et al. (1996), Al Otaiba and Fuchs (2006) cited a group of studies (e.g., Blachman, 1994, 1997; Brown & Felton, 1990; Juel, 1994; Mathes, Howard, Allen, & Fuchs, 1998; Shanahan & Barr, 1995; Smith-Burke & Jaggar, 1994; Torgesen, Morgan, & Davis, 1992) showing that 30% of children identified as at risk for reading difficulties do not benefit from early phonologically-based interventions described as generally effective by the research (e.g., National Reading Panel, 2000, Snow et al., 1998; Adams 1990). These students who struggle despite generally effective instruction have been described as treatment resisters (e.g., Blachman, 1994; Torgesen, 2000). Al Otaiba and Fuchs (2006)

conducted a study to investigate which characteristics reliably predict who become these treatment resisters. They found that a combination of naming speed, vocabulary, sentence imitation, problem behaviour, and amount of intervention predicted non-response to intervention. Of students who began their study with identified reading disabilities, 26.7% were non-responsive to the intervention, meaning they remained in the lowest 30th percentile on standardized letter-sound and segmentation fluency measures. By comparison, 66.7% of students in the control group who started with these difficulties remained in the lowest 30th percentile after receiving regular classroom instruction with a district-adopted basal reading program that represented an implicit approach to phonics and phonological awareness instruction. They concluded that, in contrast to a more implicit based attention to phonics, "a generally well-implemented, systematic, explicit, peer-mediated intervention, targeting phonological and alphabetic awareness and supplemented by teacher-directed phonological awareness training, can substantially reduce the number of students at risk for reading problems" (p. 428). They also noted the need for studies to identify a different method or combination of methods to help those resistant to this generally effective remediation.

In summary, the weight of evidence suggests that explicit instruction about phonemic awareness and letter-sound correspondences results in better literacy outcomes than practices which avoid these sub-lexical features of oral and written words. However, a substantial number of students continue to struggle despite instruction that has been established as generally effective.

What Might Be Missing from "Best Practices"?

One collateral effect of the focus on the phonics verses whole language debate was the limiting of research resources that addressed other aspects of literacy instruction. For example,

many have cited the insufficient attention to research on vocabulary instruction (e.g., Coyne, Capozzoli, Ware & Loftus, 2010; Biemiller & Boote, 2006; Henry, 2004/2010). The National Reading Panel (2000) reported that despite the long established understanding that vocabulary is a critical feature of reading instruction, there were too few published vocabulary interventions to recommend a specific instructional approach. Citing these findings, Biemiller and Boote (2006) commented pointedly, "Current reading instruction is apparently premised on the view that children can build the vocabulary they need after learning to read (decode) fluently, as little or no vocabulary instruction occurs during the primary grades" (p. 44). Because it has been underemphasized in past decades of literacy research, vocabulary instruction remains a potentially rich area in a search for effective instructional innovations beyond the refining of phonics and phonological awareness practices.

Instead of an unsystematic search for possible improvements in literacy instruction, such a search should begin with a clear definition of reading and writing. Ehri's (2000) description of reading and writing as two sides of the same coin highlights the centrality of the orthography system for these opposite but complementary processes: the recognition of written words (reading) and the production of written words (writing). The standard definition of orthography (e.g. C. Chomsky, 1970; Venezky, 1999) is that it is a system that uses conventions of print to represent the meaning of a language to those who already speak that language. Building on this background, for the studies reported in this dissertation, the definition of writing is given as the process of *constructing* representations of meaning by means of the appropriate application of orthographic conventions, whereas reading is defined as the process of *reconstructing* meaning that has been represented orthographically by a writer.

These definitions highlight the central role of orthographic conventions for reading and

writing. This emphasis echoes that of Rayner et al. (2001) who defined *learning to read* as, "the acquisition of knowledge that results in the child being able to identify and understand printed words that he or she knows on the basis of spoken language…[L]earning to read is learning how to use the conventional forms of printed language to obtain meaning from words…*This view implies that the child learning how to read needs to learn how his or her writing system works"* [emphasis added] (p. 34). This argument was used to explain the evidence that phonics-based instruction was more effective than whole language-based instruction. This view, however, can be interpreted as implying that current best practices can be improved still further if they can be revised to mirror the conventions of English orthography still more closely. This brings us to the impetus for the studies of this dissertation, the hypothesis that literacy benefits will follow from bringing greater alignment between literacy instruction and the existing conventions of English orthography. Fortunately, the linguistic accuracy of instruction is easily assessed by comparing it to the well-established account of the structures and conventions of English orthography from the field of linguistics (e.g., C. Chomsky, 1970; N. Chomsky & Halle, 1968; Henderson, 1982; Venezky, 1967, 1970, 1999).

The studies reported in this dissertation build on that linguistic foundation. It is shown that instruction that follows the recommendations of influential sources (e.g., National Reading Panel, 2000; Adams, 1990) brings explicit, systematic attention to phonological features of oral and written words, but morphology, another fundamental feature of English has been largely ignored. Researchers such as Carlisle (2010), Devonshire and Fluck (2010), Henry (2003/2010), Nunes and Bryant (2006) have complained that the morphology system – how bases, prefixes, and suffixes combine to form words – receives little attention in typical school instruction. This concern should be considered in light of the fact that morphology is either side-lined or ignored

by influential scientific recommendations for best instructional practice (e.g., Adams, 1990; Fuchs & Fuchs, 2006; National Reading Panel, 2000; Rayner et al., 2001; Snow & Juel, 2005; Torgesen, 2005). Thus, the question is whether what is considered to be best practice by major reviews of educational research can be amended to reflect more closely the conventions of English orthography by integrating the role of morphology into instruction about the written word.

The accuracy with which literacy instruction reflects its writing system is central to the studies presented here. English is the main focus of these studies, so the next section begins with a detailed description of the conventions of English orthography with an emphasis on the interrelation of morphology and phonology.

Morphology in English Orthography

Morphological Conventions

This section provides a summary of the basic conventions of morphology in English orthography. A more detailed account is provided in Appendix A (see also, Bowers & Cooke, 2012, Fall). Appendix B provides a table with definitions for key terms that are used in this dissertation. Morphology is the conventional system that governs how morphemes (*bases*[1] and *affixes*) combine in the formation of words. Morphemes are the smallest units of meaning that cannot be further reduced. They are the irreducible lexical and sub-lexical meaningful building blocks of oral and written words. Crystal (2008) described the base as the "part of the word

[1]It is important to note that both the education and linguistics literatures use the terms base and root interchangeably as morphological terms. This dissertation reserves the term base for morphological contexts because root is also an etymological term referring to the origin of words that is distinct from morphology. For example, in current usage the root of the word helpful could mean the current English base help or the Old English root helpan. Since the term base never refers to historical origin of a word, this paper uses the term base exclusively for the main morpheme in a word and the term root only in referring to a word's origin.

remaining when all affixes have been removed" (p. 50). The base carries the underlying denotation of any word in which it is found, and that meaning is modified by affixes (*prefixes* or *suffixes*).

Bases can be either free (stand on their own as words) or bound (only occurring in conjunction with at least one other morpheme). In English it is common for the addition of affixes to a base to result in an alteration of the pronunciation of that base (e.g., *heal + th → health).* Similarly, affixes can have multiple pronunciations across words. For example, the *-ed* suffix is pronounced /d/ in *played,* /t/ in *jumped,* and /ɪd/ in *painted.* The prefix *re-* can be pronounced /ri/ in *redifine,* but /rə/ in *review.* The addition of suffixes sometimes alters the spelling at the end of the base or stem[2] to which the suffix is added. These spelling changes due to suffixing conform to reliable conventions that are presented in a flow chart in Appendix C. The process of word generation by adding morphemes to a base (morphological synthesis) can be illustrated by a word sum that includes the marking of any suffixing changes that may occur. The letter immediately following a forward slash replaces the letter immediately preceding that slash. Parentheses mark a doubled consonant (e.g., *hope/ + ed → hoped; try/i + ed → tried; hop(p) + ed → hopped*).

The base is the central morpheme of any complex word and the centre of a morphological family. An *orthographic* morphological family is comprised of those words which share a common *written* base. Thus, the orthographic word sum is a tool that can be used to (a) perform orthographic morphological analysis to reveal the written form of the base of a complex word, and (b) test for words that can be categorised as members of a single orthographic morphological family. For example a set of words related in meaning such as *pleasing*, *pleasure*, *pleasantly*,

[2]See the definition of *stem* and other orthographic terms described in the Table in Appendix B.

unpleasantness, and *displease,* can be analysed with word sums to prove that they are members of the orthographic morphological family centred on the base *please*.

In addition to the word sum, another linguistic tool, called the morphological matrix (www.realspelling.com), is available for representing the interrelated structure of orthographic morphological families. The matrix shown in Figure 1.1 was constructed to represent all five members of the *please* morphological family that are presented with word sums in that same figure. By means of specified conventions (outlined in more detail in Appendix D), orthographic representations of morphemes are arranged into cells around a base that binds a morphological family. As can be seen in Figure 1.1, the matrix is able to use fewer written morphemes than is needed for word sums to represent the same members of the *please* word family. In fact, although the matrix in Figure 1.1 was constructed with the minimal number of morphemes needed to represent the words represented by the five word sums, that matrix can represent words that are not represented by the word sums (e.g., *displeasing, unpleasurable*). Thus, the matrix provides a more elegant representation of the interrelations of structure and meaning in any orthographic morphological family than is possible with word sums.

please/ + *ing* → *pleasing*
please/ + *ant* +*ly* → *pleasantly*
un + *please/* + *ant* + *ness* → *unpleasantness*
please/ + *ure/* + *able* → *pleasurable*
dis + *please* → *displease*

<table>
<tr><td rowspan="3">un
dis</td><td rowspan="3">please</td><td colspan="2">ing</td></tr>
<tr><td>ure</td><td>able</td></tr>
<tr><td>ant</td><td>ly
ness</td></tr>
</table>

Figure 1.1. The morphological structure of members of the *please* morphological family represented with word sums on the left and a matrix (www.realspelling.com) on the right.

Oral or written morphological families are critical variables in morphological research. As will be addressed in the section on *morphological awareness*, the size and frequency of morphological families are important variables for reading morphologically complex words (e.g., Carlisle & Katz, 2006; Reichle & Perfetti, 2003). As the matrix provides an efficient tool for representing the orthographic structure of morphological families, it may have implications for better understanding about morphological families and how they can be addressed by instruction. Henry (2003/2010) recommended Ramsden's (2001) matrix as an instructional tool to illustrate how affixes can be added to a base in order to target the spelling-meaning connections inherent in word families. Aside from Henry's comments, the matrix appears to be a linguistic tool that has been unrecognised in research studies. Study 1 makes extensive use of word sums and the matrix in the instruction, and thus provides the first use of these tools in an intervention study.

The Interrelation of Morphology and Phonology in English Orthography

Analysis of morphological families with word sums and matrices can be used to bring clarity to the interrelationship of morphology and phonology in English orthography. By definition a matrix assembles words built on a consistently spelled base. Because the pronunciations of written morphemes often shift across words, matrices often assemble word families which use different pronunciations of a base, thus highlighting the interrelation of morphology and phonology in English orthography.

In addition, because these tools reveal the full underlying orthographic form of morphemes before any suffixing changes are applied, they also illustrate the relationship between the abstract underlying structure of words and the surface structures that we see in print. In this way, the matrix and the word sum can be viewed as linguistic tools which provide a concrete representation of C. Chomsky's (1970) concept of a lexical spelling. She used this term

for the abstract meaning-based word forms that lie beneath surface phonetic realisations of words, as proposed by N. Chomsky and Halle (1968). C. Chomsky argued that these abstract lexical representations are not just convenient conceptual tools for linguists but that they have a psychological reality for the language user. The morphological research amassed since 1970 (which will be addressed in some detail in the section on predicting literacy development from morphological knowledge) is consistent with C. Chomsky's view that language processing is influenced by these abstract sub-lexical word forms that are more closely marked by English orthographic conventions than by surface phonetic realisations (e.g., Rastle & Davis, 2008; Reichle & Perfetti, 2003; Taft, 1979; Taft & Kougious, 2004). Similarly, C. Chomsky's (1970) speculation that instruction about these underlying morphological structures and their conventional orthographic representations might result in benefits for learning to read and spell has been supported by subsequent instructional studies (e.g., Arnbak & Elbro, 2000; Berninger et al., 2008; Henry, 1989; Nunes & Bryant, 2006). To better understand how the word sum and the matrix provide concrete representations of the concept of a lexical spelling and the relationship between morphology and phonology, consider this account from C. Chomsky (1970):

> In the lexical spelling, many predictable phonetic features of the spoken language are suppressed, e.g., vowel alterations, consonant alterations, schwa, stress and others. . . . The lexical spelling, and the conventional orthography which corresponds so closely to it, abstract away from these variations in pronunciation and represent deeper similarities that have a semantic function in the language. . . . Lexical spellings represent the meaning-bearing items directly, without introducing phonetic detail irrelevant to their identification. Thus on the lexical level and in the orthography, words that *are* the same *look* the same. In

> phonetic transcription they look different. . . . [T]he spelling system leads the reader directly to the meaning-bearing items [morphemes] that he needs to identify, without requiring that he abstract away from superficial and irrelevant phonetic detail. (p. 294)

The word sum and the matrix capture the orthographic conventions that correspond closely to C. Chomsky's (1970) concept of a lexical spelling for any complex word. The word sum provides a concrete realisation of the underlying orthographic representations of the meaning-bearing units of a single complex word. The matrix expands that concrete realisation to any orthographic morphological family. The matrix makes it possible to construct a map of the lexical spellings of members of any orthographic word family.

Implications of English Orthographic Conventions for Instruction

Despite the frequent criticism of English spelling for its lack of straightforward "letter-sound" correspondence, linguists have long pointed to the advantages of the organisation of the English orthography system which draws attention to the meaning elements of words in our morphophonemic language (e.g., C. Chomsky, 1970; N. Chomsky & Halle, 1968; Henderson, 1982; Venezky, 1967, 1970, 1999). "[T]his divergence of the conventional orthography from phonetic transcription appears well motivated. It offers the advantage of expressing an underlying reality of the language which is masked by surface phonetic features" (C. Chomsky, 1970, p. 298). Making a similar point, Venezky (1999) argued "English orthography is not a failed phonetic transcription system, invented out of madness or perversity. Instead, it is a more complex system that preserves bits of history (i.e., etymology), facilitates understanding, and also translates into sound" (p. 4).

The matrix and the word sum provide tools for bringing the underlying reality of the

language to the surface for closer inspection by learners with the guidance of teachers. Based on evidence that phonics-based practices were more effective than whole language-based practices, Rayner et al. (2001) suggested that children learning to read need to learn how their writing system works. The matrix and word sums provide a means to study the workings of our writing system in greater detail and with greater accuracy than is typically presented in schools or previous intervention studies. The matrix and word sum isolate and represent the only aspect of orthographic morphological families that is static – their underlying orthographic representation. Teachers can use that static foundation as worked examples (Schnotz & Kürschner, 2007) of the underlying structure of morphological word families. This should serve to reduce the working memory load required to make sense of the interrelation of orthographic, phonological, and semantic information.

For example, while pointing to the concrete representations of the lexical spellings of the morphemes on the left side of the word sums and in the matrix of Figure 1.1, teachers can help learners closely inspect how those underlying lexical representations relate to the surface orthographic realisations on the right side of the word sum, and to the phonological realisations for specific words that learners know from oral language. Table 1.1 lists the three surface pronunciations and two surface orthographic representations of the base *please* that are realised for the members of this word family. These interrelations of underlying structure, surface spellings, and pronunciations could be discussed in a classroom with the help of the word sums and matrix presented in Figure 1.1.

Inspecting words assembled by a matrix and analysed into word sums highlights not only the morphological structure of words for children, but it can facilitate instruction about how grapheme-phoneme correspondences work in English. As has been shown, morphemes that use

consistent spelling can vary widely in their pronunciation. This constraint on the evolution of English spelling means that grapheme-phoneme correspondences are governed by morphological conventions in a number of ways that can only be explicitly addressed by instruction that include a focus on morphology.

Table 1.1

Relationships Between Word Sums, Surface Spellings and Pronunciations, and the Underlying Lexical Spelling of the Base in Members of the please *Word Family Shown in Figure 1.1.*

Word sums for members of the *please* family	Surface spelling of base	Surface pronunciation of base	Underlying lexical spelling of base
please/ + ing → pleasing	pleas	/pliːz/	please
please/ + ant + ly → pleasantly	pleas	/plɛz/	please
un + please/ + ant + ness → unpleasantness	pleas	/plɛz/	please
please/ + ure/ + able → pleasurable	pleas	/plɛʒ/	please
dis + please → displease	please	/pliːz/	please

Three ways grapheme-phoneme correspondences are affected by morphology follow:

(a) A spelling system that represents morphemes of multiple pronunciations with consistent spellings requires a bank of graphemes that can be associated with

multiple phonemes.

(b) We cannot understand the spelling of a base in isolation. The written form of a base must use graphemes that can represent all the pronunciations associated with that base. For example, the base *please* in Figure 1.1. cannot be spelled **pleese*. The *ee* digraph can represent the 'long e' of this base word, but it cannot represent the 'short e' of words like *pleasure* and *pleasant* that it builds. With this information, teachers can explain why we need a digraph like *ea* that can represent the "long e" and "short e". As C. Chomsky (1970) pointed out, a base or stem on its own has no specific pronunciation until it is placed within the context of a specific word.

(c) Graphemes occur within morphemes. That is to say, digraphs and trigraphs cannot straddle morphemic boundaries. Thus teachers can use word sums to clarify that a word like *react* does not use an *ea* digraph (re + act) and *hothouse* has no *th* digraph (hot + house).

Instruction that aims to teach children how their writing system works should reflect these features of how graphemes operate. Armed with this linguistic knowledge, teachers can use words like *does* or *business* to explain how their spelling system works (*do + es → does; busy/i + ness*) instead of treating them as irregular spellings that have to be memorised.

The fact that the structures and conventions of English spelling described in this and the previous section can be demonstrated through linguistic analysis does not mean conscious awareness of these facts is necessary for successful literacy learning. However, explicit, detailed knowledge about how spelling works in our morphophonemic system may be of particular importance to those who struggle in the current context of instruction that fails to emphasize the role of morphology. Such knowledge is unlikely to harm stronger students, and may provide

additional benefits, particularly to vocabulary knowledge.

The Place of Morphology in Psychological Models of Reading

Do morphological conventions that are intrinsic to the oral and written language play a role in psychological models of reading even for individuals who do not receive explicit instruction about them? First I will consider the role of morphology in Ehri's influential model of phases of learning to read (Ehri, 1995; Ehri & McCormick, 1998). Clearly Ehri's model is intended specifically as a developmental model to explain the process involved in learning to read. I will then consider the role of morphology in two important reading models in the field that I describe as general models as they can be used to describe fundamental processes of either developing or accomplished reading. These general models are the triangle model of reading based on Seidenberg and McClelland (1989) and Perfetti's (2007) lexical quality hypothesis.

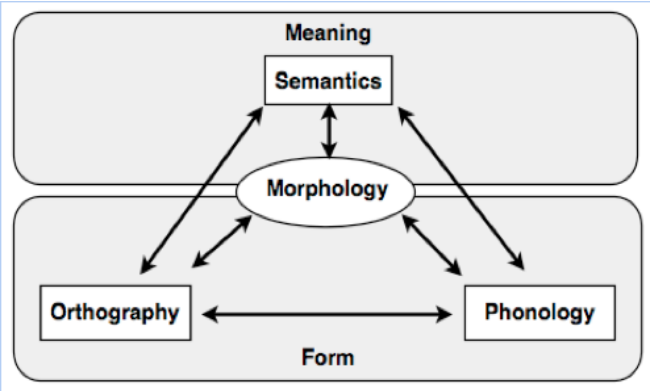
Erhi and McCormick (1998) described five phases of development in learning to read: pre-alphabetic, partial alphabetic, full alphabetic, consolidated alphabetic and automatic alphabetic. They offered instructional recommendations for each of the first four stages as the fifth stage characterized proficient reading. A central assumption of the model is that the process of learning to read involves successive stages of refining knowledge about links between letters and sounds. Morphology does not appear in their model until the fourth stage, consolidated alphabetic. They describe this stage as being characterized by consolidating "larger units out of grapheme-phoneme relations that recur in different words" (Ehri & McCormick, 1998, p. 154). For Ehri and McCormick, the important new knowledge about the writing system acquired at this stage is learning about chunks of letters that included morphemic structures of affixes and bases (roots in their terminology), but they equally emphasized letter chunks associated with onsets, rimes and syllables. Their model ignores that the unique contribution of morphemes is

that they map onto *both* pronunciation and meaning. Rather, Ehri and McCormick (1998) cited the work of Ehri (1995) and (Juel, 1983) when they emphasized that the value of learning about these chunks of letters was that this knowledge facilitates decoding speed and accuracy and sight word learning.

Ehri and McCormick (1998) offered explicit instructional implications based on their developmental model of reading in terms of morphology. According to their model, morphological structures should not be introduced until after substantial learning of grapheme-phoneme correspondences have been learned through extensive, systematic instruction. Further, when morphological instruction is introduced, they emphasized drawing attention to these structures as a decoding strategy more than as a vehicle for recognizing meaning cues between words with common morphemes. According to their instructional recommendations, morphology only featured in classroom instruction after grapheme-phoneme correspondence knowledge is well-established in the full alphabetic stage. Ehri and McCormick (1998) supported their introduction of morphological instruction only once the consolidated alphabetic stage had been reached by pointing to one of the earliest morphological interventions by Henry (1989) who found significant gains in decoding and spelling with Grade 4 and 5 students. However, without evidence from morphological interventions in younger grades, Ehri and McCormick's (1998) recommendation to introduce morphological instruction in the upper grades was an untested assumption. Evidence from morphological interventions in younger grades is needed.

The well-known "triangle model" of reading based on Seidenberg and McClelland (1989) is a general model of reading that identifies three interrelated cognitive systems involved in visual word recognition and pronunciation that facilitate an individual's ability to make meaning from print: the phonological, orthographic, and the semantic systems. The description of oral and

written English morphology in the previous section shows that it can be seen to occupy a special position in the triangle model as it is associated simultaneously with orthographic, phonological, and semantic features of words and thus can influence all three of these cognitive systems in the process of reading. Consider the word *disagreeable*, which is composed of three morphemes represented phonologically as /dɪs/ + /əgri/ + /əbəl/, and orthographically as *dis* + *agree* + *able*. Semantically, the *-able* suffix turns the verb *disagree* into the adjective *disagreeable* and the prefix *dis-* shifts the positive connotation of *agree* or *agreeable* into negative connotations. Morphemes provide a juncture of form (phonological and orthographic) and meaning linking the orthographic, phonological, and semantic systems. Figure 1.2 shows a modified version of the



triangle model illustrating this role of morphology.

Another general model of reading, Perfetti's (2007) lexical quality hypothesis, also describes processes during reading in which morphology can be seen as playing a central role. The concept of developing and binding multiple representational features of words is described in the lexical quality hypothesis as facilitating efficient access to lexical items during reading (Perfetti, 2007; Perfetti & Hart, 2002; Perfetti & Hart, 2001; Reichle & Perfetti, 2003). This

Figure 1.2. A modified version of the "triangle model" of reading showing the role of morphology. A version of this model was presented in Kirby, Bowers, & Deacon (2009, August).

theory, which can be applied to developing or accomplished readers, posits that the lexical representations people develop – the knowledge they have about words – are the source of the ability to retrieve word identities efficiently. Perfetti (2007) identified four independent constituent features of words that contribute to the quality of a lexical representation: orthography, phonology, grammar, and meaning. His fifth representational feature, constituent binding, refers to the degree to which the other features are bound together.

Oral and written morphological knowledge for any given word could be understood as acting as an agent that can bind any combination of phonological, orthographic, semantic and syntactic information for that word, thus enhancing the lexical quality of that word. When this lexical information is well integrated in memory, recognition of printed words (reading) is rapid and accurate (Perfetti & Hart, 2001; Reichle & Perfetti, 2003). Note that the previous analysis of the word *disagreeable* links each of the features of Perfetti's (2007) lexical quality to the morphology of this word, thus facilitating associations among all these features of lexical quality. A reader with rich taught or untaught knowledge about the morphological components of the word *disagreeable* has the possibility of linking lexical and sub-lexical oral and written features of words with associated semantic information. In turn, those representations (*dis-*, *agree*, and *able*) could activate other words (and associated meanings) that are constructed with these constituent morphemes of a lexical (e.g., *agreement* from the base word *agree*) or sub-lexical status (e.g., *disrupt*, from the prefix *dis-* and *reliable* from the suffix *-able*). If morphology does act as a constituent binding agent of lexical and sub-lexical features, it should influence the quality of lexical representations. Stronger morphological representations could result in more automated access to relevant lexical and sub-lexical representations during reading, reducing the cognitive load posed by accessing words (Sweller, 1988; Schnotz &

Kürschner, 2007). According to this view, morphological processing could reduce working memory required for word recognition during reading, and could thereby free up cognitive processing to attend to reading comprehension at the sentence level and beyond.

Verhoeven and Perfetti (2011) highlighted the relevance of morphology for the lexical quality hypothesis, and the relevance of their model for developing readers when they described morphological decomposition as a "self-teaching device in reading complex words via increasing lexical quality leading to instance-based learning of lexical items toward automatic recognition" (p. 461). It is important to remember that, given the current state of instruction that fails to explicitly teach morphology, this suggestion of morphological decomposition as a self-teaching device is largely based on untaught morphological knowledge. It may be that explicit instruction about morphological analysis (decomposition) and synthesis would facilitate more skilled, automatic morphological decomposition during reading, and thus more automatic word recognition.

It may be that morphological decomposition as a self-teaching device parallels the processes by which Share (1995, 2011) invoked the self-teaching hypothesis for learning sound-letter correspondences. Share argued that the process of recoding written words into their sounds forces the reader to attend to the sub-lexical letter-to-sound mappings that facilitate the formation of well-specified representations that allow for rapid automatised word recognition. Because the same sub-lexical phonemes and graphemes exist in different words, encountering these combinations over time can provide this self-teaching mechanism. Shahar-Yames and Share (2008) extended the self-teaching hypothesis to spelling. They argued that a self-teaching function might be found in the act of producing a spelling as this process also forces the individual to attend to "orthographic detail (letter identity and order) and sub-lexical print-to-

sound relationships in a systematic manner" (Shahar-Yames & Share, 2008, p. 23). In both of these suggestions of the self-teaching hypothesis through exposure to and scrutinizing of the internal structure of oral and written words, however, morphological influences on the spelling of words and the relationships to phonology and meaning are ignored. As Verhoeven and Perfetti (2011) argued, "Current models of reading have focused on how letter strings are converted to phonological strings (pronunciations), essentially ignoring any internal structure that words have as morpheme units. However, reading more complex words may involve processes of morphological decomposition as well as grapheme–phoneme connections and whole-word look-up methods" (2011, p. 458).

The hypothesis that the acquisition of lexical and sub-lexical morphological representations linking orthographic, semantic, and phonological features of words affects the efficiency of lexical retrieval during reading is consistent with the connectionist triangle model (Seidenberg & McClelland, 1989). It is consistent with C. Chomsky's lexical spelling concept (1970) and Perfetti's (2007) lexical quality hypothesis. It is also possible that morphological decomposition (based on taught or untaught knowledge) of words provides a self-teaching mechanism (Verhoeven & Perfetti, 2011), paralleling and expanding on the self-teaching hypothesis for sub-lexical processing of letter-sound correspondences through decoding activities (Share, 1995) and through spelling (Shahar-Yames & Share, 2008). If morphemes provide a conjunction of form and meaning that has a psychological influence on the efficiency of reading and writing, we should be able to find evidence of the effects of well-integrated representations of these features of words. The next section considers research on how the acquisition of morphological representations might occur and whether such representations influence word recognition.

The Acquisition and Use of Untaught Morphological Knowledge

Morphological knowledge is an umbrella term that includes both implicit and explicit knowledge about oral or written morphological features of words that can influence the processing of lexical items during language based activities. As they gain more and more language experiences, children acquire a great deal of knowledge about morphology. Some of this knowledge is tacit, supporting language and reading subconsciously. For example, Carlisle and Stone (2005) showed that lower and upper elementary students read polymorphemic words (e.g., *shady*) more quickly than matched mono-morphemic words (e.g., *lady*). Carlisle and Stone interpreted this finding as evidence that children had developed knowledge of related morphological structures (the base *shade* and the suffix *-y*) that they drew on to facilitate the reading of such polymorphemic words. Since *lady* is a base, the speed of accessing this lexical item is not facilitated by knowledge of related sub-lexical morphological structures. However, from this task we do not know if the morphological knowledge supporting that reading is tacit or conscious knowledge. If, however, a child produces the correct morphological form of a word to suit a sentence, that can be taken as evidence of a more conscious level of morphological knowledge. For example, if a child says, "There is no *shade* here. Let's go over there where it is *shady* and cool." They have demonstrated a more conscious level of morphological knowledge and an awareness of how to manipulate morphological structures conventionally. This last type of knowledge or skill has been termed morphological awareness, which has been defined by Carlisle as children's "conscious awareness of the morphemic structure of words and their ability to reflect on and manipulate that structure" (Carlisle, 1995, p. 194). One challenge for assessing the research on the relationship between morphology and literacy learning is that it is not always clear whether tasks intended to measure individual differences in morphological awareness

actually tap into the more conscious level of knowledge that can be termed morphological awareness, or if they simply measure the more general morphological knowledge.

It is also important to keep in mind that the individual differences in morphological knowledge or awareness that are found to predict various literacy measures (addressed in the next major section) are largely due to implicit learning, as morphology currently receives little explicit, systematic instruction in schools (Moats, 2009). Before reviewing the research on how untaught morphological awareness relates to literacy learning, the following section addresses how this knowledge might be acquired in the first place. Understanding how this knowledge of lexical and sub-lexical features of words is achieved without explicit instruction may facilitate the development of effective instructional strategies that capitalise on already existing implicit morphological learning processes.

Acquisition of Morphological Knowledge Via Exposure

Exposure to morphologically complex oral and written words in the context of meaningful experiences with language is needed for learners to develop and thus be able to make use of sub-lexical morphological representations during the reading of complex (polymorphemic) words (Carlisle & Katz, 2006; Perfetti & Hart, 2001; Rastle & Davis, 2008; Reichle & Perfetti, 2003; Taft, 2003; Taft & Kougious, 2004). Such exposure is required for the learner to gain experiences with the interrelation of phonological, orthographic, and semantic features of lexical and sub-lexical morphemes so that those features become well integrated in high-quality representations that can facilitate lexical identification during reading. If exposure to morphological features of words is the means by which morphological knowledge is acquired, then the frequency and nature of that exposure must play a key role in the development of that knowledge.

Ford, Davis, and Marslen-Wilson (2010) argued that the frequency effect – the finding that high-frequency words are recognised faster than low-frequency words in word/non-word lexical decision tasks – provides a means to study how language is represented in the mind. Early descriptions of the mental lexicon saw lexical representations as separate word-level entities (e.g., Morton, 1969; Forster, 1976). A substantial body of literature has demonstrated that both word frequency and morphemic frequency influence lexical processing times (e.g., Baayen, Dijkstra, & Schreuder, 1997; Ford, et al., 2010; Niswander, Pollatsek, & Rayner, 2000; Taft, 1979). That more frequent words and more frequent morphemic structures within words result in shorter latencies in lexical decision tasks suggests that extensive exposure to print is a key mechanism for the acquisition of high-quality lexical and sub-lexical morphological representations.

Carlisle and Katz (2006) outlined four measures of frequency relevant for understanding contributions to lexical quality of derived words. Results of their study with Grade 4 and 6 students showed that two of their frequency measures loaded on a factor interpreted as indicative of morphological constitution (frequency of the base word and average frequency of the members of the morphological family). The other two measures loaded on a factor interpreted as indicating degree of exposure (frequency of the whole word and size of the morphological family). Both factors contributed to how quickly and accurately children read derived words. Analyses of variance found the frequency factor distinguished between both grade and reading ability levels. Carlisle and Katz concluded that both exposure and morphological analysis contribute to reading derived words.

Rastle and Davis (2008) and Deacon, Conrad, and Pacton (2008) suggested that engaging in oral and written language may allow learners to detect statistical regularities between sounds,

letters, and meanings that support the development of morphological knowledge. Rastle and Davis (2008) proposed a mechanism by which exposure to complex words in writing could facilitate the development of morphological representations. They suggested that readers respond to bigram and trigram probabilities to learn which letter sequences cohere as morphemic units. According to this account, rarely occurring bigrams could be learned to mark probable morphemic boundaries (e.g., the *pf* in *helpful*). Conversely, as the spelling of morphemes is highly stable across words, high frequency letter sequences (e.g., digraphs such as *ea*, trigraphs such as *tch* or *igh*, or even letter strings such as *ight*) could be identified as probable within-morpheme markers. The repeated exposure to the statistical association of such letter strings in conjunction with phonological and semantic cues could help the reader develop representations of morphemic elements and cues for identifying morphemic boundaries within complex words, without necessitating explicit knowledge about the nature of these word structures.

The Nature of Morphological Representations Acquired Through Exposure

The traditional view has been that exposure to the co-occurrence of oral, written, and semantic features of words produces discrete morphological representations (e.g., Marslen-Wilson, Tyler, Waksler, & Older, 1994; Feldman, 1995; Taft & Forster, 1975, 1979). According to this view, discrete morphemic units are represented in memory and used in the processing of complex words (Feldman, 1996). For instance, learners would develop discrete morphological representations for bases such as *bake* that are then used in the processing of related words such as *baker*, *bakery*, and *unbaked.* In the same way, discrete representations of sub-lexical morphemes such as the suffix *-er* would be invoked for the processing of words such as *talker* and *writer* in the course of reading, writing, listening, or talking. Gonnerman, Seidenberg, and Anderson (2007) argued that a problem with this view is that it fails to explain the processing of

words that do not have a clear morphological status. For example, they asked how a discrete system would deal with the *groc* of *grocer*. On the pattern of *bake - baker, grocer* might be treated as morphologically complex. In that case, Gonnerman et al. argued, the definition of a morpheme as a unit of meaning would have to be abandoned since *groc* has only an obscure etymological connection to meaning that has no effect on performance. Similarly, they argued, it would be problematic to treat *grocer* as a single morpheme because that would imply that it is disconnected from words such as *baker* and *writer*. They addressed this problem by proposing a graded theory of morphological representation in which it is not necessary to parse words into categories of simple or complex. Intermediate cases like *grocery* or *cranberry* lie on a continuum between morphological complexity and simplicity. According to this view, morphemes do not have discrete representations, but emerge as a reflection of the degree of convergence between form and meaning across words. Gonnerman et al. (2007) hypothesized that the level of semantic and phonological overlap between prime-target pairs would predict effects previously attributed to morphological structure.

To test their hypothesis, Gonnerman et al. (2007) devised a series of priming experiments that manipulated amount of phonological and semantic overlap between primes and targets, and avoided the effect of orthography by presenting words orally. One experiment controlled the phonological relationship between target-prime pairs, but varied the semantic connection within those pairs with three degrees of semantic similarity: Low (e.g., *hardly-hard*), Moderate (e.g., *lately-late*), and High (e.g, *boldly-bold*). Note that the semantic similarity between these prime-target pairs varies but the phonological form of the base remains stable between pairs. In addition there was a Form Only condition. The prime-target pairs in this condition matched orthography and phonology but avoided any semantic/morphological

connection (e.g., *spinach-spin*). No priming effect was detected between pairs in the Form Only or Low Semantic conditions. They did find a significant priming effect between pairs in the Moderate and High Semantic conditions, and in support of their hypothesis, the magnitude of the effect was determined by the degree of semantic similarity with stronger effects for the High Semantic condition than the Moderate Semantic condition. Further experiments showed that the morphological priming effect only occurred when prime-target pairs were close enough in *both* phonology and semantics. The word *saintly* primed the target *sainthood* because there is only a slight phonological shift of the base between the pairs, and a slight semantic shift. In contrast *observation* did not prime *observant*. The combined phonological and semantic shifts between these two words were too much to bring a priming effect.

Gonnerman et al. (2007) reasoned that in a graded theory of morphological representation, "effects of morphological structure on processing should be predictable from the degree of semantic and phonological overlap between words, and… these effects should be graded rather than categorical" (p. 338). They argued that their findings supported this graded theory better than the traditional theory of discrete morphological representations. It is important to note, however, that Gonnerman et al. (2007) avoided the effect of orthography by presenting the primes orally. Considering the relative consistency of orthographic representations of morphemes across related words compared to shifting semantic and phonological associations, presenting primes orthographically might produce results more consistent with the view of discrete morphological representations.

The importance of the linking of morphology and orthography for a priming effect is well established (e.g., Rastle & Davis, 2008; Taft & Kougious, 2004; Taft & Nguyen-Hoan, 2010). Prime-target pairs that share orthographic strings that map onto morphological structures

produce a priming effect that is not found for pairs with orthographic strings which have no morphological role. For example, Feldman (2000) and Rastle, Davis, and Marslen-Wilson (2000) showed that briefly presented primes (under 60 ms) affect lexical decision times when the target shares an orthographic and morphological relationship (e.g., *vowed-vow*), but prime-target pairs which share an orthographic but not a morphological relationship (e.g., *vowel-vow*) do not show that same priming effect. The precise nature of morphological representations remains uncertain. Given the evidence that orthographic morphological structures influence priming effects, research attempting to clarify the nature of morphological representations needs to consider the role of orthographically presented primes.

Another insight into the effect of the binding of morphology and orthography in mental representations was shown by Taft and colleagues (e.g., Taft & Kougious, 2004; Taft & Nguyen-Hoan, 2010) and Rastle and Davis (2008). In fast masked priming tasks (under 60 ms) that block the influence of semantics, Rastle and Davis (2008) showed that target-prime pairs with plausible orthographic morphological structure have a significant priming effect. So *corner* primes *corn* even though the lack of a meaning connection signals that they are not really morphologically related. Rastle and Davis (2008) called this a morpho-orthographic effect and argued that it could represent an automated initial level of visual word perception that is followed by a second morpho-semantic decomposition. Although this initial automatic processing may cue false morphological connections, they argued that, "morpho-orthographic segmentation constitutes an efficient computational process that allows rapid access to the meanings of morphologically structured stimuli *most of the time* [emphasis in original]" (Rastle & Davis, 2008, p. 950).

A common thread can be found in the results of the research that studied the role of orthography in morphological priming (e.g., Rastle & Davis, 2008) and the research that

presented primes orally (Gonnerman et al., 2007). In each case the priming effect increases when language features between the prime and target are more similar. For Gonnerman et al., the closer phonological and semantic features overlap between primes and targets, the larger the priming effect. For Rastle and Davis, the more orthography and morphology overlap, the greater the priming effect. One interpretation of these findings is that they lend support to Perfetti's (2007) lexical quality hypothesis which posits a constituent binding feature of words whereby, as linguistic features of words are bound together more tightly in a person's lexical representation, the more efficiently that person can access that lexical item.

It is important to note that the priming research reviewed so far was all conducted in adult populations. If this research is going to be able to improve our understanding of the role of morphology in literacy learning and instruction for children, we need to consider evidence from priming studies with children. A small but growing group of studies has begun to use morphological priming studies with school-aged children (e.g., Deacon, Campbell, Tamminga, & Kirby, 2010; Feldmen, Rueckl, DiLiberto, & Vellutino, 2002; Hassan-Yari, 2011; McCutchen, Logan, Biangardi-Orpe, 2009; Quemart, Casalis, & Cole, 2011; Rabin & Deacon, 2008). Deacon, et al. (2010) used a slow priming methodology (1 second exposure) with students in Grades 4, 6, and 8. Participants were shown a prime that was either a base (e.g. *harm*), an inflection (e.g., *harmed*) a derivation (e.g., *harmful*), an orthographic control (e.g., *harmony*), or no prime at all. After the priming phase, participants were asked to complete a fragment (e.g., *ha* _ _) with the first word that came to mind. The participant could respond with a number of words to fit this stimulus (e.g. *hall, hate* etc.) that are unrelated to the prime, or they could respond with the target of the prime (*harm*). Deacon et al. found that priming effects were higher for the inflected and derived forms than for orthographic controls. The finding that morphologically-

related prime-target pairs show a significantly stronger priming effect than non-related words corroborated findings of previous child research with the fragment completion task (e.g., Rabin & Deacon, 2008; Feldmen, 2002). Hassan-Yari (2011) replicated Deacon et al.'s (2010) findings, and extended them by also showing that morphological awareness measured in Grade 3 was a significant predictor of morphological processing in grade 4 as measured by the fragment completion task even after controlling for reading, IQ, phonological awareness, and orthographic processing. McCutchen, et al. (2009) found Grade 5 and 8 students read target words with greater speed and accuracy when preceded by primes that were morphologically related compared to those that only had semantic or orthographic connections to primes. This morphological priming effect, however, was not significantly correlated either with word reading or reading comprehension measures, nor was it correlated with a morphological awareness measure using a production task. In a study in French, Quemart, et al. (2011) found evidence of significant priming for prime-target pairs that shared a real and pseudomorphological connection in a lexical decision task using a 60 ms prime for children in Grade 3, 5 and 7. In a condition with a slow prime of 800 ms, which allows for semantic processing, the priming effect disappeared for the prime-target pairs with a pseudomorphological relationship, but not for those with a real morphological relationship. These results provide evidence that the morpho-orthographic effect described by Rastle and Davis (2008) for adults extends to developing readers.

The research reviewed here points to subtle cues within the writing system that, with multiple exposures over time, allow learners to develop orthographic morphological representations without explicit instruction about these structures. Understanding the mechanisms by which such representations are developed can inform instructional design to

target these structures. Rastle and Davis (2008) argued that morpho-orthographic segmentation gained through multiple exposures to the oral and written (lexical and sub-lexical) forms of words and the associated semantic information, contributes "to the efficiency of speeded reading, particularly for users of morphologically rich languages. Thus, teaching methods that enhance morpho-orthographic segmentation should be favoured in school classrooms" (p. 967). If simple exposure to oral and written morphologically complex words is the means by which morphological representations are acquired, perhaps adjusting the quality of that exposure to those structures through instruction will result in higher quality oral and written morphological representations. Instruction with the matrix and the word sum, which are inherently tied to that structure, may be one means to this end.

Morphology and Vocabulary Development

Exposure to oral and written words is also implicated in theories of vocabulary development. Anglin (1993) tested 96 children from grades 1, 3, and 5 for their knowledge of a sample of 196 main entry words from an English dictionary to generate an estimate of vocabulary learning over these years of schooling. His sample was equally divided by grade (32 children at each grade), gender, and according to upper and lower socioeconomic status. Based on the data from this sample, he estimated that between age 1.5 and Grade 1, children learn on average about 5.5 words per day and that between Grades 1 and 3 that rate grows to approximately 12 words per day. Anglin noted that these numbers were in line with Carey's (1978) estimate of 5 words per day during preschool years and with Miller's (1977) estimate of 14.5 words per day between Grades 1 - 3. By the latter half of Grade 5, he estimated that this vocabulary knowledge grows to about 40,000 words, or roughly 20 words a day between Grades 1 and 5. Analysis of the nature of the words learned over this period found that between 1.5 years

and Grade 1, root (base) words had the highest growth rate, but "between grade 1 and grade 5, derived words were associated with the highest rate by a considerable margin" (Anglin, 1993, p. 132). Clearly children are effective independent word learners, but by which mechanism(s) do they learn words that they are not explicitly taught? Morphology is the system by which meaning is structured in oral and written words. As such, it is a prime candidate as a language feature central to language learning (Anglin, 1993; Carlisle, 2007; Carlisle & Fleming, 2003; Nagy & Anderson, 1984; Taft & Kougious, 2004).

Anglin (1993) proposed that morphological problem-solving is a process by which children could learn the meanings of unknown complex words. In his 1993 study, he coded students' definitions for evidence of the use of morphological problem solving. Of the complex main entry words (inflections, derivations and compounds) included in the test, Grade 1, 2, and 5 students used morphological problem solving in, respectively, 56%, 57%, and 65% of the cases. He provided many examples of interviews to illustrate the types of answers that were coded as illustrating morphological problem solving. In one example, a ten-year-old student worked out the meaning of the word *treelet* by saying, "Well, a piglet is a small pig, so a treelet could be a small tree" (Anglin, 1993, p. 80). In another example, a fifth grade student presented with the word *advisable* responded, "I'm not sure. I really haven't heard it. *Advise* means to give advice to someone; it means to give them help with what they're doing. And *advisable* means the same thing except for it will be advisable to go to someone else" (Anglin, 1993, p. 80). These responses illustrate that students, who presumably had received no explicit morphological instruction, were able to (a) recognize meaning cues carried by familiar morphemes within unfamiliar words, and (b) use that semantic information to derive a general sense of the word and, in the case of *advisable* the proper grammatical use, of those unfamiliar words.

It should be noted that in these examples we see students conducting morphological analysis and synthesis orally, without the aid of explicit instruction with word sums. Presumably this untaught word knowledge could be improved with explicit instruction. Even without instructional guidance, this process of morphological analysis and synthesis could well be a mechanism that strengthens the lexical quality of the representations of these morphemes. The cognitive process of isolating and manipulating morphemes across words, while considering phonological, orthographic and semantic information, could be an efficient way of developing higher quality lexical representations for these morphemes and complex words. If true, the acquisition of higher quality morphological representations and skills for analysing and synthesising morphemes could set in motion a virtuous cycle. As the quality of morphemic representations increase, the ability of the reader/writer to make sense of novel words with familiar morphemes should also increase, thus developing the quality of morphological representations even further.

Nagy and Anderson (1984) estimated that the meaning of about 60% of the novel written words elementary students encounter could be worked out through morphological problem-solving in combination with cues from their use in a sentence. This meta-linguistic process has garnered growing interest in the literature as an important word-learning skill (e.g., Baumann et al., 2002; Henry, 1989, 2003/2010; Nagy, 2005; National Reading Panel, 2000; Scott, 2005; Templeton, 1989, 2004). Given that vocabulary knowledge plays a role in literacy development (Beck & McKeown, 1991; Biemiller & Slonim, 2001), then morphological problem-solving is a means by which children can make sense of novel words. Such a word-learning skill would be an important skill to support with explicit instruction.

Morphological Awareness

Morphological awareness is a meta-linguistic awareness that involves knowledge about the interrelation of structure and meaning of morphemes and the ability to manipulate that knowledge (Carlisle, 1995). When young children make errors like saying *runned* for *ran*, they demonstrate that they have acquired oral morphological awareness via exposure to oral language. Because children are generally not exposed to a word like *runned*, this type of word production can be seen as evidence that children have learned the common way to articulate the past tense of a verb by adding /d/, /ɪd/ or /t/ to the end of a known verb, even when it results in a word to which they have not been exposed. In most cases, this results in conventional words, thus building their vocabulary. On occasion children encounter verbs such as *run* and they need to learn that a different process of marking the past tense applies.

Berko (1958) conducted the earliest study of this type of meta-linguistic knowledge. Working in the oral domain, she showed that children as young as 4 years old were able to demonstrate awareness of some inflectional suffixes such as the *-s* suffix for more than one by correctly producing that suffix orally for pseudowords. For example, in Berko's task, children were presented with a drawing of a bird-like creature and told that it was called a *wug.* When asked what a picture of two of those same birds would be called, they could properly say the word *wugs,* demonstrating morphological awareness. Children were not as successful at producing plurals like *tasses*, indicating the limited nature of this knowledge at this age. Clark (1982) described anecdotal evidence of derivational morphological knowledge in preschool children when they created novel words like *flyable* that combine a derivational suffix *–able* with the base *fly.* This type of conscious awareness of word structures is developed first orally, but then, as children learn to read, they can develop morphological awareness with respect to written

morphology as well.

As was shown in the previous section, the morphology system is a fundamental feature of both oral and written words, so when application of morphological knowledge involves some conscious awareness of oral and/or written morphological forms, it is seen as an index of morphological awareness. In the written domain, Nunes, Bryant and Bindman (1997) investigated spelling errors related to the *–ed* suffix for the past tense, a task which can be considered to tap morphological awareness. They reported a longitudinal study starting with students in Grades 2, 3, and 4 who were followed for 20 months. They showed evidence that at first students treated the phonological associations of *ed* as exceptions to the phonetic system, but later made sense of the grammatical role of this morphemic unit. They found that at first students generalize this spelling to phonologically possible but grammatically inappropriate words (e.g., *sofed* for *soft*). Later students' errors were confined to correct grammatical category of the past tense, but wrongly generalized to irregular forms (e.g., *keped* for *kept*). Finally, this spelling was correctly applied to regular past tense verbs. This pattern of errors over time indicates that young children develop and employ generative morphological knowledge from exposure to language that conforms to the predictable phonological representations of morphemes. It is not surprising that it takes more time to learn the relatively few words that use phonologically unpredictable morphological constructions.

Researchers have devised a wide variety of tasks to measure the various facets of morphological awareness for children at a wide variety of ages. Deacon, Parrila, and Kirby (2008) provided a taxonomy of morphological tasks which identified three relevant dimensions of morphological tasks: modality of input/output, content, and process. Morphological awareness measures can be conducted orally, in writing, or in a combined oral and written form. Measures

frequently use analogy tasks (e.g., Kirby, Deacon, Bowers, Izenberg, Wade-Woolley, & Parrila, 2012) to assess participants' ability to produce or decompose morphological forms or to make a judgement about real versus false morphological relations (e.g., *play/player* vs. *corn/corner*). Nunes, et al. (1997) devised an oral analogy task for six-to-nine-year-old children. In this task, the investigator says a sentence such as, "The dog is *scratching* the chair" to a puppet and the puppet responds, "The dog *scratched* the chair." Immediately after, the investigator says, "The dog is chasing the cat." and asks the child to say the sentence back as the puppet would say it. Thus, the task measures whether the individual can correctly alter the inflectional suffix to mark the past tense.

Morphological awareness measures can be manipulated to target various features of morphology. In an oral task used with third and fifth graders, Carlisle (2000) manipulated the level of phonological shifts between morphologically related prompts and targets. For example she tested participants' ability to produce a derived form given a word and a sentence prompt. In a morphological production task, some items involved a phonological shift (e.g. "revise. This paper is his second _____[*revision*]") and others did not (e.g., "teach. He was a very good _____ [*teacher*]").

Analogy tasks that force participants to apply both morphological decomposition and production may tap more explicit morphological awareness. For example, Nunes, et al. (1997) asked participants to complete patterns such as *see--saw: dance--*_____ [*danced*]. In this type of task, the participant has to recognize the morphological relationship in the first pair (form the past tense) and then apply that morphological process to the cue word in order to produce the correct response.

Morphological awareness is also measured in many ways in the written domain. For

example, Nunes and Bryant (2006) described studies comparing whether students spelled words with *–ian* and *–ion* suffixes correctly. Note that these suffixes carry different semantic information but represent the same pronunciation (e.g., *musician*, *discussion*). Manipulating words with these suffixes in spelling tasks can be used to measure learners' orthographic morphological awareness. Nunes and Bryant (2006) also described written tasks that measure whether children know that a base (or stem) is spelled consistently across related words even when the pronunciation of that base shifts. If children spell *know*, do they also spell that base in the complex word *knowledge* even though the pronunciation of that base shifts? Given spelling tests with stems and derivations, children were credited with a correct response for spelling the stem consistently across related words even if that stem was misspelled, as this shows knowledge of morphological consistency despite pronunciation shifts. For example, for the words *naughty* and *naughtiness,* children were scored correct on consistency if they spelled the words *noty* and *notiness*.

Predicting Literacy Development from Morphological Knowledge

Few educational researchers are interested in children's awareness of sub-lexical features of words for its own sake. Most are interested whether knowledge about sub-lexical features of words and the ability to apply that knowledge in literacy activities influences performance on lexical level tasks of word reading, vocabulary, and spelling and/or supralexical tasks such as reading comprehension. Thus educational research on morphology often involves measuring morphological knowledge and seeing how well it predicts various literacy skills after controlling for other factors already known to contribute to performance on literacy tasks.

The predictive research on morphology is made more complex due to the fact that the field is not always clear about the use of the terms morphological knowledge and morphological

awareness. In line with Carlisle's (1995) now classic definition, this dissertation reserves the term morphological awareness for that type of knowledge about morphological structure that rises to the level of conscious awareness and which can then be manipulated and reflected upon by the learner. Morphological knowledge is used as a more general term that, in addition to morphological awareness, includes more unconscious, tacit knowledge of morphology that can influence performance on literacy tasks without necessitating conscious awareness, manipulation or reflection. Adding to the complexity for researchers is the fact that, for some morphological tasks, it is not entirely clear which level of morphological knowledge is being tapped. For example, one measure Carlisle (2000) described as a morphological awareness task simply involved the accuracy of reading of morphologically complex words. While an individual's conscious morphological awareness should influence performance on such a task, it is not clear how to determine how much of that performance is influenced by more tacit morphological knowledge that does not rise to the level of conscious awareness. This more implicit knowledge is also tapped in morphological priming studies. Other tasks require morphological knowledge that rises to the level of conscious awareness. For example, Carlisle and Nomanbhoy (1993) used a measure they called a morphological judgement task in which children were asked to distinguish between morphologically related pairs (e.g., *teach/teacher*), and morphological foils (e.g., *corn/corner*). This task requires much more conscious identification, reflection and manipulation of the morphological structure of words, thus tapping the level of knowledge Carlisle (1995) described as morphological awareness. Although both types of task may be labelled as tests of morphological awareness in research studies, it is not always clear to what extent a given task probes conscious morphological awareness versus less conscious knowledge. In reviewing the literature, I will use the term "morphological awareness" when the researchers

use that term, even if it could be argued that they are actually referring to the more general morphological knowledge. In my own analysis, I will use these terms according to the definitions outlined above.

Yet another complexity to keep in mind when analyzing the predictive research on morphology is that most of children's morphological skill (either knowledge or awareness) has been gained in a context of instruction which has given little attention to morphology (Devonshire & Fluck, 2010; Nunes & Bryant, 2006; Henry, 2010). Thus, in the following section, morphological knowledge is understood as "untaught" knowledge.

Morphological Knowledge and Reading

Much of the educational and psychological research described as morphological awareness has investigated whether or not children's untaught knowledge of oral and/or written morphology predicts word reading and reading comprehension after controlling other factors. An early investigation of this question was conducted by Carlisle (2000). She used two oral measures of morphological awareness and one written measure with 8- and 11-year-old students and related scores on those measures to reading comprehension scores. In a morphological production task, participants were asked to produce the correct derivation of the base (e.g., *Farm*. My uncle is a _____. [*farmer*]"). In a decomposition task, the subjects would have to decompose a morphologically complex cue word into a simpler form to fit a sentence (e.g., *Driver*. Children are too young to _____. [*drive*]"). The third task simply involved the reading of morphologically complex words. Performance on these tasks accounted for 43% of the variance in reading comprehension for third graders and 55% for fifth graders. However, because this study failed to control variables such as phonological awareness, intelligence, or vocabulary, it cannot be determined whether it was morphological awareness or reading ability

and reading-related skills that predicted reading comprehension. Mahony, Singson, and Mann (2000) used a judgment task that had children from Grades three to six distinguish between morphologically related pairs (*allow-allowance*) and foil pairs (*ill-illegal*). They controlled for vocabulary and phonological awareness and found that their measures of morphological awareness accounted for about 5% of the variance in word reading ability, while phonological awareness accounted for 13%. These results are similar to those of a number of other studies (e.g., Carlisle, 2000; Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004; Fowler & Liberman, 1995, Singson, Mahony, & Mann, 2000).

Deacon and Kirby's (2004) longitudinal study with students from Grades two to five examined the relationships between morphological awareness and word reading and reading comprehension. After controlling for verbal and nonverbal intelligence and phonological awareness, they found that morphological awareness measured in Grade 2 made a contribution of about 5% to word reading in Grade 5, corroborating Mahony, et al.'s (2000) results. In comparison, phonological awareness contributed 9% to word reading after accounting for intelligence and morphological awareness. The relative effects of morphological and phonological awareness reversed with respect to reading comprehension. Grade 2 morphological awareness contributed 7% of the variance to Grade 5 reading comprehension after accounting for intelligence and phonological awareness; Grade 2 phonological awareness contributed 4% to Grade 5 reading comprehension after accounting for intelligence and morphological awareness. Deacon and Kirby (2004) concluded that morphological awareness influences many areas of reading and that its effect is above and beyond that of phonological awareness and intelligence.

Nagy, Berninger, and Abbott (2006) studied the effect of morphological awareness on a variety of literacy measures in three grade-level groupings (Grade 4 and 5, Grade 6 and 7, Grade

8 and 9). At all three grade levels, morphological awareness made an independent contribution to reading comprehension, over and above that of vocabulary. Roth, Lai, White, and Kirby (2006) found that morphological awareness contributed to reading comprehension in a study with 182 Grade 3 students after controlling for verbal and nonverbal intelligence, phonological awareness, naming speed, and orthographic processing. They found that although morphological awareness explained unique variance in reading speed, reading accuracy, and decoding, passage comprehension showed the strongest result, having 8% of its variance accounted for by morphological awareness after controlling for all five variables described.

Kirby et al. (2012) investigated the nature and extent of the relationship between children's morphological awareness and reading as it develops over Grades 1-3. They controlled for the effects of the well-established reading predictors of general cognitive ability and phonological awareness, which may overlap with morphological awareness. They measured children's morphological awareness in Grades 1, 2, and 3 in an effort to map out the developmental trajectory of any contribution of morphological awareness to reading over the course of these early years of learning to read. Because they were also interested in how morphological awareness contributed to different aspects of reading, they used measures of word reading, comprehension, accuracy, and fluency.

The contribution of morphological awareness to Grade 3 reading increased at each time period. After accounting for phonological awareness and intelligence, morphological awareness measured in Grade 1 did not predict any of the Grade 3 reading measures. In Grade 2 morphological awareness contributed to all the reading measures except speed of word reading, and Grade 3 morphological awareness contributed to all five reading measures. The unique contribution of Grade 3 morphological awareness was greater for all five Grade 3 reading scores

than was the contribution of Grade 2 morphological awareness. These results may indicate that the contribution of morphological awareness to reading achievement increases with age as other research has suggested (Carlisle, 1995; Singson, et al., 2000). However, as the authors indicated, other interpretations include the possibility that the relationship between morphological awareness and reading is stronger when measured closer together in time. Other studies have not found an increase in the role of morphological awareness with time (e.g., Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009) and some studies have found mixed results on this question (e.g., Deacon & Kirby, 2004). Kieffer and Lesaux (2008) looked at the contribution of morphological awareness to reading comprehension for a different group, upper elementary Spanish-speaking English language learners. After controlling for word reading, vocabulary and phonological awareness, they found that morphological awareness (measured at each grade) did not make a significant unique contribution to reading comprehension for Grade 4 students, but did for Grade 5 students. Clearly the relative contribution of untaught morphological awareness to literacy success at different ages remains unclear. This mixed evidence highlights the need for clear evidence regarding the age at which morphological instruction can bring literacy benefits.

Although the developmental trajectory of the contribution of untaught morphological awareness to word reading remains unclear, Kirby et al.'s (2012) results do show a steady growth in the contribution of morphological awareness to reading measures including reading comprehension from Grade 1 to 3. In Grade 3 they found significant contributions (3–9%) of untaught morphological awareness for all five of their reading measures. After controlling for intelligence and phonological awareness, the largest contributions were for the two measures that involve comprehension: Text Reading Speed (9%) and Passage Comprehension (6%). Their finding that morphological awareness made a significant contribution to reading comprehension

after controlling word reading is particularly strong evidence that untaught morphological awareness makes a significant unique contribution to reading comprehension.

The hypothesis that morphological knowledge (implicit and/or explicit) might function to integrate multiple elements of information into fewer more richly integrated elements of information, thereby reducing cognitive demands during reading, is consistent with assumptions of Perfetti's (2007) lexical quality hypothesis, Seidenberg and McClelland's (1989) connectionist model of reading, cognitive load theory (Schnotz & Kürschner, 2007; Sweller, Merrienboer, & Paas, 1998), and C. Chomsky's (1970) lexical spelling. According to cognitive load theory, long-term memory organizes information in the form of cognitive schemas that help reduce the load on working memory. "The major mechanisms of learning are schema acquisition and schema automation. Schema acquisition changes what individuals treat as an element. Thus, learning reduces cognitive load. If a schema is acquired, the set of former elements that were integrated into the schema can now be treated as a single element. In this way, schema acquisition reduces the number of interacting elements in working memory" (Schnotz & Kürschner, 2007, p. 477). If Kirby et al. (2012) were correct that recognition of morphemes allows readers to reduce the cognitive cost of processing letters by instead facilitating the processing of larger units of information (morphemes), the load on working memory during reading would be reduced. Readers would have less effortful access to larger elements of information signalled by text.

Orthographic morphemic units that are perceived and processed as units (instead of processing each letter individually) correspond closely to C. Chomsky's (1970) lexical spellings. Compared to letters, those units of processing are more directly linked to meaning cues and words of the same orthographic morphological family. When a reader does not immediately

recognize whole written words, recognition of sub-lexical morphological units could provide efficient access to meaning cues and relevant related words that are not cued by recognition of letter-sound correspondences. Further, given the interrelation between morphology and phonology, it may be that processing orthographic morphemic units provides more efficient phonological cues than the processing of letter-sound cues without reference to morphology.

According to Perfetti's lexical quality hypothesis (Perfetti, 2007) and Seidenberg and McClelland's (1989) connectionist triangle model of reading, making meaning from print involves using orthographic cues to spark phonological and semantic information. Increased morphological knowledge could facilitate more automaticity in the recognition of words by cuing semantic, orthographic and phonological information associated with words, thereby freeing up cognitive processing for higher level processing needed for reading comprehension. If schemas for sub-lexical representations are well integrated with phonological, semantic, and orthographic information, readers are likely to have easier access to the pronunciation and meaning of words when processing text.

The role of morphological awareness in reading for less able students has received growing attention. Nagy, Berninger, Abbott, Vaughan, and Vermeulen (2003) conducted a study with at risk second-grade readers and at risk fourth-grade writers. They found that for their Grade 2 sample, morphological awareness uniquely predicted reading comprehension after controlling for phonological and orthographic awareness and oral vocabulary. However, morphology and oral vocabulary did not contribute to any of these outcomes for the Grade 4 sample. Siegel (2008) investigated the morphological awareness of dyslexic and typically achieving Grade 6 students. Dyslexics were found to have significantly weaker scores on the morphological tasks than the typically achieving students. She concluded that poor morphological awareness may be

a significant contributor to reading and spelling deficits in dyslexic learners. Tong, Deacon, Kirby, Cain, and Parrila (2011) conducted a longitudinal study investigating the role of morphological awareness for poor comprehenders. They found that compared to average comprehenders, unexpected poor comprehenders were significantly weaker on a morphological derivation task in Grade 5 but not in Grade 3.

Apel and Lawrence (2011) compared the morphological awareness of Grade 1 children with a speech sound disorder (SSD) to that of children with typical speech abilities matched for age, gender and classroom attendance. Apel and Lawrence described *speech sound disorder* as a term used to describe individuals with atypical speech patterns that can result from phonological or articulation difficulties that result in deficits in the developing and using of phonological representations. Students were assessed on a production task based on Carlisle's (1988) task that measured awareness of inflectional and derivational suffixes and a decomposition task in which children were asked to decompose inflected words into base words for a sentence completion task. Grade one students with SSD performed lower than typically performing Grade 1 students on all morphological tasks. For typically achieving students, morphological awareness accounted for significant unique variance of real word and pseudoword reading and spelling after controlling for phonemic awareness, letter knowledge, receptive vocabulary, and nonverbal cognition. However, for the SSD children morphological awareness was only a significant predictor for the spelling task. Apel and Lawrence cited similar findings from Peterson, Pennington, Shriberg, and Boada (2009) and drew the same conclusion that the literacy skills of children with SSD are best explained by multiple linguistic variables, rather than just a deficit in the phonological domain.

These studies show that those who struggle with literacy for various reasons show

weaknesses not only on phonologically based measures, but also on morphology, and that like phonology, morphology explains significant unique variance of literacy skills. In light of the overwhelming evidence that early phonologically based literacy instruction supports literacy learning (e.g., Adams, 1990; National Reading Panel, 2000), the finding that early morphological awareness deficits signal later literacy difficulties suggests that research on the effect of morphological instruction for less able students is warranted.

Morphological Knowledge and Vocabulary

As morphemes are meaning units of words, understanding the relationship between morphology and vocabulary knowledge is an important part of the literature on vocabulary learning in school children (e.g., Baumann et al., 2002; Henry, 1989, 2003; Nagy, 2005; National Reading Panel, 2000; Scott, 2005; Templeton, 1989, 2004). Wysocki and Jenkins (1987) investigated the extent to which morphological awareness could account for the growth in children's vocabulary knowledge that exceeds what is explicitly taught. They taught Grade 4, 6 and 8 students the meanings of complex words (e.g., *gratuity*) and found a significant effect on their knowledge of untaught morphologically-related transfer words (e.g., *gratuitous*). To ensure that any gains in knowledge of the transfer words was through independent, spontaneous use of morphology, instruction avoided addressing morphological structure, and testing took place two weeks after the instruction had ended. The evidence from this study suggests that even without explicit morphological instruction, children can take advantage of the inherent morphological structure of words to build new vocabulary on a foundation of existing vocabulary.

McBride-Chang, Wagner, Muse, Chow, and Shu (2005) investigated the role of two distinct measures of morphology for predicting vocabulary in English-speaking kindergarten and Grade 2 students after controlling for measures of reading, phonological awareness, and naming

speed. A measure of morphological structure used 20 orally presented scenarios in English, after which students were asked to give a name for objects or concepts presented by the scenarios. For example, consider this prompt: *Early in the morning, we can see the sun coming up. This is called a sunrise. At night, we might also see the moon coming up. What could we call this?* Participants who could provide the correct response, *moonrise*, were judged to have applied some level of conscious knowledge of morphological structure. Scores on this task predicted 6% of variance in vocabulary (after controlling for the aforementioned variables) for kindergartners and 13% for Grade 2 students. As a morphological production task, this measure can be seen to invoke conscious morphological awareness. The second measure of morphological identification controlled the phonology of morphemes by using homophones. For example, one item asked participants to look at a picture showing *the colour blue* and another showing *he blew out some air* and select the one containing the meaning of *blue* in *blueberries.* Since this task fails to require conscious application of morphological awareness, it can be seen as a measure of morphological knowledge. After accounting for the control variables, this task explained a significant 4% of kindergarten vocabulary and 6% of Grade 2 vocabulary. These results provide evidence that from the very beginning of schooling children have developed morphological knowledge and awareness that is distinct from other cognitive constructs like phonological awareness and that this type of knowledge is associated with the development of vocabulary.

Morphological Knowledge and Spelling

The consistent orthographic representation of morphemes across related words in English suggests that morphological knowledge might play a role in spelling ability. One way this type of meta-linguistic knowledge could support spelling accuracy is by providing a means of accessing the correct grapheme for a word when a number of options are available to represent

a given phoneme. For example, the words *shell*, *action*, and *musician* each represent the /ʃ/ phoneme with a different grapheme (*sh*, *t*, and *c* respectively). Accurate spelling of these words must rely on more than knowledge of letter-sound correspondences. If morphological knowledge includes recognition (whether conscious or not) of morphological constancy – the principle that morphemes are marked with consistent spellings despite shifts in pronunciation (Bourassa & Treiman, 2008) – that knowledge could provide a cue to the spelling of words like *action* or *musician*. For the speller who relies only on possible grapheme-phoneme correspondences, the misspellings **acshun* and **musishun* (and other options) are as plausible as the correct spellings. Most phonemes in English can be represented by more than one grapheme, so knowledge of grapheme-phoneme correspondences is necessary but it is often not sufficient for accurate spelling. However, the correct spelling of words like *action* or *musician* is not necessarily evidence of morphological awareness. Orthographic memory for either whole words or non-morphological strings such as *-tion* or *-sion* could explain correct spelling of such words without drawing on morphological knowledge.

In a series of studies, Deacon and colleagues (Deacon & Bryant, 2006a, b; Deacon, 2008; Deacon & Dhooge, 2010) looked for evidence of children's awareness of "root consistency," the fact that the root (base) of a word maintains its spelling across related words across a range of types of words (inflections and derivations). Deacon and Bryant (2006a) showed that 7- and 9-year old children were sensitive to the spelling of the bases of inflected words as they were better able to spell the same letter-sound sequence when it was a root (*turn* in *turning*) than when it was not (*turn* in *turnip*). This sensitivity was also found by Deacon and Bryant (2006b) for six- and eight-year-old students for both inflections and derivations. Deacon and Dhooge (2010) found evidence of knowledge of the root consistency principle in the spellings of students across

Grades 2-4 for both inflected and derived words and for growth of this awareness with age. “By grade 4 children were just as accurate in spelling the roots on their own as in spelling the same portions of inflected and derived forms, suggesting maximum impact of the principle” (Deacon & Dhooge, 2010, p. 1064). They argued that this development of morphological spelling knowledge was consistent with the findings of Treiman, Cassar, and Zukowski (1994) and Kemp (2006), but that much more work is needed to understand the extent and developmental trajectory of this morphological spelling knowledge in the face of morphological relations that vary in phonological, orthographic, and semantic shifts.

Devonshire and Fluck (2010), Deacon, et al. (2008), and Pacton and Deacon (2008) described a group of research models loosely termed “late” or “stage” theories (Nunes, et al., 1997; Ehri & McCormick, 1998; Frith, 1985; Henderson, 1985; Moats, 2000) in which morphology does not play a role until children are in about grade three or four. Contradicting these theories, Wolter et al. (2009) and Deacon et al. (2008) pointed to findings by Treiman and colleagues (Treiman, 1993; Treiman & Cessar, 1996; Trieman et al., 1994) that showed even very young students show the influence of morphological knowledge in spelling. One source of evidence for this early role of morphology in spelling came from investigating the spelling of voiced “flaps” which are pronounced /ɾ/ but can be represented by the graphemes *t* or *d*. Treiman et al. (1994) observed that the *d* of *study* and the *t* of *duty* are both pronounced /ɾ/ and showed that students in Grades 1, 2, and 3 had a bias toward spelling the flap with *d*. However, when those students were presented with multi-morphemic words such as *hated,* that have a base form in which that *t* is pronounced /t/, students from each grade were more likely to spell the flap correctly than in words that provided no morphological cue (e.g., *beetle*). Wolter et al. (2009) found similar results with children during the first term of Grade 1. The studies showing young

children's sensitivity to root consistency (Deacon & Bryant, 2006a, b; Deacon; Deacon & Dhooge, 2010) also contradict the view that morphological awareness is only important for literacy in later grades. Deacon, Kirby, and Casselman-Bell (2008) found that morphological awareness measured in Grade 2 accounted for approximately 8% of the variance of Grade 4 spelling after controlling verbal and nonverbal intelligence, phonological awareness, verbal short-term memory, and rapid automatised naming. They concluded that these findings show a robust influence of morphological awareness on spelling that "is relatively impervious to other related variables" (p. 318).

Summary of Findings of Predictive Research on Morphological Knowledge

The evidence from the predictive research described above paints a picture in which morphological awareness, as well as morphological knowledge more broadly, contributes to a variety of literacy outcomes (word reading, reading comprehension, vocabulary, and spelling) after controlling for a wide range of factors associated with literacy development. (e.g., Carlisle, 2000; Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004; Fowler & Liberman, 1995; Kirby et al., 2012; Singson et al., 2000). The studies described controlled for some subset of phonological awareness, intelligence, vocabulary, naming speed, and orthographic awareness. Further, this effect was found in studies of populations of a wide variety of ages and abilities, including children in the first years of schooling (e.g., Deacon et al., 2008; McBride-Chang, 2005; Nagy et al., 2003; Kirby et al., 2012; Wolter et al., 2009) and in less able populations (e.g., Nagy et al., 2003; Siegel, 2008). Given this evidence, a number of researchers have begun to conduct intervention studies to determine whether explicit instruction of morphology can be shown to bring literacy benefits.

Morphological Interventions

In considering the implications of these predictive/correlational studies and priming studies for designing interventions, the educational contexts in which they were conducted should be kept in mind. Current instruction places little emphasis on morphology (Devonshire & Fluck, 2010; Henry, 2003; Moats, 2009; Nunes & Bryant, 2006), so the relationship between morphological knowledge and literacy skills described above is based on largely untaught morphological knowledge. Furthermore, no predictive study can control every possible variable. It is always possible that some variable beyond what has been controlled is actually responsible for variance attributed to morphological awareness. Only examination of evidence from experimental studies of morphological interventions can shed light on the causal role of morphological knowledge. The relevant evidence is addressed briefly here, and then reviewed in more detail in the literature review sections of Studies 1 and 2.

An empirical question with important practical implications for schools, students, and society is whether morphological instruction has particular benefits for those that struggle with literacy in the current forms of instruction. It may be that some less able students fail to acquire sufficient morphological awareness independently to bring significant literacy benefits. Some of those same students, however, may reap important benefits from morphological knowledge if it is explicitly taught. Given the well established importance of knowledge of letter-sound correspondences already described, increased morphological knowledge may help not only with regard to recognition of morphemic cues, but also through increased understanding of letter-sound correspondences that can be understood with morphological cues. For example the *c* in *musician* is easier to understand when one knows to make the link to the word *music.* (For more on this topic, see Bourassa & Treiman, 2008; Nunes & Bryant, 2006; Nunes, et al., 1997).

Studies have been conducted to examine the effect of morphological instruction with participants identified with reading difficulties (e.g., Arnbak & Elbro, 2000; Tyler, Lewis, Haskill, & Tolbert, 2003) and spelling difficulties (e.g., Kirk & Gillon, 2009) and for students without identified language or literacy difficulties (e.g., Baumann, 2001; Henry, 1989).

Bowers (2006) investigated the role of instruction about orthographic morphological structure using word sums and matrices in a twenty-session intervention in Grades 4 and 5 classrooms. Results showed that after controlling for verbal intelligence, word reading, phonological awareness, and naming speed the instructed group had higher scores than controls on experimental measures of written morphological awareness, spelling, and word reading, but effects were not found for standardised literacy measures. The instructional gains were largely unrelated to participants' initial reading skills (as measured by Word Identification). However, Bowers (2006) warned that, at least in the case of one written morphological measure, the lack of a significant interaction with reading ability may have been due to an apparent ceiling effect for the experimental group. There was one significant interaction, but it showed that morphological instruction favoured the more able students. More research is needed to establish whether deliberate morphological instruction could bring specific benefits to less able readers.

Research is also needed to establish the optimal timing of instruction. The predictive/correlational research cited above provided evidence that untaught morphological knowledge measured as early as Grades 1-2 is associated with success in literacy skills including word reading, reading comprehension, spelling, and vocabulary (e.g., Berninger, Abbot, Nagy, & Carlisle, 2010; Deacon & Kirby, 2004; Deacon et al., 2008; McBride-Chang, 2005; Nagy et al., 2003; Wolter et al., 2009). See, however, Kirby et al. (2012) for a contrary finding in which Grade 1 morphological awareness did not predict any of five reading measures after controlling

intelligence and phonological awareness, although Grade 2 morphological awareness predicted four of five reading measures. Morphological interventions in preschool to Grade 2 (e.g., Lyster, 1998, 2002; Tyler et al., 2003, Vadasy, Sanders, & Peyton 2006) provide promising evidence that early morphological instruction can be effective in facilitating literacy learning. A systematic study of the effects of morphological interventions across the primary and elementary years is needed to clarify this picture. If morphological instruction began at the beginning of literacy learning, morphological knowledge would have more time to become consolidated and might be more likely to contribute to literacy learning.

In addition to when morphological instruction might be best introduced, research is also required to identify the most effective ways morphological instruction should be incorporated into classroom or individual instruction. For example, interventions could be designed to test whether students gain more when they receive extensive instruction in morphology in an isolated fashion or whether it is more effective to teach about both morphology and phonology and how they are represented by orthography in an integrated way from the beginning.

Morphological instruction may also have different effects on different literacy outcomes. The predictive/correlational studies summarised above showed that untaught morphological knowledge was associated with spelling, word reading, reading comprehension, and vocabulary outcomes (Nagy et al., 2003; Kirby et al., 2012). Morphological interventions have been conducted to investigate effects on word reading and reading comprehension (e.g., Abbott & Berninger, 1999; Berninger et al., 2003; Berninger et al., 2008), spelling (e.g., Nunes, Bryant, & Olsson, 2003; Robinson & Hesse, 1981), and vocabulary (e.g., Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003; Baumann et al., 2002). A quantitative synthesis that identifies all the published morphological interventions with outcomes for all these literacy domains is needed

to determine whether morphological instruction brings stronger effects for particular literacy skills.

Whether morphological instruction can be used as an effective tool for vocabulary instruction is of particular interest. A dearth of vocabulary intervention studies (National Reading Panel, 2000) combined with evidence that vocabulary knowledge is crucial to literacy development (RAND Reading Study Group, 2002; Snow et al., 1998) has led to increased interest in identifying effective vocabulary instruction strategies (e.g., Beck, McKeown & Kucan, 2002; Biemiller & Boote, 2006). Because schools cannot be expected to explicitly teach individually all the words children need to learn, a central challenge for vocabulary instruction is to find strategies that develop generative word-learning knowledge. This knowledge would entail not only learning the meaning of words that are taught, but also the ability to use that knowledge to make sense of words that are not explicitly taught and the deepening of one's knowledge of words beyond the level of meaning explicitly taught. A quantitative synthesis of morphological interventions that have targeted vocabulary outcomes could illuminate whether morphological instruction results in word learning beyond the specific words that are taught.

Study 1: Effects of Morphological Instruction on Vocabulary Acquisition

The first study reported here investigated whether classroom instruction about morphological structure can produce generative vocabulary learning. Despite the importance of vocabulary for literacy learning (Cunningham & Stanovich, 1997; Stanovich, 1986), typical schooling places little emphasis on explicit vocabulary instruction (Biemiller & Slonim, 2001; Biemiller & Boote, 2006). Furthermore, educators attempting to rely on research to design effective classroom vocabulary instruction are faced with a scarcity of vocabulary intervention studies (National Reading Panel, 2000) and conflicting advice from researchers. Study 1

attempted to address the need for both depth and breadth of vocabulary learning. The intervention used a problem-solving approach with the aid of matrices and word sums to provide concrete worked-out examples (Sweller & Cooper, 1985) of how orthographic morphological families of words relate in meaning and structure and how those orthographic structures relate to the phonology system.

Study 2: The Effects of Morphological Instruction on Literacy Skills: A Systematic Review of the Literature

Study 2 is a quantitative synthesis using the principles of systematic review to investigate the effects of morphological interventions. As described in the preceding literature review, a small but growing body of research has investigated the effects of morphological instruction. The existing interventions have focused on a wide variety of literacy outcomes for students of a wide range of age and ability. A quantitative synthesis of the effects according to specific literacy outcomes and student characteristics would be a benefit to researchers and teachers attempting to determine whether there is good evidence to integrate morphological instruction into classroom instruction, to identify for which student populations such instruction is or is not appropriate, and to learn from and refine the instructional strategies currently in use.

CHAPTER 2: EFFECTS OF MORPHOLOGICAL INSTRUCTION ON VOCABULARY ACQUISITION

Abstract

The effects of a 20-session intervention targeting morphological word structure on vocabulary knowledge were investigated in four Grade 4 and 5 classes, assigned randomly to treatment and control conditions. Hierarchical regression analyses controlling for initial vocabulary showed significant instructional effects on morphological analysis and vocabulary with words that were taught directly and novel words built on bases that were taught in the context of other derivations, but not for words with untaught bases. Results indicated that the treatment group made better use of pre-test vocabulary knowledge in learning new vocabulary. Results are discussed in light of the growing debate regarding whether to teach many words in a shallow way or to provide deep, rich instruction about fewer words.

Introduction

The vocabulary children learn during elementary school represents a staggering achievement. Estimates suggest that, on average, children at the end of Grade 2 understand about 6,000 root word meanings, and by the end of Grade 6 about 10,000 (e.g., Anglin, 1993; Biemiller, 2005). Such estimates are far from exact. Quantifying such information is complicated by many factors including varied definitions of what it means to know a word and what counts as a word or word family (Biemiller & Slonim, 2001). Regardless of the exact quantity, it is clear that children learn a great number of words in a relatively short period of time.

Vocabulary knowledge plays a fundamental role in literacy development and therefore scholastic success (National Reading Panel, 2000). Furthermore, a child's socio-economic status is a critical correlate of vocabulary knowledge (Biemiller, 2005; Hart & Risley, 1995). This

dynamic is not hard to understand. The stronger oral vocabulary associated with children of middle and upper classes supports reading success (Biemiller & Slonim, 2001). Successful readers are exposed to more text because they read more, which in turn expands those students' written word vocabulary, thus encouraging still more reading success. All the while, students who begin the process of learning to read with an impoverished vocabulary fall further and further behind their advantaged peers, not only in reading, but in the content areas that depend more and more on independent reading skills (Beck, et al., 2002).

A striking feature of the vocabulary learning that children achieve is that it occurs despite the fact that school curricula appear to place little emphasis on explicit vocabulary instruction (Beck, et al., 2002). Reacting to conclusions on the state of classroom vocabulary instruction by the National Reading Panel (2000), Biemiller and Boote (2006, p. 44) noted critically, ''Current reading instruction is apparently premised on the view that children can build the vocabulary they need after learning to read (decode) fluently, as little or no vocabulary instruction occurs during the primary grades''.

Although the National Reading Panel (2000) emphasized vocabulary instruction as a crucial aspect of literacy instruction, it cited lack of sufficient research to recommend any particular strategy over another. Complicating matters for educators who use research to guide their vocabulary instruction, two of the strategies that are commonly cited appear to be in conflict. Biemiller et al. (Biemiller & Slonim, 2001; Biemiller & Boote, 2006) favoured what can be characterized as shallow but wide direct vocabulary instruction. By contrast, Beck, McKeown and colleagues (e.g., Beck, Perfetti, & McKeown, 1982; Beck, et al., 2002; McKeown, Beck, Omanson, & Perfetti, 1983; McKeown, Beck, Omanson, & Pople, 1985) favoured what can be characterized as rich but narrow vocabulary instruction.

The shallow but wide approach is exemplified by Biemiller and Boote's (2006) recommendation that primary students should be taught about ten words a day with the support of context (e.g., reading a story). To support this approach, they cited intervention studies using brief word explanations to build knowledge of those words (e.g., Biemiller & Boote, 2006; Sénéchal, 1997; Stahl, Richek, & Vandevier, 1991). Studies showing preschool children effectively using narrative-based referents (e.g., Hargrave & Sénéchal, 2000; Sénéchal, 1997) were cited by Biemiller and Boote (2006) as evidence that brief explanations of one or two sentences can be sufficient to establish effective referents for new words. This instruction is consistent with Carey's (1978) fast mapping hypothesis that young children use meaning that is illustrated by specific concrete task contexts to map (quickly associate) new words with meaning. Carey reasoned that after that initial mapping, learners extend the meanings of words as they encounter them in other contexts. Both Carey (1978) and Biemiller and Boote (2006) stressed that brief explanations of word meanings in context are just the beginning of acquiring word meanings; subsequent exposure is needed.

The contrasting rich but narrow approach (e.g., Beck, et al., 2002; Blachowicz & Fisher, 2000) grew from the findings of two reviews of vocabulary instruction (Mezynski, 1983; Stahl & Fairbanks, 1986). This research found that vocabulary instruction influenced comprehension only if it engaged active or deep processing and involved multiple and varied experiences with word meanings. For example, Beck and McKeown (1983) and more recently Blachowicz and Fisher (2000) found evidence that combining the teaching of definitions with other active processing tasks is more effective than instruction that uses definitions alone. Instruction fostering metalinguistic awareness and interest in learning about words, sometimes described as *word consciousness* (e.g., Scott & Nagy, 2004), is a common recommendation in the literature

on vocabulary instruction (e.g., Blachowicz, Fisher, & Ogle 2006; Graves & Watts-Taffe, 2002; National Reading Panel, 2000).

Repeated and educationally rich exposure to specific words may bring important benefits, but it cannot directly address the quantity of words that are taught through the shallow but wide approach recommended by Biemiller et al. For example, Beck et al. (1982) and McKeown et al. (1983) demonstrated that direct instruction in word meanings for 104 words taught over 5 months was effective. While it is important to have evidence that students can learn words that they are taught, this rate of word learning is modest compared to the number of words students need to learn (Anglin, 1993; Nagy & Anderson, 1984; White, Graves, & Slater, 1990). Whether time spent on deeper processing tasks makes up for teaching fewer words is a question that remains for educators and researchers.

Morphology and Vocabulary Learning

Morphology is widely held to be part of the explanation for how children learn so many words that they were never explicitly taught (e.g., Anglin, 1993; Carlisle & Fleming, 2003; Carlisle, 2007; Nagy & Anderson, 1984; Taft & Kougious, 2004). Anglin (1993) described morphological problem solving as a process by which the meaning of previously unknown complex words can be deciphered. This process involves morphological analysis in which learners break complex words into constituent meaning elements called morphemes (bases, prefixes, and suffixes). A synthesis of the meaning of those component morphemes provides cues to the meaning of a previously unknown word. Nagy and Anderson (1984) estimated that about 60% of the novel words students encounter in texts could be worked out through problem solving morphological structure and their use in a sentence. This metalinguistic process has garnered growing interest in the literature as an important word-learning skill (e.g., Baumann et

al., 2002; Henry, 1989, 2003; Nagy, 2005; National Reading Panel, 2000; Scott, 2005; Templeton, 1989, 2004). Wysocki and Jenkins (1987) investigated the extent to which untaught morphological knowledge could account for the increases evident in children's vocabulary that far exceeded the number of words explicitly taught. They found evidence of transfer of word knowledge from taught words to untaught derivations of those words. Anglin (1993) suggested that morphological problem solving is in part responsible for the rapid growth in the knowledge of the meaning of derivations between Grade 3 and 5.

Researchers have begun to investigate the effects of explicit instruction about morphology (e.g., Baumann et al., 2002, Baumann, et al, 2003; Carlisle, 2007). Nunes, Bryant, and Olson (2003), Nunes and Bryant (2006), and Henry (1989) provided experimental evidence that morphological instruction improves word reading and spelling, but they also noted that this type of instruction is rare in schools. This omission may have particular relevance for literacy development in English due to the particular nature of oral and written morphology in English.

English has been called a morphophonemic language due to the special interrelationship of its phonology and morphology (Venezky, 1999). It is common for the pronunciation of morphemes to shift across English words. For example, consider the pronunciation of the base *do* in its inflections *does* and *done* or that of *sign* in derivations such as *signal* and *design*. Carlisle (2003) pointed out that familiar word parts can facilitate language learning compared to learning each complex word in isolation. This, however, can only occur when students recognize morphemes within complex words. In a study with third and fifth grade students, Carlisle (2000) showed that learners are less able to recognize morphological cues in *shift words* that have changes in pronunciation and/or spelling due to suffixing patterns across related forms. Written morphology links large word families with concrete meaning elements via a system of consistent

compounding and affixing patterns. It is an empirical question whether explicit instruction about how this system works would help children make better use of relatively transparent connections for independent vocabulary learning. Such instruction could also help children by making it easier for them to recognize morphological cues in shift words. Carlisle (2003) commented, ‘‘Leaving morphological analysis to be discovered by students on their own means that those who are not inherently linguistically savvy are likely to be left behind their peers in the development of vocabulary, word reading and comprehension, and spelling’’ (p. 312). So far, however, morphology remains a resource of meaning cues that has been poorly exploited by explicit instruction and is only beginning to be investigated experimentally (Nunes & Bryant, 2006; Henry, 2003).

Morphology and Vocabulary Instruction

Pressley, Disney, and Anderson (2007) reviewed the evidence for the value of teaching internal context cues (morphological word parts) for vocabulary development. Although they described the evidence so far as ‘‘thin and equivocal’’ (Pressley et al., 2007, p 214) they reported that there was some evidence that teaching about morphemes can improve children’s and adults’ ability to infer the meanings of words.

Graves and Hammond (1980) taught Grade 7 students the meaning of prefixes in the context of one set of vocabulary words. Those students were able to generalize the knowledge to new vocabulary words. The vocabulary intervention by Baumann et al. (2002) incorporated morphology instruction that taught the meaning of eight common prefix families. Morphological instruction produced large immediate effects for deriving the meaning of morphologically decipherable instructed words compared to a comparison group who received vocabulary instruction about learning words from (non-morphological) context cues, and to a control group,

but delayed effects were small. There were no instructional effects on delayed transfer tests. In a follow up intervention, Baumann et al., (2003) used the context of social studies textbook lessons in the classroom to compare the effects of vocabulary instruction which integrated teaching about external context cues and morphological instruction (MC) with the effects of instruction of textbook vocabulary (TV). The morphological instruction in this study focused on 15 prefixes and five suffixes and how to use the meaning of these word parts in conjunction with root words (base words) to learn the meaning of new vocabulary words. MC students were more skilled than TV students at inferring the meanings of morphologically decipherable words on a delayed test but not an immediate test. These studies provide evidence of moderate to small effects on word learning skills through morphological instruction.

Finally, the potential of motivating students to engage in active processing tasks with words through instruction which emphasizes problem solving of word structure cues rather than memorization is another reason for investigating morphological instruction. Focusing on morphology introduces order to the English spelling system, which brings with it the possibility of using problem solving to investigate what Templeton (2004) described as the vocabulary-spelling connection. Studying words through one-at-a-time memorization characterizes much of spelling instruction, but it fails to motivate many children to learn about words (Fresch, 2007). Students who begin to understand morphological structure can find ordered spelling and meaning cues in words that morphologically unaware students could only assume are irregular. (e.g., *busy/i + ness* → *business; do + es* → *does*). Vocabulary instruction can involve meaning-rich, active processing, and learning experiences without addressing morphology. However, neither the shallow but wide instruction encouraged by researchers such as Biemiller (2004) nor the rich but narrow instruction recommended by others such as Beck, et al. (2002), offers students the

generative spelling knowledge that ‘‘provides the basis for explicit awareness and understanding of morphology, which, in turn, may guide the systematic growth of vocabulary knowledge’’ (Templeton, 2004, p. 120). Such instruction may bring a double benefit of (a) generative word structure knowledge, and (b) motivation to attend closely to words.

The Current Study

The current study was designed to address the need for word structure knowledge to learn both taught and untaught words, and motivation to use that knowledge, by means of a problem-solving orientation. Teaching students to discover spelling-meaning connections between words via a structured inquiry, problem-solving approach was intended to motivate children to see studying word structure as an interesting, engaging activity in accordance with researchers who encourage the development of word consciousness (e.g., Graves, 2006; Nagy & Scott, 2004; National Reading Panel, 2000). Graphic representations of the word structure of morphological families were used to reduce students’ working memory load by presenting the integrated structure and meaning of sets of words instead of presenting those connected words one at a time.

The instructional design of this intervention differs from the studies noted above in terms of (a) the detail of morphological content studied, and (b) how that content was integrated with and dependent on teaching morphological problem-solving. This intervention did not focus on teaching a specific set of prefixes as did Graves (2004), or even a particular set of bases, prefixes, and suffixes like the studies of Baumann et al. (2002, 2003). Instead, this instruction used sets of morphologically related words to teach how to find meaning cues in consistent spelling patterns. Tools such as the word matrix and word sum (described below) were used to investigate morphological word families to guide learning how a relatively small number of

meaningful word elements—morphemes—form a large number of words and how these morphemes within complex words can give clues to word meanings. Students were taught about morphological elements, suffixing patterns, and morphological problem solving skills to help them discern morphemes not only in transparent words but also in shift words, in which orthographic shifts due to suffixing patterns or pronunciation shifts might hinder morphological awareness.

The specific research questions investigated were the following:

1. Can Grade 4 and 5 students learn to identify the bases of morphologically complex words as a result of instruction?
2. Does instruction about morphological structure lead to gains in vocabulary learning after controlling for initial vocabulary knowledge?
3. Does ability to identify bases in complex words explain variance in vocabulary knowledge for both the control and experimental groups at post-test?

Method

Participants

The participants were 81 children in two Grade 4 classes and two Grade 5 classes from two public Catholic schools in and around the area of Kingston, Ontario. One school was in a suburban neighbourhood and the second was in a nearby small town. Classes were randomly assigned to the experimental (n = 38; average age = 10 years, 2 months) and control (n = 43; average age = 10 years, 1 month) conditions with the constraints that each condition included one Grade 4 and one Grade 5 class, and each had a class from each school. Data from students designated by the school as having a learning disability, language impairment, or autism were excluded from the analysis.

Of the 110 students in the four classes, 94 returned signed permission forms (85%). (See Appendix E for Parent Information Letter and Appendix F for Parent Consent form.) Of these, one student moved before post-test and nine were dropped from the analysis due to being designated by the school as having a learning disability, language impairment, or autism. Finally, incomplete data for three participants left a final sample size of 81. Although only students with signed permission forms participated in the testing, all students in the experimental classes participated in the intervention lessons, which teachers treated as a part of the core literacy curriculum. This study reports specifically on data concerning written morphological knowledge and vocabulary learning. Other pretest and posttest measures were administered in conjunction with the study. Only testing related to the data analyses presented in this study is described here.

Measures

Pre-test measure. Prior to instruction, all participants were administered the Peabody Picture Vocabulary Test III (PPVT-III) (Dunn & Dunn, 1997), a test of receptive vocabulary knowledge. In this task, a vocabulary word is presented orally to the child who is asked to point to one of four pictures that best represents the meaning of the word. Two practice pages were used to make sure children understood the task. The maximum number of items on the test is 204, but the highest item a participant reached was 192. The score was the total number of correct responses. The alternative forms reliability coefficient reported in the manual for this task is .91 for 10-year-olds. Three trained testers (including the first author) assessed participants from the four classes during the same time period. The test was administered individually during the regular class time in a quiet room at the participant's school. The assignment of classes to control and experimental conditions occurred after pre-testing so that testers did not know which students would be in the experimental group.

Post-test measures. Two measures were constructed based on the words included in the intervention program, Base Identification and Morphological Vocabulary. The two measures were linked in that after each item in Base Identification the participant was asked to define the word. (See Appendix G for a detailed description of these tasks.) Both tests used the same set of 30 words, which were divided into three groups: Word Taught, Base Taught, and Affix Taught. (All words are shown in Appendix H.) A trained research assistant, who was blind to the status of students as control or experimental group members, conducted the testing. We first describe the two measures, then the three groups of words.

Base identification. This individually administered task assessed participants' ability to identify the base in multi-morphemic words. The test was introduced as an activity called *Circle the Main Part of the Word*. The participant was shown how to do the task with the help of a practice set of words for which the tester could clarify incorrect, good, and better responses. The practice words were *books*, *making*, *running*, *enjoyment*, and *bookstore*. Whether their initial response was correct or not, the tester made sure that the student saw the correct answer. For example, for *making*, the tester noted that the *e* of the word make (the real main part of the word) was missing, so the best they could do was to circle the letters *mak*.

For *running*, it was indicated they should only circle *run*, because the main part of *running* was *run*, which only had one *n*. Whether the student circled *enjoy*, or *joy*, for *enjoyment*, the tester made it clear that either was good, but that *joy* was the best answer because it was the smallest main part of the word. For the compound *bookstore*, participants were told that they could circle both *book* and *store*, because they were both main parts of the word.

The test consisted of 30 words which were presented in a booklet arranged in a single column down the centre of each page. Each participant was allowed as much time as desired to

complete the test and no feedback was provided. Each item was scored on a 3-point scale using the following criteria: (a) 2 points were awarded for circling the base (either a real word or a bound base) or the smallest stem that could stand on its own as a word (a stem is a base with at least one affix); (b) 1 point was awarded for circling any part of a word that removed at least one affix, but failed to reduce the stimulus word to the smallest stem that could stand on its own as a word; and (c) 0 points were given for circling part of a stimulus word that was neither a base nor a stem. The scoring system was designed to avoid awarding points for knowledge of linguistic features that only students with explicit instruction (i.e., those in the experimental group) could be reasonably expected to have. For example, for the word *victoriously*, circling the stem *victor* (vict + or) or circling the bound base *vict* for 'conquer' each earned 2 points. Only the experimental group had been taught that a base does not have to be a word on its own. Circling *victori* (representing *victory*), or *victorious* each scored 1 point as they both represent real word stems of the target word *victoriously*. (Appendix I shows more details on the scoring procedure.) The Cronbach alpha reliability of this test was 0.88.

Morphological vocabulary. This measure assessed the ability of participants to explain the meaning of the words used for the Base Identification task. After completing the practice words for Base Identification, the tester said, "After you circle the main part of a word, I'm going to ask you to try to give a short description of the meaning of the word". When the participant finished circling, the tester asked, "Could you tell me what that word means?" If the participant gave no answer, or the answer was unclear, the tester used these prompts: "Can you add any more detail?" and, "Can you use that word in a sentence?" The tester recorded the exact wording used by the student.

A 3-point scale was used for each item to distinguish among no understanding, a limited

understanding, and a more fully realized understanding of the meaning of a word. The scoring criteria were as follows: (1) two points were awarded for responses that showed a clear understanding of the target word, including base or stem and affixes, either by providing a definition, or by using the target word correctly in a sentence. (2) One point was given to responses that either (a) gave a vague sense of the meaning of the word by using it in a sentence, or (b) gave the meaning of one of the main morphemes (e.g., the *produce* or the *re* of *reproduce*), or (c) gave a vague sense of the meaning of one of the main morphemes by using it in a sentence. (3) Zero points were given if participants gave no response or if their answer was not connected to the meaning of target word. Two raters scored the definitions of 10 randomly selected tests with the scoring criteria set out below. Inter-rater agreement was 95%, so the remaining tests were scored by the first author; test papers were put in random order so that the scorer could not determine group membership. Any uncertainties were resolved through discussion. The Cronbach alpha reliability estimate for this measure was also 0.88.

Selection of words. The words used in these measures were selected specifically with respect to the words taught in the intervention to assess the effect of instruction along a continuum of near, to mid, to far transfer. The 30 words were divided equally among three groups and presented in mixed order.

The words in the first group were termed *Word Taught*. Inclusion criteria for this near transfer category were that the instructor had addressed it explicitly in class and/or that exact word had been included on one of the children's written assignments. If a word appeared on a page handed out to the children, if it was on an overhead, or posted in the classroom, it was considered to be in the *Word Taught* category. This included words that were not presented in full form, but could have been created by the student from a word matrix presented by the

teacher (see Fig. 2.1 for an example of a word matrix). The intervention used a total of 20 matrices; representing 196 words fitting the *Word Taught* criteria. Activities that did not include a matrix but presented words for creating word sums presented children with 234 more words. Thus a total of 430 words met the criteria of *Word Taught*. Ten of those words were used as *Word Taught* words during testing.

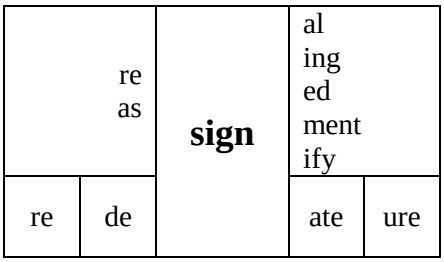


Figure 2.1. A word matrix on the base sign.

The words in the second group were *Base Taught* words, whose bases and affixes had been taught explicitly during lessons, but never in the specific derivational or inflectional form used on the test. This category represented a level of transfer beyond *Word Taught* words. To demonstrate a gain from instruction on these words, students would have to apply knowledge of bases, affixes, and perhaps suffixing patterns to words that were not explicitly taught.

The words in the third group were *Affix Taught* words. These words used bases that were not taught during the intervention. Students would have encountered the affixes in these words during instruction, but only in combination with other bases. Because the base is the morpheme that carries the core meaning of a word, this category of word represents the farthest level of transfer of the three word groups.

Instruction

While the control group classes continued with typical instruction, the experimental classes participated in three or four 50-min lessons each week taught by the first author until 20

sessions were completed. Instruction took place in the regular classroom with the classroom teacher present and participating in the sessions.

Content. The instruction was designed to convey the following key terms and concepts about morphology and orthography:

1. English spelling is a highly consistent system for representing the meaning of words. Few words fail to follow established conventions for this purpose.
2. Morphemes (bases, prefixes, and suffixes) are the smallest units in a word that carry meaning. Morphemes can be combined and recombined to form many words like Lego pieces are rearranged into countless structures.
3. Bases, prefixes, and suffixes maintain consistent spellings in words regardless of shifts in pronunciation. Spelling changes occur across derivations according to consistent suffixing patterns.
4. Compounding and three consistent suffixing patterns were taught: (a) replacing the single, silent *e*, (b) doubling single, final consonants, and (c) *y/i* changes.
5. The base carries the core meaning of a word, which is then modified by the affixes with which it is combined. A base that can stand on its own as a word is called a *free base* (e.g., *run*). There are bases that never stand on their own as words, called *bound bases* (e.g., *struct*, denoting build).
6. Twin bases are two forms of the same base that carry the same core meaning in the morphological family of words they build. For example, the twin bound base *duce/duct* for ‘lead, bring’ are the foundation for all the derivations built on both *product* (*pro* + *duct*) and *produce* (*pro* + *duce*) or words that do not include these stems such as *educate* (*e* + *duce/* + *ate*) or *deduce* (*de* + *duce*).

Process. The experimental program was labelled *structured word inquiry* to describe its underlying philosophy of instruction. A guided problem-solving approach was used to investigate how word structure provides cues to meaning. Students were asked to act as "spelling detectives" to investigate sets of words chosen to reveal a targeted spelling pattern. For example, the first lesson was designed to introduce the building block structure of written morphemes despite pronunciation shifts. Students were challenged to use the morphological matrix for sign (Fig. 1) to investigate the question "Why is there a *g* in *sign*?" From that matrix words like *signal*, *assignment* and *signature* were built with word sums (*sign* + *al* → *signal*; *as* + *sign* + *ment* → *assignment*; *sign* + *ate/* + *ure* → *signature*) to show how morphemes are assembled like pieces of Lego to form complex words. The teacher (first author) used an overhead projector to share discoveries and guide students' understanding of the principle that the spelling of these word parts, called bases, prefixes, and suffixes, remain the same across words even if pronunciation shifts. Each new concept (e.g., suffixing pattern for the single, silent *e*) was introduced with a starter question that could be resolved by investigating patterns in selected sets of words. In this way, it was hoped that students would gain not only the word structure knowledge targeted by the lessons but also metalinguistic problem-solving strategies that could be used independently on novel words.

Over the course of 20 lessons, a consistent process of instruction was employed to help students develop and test hypotheses about increasingly complex orthographic patterns. The basic structure of the instruction was as follows:

1. Present an interesting spelling problem that highlights a core orthographic element, pattern or principle.
2. Present students with sets of words selected to reveal the pattern that is the focus of

the lesson. Encourage the development of hypotheses for the class to test.

3. Test hypotheses in order to confirm and describe exact orthographic pattern.
4. Provide systematic practice of newly learned patterns with a set of words chosen to reinforce a given pattern. (Fig. 2.2 provides an example of a flow chart used to practice suffixing patterns after students had identified them through structured inquiry.)
5. Identify spelling questions in preparation for the next investigation.

Instructional activities were of three types: (a), exploratory problem-solving (hypothesis development), (b) focused problem-solving (hypothesis testing/confirmation), and (c) structured practice of newly learned content. Instructional time was divided roughly equally between activities that emphasized problem solving and those that emphasized practicing newly learned

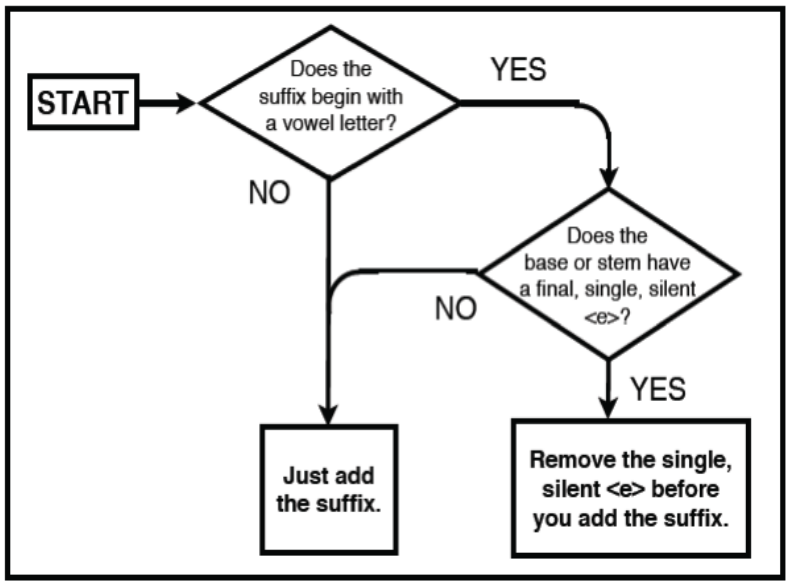


Figure 2.2 Flow chart of pattern for suffixing pattern for dropping the single, silent e (Ramsden, 2001, p. 17). *Reprinted with permission of author.*

concepts. Instruction was designed to shift regularly between practice and problem solving in an attempt to maintain the interest of students, while also giving systematic practice of the orthographic principles being taught. Worksheets were used over the course of the intervention that included prepared matrices, sets of words, and word sums selected to target particular patterns. Put together these lessons presented children with 430 words meeting the criteria of *Word Taught*. Thus in this study, words that were considered to have received direct instruction received much less attention compared to vocabulary interventions such as those of Beck et al. (1982) or Baumann et al. (2002, 2003).

The orthographic and morphological knowledge that grew through this process was intended to encourage independent thinking about orthographic patterns, and knowledge about how to use resources to test those hypotheses. Reference works including typical dictionaries and word origin dictionaries became regular tools in investigations, and were used to confirm students' morphological hypotheses. Lessons used word matrices (Ramsden, 2001) and word sums to support instruction about morphological structure with concrete representations that could be interrogated in a full class lesson. Multiple sensory channels as suggested by Mousavi, Low, and Sweller (1995) were used. For example, students were taught to spell out word sums both in writing and orally to emphasize morphemic and graphemic units. Thus the word sum */pleɪ/* + *ure* → *pleasure* was modelled on an overhead transparency as the class and teacher simultaneously wrote and spoke out loud, "*p–l–ea–s–e–plus–ure - is rewritten as - p–l–e-a–s–no e—u-r-e*". The dash length represents pause length between saying letter names. For this word sum, a long pause indicates the morphemic boundary between the base and the suffix. The letter names of the *ea* string are named together quickly to highlight its structure as a digraph. Students were also explicitly taught to use a finger to follow the path of questions on the flow chart (Fig.

2.2) for suffixing patterns while reading the relevant questions for suffixing as a way of reinforcing a regular sequence of questions to pose when investigating the structure of complex words. These tools were also intended to motivate active participation in word structure activities by offering an entertaining way to focus students' attention directly to the content of the intervention. Put together, all these tools supported an instructional approach targeting the development of students' word consciousness (Scott & Nagy, 2004).

Results

Means and standard deviations for all pre- and post-test measures are presented in Table 2.1. The only pre-test measure was PPVT-III. Means and standard deviations for scores on this measure showed that the control and experimental groups were not significantly different in vocabularly knowledge at pre-test $t(79) = 1.29$, $p = .20$. These raw PPVT-III scores are in the average range for students of 10 years, 2 months.

Table 2.1

Means and Standard Deviations for Control and Experimental Groups on all Measures

Measure	Control			Experimental		
	n	Mean	SD	*n*	Mean	SD
PPVT-III (raw scores)	43	134.88	14.72	38	130.50	15.75
Morph. Vocabulary Word Taught	43	8.84	3.89	38	10.50	4.43
Morph. Vocabulary Base Taught	43	5.75	2.61	38	6.76	3.65
Morph. Vocabulary Affix Taught	43	10.63	3.95	38	9.55	5.32
Base Identification Word Taught	43	9.47	2.07	38	13.79	4.20
Base Identification Base Taught	43	12.91	2.98	38	16.76	3.90
Base Identification Affix Taught	43	9.95	2.53	38	12.13	3.29

Table 2.2 presents correlations between all measures.

Table 2.2

Correlations between Pre-Test Vocabulary (PPVT-III) and Outcome measures for Control Group (N = 43) above diagonal) and Experimental Group (N = 38) below diagonal)

	1	2	3	4	5	6	7
1. PPVT-III	--	.331*	.195	.261	.475***	.257	.382*
2. Base Identification Word Taught	.165	--	.165	.218	.204	.119	.178
3. Base Identification Base Taught	.153	.716***	--	.389**	.431**	.491***	.473***
4. Base Identification Affix Taught	.165	.624***	.779***	--	.382*	.367*	.363*
5. Morphological Vocabulary Word Taught	.669***	.424**	.369*	.440**	--	.636***	.662***
6. Morphological Vocabulary Base Taught	.634***	.284	.249	.374*	.752***	--	.713***
7. Morphological Vocabulary Affix Taught	.500***	.412**	.414**	.521**	.754***	.816***	--

Note. PPVT-III = Peabody Picture Vocabulary – III (Dunn & Dunn, 1997)
***$p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$, (all 2-tailed tests).

Raw scores within each level of Base Identification and Morphological Vocabulary were transformed into *z* scores. A 2 (Group: experimental vs. control) x 3 (Level of Transfer: near, medium, and far) ANCOVA was performed, with repeated measures on the second factor

represented by the three types of words (Word Taught, Base Taught and Affix Taught, respectively), for each of the outcome measures (Base Identification and Morphological Vocabulary). The covariate in each analysis was pretest vocabulary (PPVT-III), to control for the small but nonsignificant differences on the pretest.

Base Identification

For Base Identification, the covariate was found to have a significant effect, $F(1,78) = 4.57$, $p < .05$, $\eta_p^2 = .06$. There was also a significant effect of Group, $F(1,78) = 36.53$, $p < .001$, $\eta_p^2 = .32$ indicating that the experimental group outperformed the control group. The linear component of the interaction term (Group x Level of Transfer) was marginally significant $F(2,156) = 3.87$, $p = .053$, $\eta_p^2 = .05$. A graph of this interaction is shown in Figure 2.3.

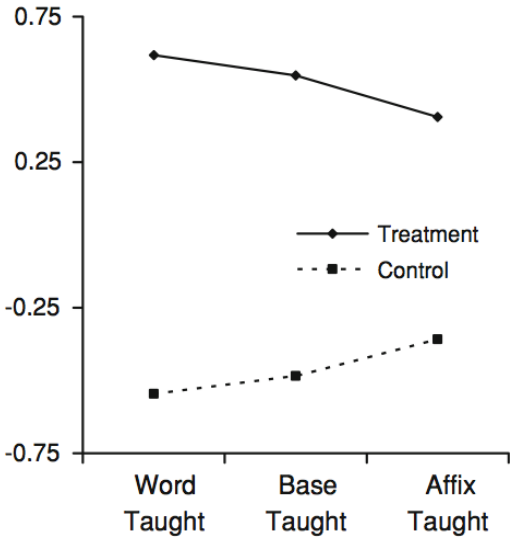


Figure 2.3 Base Identification *z*-scores for experimental and control groups after controlling initial vocabulary.

To explore the interaction, tests of between-subjects effects for each level of transfer were conducted to assess the effect of instruction with pretest vocabulary as a covariate. The covariate

effect was not significant for any level of transfer. For each level of transfer, the group effect was significant, for the near transfer measure, Word Taught, $F(1, 78) = 39.49$, $p < .001$, $\eta_p^2 = 34$, for the mid transfer measure, Base Taught, $F(1, 78) = 28.02$, $p < .001$, $\eta_p^2 = 26$, and for the far transfer measure Affix Taught, $F(1, 78) = 13.33$, $p < .001$, $\eta_p^2 = 15$. Inspection of the graph shown in Figure 3 indicates the source of the marginally significant interaction between Group and Level of transfer was that the difference between the groups decreased with greater degree of transfer assessed, as is suggested by the strength of the individual between-groups effects.

Morphological Vocabulary

The same repeated measures ANCOVA, 2 Group x 3 Level of Transfer, with PPVT-III as the covariate, was conducted with the Morphological Vocabulary scores as the dependent measure. The covariate of initial vocabulary was significant, $F(1,79) = 30.81$, $p < .001$, $\eta_p^2 = .28$ as was the effect of Group, $F(1,79) = 3.99$, $p < .05$, $\eta_p^2 = 05$. The linear component of the Group x Level of Transfer interaction was significant, $F(2,158) = 15.36$, $p < .001$, $\eta_p^2 = .16$. A graph of this interaction is presented in Figure 2.4.

To investigate the interaction, the two groups were compared at each level of transfer, again using pretest vocabulary as a covariate. The covariate was significant for each level of transfer: for the near transfer measure, Word Taught, $F(1, 79) = 35.6$, $p < .001$, $\eta_p^2 = .31$; for the mid-transfer measure Base Taught, $F(1,79) = 20.2$, $p < .001$, $\eta_p^2 = .20$, and for the far transfer measure Affix Taught, $F(1, 79) = 18.86$, $p < .001$, $\eta_p^2 = .19$. The experimental and control groups differed on the near transfer Word Taught measure, $F(1, 79) = 10.4$, $p < .01$, $\eta_p^2 = .12$, and on the mid-transfer measure Base Taught, $F(1, 79) = 6.01$, $p < .05$, $\eta_p^2 = .07$. These results clearly indicate that morphological instruction helped the students define words when either the base or the whole word had been taught, but not when only the affix had been taught.

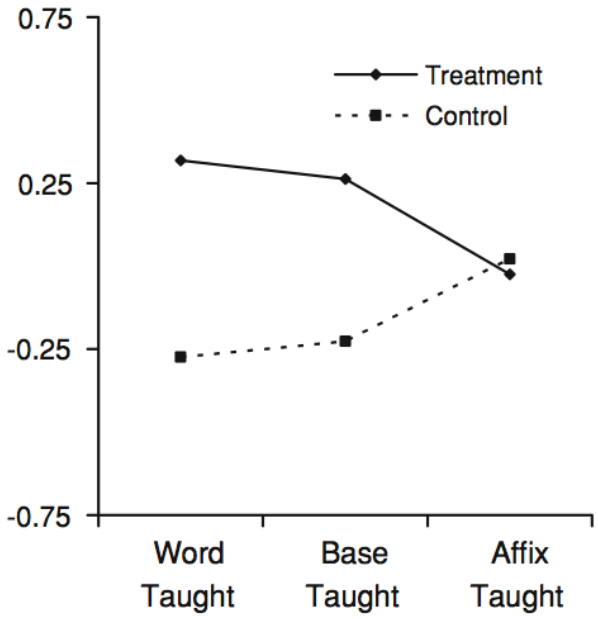


Figure 2.4

Morphological Vocabulary z-scores for experimental and control groups after controlling initial vocabulary.

Finally, regression analyses were conducted to investigate whether being able to identify the bases of words (defined by their Base Identification scores) helped the students define those words (as indexed by their Morphological Vocabulary scores). Separate analyses were conducted for the control and experimental groups; pretest vocabulary (PPVT-III) was entered in the first step of the model, and the total score on the Base Identification measure was entered in the second. Table 2.3 shows that for both control and experimental groups, initial vocabulary knowledge explained significant variance in the Morphological Vocabulary measure (19.1% for the control group, and 44.3% for the experimental group). After controlling for this effect, scores on the Base Identification task explained 12.8% of the variance in scores on the post-test vocabulary measure for control students and 11.7% for the experimental students.

Table 2.3

Results of Hierarchical Regression Analysis Predicting Morphological Vocabulary from Base Identification on after Controlling for Initial Vocabulary (PPVT-III) for Control and Experimental Groups

Dependent Variable Total Vocabulary Outcome

	Control (N = 43)		Experimental (N = 38)	
Model	ß	ΔR^2	ß	ΔR^2
1. PPVT-III	.437	.191**	.666	.443***
2. Base ID	.383	.128**	.348	.117**

Note. ß shown for the step at which its variable is entered in the model.

***$p \leq 0.001$, ** $p \leq 0.01$

Discussion

The current study tested an approach to teaching vocabulary that attempted to address a variety of criteria identified by the National Reading Panel (2000) and others (e.g., Pressley, et al., 2007) as important to effective vocabulary instruction. Evidence that teaching part of a morphological family transferred to words in that family that were not taught, would address the concerns emphasized by Biemiller (2005) and others regarding the quantity of vocabulary that students need to learn. By capitalizing on well-ordered morphological spelling patterns, a problem-solving structured word inquiry approach was intended to provide the deeper processing of words during vocabulary instruction called for by other researchers (e.g., Beck, et al., 2002). Using this instruction, we aimed to build both students' generative word knowledge and their motivation for understanding words – their word consciousness that Nagy and Scott (2004, p.

201) described as “the knowledge and dispositions necessary for students to learn, appreciate, and effectively use words”. We begin by summarizing the evidence regarding each of the research questions, and then turn to discussion of the implications.

The first research question addressed whether students learn to identify the bases of morphologically complex words as a result of the instruction. If targeting the morphology system as a tool for generative word knowledge for elementary students is to be successful, it must be established that these children master morphological linguistic content that they would not master as a result of typical classroom instruction. The Base Identification results were clear. After controlling for initial vocabulary, the instructional group was significantly better at identifying the base of complex words for each level of transfer.

The second research question was whether instruction about morphological structure would lead to gains in vocabulary learning. After controlling for the significant correlation between initial vocabulary and Morphological Vocabulary, instruction had an effect on the near and mid transfer measures of Morphological Vocabulary. Instruction did not have any effect for the far transfer vocabulary words – those words outside of the morphological families that were taught.

The third research question asked whether ability to identify bases in complex words would predict vocabulary knowledge. Whether or not students received direct instruction about morphology, their ability to identify the base in complex words contributed a significant amount of variance to their knowledge of the words in the Morphological Vocabulary measure.

This study provides evidence that a 20-lesson classroom intervention for Grade 4 and 5 students can teach morphological analysis knowledge and skills that provide them with a means to develop vocabulary beyond the words they are taught, but not beyond the morphological families that they are taught. It would have been good news if this instruction had improved

students' ability to define words from untaught morphological families, but that hope may well be too high, at least for a 20-session intervention. Because the base carries the core meaning of a word, unless students are already familiar with the meaning of a base – by instruction or by incidental learning – morphological analysis cannot provide the learner with access to the meaning of a word.

The results for Base Identification showed that teaching Grade 4 and 5 students how morphology works improved their ability to peel affixes off complex words. Students can be taught to identify the bases of novel words, but that skill in and of itself cannot provide a student with knowledge of the meaning of novel bases. Being taught morphological analysis skills may, however, make it easier for students to recognize a base they know in large complex words that could be missed without the scaffolding of word structure knowledge gained through instruction. Suggestive evidence that this may have occurred is found in the much greater contributions of initial vocabulary knowledge (PPVT) to variance in morphological vocabulary for the experimental group (41.6%) than the control group (15.1%), with similar contributions of the ability to identify the base for both groups. Because the experimental group had higher Morphological Vocabulary scores than the control group despite their initially similar PPVT scores, the differing contribution of that PPVT knowledge to morphological vocabulary suggests that morphological instruction may have helped the experimental students apply their initial vocabulary knowledge to the task of describing word meanings. These results are consistent with the idea that when faced with an unfamiliar word, a more skilled morphological problem-solver is better able to recognize a meaningful link to a related familiar word. A part of the benefit may come from simply knowing that there are often meaningful links to look for. "It is only when

students believe they know how to analyze unfamiliar words in texts that they will expend the energy to become close readers" (Carlisle, 2007, p. 99).

A hypothetical scenario of morphological analysis that mirrors the kind of investigations that occurred during the intervention is offered as speculation about how taught morphological awareness might support students in their more effective use of initial vocabulary knowledge. Faced with a word like *condensation*, students in the control group who happen to know the base *dense* might fail to recognize that familiar base within this complex word due to a slight phonological shift and the spelling change between the target word and its base. Students in the experimental group with the same initial vocabulary knowledge could plausibly discover this base that they knew, but did not immediately recognize, by the application of morphological knowledge gained through instruction and practice. An ability to mentally peel off the familiar *con-* prefix and the *-ate* and *-ion* suffixes may increase the salience of the *dens* letter string as a possible marker for the word *dense* that they have in their lexicon. If that *dens* orthographic string activates students' knowledge of the word *dense* with the meaning of 'tightly packed together', the semantic link between this base and the scientific term *condensation* could help them form a hypothesis. It may be that the experimental group's greater Morphological Vocabulary knowledge was achieved by giving students technical skills to help them capitalize on mutually reinforcing meaning cues across derivations that lie dormant in untaught students.

The consistent structure of written morphology facilitates the use of problem-solving activities in which learners act as "word detectives". The literature emphasizes the importance of vocabulary instruction that motivates children to enjoy and actively engage in the study of words and their meanings (e.g., National Reading Panel, 2000). Motivating students with engaging word study was a key element in the design of the instruction. A limitation of this study,

however, is that it can only provide anecdotal evidence on this aspect of the instruction. The instructor/first-author observed that there were clear signs of high interest for studying the content for many of the students in the experimental group. For example, several opportunities for independent word inquiries were well used. Students frequently submitted written questions about the spelling of words, regularly added hypotheses about prefixes and suffixes to the class affix chart, and posed oral questions in class. Although these were voluntary assignments with no grade attached, students were told that to have their inquiries addressed, they needed to write their theory of the word sum related to their question. The keen response to this extra work is akin to what Beck, et al. (2002) reported with their "Word Wizards" activity that resulted in students bombarding them with questions about words.

Students from both intervention classes consulted dictionaries frequently to test orthographic hypotheses independently. Students expressed a preference for the larger dictionaries over "student dictionaries", because they included word origin information that helped them test hypotheses of morphological connections. They also made use of two etymological references, a large Word Origin Dictionary (Ayto, 1993) and a dictionary called *Word Stems* (Kennedy, 1890/1996).

Perhaps the most convincing evidence that this instruction was received with enthusiasm by students and teachers is that after the intervention, with great effort by the teachers and special education teachers who had students in classes of the experimental group, funds were secured to buy the Real Spelling materials (Ramsden, 2001) upon which this instruction was based. Since the intervention, teachers in both schools who were involved in the intervention – and teachers who were not – continued to integrate this instruction into their teaching.

Vocabulary Instruction that is Deep and Wide

At the outset of this paper, we pointed to an apparent conflict between two strategies for vocabulary instruction recommended by the literature (e.g., National Reading panel, 2000; Pressley, et al., 2007). We characterized the strategy of Biemiller and colleagues (Biemiller & Slonim, 2001; Biemiller & Boote, 2006) as the wide but shallow approach because it favors direct teaching of many words at the expense of rich, repeated instruction of words. In contrast we described the strategy favored by Beck, et al. (2002) and others, as deep but narrow because, at the expense of direct instruction of many words, it recommends repeated rich instruction aimed at developing not only a deep understanding of the words taught, but also a generative interest and engagement with the study of words. The current study provides evidence that morphological structure may provide a way to address both of these seemingly incompatible strategies, while simultaneously meeting the goal identified in the vocabulary research – teaching word-learning strategies.

The role of the word matrix (Ramsden, 2001) may help clarify how all these goals can be addressed simultaneously. When a matrix was used, instruction did not give each possible derivation or inflection equal attention. For example, of the 18 words represented by the *sign* matrix (Figure 2.1), 3 were selected for close attention, 7 received brief explicit attention, and some were not explicitly addressed by the teacher at all. The words *signal* and *assignment* received special attention as they were used for examples of building word sums from the matrix. They were also used to illustrate that the semantic distance of a derivation from its base can be small (*signal*) or relatively large (*assignment*), and that the pronunciation of a base can change dramatically or not at all in related words. The word *signature* was used as another example of a phonological shift across related words, but this word received particular attention as the word used to introduce the investigation of suffixing patterns for single, silent *e*. Another subset of

seven words (*sign, signed, signing, design, redesign, assign,* and *signify*) was explicitly targeted to practice the interconnection of structure and meaning of morphologically related words, but only received brief explanations of meaning when necessary. Although the word *designate* is represented by the matrix, and may have been identified independently by some students, it did not receive explicit whole class instruction. This instruction offered learners the rich active processing recommended by Beck et al. (2002) for 3 of the 18 words for the *sign* family while providing quick exposure to a larger number of words with the benefit of a structure and meaning referent to help 'map' new word meanings as recommended by Biemiller and Boote (2006). Evidence of vocabulary learning was found not only for words that received rich or brief attention, but also for untaught relatives of taught words. These results suggest that it may be productive to reframe the question of how many *words* vocabulary instruction should target as a question of how many *morphological families* should be taught. Teaching many base words with attention to the application of morphological principles should improve vocabulary significantly, and potentially affect reading comprehension.

The word matrix provides the lynchpin that makes it possible to bring these elements together into one instructional design. It provides a concrete, visual representation of morphological structure linking large families of words regardless of pronunciation via the consistent spelling of morphemes. Word sums then provide a practical tool for problem-solving and practicing the consistent suffixing patterns that clarify how those morphemes combine into the completed spelling of a word. The matrix and the word sum help students focus directly on the coherent, reliable patterns that drive how the English spelling system represents meaning.

The nature of the integration of meaning and structure in morphological families and the use of the matrix and word sums to focus learners' attention directly on how that structure works,

provide ground for suggesting links to Perfetti's lexical quality hypothesis (Perfetti, 2007). He posited that the quality of the mental representations of words affects the ease with which a person gains access to a word. Lexical quality is defined by the extent to which a mental representation specifies its form (orthographic and phonological) and meaning components. Perfetti presented five features of lexical representation that determine lexical quality. The first four, *orthography*, *phonology*, *grammar*, and *meaning*, are constituents of word identity, and the fifth, *constituent binding*, "…is not independent but rather a consequence of the orthographic, phonological and semantic constituents becoming well specified in association with another constituent" (pp. 360-361). It seems plausible that morphological knowledge acts as a constituent binding agent – a kind of "lexical representation glue" which contributes to and strengthens knowledge of word meanings including grammatical knowledge carried by suffixes. By means of various lexical features, morphological knowledge provides a stronger binding force for words of a morphological family, but less so for unrelated words, because the core meaning of a complex word is carried by its base. If this were the case, increasing precise morphological knowledge would support the development of high quality lexical representations, not just for words, but for families of structurally and meaningfully related words. The word matrix – a schematic diagram of the integrated structure of a morphological word family – provides a tool to draw students' attention to the various features of word identity and how they bind together.

Limitations and Suggestions for Future Research

One limitation of the instruction in the study may have been an overemphasis on the mechanics of the morphological spelling patterns and too little emphasis on explicit modeling of how to use these skills to infer the meanings of complex words. Learning how words are built is

a crucial step in learning how to find meaning cues in words, but more time could have been used to teach how to use that knowledge to infer meaning. Ironically, despite the positive vocabulary results, this intervention used little direct practice of word meanings as is standard in vocabulary interventions.

Another important limitation of the study was lack of good data on student engagement and teacher attitudes about the instruction. Increased motivation for word study was one of the goals of the instruction. While success in this aspect of instruction has been reported anecdotally, future research should systematically investigate the question of student motivation and teacher attitudes.

In light of the current positive results, it would be valuable to investigate the effect of similar morphological instruction with populations identified for reading and/or learning disabilities. One question is whether students identified for phonological processing deficits are able to capitalize on this instruction as a compensatory strategy for literacy learning. It might be that gaining awareness of the concrete representations of morphemes with the aid of the word matrices and word sums would give particular benefits to students who typically struggle to make sense of the writing system.

There is a clear implication from these results that research and practice should investigate the effects of providing children with a more explicit and complete understanding of the English spelling system. Since morphology is a fundamental feature of how words work to represent meaning, the potential for developing a child's interest in and understanding of how words work – their word consciousness – is hindered by instruction that fails to address morphological structure. Findings from this study suggest that morphological instruction should be organized to facilitate students' ability to identify the bases of words. For example, instead of asking children

to attend to *–tion* as a suffix in words such as *prevention*, *question*, or *action* (as we have seen classroom materials do), it may be more helpful to direct them to the suffix *–ion*, which makes it easier to see the base in those words. The current study has shown that instruction about the details of written morphology aids ability of students in Grades 4 and 5 to recognize meaning cues in complex words and build vocabulary.

Four decades ago, the linguist Richard Venezky wrote, "...the simple fact is that the present orthography system is not merely a letter-to-sound system riddled with imperfections, but, instead, a more complex and more regular relationship wherein phoneme and morpheme share leading roles" (Venezky, 1967, p. 77). Results from this study support the common sense idea that English literacy instruction should accurately represent the basic principles of how the English orthography system works to represent the meaning of words.

CHAPTER 3: THE EFFECTS OF MORPHOLOGICAL INSTRUCTION ON LITERACY SKILLS: A SYSTEMATIC REVIEW OF THE LITERATURE

Abstract

The authors reviewed all peer-reviewed studies with participants from pre- school to Grade 8 for this meta-analysis of morphological interventions. They identified 22 applicable studies. Instructional effects (Cohen's *d*) were averaged by linguistic outcome categories (morphological sub-lexical, non-morphological sub-lexical, lexical, and supra-lexical) and comparison group (experimental group vs. control or experimental group vs. alternative training). The authors investigated the effects of morphological instruction (a) on reading, spelling, vocabulary, and morphological skills, (b) for less able readers versus undifferentiated samples, (c) for younger versus older students, and (d) in combination with instruction of other literacy skills or in isolation. Results indicate that (a) morphological instruction benefits learners, (b) it brings particular benefits for less able readers, (c) it is no less effective for younger students, and (d) it is more effective when combined with other aspects of literacy instruction. Implications of these findings are discussed in light of current educational practice and theory.

Introduction

Our purpose in this paper is to provide a systematic review of the evidence about the effects of instruction about the morphological structure of words on literacy learning. Morphology is the conventional system by which the smallest units of meaning, called morphemes (bases, prefixes, and suffixes), combine to form complex words. For example, the word *unhelpful* has three morphemes that can be represented orally /ən/ + /hɛlp/ + /fəl/, or in writing <un-> + <help> + <-ful>. The English orthography is considered to be morphophonological (Chomsky & Halle, 1968; Venezky, 1967, 1968, 1999), in that both units of

meaning and of sound are represented in print. Morphology has received far less attention in literacy research than has phonology (National Reading Panel, 2000). As we will see in the review that follows, there is growing evidence of the role of morphological knowledge in literacy development (Carlisle, 2003; Deacon & Kirby, 2004; Nunes, et al., 1997; Roman, et al., 2009).

Morphological knowledge is referred to in various ways in the literature, including as morphological awareness and morphological processing. Morphological awareness has a specific meaning, referring to "awareness of morphemic structures of words and the ability to reflect on and manipulate that structure" (Carlisle, 1995, p. 194). Morphological processing on the other hand can include less conscious or implicit processing of morphological information (e.g., Deacon, et al., 2008). For the purposes of this review, because it was not always clear what the participants were learning, we use the more general term *morphological knowledge*.

Morphological knowledge has the potential to affect literacy skills in at least three ways, through word recognition, comprehension, and motivation. A great deal is known about the factors supporting word recognition: these include phonological awareness, rapid automatized naming, orthographic processing, and vocabulary knowledge (see National Reading Panel, 2000, for a review). Morphological knowledge is a further factor supporting efficient and accurate word recognition (Carlisle, 2003). For example, morphemic boundaries affect the pronunciation of letter sequences: *ea* is pronounced as one phoneme in *reach* because it occurs in one morpheme, but as two phonemes in *react* because the two letters are in different morphemes. The relationship between morphological knowledge and word reading has been shown to be independent of the other factors mentioned above (Deacon & Kirby, 2004; Roman et al., 2009). Morphological knowledge may also contribute to reading comprehension, through improved word recognition, but also by helping readers understand the meanings or syntactic roles of

unknown words (Carlisle, 2003). A number of the authors of the intervention studies reviewed here commented that morphological instruction may contribute to literacy by increasing motivation to investigate words (e.g., Berninger, et al., 2003; Bowers & Kirby, 2010; Tomesen & Aarnoutse, 1998). We found no studies that included outcome measures of motivation, so this interpretation is still speculative.

Given the increasing evidence of the relationship between morphological awareness and reading outcomes (e.g., Carlisle, 2003), there is a parallel increase in interest in teaching children about morphology. By its nature morphological instruction addresses sub-lexical features of a language. The ultimate goal of this instruction, however, is not for children to learn about morphemes. Rather, it is hoped that explicit morphological instruction will increase understanding about oral and written features of morphology at the sub-lexical level that, in turn, will influence literacy skills at the lexical level (e.g., word reading, spelling, and vocabulary) and the supra-lexical level (e.g., reading comprehension). For sub-lexical morphological instruction to result in literacy gains at higher linguistic layers there must be some transfer beyond that sub-lexical content. Presumably this transfer would occur through improved word recognition, which in turn might facilitate text comprehension. It can be expected then that any gains found for lexical measures would be less than gains found for morphological sub-lexical tasks. Similarly, it may be that increased knowledge of morphemes as meaning cues for words could affect reading comprehension, the supra-lexical layer. Transfer to reading comprehension may be less immediate and weaker than that found for the lexical layer, and may require the integration of morphological knowledge with other literacy skills.

The merits of new instructional content cannot be investigated effectively in isolation from questions about how that content is taught and the individual differences among those who

receive the instruction. Any benefits of morphological instruction may differ greatly based on a variety of factors. Developmental issues such as the learners' age and language ability at the point of instruction may have instructional consequences. Instructional design questions include the ideal length of interventions and the optimal manner of presentation of morphological content. These instructional questions also provide structure to our investigation of morphological intervention studies.

Importance of Morphological Knowledge in Reading Outcomes

Before reviewing the studies of morphological instruction, it is helpful to briefly review evidence for the correlation between morphological knowledge and literacy in students who have not received special morphological instruction. Morphological knowledge (assessed in the absence of specific instruction) has been found to predict unique variance in sub-lexical tasks like pseudoword reading after controlling for factors including phonological awareness, orthographic processing, and naming speed (e.g., Deacon & Kirby, 2004; Fowler & Liberman, 1995; Roman, et al., 2009). An influence of morphological knowledge on lexical tasks has been shown in studies of word reading accuracy (e.g., Carlisle, 1995, 2000; Carlisle & Katz, 2006; Elbro & Arnbak, 1996; Fowler & Liberman, 1995; Leong, 1989; Singson, et al., 2000; Roman et al. 2009). Also at the lexical layer, morphological knowledge has been shown to predict unique variance in vocabulary knowledge (Bertram, Laine, & Virkkala, 2000; Carlisle, 2007; Mahony, et al., 2000; Wysocki & Jenkins, 1987) and spelling (e.g., Deacon, et al., 2009). Finally, evidence at the supra-lexical level can be found in research showing a unique contribution of morphology to reading comprehension after controlling for other variables associated with reading (e.g., Carlisle, 1995; Carlisle, 2000; Deacon & Kirby, 2004; Elbro & Arnbak, 1996). Although the correlational/predictive studies offer strong support for the role of morphological knowledge in

literacy development, correlational studies can never completely answer the question of causation.

Developmental Trends and the Timing of Instruction

There is some suggestion of changes in the role of morphological knowledge for literacy skills in different age groups. Early research established that children as young as 4 years had morphological knowledge (e.g. Berko, 1958). Evidence for morphological cues influencing spelling has been shown for 5 and 6 year old children (Deacon & Bryant, 2006; Kemp, 2006; Treiman, et al., 1994). Carlisle and Stone (2005) found that children aged 7 to 10 years made use of morphological structure in reading derived words (see also Deacon, Whalen, & Kirby, 2009). There is some suggestion that the role of morphological knowledge in reading increases with age while that of phonological awareness decreases (Singson, et al., 2000), but that does not appear in all analyses in all studies (e.g., Deacon & Kirby, 2004; Roman et al., 2009). Certainly, an increase in the importance of morphological knowledge is the prediction of some prominent models of literacy development (e.g., Ehri, 1995, 1997; Ehri & McCormick, 1998); children are expected to become more fluent readers later in reading development as they increasingly use commonly recurring letter patterns (such as *–ight* and *–ed*) as units. Notably, these units include morphemes. The question of the developmental pattern of the contributions of morphological knowledge to reading outcomes clearly has substantial empirical and theoretical implications.

Accordingly, the most effective point at which to introduce this content to classroom instruction remains an important unresolved question. Adams (1990) recommended avoiding explicit morphological instruction until upper elementary years. More recently, researchers have called for early instruction about morphology along with other oral and written features of

language (e.g., Carlisle & Stone, 2005; Henry, 2003; Nunes & Bryant, 2006). Results from intervention studies are needed to shed light on when this instruction is most effective.

Differential Effects Associated with Reading Ability

The role morphological knowledge plays for more and less able readers is another important question. A well-established source of difficulty for struggling readers is a phonological processing deficit (National Reading Panel, 2000). A number of researchers have suggested that morphological knowledge may represent a particular advantage for struggling readers (e.g., Carlisle, Stone & Katz, 2001; Casalis, Colé, & Sopo, 2004; Elbro & Arnbak, 1996). As an example, Carlisle et al. (2001) found that both poor and average readers were better able to read morphologically transparent words than shift words (transparent words are those in which the pronunciation of the base is the same after adding affixes, whereas shift words are those in which the base's pronunciation changes). Carlisle et al. concluded that both poor and average readers must draw on morphological knowledge when they are reading. A more detailed picture comes from Casalis et al. (2004). They found that dyslexics were behind reading-age controls in morphemic segmentation, but that the two groups performed equally in a morphological sentence completion task and dyslexics in fact outperformed the reading-age controls in a morphological production task. They concluded that dyslexics might take advantage of morphemes in processing, particularly given that these are typically larger units of sound that are connected to meaning. Introducing explicit morphological instruction may build on a relative strength for dyslexic learners (Deacon et al., 2008; Elbro & Arnbak, 1996).

Rationale for Studying Morphological Instruction

Typical classroom instruction includes very little, if any systematic and sustained attention to the morphological structure of words (Henry, 2003; Nunes & Bryant, 2006; Moats,

in 2009). Therefore, virtually all the findings outlined in the preceding sections are based on uninstructed morphological knowledge. Only examination of evidence from morphological interventions can shed light on the causal role of morphological knowledge and whether the existing research accurately represents the role morphology plays in literacy development.

The distinction between taught and untaught morphological knowledge may have special relevance for some of the questions addressed in the preceding sections. If uninstructed morphological knowledge provides some struggling readers with a compensation strategy, as suggested by Casalis et al. (2004), deliberate morphological instruction may help them harness this strategy more effectively. Deliberate morphological instruction may create knowledge that is different from the untaught knowledge examined in existing correlational/predictive studies. Deliberate instruction should lead to more accurate and quicker learning, and more explicit knowledge. If morphological instruction were introduced early in literacy learning, morphological knowledge would have time to become consolidated and have more opportunities to contribute to literacy learning.

Intervention studies are necessary to investigate the causal links between morphological knowledge and literacy development, just as studies such as Bradley and Bryant's (1983) were needed to establish a causal link between phonological awareness and later reading ability. The predictive/correlational studies are important, but fail to address the directionality of influence between morphological knowledge and literacy skills. It may be that morphological knowledge builds literacy skills or that developing literacy skills builds morphological knowledge, or that there is some mutually supportive relationship. Evidence from morphological interventions is needed to determine whether an increase in morphological knowledge will influence the development of literacy skills. Also, as we will revisit in more detail in the discussion, the

question whether morphological instruction is helpful for younger and/or less able readers has clear implications for current models of reading development (e.g., Ehri, 1995).

Current Morphological Instruction Research

A small but growing body of research has investigated the effects of morphological instruction on reading (e.g., Abbott & Berninger, 1999; Berninger et al., 2003, 2008), spelling (e.g., Nunes, et al., 2003; Robinson & Hesse, 1981), and vocabulary (Baumann, et al, 2003, Baumann et al., 2002; Bowers & Kirby, 2010). The meta-analysis described here synthesizes results from morphological interventions that have examined the effect of instruction both with participants identified with reading difficulties (e.g., Arnbak & Elbro, 2000; Tyler, Lewis, Haskill, & Tolbert, 2003), spelling difficulties (e.g., Kirk & Gillon, 2009) and with undifferentiated participants (e.g., Baumann, et al., 2003; Baumann et al., 2002; Bowers & Kirby, 2006, 2010). We investigate results from instructional studies with age groups from pre-school (e.g., Lyster, 1998, 2003) to upper elementary (e.g., Robinson & Hesse, 1981), and across a variety of languages (English, Danish, Dutch, and Norwegian). A meta-analysis will allow patterns to be seen on a larger scale than is possible in separate studies, and will to some extent overcome limitations due to sample size, instructional methods, and variable selection.

Reed (2008) published the only quantitative synthesis of morphological interventions that we have been able to identify. Her study investigated morphological intervention studies conducted in English between 1986 and 2006 with students from Kindergarten to Grade 12. Reed identified seven studies that met her inclusion criteria and provided a descriptive account of the effect sizes for all outcome measures. In her sample, three studies focused on word identification, three on vocabulary, and one on spelling. Reed reported a wide range in effect sizes and concluded that stronger effects were associated with instruction focused on root (base)

words compared to affixes alone. Three studies from two publications in her review (Abbott & Berninger, 1999; Vadasy, et al., 2006) specifically selected low achieving readers. Reed reported medium effect sizes on reading and reading-related outcomes from these studies and found these effects to be larger in general than those for the other intervention studies. She concluded that morphology instruction should be tailored to students' developmental age, and that it should include instruction about root (base) words.

Purpose of the Current Study

Our study is designed to provide a comprehensive systematic review of available data on the impact of morphological instruction on literacy outcomes. To do so, we included a wide search range (expanding on that offered in Reed, 2008). We included studies reported prior to 1986, and unpublished studies presented at peer-reviewed scientific conferences. To identify all relevant studies we included studies even if they did not explicitly state they were investigating morphology (unlike Reed), as long as the focus on morphology was clear from the description of the studies' methods. We included studies that took place in other alphabetic orthographies (as it turned out, there were studies in Danish, Dutch, and Norwegian), extending Reed's exclusive focus on English.

Interpreting results from interventions across languages should be done cautiously because languages differ in terms of oral and written features. One criterion the literature uses to distinguish alphabetic languages is the complexity of grapheme to phoneme correspondences. Languages with consistent grapheme-phoneme correspondences are considered *shallow*. Languages in which the grapheme-phoneme correspondences are complex and inconsistent are labeled *deep*. Whereas English is seen as deep for both spelling and reading, Danish, Dutch, and Norwegian are seen as moderate on these dimensions (e.g., Borgwaldt, Hellwig, & de Groot,

2004, 2005; Bosman, Vonk & van Zwam, 2006; Seymour, Aro, & Erskine, 2003; Stone, Vanhoy, & Van Orden, 1997). Although there are too few studies in languages other than English to compare languages statistically, we judged it more advantageous to include all these languages in our review in order to provide a wider sample of studies for this early assessment of morphological interventions. As noted regarding study selection criteria, we did limit the studies to those conducted in alphabetic orthographies.

Our study employed a design to facilitate synthesis of this wide variety of data according to three linguistic layers. Outcomes for all studies were coded as sub-lexical, lexical, or supra-lexical in nature. This categorization system (which is described in more detail in the Method section) allowed us to draw a more fine-grained picture of the effects of instruction. Our design allows us to investigate the degree to which sub-lexical instruction transfers up to lexical and supra-lexical measures. We expect high variability within and between these categories due to the application of different treatments to different students, and a wide variety of outcomes. Nevertheless, analyzing effect sizes by these linguistic categories allows for a principled synthesis of results across a variety of studies to investigate pertinent theoretical and practical questions. To investigate ability and age effects, we categorize studies on those characteristics.

If morphological instruction does transfer from the sub-lexical to the lexical and supra-lexical levels, this transfer is likely to be facilitated by instructional methods that integrate morphological instruction with other aspects of literacy instruction (cf. Salomon & Perkins, 1989). This type of integrated instruction, as opposed to that which presents morphological knowledge in a more isolated fashion, should provide more opportunities for guided application of morphological knowledge at the lexical and supra-lexical levels. It is also possible that greater

application at the higher levels will work backwards to strengthen sub-lexical skills. To investigate this, we also categorize the studies with respect to this characteristic.

In summary, this systematic review assesses the evidence for literacy and morphological gains for elementary students (preschool through Grade 8) through explicit instruction about morphology. Our research questions are: (a) What are the effects of morphological instruction for sub-lexical, lexical, and supra-lexical measures of reading, spelling, vocabulary, and morphological skills? (b) Is the effect of morphological instruction different for less able than undifferentiated children? (c) Does the effect of morphological intervention differ when conducted with older versus younger students? and (d) Is morphological instruction more effective when taught in isolation or integrated with other literacy knowledge and skills?

Method

Study Selection

To identify the relevant studies, the EBSCO Research Complete, PsychINFO, and WorldCat electronic data bases were searched with the following descriptors: morpholog*, morphem*, interven*, teach*, train*, instruct*, vocabulary, spell*, read*, base*, root*, prefix*, suffix*, affix*, litera*, dyslex*. Over 1000 abstracts were identified by December 7, 2009. To be included in the analysis, studies needed to meet all the following criteria:

1) Published in English, reporting on research carried out in an alphabetic orthography.
2) Investigated instruction with elementary school students (preschool to Grade 8).
3) Investigated instruction about any element of oral or written morphology (including prefixes, suffixes, bases or roots, compounds, derivations, and inflections). Studies did not need to mention morphology explicitly, as long as the role of morphology was clear in the description of the intervention.

4) At least one third of the instruction was focused on morphology, based on the intervention description.
5) Reported literacy outcome measures (including morphological measures) with means and standard deviations for comparison.
6) Used either an experimental and control/comparison group, or a training group with pre- and post-tests using measures that could be compared to established norms. (No studies were identified that used a pre-test – post-test design without a comparison group, so this last criterion was not implemented.)

Once studies meeting these criteria were identified, experts in the field were contacted to inquire whether they could identify additional relevant published or unpublished studies. Reference lists from identified studies were examined for still more potentially relevant studies. Twenty-two studies met the inclusion criteria; these are identified with an asterisk in the reference list.

Coding the Studies and Outcome Variables

Studies and outcome variables were coded for characteristics of type of linguistic outcome measure, participants, and instructional design. We describe each in turn.

Coding outcomes by linguistic layer. An overarching system of coding outcome measures was designed to facilitate the synthesis of a wide array of outcomes from the 22 studies along the dimensions relevant to our research questions. Sub-lexical outcomes were defined as tasks that require students to process sub-lexical features and that were scored on the basis of sub-lexical features, even if the stimulus and/or responses were at the lexical level. Sub-lexical tasks were further subdivided into *morphological sub-lexical tasks* and *non-morphological sub-lexical tasks*. Morphological sub-lexical tasks included oral tasks such as morphological analogy

(*walk : walked :: shake :_____ (shook)*; Nunes, et al., 1997), or written morphological tasks in which students select words linked by the base to a cue word (e.g., identifying which of the following words "have a real connection" to the cue word *create*: *creative, cream, creature, ate, recreation, crease;* Bowers & Kirby, 2006). Non-morphological sub-lexical tasks included phonological awareness, syllable segmentation, pseudoword reading, and rhyme recognition.

Lexical outcomes included tasks that target linguistic processing at the word level, even though participants must process sub-lexical features to complete them. Lexical outcome tasks include vocabulary, word reading accuracy or efficiency, spelling, and word level orthographic processing tasks such as those in which students choose the correct spelling of two phonologically plausible options (e.g., *rain* or *rane*). Lexical outcomes were further coded as measures of reading, spelling, or vocabulary.

Supra-lexical outcomes included tasks that required oral or written processing beyond the word level. Examples include reading comprehension tasks, syntactic awareness, or listening comprehension.

Coding of participant characteristics. Studies were first coded to indicate whether they investigated *less able* or *undifferentiated readers.* The authors' formal identification of participants (e.g., those with dyslexia or specific language impairment) or informal designations such as "students achieving below expected levels" resulted in the coding "less able". Samples that failed to select for different ability levels were coded as "undifferentiated". Studies were then coded according to participants' grade level, either from preschool to Grade 2 or Grade 3 to Grade 8. This division is consistent with models of reading development (Ehri, 1995, 1997; Ehri & McCormick, 1998) cited earlier.

Coding of instruction and study characteristics. To investigate our question about instructional design, each study was coded as using either *Integrated* or *Isolated* morphological instruction. Studies that combined morphological instruction with instruction about literacy strategies and knowledge were coded *Integrated.* Interventions that focused solely on morphological content were coded *Isolated*. For descriptive purposes, we also coded various aspects of the instruction.

Studies were also coded on two study characteristics to aid analysis of the reported effects: (a) *Experimental versus quasi-experimental* - that is, random or not random assignment of subjects to conditions; and (b) *Comparison group type* - whether treatment groups were compared to untrained control groups (termed E vs. C comparisons) or to comparison groups which received alternative treatment (E vs. AT). None of the Alternative Treatments included any explicit morphological instruction.

Effect Size as an Index of Treatment Efficiency across Studies

The effect size statistic used in this study is Cohen's *d*, which is calculated as the difference between the mean posttest score of the treatment group and that of the comparison group, divided by the pooled standard deviation. An effect size of 1.0 represents a difference of 1 standard deviation between the treatment and comparison groups. Cohen (1988) provided general benchmarks for effect sizes of 0.2 as small, 0.5 as medium, and 0.8 as large, but emphasized that this guideline is subject to judgment. Thompson (2006) explained that depending on the potential consequences of a given outcome, small effect sizes could be of large practical importance, just as large effect sizes could be of little practical significance.

One concern with meta-analyses is that there may exist unpublished studies with null findings which, if they were included in the calculation of the overall effect size, would reduce it

below the level at which it would be meaningful or useful (the so-called "file drawer" problem). Therefore we indicate in the analyses the number of null effects (i.e., $d = 0.0$) that would be required to reduce the effects found below $d = 0.2$ (Hunter & Schmidt, 2004). We chose the .2 criterion on the basis of Cohen's (1988) benchmarks.

Results

Sample Characteristics

Table 3.1 presents basic information about each study analyzed. This table is organized by the sample populations studied rather than by publication. Some publications reported on more than one study (Hurry et al., 2005; Tyler, et al., 2003; Vadasy, et al., 2006) and some samples/interventions were used for more than one study (Bowers & Kirby, 2006, 2010; Lyster, 1998, 2002). Table 3.1 also provides the identification numbers assigned to each study as a shorthand when discussing groups of studies. A total of 2,652 students participated across the studies included, with a range of 16 to 686 participants per study. The 22 studies involved 18 distinct samples; 8 included only less able children, 8 included only undifferentiated students, and 2 studies (#17 and #18) assessed broad samples of students and then also divided these samples into more and less able students. Of the 18 samples, five participated in experiments in which individuals were randomly assigned to conditions; the remainder participated in quasi-experimental designs in which, for instance, intact classes were assigned to conditions. Most of the interventions were carried out in English (18 studies), two were in Norwegian, one was in Danish, and one in Dutch.

Table 3.1

Basic Study Features

Study	Reference	Instructional Characteristics				Grades	N	Ability Level
		Language	Duration	- Instructional Group Size - Instructor	Isolated / Integrated Instruction			
1	Abbott and Berninger (1999)	English	Total time: 400 min. 16 25-min sessions 1 session per week	- Individual tutoring - Researcher instructor	Integrated	4, 5, 6, 7	20	LA
2	Arnback & Elbro (2000)	Danish	Total time: 540 min. 36 15-min sessions	- Small group (3-4) - Regular remedial teacher	Isolated	4,5	60	LA
3	Baumann et al. (2003)	English	Total time: 450 min. 30 45-min sessions	- Large group (classroom) - Regular classroom teacher	Integrated	5	157	UD
4	Baumann et al. (2002)	English	Total time: 600 min. 12 50-min sessions	- Large group (classroom) Researcher instructor	Integrated	5	88	UD
5	Berninger, et al. (2003)	English	Total time: 1680 min. (700 min. of morphology or orthographic instruction) 2-hour sessions on 14 consecutive weekdays	- Groups of 10 (with main teacher and 2 assistants) - Teachers trained by researchers	Integrated	4,5,6	20	LA

Table 3.1

Basic Study Features Continued…

Study	Reference	Instructional Characteristics				Grades	N	Ability Level
		Language	Duration	- Instructional Group Size - Instructor	Isolated / Integrated Instruction			
6	Berninger et al. (2008)	English	Total time: 1680 min. (840 min. of morphology or orthographic instruction) 14 2-hour sessions over 3 weeks	- Groups of 10 (with main teacher and 2 assistants) - Teachers trained by researchers	Integrated	4,5, 6, 7, 9	39	LA
7	Bowers & Kirby (2006)	English	Total time: 1000 min. 20 50-min lessons (3-4 sessions a week)	- Large group (classroom) Researcher instructor	Isolated	4,5	82 [a]	UD
8	Bowers & Kirby (in 2010)	English	Total time: 1000 min. 20 50-min lessons (3-4 sessions a week)	- Large group (classroom) Researcher instructor	Isolated	4,5	82[a]	UD
9	Henry (1989)	English	Total time: Group 1: 1000 min. Group 2: 2000 min 20 40-min sessions	- Large group (classroom) - Classroom Teacher	Integrated	3,4,5	443	UD
10	Hurry et al. (2005) Study 1	English	Total time: NR. 7 sessions 1 per week	- Large group (classroom) - Classroom Teacher	Isolated	3,4,5,6	686	UD

Table 3.1

Basic Study Features Continued…

Study	Reference	Instructional Characteristics				Grades	N	Ability Level
		Language	Duration	- Instructional Group Size - Instructor	Isolated / Integrated Instruction			
11	Hurry et al. (2005) Study 2	English	Total time: NR. 13 sessions 1 per week	- Large group (classroom) - Classroom Teacher	Isolated	4	68	UD
12	Kirk and Gillon (2009)	English	Total time: 870 (approx..); 1 individual and 1 group session per week; range of 16 to 20	Half individual and half small group sessions; researcher instructor	Integrated	4	68	UD
13	Lyster (1998)	Norwegian	Total time: 510 min. 30 min sessions 1 per week 17 sessions	NR	Isolated	pre school	225	UD
14	Lyster (2002)	Norwegian	Total time: 510 min. 30 min sessions 1 per week 17 sessions	NR	Isolated	pre school	225	UD
15	Nunes, et al. (2003)	English	Total time: 360 min. 12 30-min sessions over 12 weeks	- Small group (4-8) - Researcher Instructor	Isolated	3,4	457	UD
16	Parel (2006)	English	Total time: NR 8 classes over consecutive school days.	- Large group (classroom) - Instructor: NR	Isolated	3	77	UD
17	Robinson & Hesse (1981)	English	140 lessons over a full school year.	- Large group (classroom) - Instructor: NR	Isolated	7	172	LA & UD

Table 3.1

Basic Study Features Continued…

Study	Reference	Instructional Characteristics				Grades	N	Ability Level
		Language	Duration	- Instructional Group Size - Instructor	Isolated / Integrated Instruction			
18	Tomesen & Aarnoutse (1998)	Dutch	Total time: 540 min. 2 45-min sessions per week Over 6 weeks	- Group: NR - Researcher Instructor	Integrated	4	31	LA & UD
19	Tyler, et al. (2003) Study 1	English	Total time: 900 min. 2 sessions per week (1 30-min and 1 45-min) Over 12 weeks	- Small group (2 or 3) - Researcher Instructor	Alternative treatments: Isolated & Integrated	pre school	27	LA
20	Tyler, et al. (2003) Study 2	English	Total time: 1800 min. 2 sessions per week (1 30-min and 1 45-min) Over 24 weeks	- Small group (2 or 3) - Researcher Instructor	Integrated	pre school	27	LA
21	Vadasy et al. (2006)	English	Total time: 2400 min. 4 30-min sessions per week Over 20 weeks	- Small group - Community tutors (researcher trained)	Integrated	2	31	LA
22	Vadasy et al. (2006)	English	Total time: 2160 min. Schedule: NR	- Small group - Community tutors (researcher trained)	Integrated	2,3	21	LA

Note. LA = Less Able Students, UD = Undifferentiated Students. Studies 7 and 8 are based on the same intervention and sample. Studies 12 and 13 are based on the same intervention and sample. Study 12 reported on outcome measures at the end of Grade 1 of children taught before school entrance while Study 13 measured a sub group of those students in Grades 2 and 3. Study 11 was a sub-study (n=68) of participants in Study 10 (n=686). Studies 18 and 19 investigated students at two different times of an intervention. Studies 20 and 21 were from the same published article, but reported on separate interventions students.

Characteristics of Instruction

Table 3.2 provides descriptive information about the nature of the morphological instruction the studies in our sample used. The studies needed to show a substantial focus on a given aspect of instruction to be identified for that characteristic. Thus, the absence of a check should not be interpreted to indicate that a given item was omitted from the instruction completely, but rather that it was not a substantial focus of instruction for that study. For example, the instruction in all of the studies in our sample targeted affixes, but 8 of the 21 studies targeted bases or stems. The nature of affixes is that they attach to bases and stems, so studies which chose to focus on instruction about affixes (e.g., Baumann et al., 2003, 2002) also addressed bases during instruction, but our table reflects the fact that the main target of instruction for those studies was affixes.

The information in Table 3.2 is provided for descriptive purposes. We did not attempt to compare quantitatively the effectiveness of the various instructional characteristics, because they were not systematically varied and because characteristics may interact with each other in complex ways. We provide the descriptive information to clarify the nature of existing research, and as a guide for those designing future studies. Some instructional categories require further clarification. We distinguished between studies in which instruction merely drew attention to bases or stems, and those in which instruction targeted the meaning of bases or stems. Drawing attention to the meaning of a base or stem was often the focus of instruction that helped students identify the base or stem of words, but this was not always the case. For example, Robinson and Hesse (1981) used tasks that had students identify the base or stem in complex words, but their focus was spelling rather than meaning.

Table 3.2
Characteristics of Morphological Instruction

Study	Main outcome focus of instruction	Integrated morphology with other literacy instruction	Targeted affixes (prefixes and/or suffixes)	Targeted bases or stems	Targeted base or stem for word meaning	Targeted bound bases (eg. *rupt* for 'break')	Targeted compound words	Targeted word origin	Oral morphology only	Oral and written morphology	Targeted consistent spelling of morphemes despite phonological shifts	Targeted patterns of orthographic shifts in suffixing patterns	Explicit link of morphology and grammar	Morphological tasks					
														Morphological analysis	Morphological synthesis	Morphological recognition: sorting / selecting	Morphological production: cloze / analogy	Morphological analysis with morphological 'foils' (e.g. is there a re- prefix in renter?)	Morphological problem-solving
1 Abbot & Berninger (1999)	R / S	√	√	√	√	√		√		√				√					
2 Arnback & Elbro (2000)	R		√	√	√		√		√					√	√	√		√	
3 Baumann et al. (2003)	V	√	√							√				√		√			
4 Baumann et al. (2002)	V	√	√							√				√					
5 Berninger et al. (2008)	R / S	√	√	√	√					√		√		√	√		√		
6 Berninger, et al. (2003)	R / S	√	√	√	√					√				√	√	√		√	√
7 & 8 Bowers & Kirby (2006, 2010)	M		√	√	√	√	√			√	√	√		√	√	√		√	√
9 Henry (1989)	R / S	√	√	√	√	√	√	√		√		√		√	√	√			√
10 & 11 Hurry et al. (2005) Study 1 & 2	S		√	√	√					√		√	√	√	√		√		√
12 Kirk & Gillon (2009)	R/S	√	√	√	√					√	√	√	√	√	√	√			
13 & 14 Lyster (1998; 2003)	R / S		√				√			√			√	√	√[a]			√	
15 Nunes, et al. (2003)	R / S		√	√					√[b]	√[b]	√		√	√	√	√	√		√
16 Parel (2006)	V		√							√		√		√		√			
17 Robinson & Hesse (1981)	S		√	√						√		√		√	√				
18 Tomesen & Aarnoutse (1998)	V	√	√	√	√					√				√					√
19 Tyler et al. (2003) Study 1	OL	√	√						√					√			√		
20 Tyler et al. (2003) Study 2	OL	√	√						√					√			√		
21 Vasady et al. (2006) Study 1	R / S	√	√							√	√	√		√	√				
22 Vasady et al. (2006) Study 1	R / S	√	√							√	√	√		√	√				

Note. R = reading, S = Spelling, V = Vocabulary, M = Morphology, OL = Oral Language; [a]Morphological synthesis only conducted in the context of compounds. [b]Study included a condition with only oral morphological instruction, and another with written morphological instruction.

The heading "morphological tasks" in Table 3.2 identifies specific types of tasks in which participants engaged. All studies used morphological analysis tasks in which participants identified morphemes in morphologically complex words. Some studies also used morphological synthesis tasks in which students were given morphemes and asked to combine them to form words.

We use the term morphological recognition to describe tasks that had students find common morphemes that linked sets of two or more words. For example, Berninger et al. (2003) presented word pairs to students (e.g. *respectfully/respect* and *pillow/pill*) and asked them to identify which word "came from the other word". This task also provides an example of morphological analysis with morphological foils, as it requires a child to recognize when a letter or sound sequence that is common to two or more words does not mark a common morpheme (e.g., as is the case for *pill* and *pillow*).

Morphological production tasks asked students to generate derivations or inflections without providing the needed morpheme. For example, Nunes et al. (2003) used an analogy task (e.g., *sing* : *singer :: magic* : ?) which required students to produce a specific derivation of a word but did not provide the needed suffix.

The morphological problem-solving category attempts to indicate tasks that required students to engage in deeper level processing (Edwards, Font, Baumann, & Boland, 2004; Templeton, 2004). These tasks require students to apply knowledge in novel contexts, often with more than one possible route to a solution and involving the use of deductive or inductive reasoning. For example, Bowers and Kirby (2006, 2010) presented students with sets of morphologically related words with characteristics to help them deduce morphological suffixing pattern rules for dropping the silent *e*, doubling consonants and changing *y* to *i*.

Calculation, Reporting, and Interpretation of Effect Sizes

Outcomes were categorized by linguistic layer and by type of comparison group, producing eight distinct average effect sizes. The four linguistic layers are: (a) morphological sub-lexical, (b) non-morphological sub-lexical, (c) lexical, and (d) supra-lexical. The first comparison type was experimental morphology treatment (E) versus untrained comparison group (C) that received typical classroom instruction. The other comparison type was E versus a comparison group for which the researchers provided special alternative training (AT).

It is difficult to generalize about the ATs because they were different from each other, and need to be considered with respect to the linguistic level of the outcomes. Across the 22 studies, there were 22 non-morphological, sub-lexical outcomes for E vs. AT comparisons. In 16 of those 22 instances, the AT emphasized phonologically oriented instruction, for example in phonological awareness. Of the 75 lexical outcomes for E vs. AT comparisons, 31 involved ATs with a phonological focus, and 32 involved vocabulary instruction. There were 9 outcomes in the supra-lexical linguistic layer that used ATs. Five of these emphasized phonological instruction, 3 vocabulary instruction, and 1 study skills. In general, the ATs represented established intervention methods with a record of positive outcomes, rather than placebo-like attempts to control for instructional time and teacher attention that were not expected to produce positive results. Performing equivalently to these ATs would indicate that morphological instruction is as successful as other more established methods. Furthermore, it is important to acknowledge that almost all of the "control" groups received some form of regular classroom instruction during the times when the E children received morphological instruction; thus each C group is also an AT group to some extent, representing a standard practice comparison group. We would argue that the E vs. C comparisons represent the cleanest test of the effect of adding morphological

instruction to regular classroom instruction, whereas the E vs. AT comparisons test the effects of morphological instruction against those of other established experimental methods that may not be typical of regular classrooms.

Average effect sizes for these categories are reported in Table 3.3, as are the standard deviations of the effect sizes, the number of effects included in the average, the range of effect sizes, and the number of null effects that would be required to reduce the average effect to 0.2. Posttest means and standard deviations reported in the studies were used to calculate effect sizes with an effect size calculator (Coe, 2000)[3]. Random assignment was used with six of the samples investigated by 7 of the 22 studies (studies 1, 5, 6, 12, 13, 14, and 20 in Table 3.1). Where possible, effect sizes were calculated with adjusted posttest means that controlled statistically for group difference at pretest.[4]

Effects of Morphological Instruction

We begin addressing our first research question by reporting the overall average instructional effects by linguistic layer. Then we present the instructional effects within the literacy areas of reading, spelling, and vocabulary for the lexical layer.

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[3]For Nunes, Bryant, and Olsson (2003), standard deviations were calculated from standard error scores before calculating effect sizes. For Berninger et al. (2008), effect sizes were calculated from *F* values. No effect size calculations were conducted for the two studies from Tyler, Lewis, Haskill, and Tolbert (2003) because they reported means and standard deviations of percentage change in scores. Because they reported Cohen's *d* and significance values, those statistics were taken from their calculations. The two studies by Hurry et al. (2005) reported raw means, but they also reported effect sizes, based on regression calculations that accounted for pretest differences. Their reported effect sizes were used instead of calculating effects from raw means.

[4]A master results table, which includes (a) outcomes for each individual measure involved in the synthesis, (b) information about whether effect sizes were calculated on raw or adjusted means, and (c) what variables were controlled in the original studies, is available from the authors.

Overall effects by linguistic layer. Table 3.3 presents the overall average effect sizes due to morphological instruction for each linguistic category. For E vs C comparisons the strongest average instructional effects were for morphological sub-lexical outcomes, followed by lexical and then supra-lexical outcomes. The null-effects calculation reinforces the strength of the sub-lexical morphological and lexical effects. In E vs AT comparisons, the sub-lexical morphological effect remained substantial, but the others were much weaker. These findings are corroborated by null effects statistics.

Table 3.3

Overall Average Effect Sizes by Linguistic Categories and Comparison Group

	Linguistic Category of Outcome Variable							
	Sub-Lexical							
	Morphological		Non-Morphological		Lexical		Supra-Lexical	
Comparison Groups	E vs. C	E vs. AT	E vs. C	E vs. AT	E vs. C	E vs. AT	E vs. C	E vs. AT
Cohen's *d*	**0.65**	**0.51**	**0.34**	**0.08**	**0.41**	**0.12**	**0.28**	**-0.08**
SD	0.72	0.55	0.37	0.34	0.48	0.47	0.26	0.30
Number of effects	37	11	26	22	93	75	12	9
Range	-0.13, 3.56	-0.34, 1.55	-0.37, 1.22	-0.53, 0.97	-0.58, 1.88	-0.78, 1.59	-0.02, 0.97	-0.54, 0.39
Null effects	83.3	17.1	18.0	-	88.0	-	4.8	-

Note. E = Experimental group, C = Control group, AT = Alternative Treatment Group. Null effects indicates the number of effects with $d = 0.0$ required to reduce d to .20 (not calculated if d is already .20 or less).

Morphological sub-lexical outcomes showed the highest average effect size 0.65 (*SD* = 0.72). This average, drawn from 37 outcomes, is half-way between Cohen's (1988) benchmarks for a medium and large effects. The high *SD* reveals a wide variety of scores. For E vs AT, *d* is 0.51, still a medium effect size. A smaller effect (*d* = 0.34, *SD* = 0.37) was found for non-morphological sub-lexical measures in E vs. C comparisons (26 outcomes). The lexical category (E vs C) approached the medium benchmark with an average instructional effect of 0.41 (*SD* = 0.48) based on 93 outcome measures. The average instructional effect for the far transfer category of supra-lexical effects, based on 12 outcome measures, was small (0.28, *SD* = 0.26). The E vs AT *d*s for the last three linguistic levels were close to 0, indicating that morphological treatments were roughly equally in their effectiveness to the alternative treatments.

Reading, spelling, and vocabulary outcomes at the lexical layer. The overall effects at the lexical linguistic layer reported in Table 3.3 and addressed in the previous section reflect the combined average of effects across word reading, spelling, and vocabulary tasks. Table 3.4 pulls these effects apart to reveal effects on these different literacy outcomes.

Word reading tasks such as word identification, speed of real word reading, and orthographic tasks including real words (e.g., choosing the correct spelling of two phonologically plausible spellings such as *taik* and *take*) were considered lexical reading tasks. Results under the heading "Reading" in Table 3.4 show that lexical reading measures for E vs. C comparisons had a modest instructional effect (*d* = 0.41, *SD* = 0.45) and that the E vs. AT effect was close to 0. The average instructional effect for lexical spelling outcomes (*d* = 0.49, *SD* = 0.48) is approximately the same, and again the E vs. AT effect is close to 0. The instructional effects for vocabulary measures (*d* = 0.35, *SD* = 0.51) were slightly lower than those for the lexical reading and spelling outcomes, but the E vs AT effect was larger at *d* = .20. A substantial number of null

effects would be needed to reduce the moderate effects for E vs. C comparisons; the E vs. AT comparisons were already at the *d* = .20 level or lower.

Table 3.4

Average Instructional Effect Sizes by Comparison Group for Literacy Outcomes

	Literacy Outcome (Lexical Variables)					
	Reading		Spelling		Vocabulary	
Comparison Groups	E vs. C	E vs. AT	E vs. C	E vs. AT	E vs. C	E vs. AT
Cohen's *d*	**0.41**	**0.05**	**0.49**	**0.05**	**0.35**	**0.20**
SD	0.45	0.32	0.48	0.37	0.51	0.60
Number of effects	39	34	21	9	34	32
Range	-0.58, 1.88	-0.52, 0.76	-0.31, 1.88	-0.48, 0.78	-0.20, 1.76	-0.78, 1.59
Null effects	38.5	-	22.8	-	25.5	-

Note. See Table 3.3 for notes regarding abbreviations.

The Effects of Morphological Instruction for Undifferentiated and Less Able Children

Table 3.5 presents the results for undifferentiated and less able students according to the four linguistic levels. See Table 3.1 for the ability level coding for each study, and study reference numbers. Effect sizes for less able students were drawn from 11 studies (#s 1, 2, 5, 6, 12, 17, 18, 19, 20, 21, and 22). Effect sizes for "undifferentiated" samples were drawn from 13 studies (#s 3, 4, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17 and 18).

Results in Table 3.5 show that average effect sizes for every linguistic level and for both E vs C and E vs AT comparisons were higher for the less able readers than those found for undifferentiated students. For the comparison of E vs C, effects favoured the less able for morphological sub-lexical (0.99 versus 0.65), non-morphological sub-lexical (0.63 versus 0.27),

Table 3.5

Average Instructional Effect Sizes by Linguistic Category and Comparison Group for Less Able and Undifferentiated Students

	Linguistic Category of Outcome Variable							
	Sub-Lexical							
	Morphological		Non-Morphological		Lexical		Supra-Lexical	
Comparison Groups	E vs. C	E vs. AT	E vs. C	E vs. AT	E vs. C	E vs. AT	E vs. C	E vs. AT
A. Less Able Students								
Cohen's *d*	**0.99**	**1.25**	**0.63**	**0.25**	**0.57**	**0.24**	**0.67**	**0.39**
SD	0.87	0.27	0.54	0.51	0.54	0.48	0.56	0
Number of effects	9	3	5	7	24	15	6	1
Range	0.1, 2.38	1.06, 1.55	-0.04, 1.22	-0.53, 0.97	-0.58, 1.61	-0.52, 0.78	0.17, 1.71	0.39, 0.39
Null effects	35.5	15.7	10.7	1.8	36.1	3.0	14.1	1.0
B. Undifferentiated Students								
Cohen's *d*	**0.65**	**0.24**	**0.27**	**0.00**	**0.40**	**0.08**	**0.27**	**-0.15**
SD	0.77	0.31	0.29	0.20	0.50	0.46	0.29	0.23
Number of effects	30	8	21	15	72	60	9	8
Range	-0.13, 3.56	-0.34, 0.75	-0.37, 0.71	-0.40, 0.30	-0.31, 1.88	-0.78, 1.59	-0.02, 0.97	-0.54, 0.20
Null effects	67.5	1.6	7.4	-	72.0	-	3.2	-

Note. See Table 3.3 for abbreviations.

lexical (0.58 versus 0.40) and supra-lexical (0.67 versus 0.27). E vs AT effect sizes were in general smaller, but still favoured the less able participants. This consistent advantage for the less able students needs to be interpreted carefully. One important confound is that, except for the study by Robinson and Hesse (1981), all of the data for less able students were gathered from interventions that used small group or individual instruction. Of the 13 studies from which undifferentiated student data were drawn, 8 studies used whole class instruction. Thus, the increased average effects for the less able groups may be attributable, in whole or in part, to small group instruction.

The Effects of Morphological Instruction for Younger and Older Students

Six studies (#s 13, 14, 19, 20, 21, 22) from our sample of 22 interventions involved students from preschool to Grade 2. These six studies represent four sample populations. The 15 remaining studies involved students in Grades 3-8. Although our sample has fewer studies coded as "younger" than "older," we judged this distribution to be sufficient to shed light on our third research question, particularly given its theoretical importance.

Table 3.6 presents results by linguistic category for preschool – Grade 2 students compared to Grade 3–8 students. In the sub-lexical morphological category for E vs C comparisons, there were only 2 outcome measures for younger students compared to 35 for older students. Thus the advantage for younger students (d = 1.24, SD = 0.41 vs. d = 0.62, SD = 0.72) should be interpreted cautiously, though more than 10 null effects would be required to reduce this effect to .2. In the E vs AT comparison, the effect was similar for the younger children, but lower for the older ones. For non-morphological sub-lexical measures, younger students showed a medium effect of 0.49 compared to a small average effect of 0.24 for older students in the E vs C comparisons. The results were weakly reversed for the E vs AT comparisons. The lexical level

also showed an advantage for younger students (d = 0.57, SD = 0.48) compared to older (d = 0.37, SD = .48) in the E vs C comparisons, but not in the E vs AT comparisons.

Table 3.6

Average Instructional Effect Sizes by Linguistic Category and Comparison Group for Preschool to Grade 2 Versus Grade 3 to 8 students

	Linguistic Category of Outcome Variable							
	Sub-Lexical							
	Morphological		Non-Morphological		Lexical		Supra-Lexical	
Comparison Groups	E vs. C	E vs. AT	E vs. C	E vs. AT	E vs. C	E vs. AT	E vs. C	E vs. AT
A. Preschool – Grade 2								
Cohen's *d*	**1.24**	**1.25**	**0.49**	**-0.16**	**0.57**	**-0.07**	**0.27**	**-0.22**
SD	0.41	0.27	0.44	0.16	0.48	0.17	0.14	0.22
Number of effects	2	3	10	7	19	11	7	5
Range	0.95, 1.53	1.06, 1.55	-0.37, 1.22	-0.4, 0.03	-0.31, 1.88	-0.33, 0.23	0.09, 0.51	-0.54, 0.02
Null effects	10.4	15.7	14.5	-	35.2	-	2.45	-
B. Grade 3 – Grade 8								
Cohen's *d*	**0.62**	**0.24**	**0.24**	**0.20**	**0.37**	**0.15**	**0.29**	**0.08**
SD	0.72	0.31	0.28	0.35	0.48	0.49	0.40	0.29
Number of effects	35	8	16	15	74	64	5	4
Range	-0.13, 3.56	-0.34, 0.75	-0.11, 0.71	-0.53, 0.97	-0.58, 1.88	-0.78, 1.59	-0.02, 0.97	-0.28, 0.39
Null effects	73.5	1.6	3.2	-	55.2	-	2.25	-

Note. See Table 3.3 for abbreviations.

At the supra-lexical level there were fewer outcome measures for younger and older students. The two age groups had a similar small advantage in the E vs C comparisons (older: *d* = 0.29, SD = 0.40 vs. younger: *d* = 0.27, SD = 0.14), but very few null effects would be required to reduce this effect and this advantage disappeared in the E vs AT comparisons. Results in Table 3.6 indicate that in general the preschool to Grade 2 students gain as much or more than the older students across lexical categories in the E vs C comparisons. For the E vs AT comparisons, the younger students only have an advantage in the sub-lexical morphological outcomes.

The Effects of Integrated versus Isolated Morphological Instruction

The fourth research question concerned the dimension of *integrated* versus *isolated* morphological instruction. Integrated morphological interventions were those in which morphological instruction was integrated with other instruction, while isolated morphological interventions targeted only morphological content. Table 3.2 indicates how each study was coded on this dimension.

The results are presented in Table 3.7. With the exception of the E vs. C comparison for sub-lexical morphological outcomes, in which isolated instruction was more successful (0.67 versus 0.55), all of the comparisons favoured integrated instruction. The E vs. AT comparisons for morphological sub-lexical linguistic outcomes showed a strong effect for integrated instruction (*d* = 1.25) compared to a small effect (*d* = 0.24) for isolated instruction, though these effects were based, respectively, on only 3 and 8 outcomes.

Table 3.7

Average Instructional Effect Sizes by Linguistic Category and Comparison Groups for Integrated Morphological Instruction Versus Isolated Morphological Instruction

	Linguistic Category of Outcome Variable							
	Sub-Lexical							
	Morphological		Non-Morphological		Lexical		Supra-Lexical	
Comparison Groups	E vs. C	E vs. AT	E vs. C	E vs. AT	E vs. C	E vs. AT	E vs. C	E vs. AT
A. Integrated Instruction								
Cohen's *d*	**0.55**	**1.25**	**0.49**	**0.27**	**0.46**	**0.22**	**0.37**	**0.39**
SD	0.58	.27	0.38	0.53	0.45	0.52	0.21	-
Number of effects	5	3	12	7	31	28	2	1
Range	0.11, 1.53	1.06, 1.55	-0.01, 1.22	-0.53, 0.97	-0.58, 1.05	-0.52, 1.15	0.22, 0.51	0.39, 0.39
Null effects	8.75	15.7	17.4	2.45	31.2	2.8	1.7	.95
B. Isolated Instruction								
Cohen's *d*	**0.67**	**0.24**	**0.20**	**0.00**	**0.38**	**0.05**	**0.26**	**-0.15**
SD	0.74	0.31	0.31	0.20	0.50	0.44	0.28	0.23
Count	32	8	14	15	62	46	10	8
Range	-0.13, 3.56	-0.34, 0.75	-0.37, 0.85	-0.4, 0.30	-0.31, 1.88	-0.78, 1.59	-0.02, 0.97	-0.54, 0.2
Null effects	75.2	1.6	-	-	55.8	-	3.0	-

Note. See Table 3.3 for abbreviations.

Discussion

This systematic review investigated the effects of morphological instruction on literacy outcomes categorized into sub-lexical (morphological and non-morphological), lexical, and supra-lexical categories. We calculated the average effect sizes in these categories for (a) overall samples, (b) less able versus undifferentiated samples, (c) younger (preschool to Grade 2) versus older students (Grades 3-8), and (d) samples that received morphological instruction in isolation compared to morphological instruction integrated with other literacy instructional strategies. We considered two types of effects, those found comparing morphological instruction with a control group that received nothing other than regular classroom instruction, and those found comparing morphological instruction with some alternative treatment.

Before addressing the research questions, we can make two general observations about the corpus of studies that we located. First, although research on morphology and literacy is increasing, we were only able to locate a relatively small number of instructional studies (n = 22). Although this number is larger than that identified by Reed (2008), there is clearly need for more studies particularly across age and ability levels. Second, with respect to research design, there were a number of examples of random assignment of individuals to instructional conditions (Abbott & Berninger, 1999; Berninger et al., 2008; Berninger et al., 2003; Kirk & Gillon, 2009; Lyster, 1998, 2002; Tyler et al., 2003), though many of the other investigators did manage to randomly assign classes. Given that most studies saw morphological instruction as a part of regular classroom instruction and that the instruction usually took place over several weeks or more, the proportion of studies with random assignment of individuals seems reasonable. In future studies, more random assignment may be possible in small group instruction studies.

The Effects of Morphological Instruction

To summarize our findings, when we consider the results across all available studies (Table 3.3), it is clear that morphological instruction has its greatest effects at the sub-lexical morphological level. This indicates that morphological instruction was successful in improving morphological abilities, whether compared to Control or Alternative Treatments. The null effects necessary to reduce the *d* to 0.2 for morphological outcomes support this finding. At the other linguistic levels in the overall analysis, the effects ranged from small to moderate in the Experimental versus Control comparisons and they were negligible in the Experimental versus Alternative Treatment comparisons. There was a consistent moderate effect of morphological instruction in the Experimental versus Control comparisons. When effects were separated by ability and age of student and type of instruction (integrated vs isolated), more detail was revealed. Experimental versus Control effects were stronger for the younger students, but this was not true for the Experimental versus Alternative Treatment comparisons. There were stronger effects for the less able participants in both types of comparison, and also for those studies that integrated morphological instruction with other literacy instruction. The picture that emerges is that morphological instruction is particularly effective when integrated with other literacy instruction and aimed at less able and perhaps younger readers.

We need to consider why the effects were often (but not always) greater in the Experimental versus Control rather than the Experimental versus Alternative Treatment comparisons. There are basically two reasons for including alternative treatments in a research design, either (a) to control for extraneous effects (such as Hawthorn effects or instructor attention) that are not part of the phenomenon being investigated, or (b) to investigate the effects of an alternative treatment that is meaningfully designed to affect aspects of the outcomes. Most

of the comparisons that we categorized as Experimental versus Control did not involve true control groups in the classic sense. Instead of receiving nothing that the experimental group did not receive, these groups typically received more regular classroom instruction. As such, these groups may be considered as "alternative treatments" too. Most of the Alternative Treatments employed in these studies appear to have been designed to achieve the second objective; the majority addressed phonological processing or vocabulary. Phonologically-oriented instruction is well developed, widely regarded as a solid basis for learning to read words, and especially recommended for students with reading difficulties (National Reading Panel, 2000; Rayner, et al., 2001). Similar points could be made about vocabulary instruction (Biemiller & Boote, 2006; Beck, McKeown, & Kukan, 2002; Graves, 2004). Accordingly, it is not surprising that the Alternative Treatments in our sample provided effective instruction. That morphological instruction generally was as successful as these alternative treatments provides evidence that morphological instruction, a relatively new focus of instructional research, brings benefits comparable to those of instruction designed on the basis of extensive research. Our conclusion is that morphological instruction was effective at the morphological sub-lexical and lexical levels, but that beyond the sub-lexical morphological level it was often no more effective than other well-established instructional methods.

There was considerable variability associated with many of the effects, and in some cases relatively few null studies would be required to reduce the effects below the benchmark of .2. There were also instances of negative effects in some studies, and weak negative average effects, the latter being largely in Alternative Treatment comparisons at the supra-lexical linguistic layer (see Tables 3.3 to 3.6). This high variability suggests that some studies employed methods of instruction that were better than others. It will be an important task for future research to

determine which types of morphological instruction are most beneficial, and how these can best be combined with other forms of instruction (e.g., in phonology and vocabulary).

Understanding the Effects of Morphological Instruction

At the outset we hypothesized as to why, in theory, morphological instruction might bring additional benefits to literacy instruction. We argued that instruction about meaning bearing sub-lexical elements might produce word knowledge that could transfer up to lexical and supra-lexical skills. We found that instruction about sub-lexical morphological elements brought measurable literacy effects compared to controls, and those effect sizes reflected the level of transfer from instruction. Morphological instruction performed comparably to the alternative treatments at the higher linguistic levels. Morphological instruction was more effective for less able learners and when it was integrated with other aspects of literacy instruction; there was some evidence that it was more effective for younger learners.

One way of understanding these results is to conceptualize sub-lexical morphological knowledge as a mechanism for strengthening learners' lexical representations (Carlisle & Katz, 2006; Carlisle & Stone 2005). The lexical quality hypothesis (Perfetti & Hart, 2001, 2002; Perfetti, 2007) is one potentially fruitful framework through which to understand the effects of morphological instruction, as well as the association of untaught morphological knowledge and literacy skills (e.g. Carlisle, 2003; Deacon & Kirby, 2004). In describing the lexical quality hypothesis, Perfetti (2007) presented five features of lexical representation that determine lexical quality. The first four, orthography, phonology, grammar, and meaning, are constituents of word identity, and the fifth, constituent binding, "…is not independent but rather a consequence of the orthographic, phonological and semantic constituents becoming well specified in association with another constituent" (pp. 360-361). Knowledge of how oral and written morphology work

in a given language could be understood as a binding agent that pulls together these individual features of lexical representation to enhance lexical quality. The word "binding" is an appropriate way to describe how written morphological structure links families of words with consistent orthographic patterns. The letter-patterns for morphemes are associated with phonological representations and they can also provide grammatical cues. In fact, each of the features of lexical quality identified by Perfetti has direct associations with oral and written morphological elements. If sub-lexical morphological knowledge acts as a constituent binding feature of lexical quality, increasing that sub-lexical morphological knowledge though instruction should facilitate the efficient retrieval of word identities, which in turn should result in improved scores on lexical measures as we found in this review.

Perfetti (2007) also argued that lexical quality is important for reading comprehension (supra-lexical performance). He suggested that the source of the ability to efficiently retrieve the words needed during reading is the integrated orthographic, phonological, grammatical, and semantic word knowledge that reader has for a given word – the quality of that word's lexical representation. If morphological instruction increases lexical quality, those stronger mental representations could improve reading comprehension by (a) increasing efficiency of word identification, thereby reducing the cognitive load needed for processing and integrating connected text, and (b) providing the reader with easier access to semantic information associated with that word. The reading comprehension gains from morphological instruction should be less robust than the lexical gains, at least in the short term, but if morphological instruction does improve lexical quality, it should become apparent in reading comprehension measures, and that is what we found.

The instruction investigated in this review addresses aspects of word knowledge that bear directly on efficient processing of words and meanings during reading. Perfetti (2007, p. 359) stated, "Underlying efficient processes are knowledge components; knowledge about word forms (grammatical class, spellings and pronunciations) and meanings. Add effective practice (reading experience) of these knowledge components, and the result is efficiency: the rapid, low-resource retrieval of a word identity." The interventions reviewed in this study used instruction that explicitly targeted knowledge about oral and written morphological features of words. Morphemes are characterized by consistent spelling patterns, but are also associated with pronunciations, meanings, and they may also mark grammatical cues. Explicit morphological instruction offers teachers a way of directly targeting the development of lexical quality. Such cognitive processing itself may function to strengthen mental representations and decrease cognitive load (e.g., Schnotz & Kürschner, 2007; Sweller, 1988) in reading.

However, explicit morphological instruction is not required for morphological knowledge to develop and play a role in developing lexical quality. This is demonstrated in the correlational/predictive studies we reviewed briefly at the beginning of this paper (see, e.g., Carlisle, 2003, for a more extensive review). In the absence of explicit instruction in morphology, children develop considerable competence in it and this competence is related to success in literacy. There is also evidence that simple exposure to the consistent underlying structures that integrate morphological families improves the quality of our lexical representations. Nagy, Anderson, Schommer, Scott, and Stallman (1989) found that adults read words from larger morphological families more fluently than words from small families and cited this as evidence that words are processed through morphological relationships, not as separate entities (see Carlisle & Katz, 2006, for similar results with children). Citing the work of

Taft and colleagues with adult readers (e.g., Taft, 2003; Taft & Kougious, 2004; Taft & Zhu, 1995), Carlisle and Stone (2005) described the role of uninstructed experiences with morphology on lexical representations by concluding that "frequent encounters with a base word (by itself or combined with affixes in words) reinforce the mental representation of the morphemes in those words, and access to memory for the morphemes speeds identification of words containing those morphemes..." (p. 431).

Untaught morphological knowledge may also lie behind the relative weakness of the instructional effects beyond the sub-lexical level. Some children in the control or alternative treatment groups may have developed enough morphological knowledge to support their lexical and supra-lexical processing, so that they perform as well as children who received explicit morphological instruction at these levels. This may also be related to the stronger effects we found for less able readers (see next section). Morphological instruction that was sustained and integrated with other literacy instruction over an extensive period of time may show greater transfer.

Reading Ability Effects

In response to our second research question, we found that the effects of morphological instruction were stronger on average in groups of less able readers than in more broadly based samples. Reed (2008) came to the same conclusion from a smaller set of studies. We see four plausible explanations for this pattern. First, the more able readers may already have known at least implicitly some of the morphological content being taught, and so would not differ as much from the comparison groups as the poor readers, who initially were likely to know little of the content being taught. Less able readers may need more explicit instruction. Second, the studies involving less able learners generally used small groups rather than class-sized groups in their

instruction. Although smaller group sizes are representative of remedial instruction, it is possible that this approach would also have been more successful with the more able learners.

The third interpretation is that morphology is a cognitive domain that is a relative strength for less able readers. A common characteristic of struggling readers is weak phonological awareness (e.g., National Reading Panel, 2000). Casalis et al. (2004) suggested that dyslexics may use (untaught) morphological knowledge as a compensatory strategy and that introducing explicit morphological instruction could build on a relative strength for dyslexic learners; the same may be true for other less able readers. A phonological processing deficit may be less of a hindrance to developing higher quality lexical representations if explicit instruction in morphological structure builds up an integrated lexical representation of orthographic patterns and meaning cues to which phonological associations can be linked. Making the written morphological structures more salient could scaffold more effective use of phonological knowledge for less able readers. In effect, explicit instruction about sub-lexical morphological structures and how they link to orthographic, semantic, phonological, and grammatical cues may activate the constituent binding quality offered by morphology (see the earlier discussion of Perfetti's (2007) lexical quality hypothesis). Phonological processing deficits may be less of an impediment when students are explicitly shown how phonological structures link to linguistic structures for which these students have no processing deficit.

Findings from one intervention in our review illustrate how morphology might act as a binding agent of multiple features for less able readers. Arnbak and Elbro's (2000) intervention with Danish dyslexic students was restricted to oral instruction, and yet their strongest results were for measures of spelling, and this was despite the fact that the control groups had more practice with written words in their typical remedial instruction. They hypothesized that

awareness of morphemic units in words facilitated the segmenting of complex words into linguistic units they knew how to spell and that this process may have also eased the load on verbal working memory. Morphological instruction may have facilitated the ability to maintain meaningful units of words (morphemes) in working memory while spelling, which may be another consequence of increased binding.

The fourth explanation of why morphological instruction was more effective for less able readers is through providing increased motivation to work with words. A number of authors of the studies in this sample commented on the enthusiasm children showed during morphological instruction; increased motivation and improved literacy skills may support each other mutually (e.g, Berninger, et al., 2003; Bowers & Kirby, 2010; Tomesen & Aarnoutse, 1998). Without measures for motivation, however, this explanation remains speculative. The ability and motivation to explore language independently, word consciousness, is a frequently emphasized goal of vocabulary instruction (Graves 2006; Scott & Nagy, 2004; Stahl & Nagy, 2006). Less able readers are likely to have had more frustrating experiences in school trying to understand how written words work. Introducing morphology as an organized system which links words even when pronunciation shifts appear irregular (e.g., *heal/health, sign/signal*) may motivate struggling students to study words more closely. Studying morphological families of words also has the advantage of exposing struggling older students to advanced, complex vocabulary with the support of connected words they do know. For example studying the *sign* family can be used to introduce words such as *design, designate, insignia, significantly,* and *assignment*. Studying the structure and meaning connections in these words builds lexical representations in a way that does not require struggling readers to process long passages of text.

Further research will be required to select among these explanations for the greater effectiveness of morphological instruction with less able readers. It is also possible that more able readers would show increased benefit from morphological instruction if it were tailored to their strengths.

Grade Level Effects

The answer to our third research question was that morphological instruction was at least as effective for students in the early stages of formal literacy instruction as it was for students in later grades (see Table 3.6). These findings challenge the assertion by Adams (1990) that "teaching beginning or less skilled readers about them [roots and suffixes of morphologically complex words] may be a mistake" (p.152). Evidence that morphological instruction brings benefits to younger students, and that this instruction brings special benefits to less able students could have important practical implications. With a foundation of morphological knowledge gained with the support of instruction from the start, it is possible many students who fail in response to typical instruction could achieve much stronger success.

A striking example of the potential of early and sustained morphological instruction comes from Lyster's (1998, 2002) study with Norwegian children. She investigated the effects of morphological and phonological interventions compared to a control group with students prior to school entry. She found a very large effect of morphological instruction (d = 1.88) on a word reading measure 6 months after the intervention stopped. The phonological intervention group showed a gain of d = 0.82 on this same measure. Compared to controls, she also found a significant difference for the morphological group (effect sizes not provided) on an orthographic coding task in Grades 2 and 3. Although there were relatively few intervention studies with young children, the magnitude of the possible effects suggests that further studies be conducted.

Effects of Methods of Instruction

The fourth research question asked whether instruction that integrated morphology with other aspects of literacy instruction would differ in its effects from isolated instruction. For the majority of outcome comparisons, including those with alternative treatments, integrated instruction was more effective than isolated instruction, and in the other cases the effects were similar (see Table 3.7). Integrated instruction should facilitate construction of lexical representations in which phonological, orthographic, grammatical, and semantic information is linked to morphological information. By generating richer lexical representations, instruction that integrates morphological and other linguistic features should facilitate lexical access and thus enhance the binding role of morphology, more so than would be accomplished by isolated instruction.

Vocabulary is one of the most obvious other areas of literacy instruction to integrate with morphological instruction. Despite the importance of vocabulary instruction cited by National Reading Panel (2000), there is a growing recognition that vocabulary instruction has received insufficient attention in classroom instruction and literacy research (Beck, et al., 2002; Biemiller & Boote, 2006). Because morphemes, when encoded in print, are fundamentally orthographic representations of sub-lexical and lexical meaning units that occur in multiple words, written morphological instruction may provide a generative component within vocabulary instruction, supporting transfer to the learning of new words (Bowers & Kirby, 2010).

The final point to be made about methods of instruction concerns the problem solving approach adopted in four of the studies reviewed here (Baumann et al., 2003; Berninger et al., 2003; Bowers & Kirby, 2006, 2010; Tomesen & Aarnoutse, 1998). Each of these studies used the theme of "detectives" to frame their instruction, designed to enhance student motivation.

Although not one of our research questions, the inclusion of a problem solving approach may be a critical feature in obtaining transfer beyond the morphological sub-lexical level. Although there were not enough appropriate studies to assess this possibility quantitatively, the problem solving approach appears to be worth of further investigation. This instructional strategy may have its effect in part by increasing students' focus on the working of words while fostering the deeper processing associated with more effective long-term learning. Employing problem solving tasks about spelling/meaning connections (Templeton, 2004) should also develop the constituent binding feature in Perfetti's (2007) lexical quality hypothesis by targeting the juncture of semantics, orthography, and phonology during an engaging task.

Limitations, Future Directions, and Conclusions

Several limitations deserve noting. First, this review was limited by the number of studies available. If there had been more studies in the literature, further research questions could have been addressed, and the variability we observed in the effects may have been reduced. There is a need for more fine-grained studies of morphological instruction, to determine how to maximize its effects. We have presented a descriptive listing of the methods used in Table 3.2; these are some of the instructional parameters that could be varied in future studies. One question in particular that deserves further attention is the optimal ratio of relatively procedural tasks (i.e., relatively specific tasks that have been demonstrated in class, with single correct answers and obvious strategies) to more open-ended problem solving activities (those which require the students to go beyond tasks they have been shown, in which there may be multiple correct answers and various solution strategies). Another question lies in aptitude-treatment interactions, particularly given that particular instructional programs may suit some learners more than others. Second, we were not able to make cross-linguistic comparisons due to the relatively small

number of studies in orthographies other than English. As more morphological interventions are conducted, it may be fruitful to investigate the effect of morphological instruction in different languages. It may be useful to compare the effects of morphological instruction in languages whose scripts differ in phonological transparency. Third, the decision to exclude research in non-alphabetic languages means that our review does not include morphological research in other writing systems. This is a particularly interesting question for future research, given the suggestion of the importance of morphological processing in morphosyllabic writing systems (e.g., McBride-Chang et al., 2005). Future research on the effectiveness of morphological interventions in non-alphabetic languages could be conducted and compared to see if the effects follow a similar or different pattern than we found here.

A third limitation is that most studies worked with whole classes; where there were small groups taught, these were usually within the context of remedial instruction. This difference in purpose, regular versus remedial instruction, tended to confound learner ability with group size, necessitating caution in drawing conclusions about ability effects. More studies that vary ability and group size independently are needed.

Overall, we found that morphological instruction made a positive contribution to literacy outcomes, but there are several caveats that need to be attached to this conclusion. First, as we detailed in our analyses, the effects were stronger for less able readers and for those who received integrated instruction; there was a tendency for studies with younger children to be more powerful, but there were not enough studies to state this with confidence. Second, there was only limited evidence of transfer to the lexical and supra-lexical levels. It is plausible that this is due in part to the relatively undeveloped state of morphological instructional methods and how unfamiliar morphological knowledge is for most children. Our evidence indicates that

instruction is more effective when it is integrated with other aspects of literacy instruction; we suggest that morphological instruction needs to be embedded in the curriculum in a sustained manner, rather than being added as a temporary patch. We also suggest that integration of problem solving techniques may contribute to transfer of morphological knowledge. Finally, we suggest that morphological instruction has more potential than has yet been realized. We look forward to new attempts to refine this promising instructional method.

CHAPTER 4: GENERAL DISCUSSION

The two studies reported here built on the straightforward assertion that understanding how one's writing system works should facilitate literacy learning (Rayner et al., 2001). The review of the literature in Chapter 1 showed that, although morphology is a foundational feature of oral and written words, it has received little attention in typical instruction (Carlisle, 2003; Henry, 2003/2010; Moats, 2009; Nunes & Bryant, 2006). Further, it was shown that morphology has been either ignored or received very little attention by influential reviews of educational research (Adams, 1990; Fuchs & Fuchs, 2006; Snow & Juel, 2005; Snow, et al., 1998; National Reading Panel, 2000; Rayner et al., 2001; Torgesen, 2005). Thus, it was argued that literacy instruction could be made to represent how the writing system works more accurately by introducing a focus on the role of morphology. The two studies presented here tested the hypothesis that bringing instruction more into alignment with the conventions of the written word through explicit morphological instruction would bring literacy benefits.

This general discussion begins with a short summary of each of the two studies. Those summaries are followed by analysis of the theoretical implications and practical applications of the findings of the studies in light of the research on literacy learning and instruction. Suggestions for further research are embedded throughout the discussion where relevant, and also in the section on limitations and needed research.

The discussion of the results starts by considering the results of morphological instruction through the wider frame of sub-lexical versus lexical level instruction. Next, possible explanations for the finding in Study 2 that less-able students benefited more from morphological instruction are discussed. That is followed by a section further investigating the results of the two studies through the frame of Perfetti's (2007) lexical quality hypothesis. A

section on practical implications of the findings in the two studies is followed by the final section on limitations and suggestions for further research.

Study 1 was an intervention in Grade 4 and 5 classrooms targeting vocabulary learning through explicit morphological instruction. It made use of the lexical word sum and the morphological matrix as well as a scientific problem-solving orientation described as structured word inquiry. This approach aimed to reveal how the interrelation of structure and meaning of morphological families is marked by consistent English spelling conventions. The instruction targeted the fact that words of an orthographic morphological family are related in meaning, and that the consistent spelling of the underlying base -- despite shifts in pronunciation of that base -- marks that meaning connection for the reader. Results showed that through a 20-session intervention, the experimental group was better at defining words to which they were exposed and to novel words that shared a base with one of those words. The instructional effect did not extend to words with untaught bases. Regression analysis predicting a vocabulary task score suggested that explicit morphological instruction about written morphology allowed children to make better use of their pre-test vocabulary.

Study 2 was a quantitative synthesis of 22 morphological interventions using the principles of systematic review. Results showed that morphological instruction generally matched the effects of alternative treatments that were mostly based on long-established "best-practice" approaches including phonologically based instruction and explicit vocabulary instruction. Morphological interventions brought greater literacy benefits compared to typical instruction, but especially to less able and younger students. In general, morphological instruction was more effective when it was integrated with instruction of other established features of literacy instruction. Thus findings from both studies supported the hypothesis that

including morphology in instruction is effective right from the start of formal schooling, particularly for less able students. The finding that less able students gained more from morphological instruction than undifferentiated samples supports the suggestion from predictive literature that morphology knowledge may provide a compensatory strategy for those with phonological deficits (e.g., Casalis, et al., 2004; Elbro & Arnbak, 1996). These findings contradict untested recommendations from the literature that suggested that morphology not be taught until about third or fourth grade (Henry, 2002/2010) or not even until upper elementary grades (Adams, 1990).

Further research on morphological interventions has been published after the inclusion criteria used for Study 2. A meta-analysis of studies with experimental and control groups focusing on the effect of morphological interventions with dyslexic students (Goodwin & Ahn, 2010) and an integrative review by Carlisle (2010) found that morphological instruction benefits children's literacy learning, particularly for less able children and for children in the youngest grades, corroborating the findings of the studies presented here. In addition, searches for the keyword terms *morph*, intervention, and teach** on two research data bases (EBSCO Research Complete, and PsycINFO) from 2009 to November 5, 2012 yielded 5 morphological intervention studies (Kieffer & Lesaux, 2012; Leseaux, Kieffer, Faller, & Kelley, 2010; Tsesmeli & Seymour 2009; Weiss, Grabner, Kargl , Purgstaller, & Fink, 2012; Wood, Mustain, & Cooke 2012). These studies found gains in morphological awareness (Kiefer & Lesaux, 2012), spelling (Tsesmeli & Seymour, 2009; Weiss et al., 2010), vocabulary (Wood, et al. 2012; Leseaux et al., 2010), and word reading (Weiss et al., 2010). In line with the results in Study 2, those studies that compared effects for less able and undifferentiated readers (Tsesmeli & Seymour, 2009; Kiefer & Lesaux, 2012; Leseaux et al., 2010) found particular benefits for less able students. The one study

(Wood, Mustain, Cooke 2012) that only looked at dyslexic students, (one group in a whole word vocabulary treatment and another in a morphologically based vocabulary treatment) found benefits for the morphology treatment. The one finding that appears to counter the results of Study 2 was from the study of Weiss et al. (2010). They found benefits in morphological awareness for all students (Grades 3-9) but only in Grades 5-9 were significant gains in reading and spelling achieved. This counters the finding in Study 2 that younger students gained as much or more from morphological instruction than older students. At least two factors should be kept in mind in interpreting this result. First, this was the only study with a German speaking population. (The other four new studies were all in English.) As an orthographically shallow language with a particularly consistent sound symbol correspondence (Bosman, et al., 2006), German does not have the same morphophonemic characteristic as English, which may mean that morphological instruction differs in its effect. Second, much of the intervention was conducted by children independently via a computer program. This method may differ in effectiveness for older and younger students.

Taken together, the results from Study 2 and the evidence from morphological interventions published after that study converge on the finding that morphological instruction brings literacy benefits to students of a wide variety of ages and abilities. Given that these results have been found in what are the initial attempts at morphological instruction, there is good reason for optimism that with continued refinement of the methods and content of morphological instruction by teachers, and in scientific studies, the effectiveness of this instruction can be increased over time.

Theoretical Implications and Applications

Sub-lexical versus lexical level instruction. One way to view these findings of positive effects of morphological instruction is as a continuation of the trajectory of educational research that has been amassed over the last several decades. That evidence showed that explicit instruction focussed on one type of sub-lexical feature of words (phonologically based features) was more effective than instruction that focussed on whole words. On that basis, research has long made the case that understanding the writing system was important for literacy learners (Adams, 1990; National Reading Panel, 2000; Rayner et al., 2001). However, that argument in these influential reviews did not include a focus on morphological instruction. The National Reading Panel (2000) made no reference to morphology. Adams (1990) argued that "teaching older readers about the roots and suffixes of morphologically complex words may be a worthwhile challenge, teaching beginning or less skilled readers about them may be a mistake" (Adams, 1990, p. 152). Rayner et al., 2001 described the central role of morphology in English orthography, but only the teaching of phonologically based sub-lexical features was emphasized; lexical and sub-lexical morphological features were not included in their instructional recommendations.

Similarly, Snow and Juel (2005) placed an instructional emphasis on sub-lexical phonological features of words, but ignored sub-lexical morphological instruction. Citing Harm, McCandliss, and Seidenberg (2003), Snow and Juel (2005) argued that each time the learner avoids "scrutinizing the internal structure of a printed word in favour of using contextual cues or illustrations to identify the word, the child loses an opportunity to imprint the orthography" (p. 516). For Snow and Juel (2005), however, the "internal structure of the printed word" to which

learners should attend was limited to grapheme-phoneme correspondences. Neither Harm et al. (2003) nor Snow and Juel (2005) made any reference to morphology.

Additional means of helping students to scrutinize the internal structure of words were illustrated by instruction in Study 1 which used linguistically structured tools like the matrix and word sum, and conventions for spelling-out and simultaneously writing-out the morphemic and graphemic structures of words. Consider the example given in Study 1 for spelling-out the word sum for the complex word *pleasure* <please/ + ure → pleasure>: *''p--l--ea--s--e--plus-ure is rewritten as p--l--ea--s--no e----ure."* (The number of dashes signals the length of pause between letter names.) This example illustrates how these conventions for spelling-out word structure map directly onto the sub-lexical morphemic *and* graphemic structures of complex words and the suffixing processes for word formation. In the base, letters of single-letter graphemes are announced and written singly and the letters of the *ea* digraph are announced and written together, reflecting the graphemic structure. The suffixing change forced by the vowel suffix is signalled by stating "*no e*" before pausing and spelling out the *–ure* suffix. The long pause between the base and suffix signals the morphological structure of the word. Announcing and writing the *-ure* quickly mark this affix as a morphemic unit. Regular practice using these conventions for spelling-out and writing-out word structure was intended to guide learners to explicitly process the constituent morphemic and graphemic internal structures of *any* complex word. These practices draw on recommendations of cognitive load theory (Schnotz & Kürschner, 2007) by using multiple memory routes to build well integrated mental representations of schemas -- effectively to build the "imprinted orthography" sought by Snow and Juel (2005).

Note that the word sum, the matrix and the practice of spelling-out and writing-out word structures employed in the intervention of Study 1 are not tools that targeted morphology at the

expense of phonology. Because those written morphemes often include varied pronunciations, these tools highlight not only how the writing system marks morphology, they also reveal the fundamental convention about how morphology and phonology map onto orthography. For the child who knows how to pronounce the words *heal* and *health,* spelling-out and writing-out the word sum *heal* + *th* → *health* highlights the fact that the base *heal* varies in pronunciation. Spelling out the graphemic structure of that base "*h--ea--l*" signals the *ea* vowel digraph that is associated with the vowel phoneme shift. This practice guides the learner to scrutinize morphemic and graphemic structure which can then be linked to phonological and semantic knowledge of the words *heal* and *health.* Such a process could trigger attention to (a) the meaning connection between these words (hindering possible confusion with the homophone *heel*) and (b) the fact that *ea* is a digraph that can be pronounced as a "long e" or a "short e."

The spelling-out and writing-out of word structure described above has important parallels to Share's (1995) self-teaching hypothesis. Like Snow and Juel (2005), Share drew on the idea of scrutinizing of internal word structure when he argued that the act of decoding unfamiliar printed words leads to acquiring orthographic representations. More recently Share (2011) described spelling as another likely candidate for a self-teaching mechanism in part because of the added demands spelling places on retrieval and motor memory. Snow and Juel (2005) emphasized decoding as a means for scrutinizing text in order to imprint the orthography in learners' minds, but spelling-out and writing-out forces a deeper level of processing of text structures, and thus should be a better means of achieving their stated goal.

Shahar-Yames and Share (2008) found evidence supporting the hypothesis of spelling as a self-teaching mechanism in their study of third grade Hebrew-speaking children. They found greater orthographic learning of pseudowords from spelling/reading practice than reading

practice which equated the number of exposures to target pseudowords. Perhaps it is not surprising that spelling practice resulted in better performance on spelling tasks than reading practice. Nevertheless, given this finding with pseudowords, it is reasonable to hypothesize that even higher quality lexical representations would result if instruction were designed such that the motor memory of letter formation and simultaneous spelling out-loud was tied directly to the sub-lexical graphemic and morphemic structures of real words as was the case in Study 1. In order to test this hypothesis, a study carefully manipulating these conditions is required.

Lexical level instruction of spelling combined with writing the graphemes has been shown to be of particular benefit. Cunningham and Stanovich (1990) provided further insights into the effect of the mode of spelling instruction by comparing the effect of three types of spelling practice on spelling performance in Grade 1 students in two related studies. Children practiced the spelling of real words either by handwriting, typing on a keyboard, or with tile letters. Handwriting practice was superior to the other conditions in their first study (assessed in a task using handwriting). Their second study used the same training, but assessed spelling learning via typing on a keyboard. Even in this more stringent test, handwriting practice resulted in better spelling learning. They did not find an advantage for a condition with simultaneous spelling out-loud and writing-out of words. Cunningham and Stanovich (1990) noted that their results confirmed those of Hulme and Bradley (1984) who found that practicing spelling in handwriting was superior than using letters on cards for normally achieving students. Unlike Cunningham and Stanovich, however, Hulme and Bradley also studied older children described as reading-disabled. For the underachieving students, but not for the normally achieving students, Hulme and Bradley (1984) found that spelling out-loud simultaneously while writing-out the words added a significant effect.

A key point about the instructional practice studied by Cunningham and Stanovich (1990) and Hulme and Bradley (1984) is that they targeted the development of *lexical level* spelling representations in contrast to the instruction used in Study 1 that targeted *sub-lexical* representations. Research is needed to determine whether this difference in the lexical level targeted brings different effects. The finding in Study 1 that this instructional approach resulted in vocabulary learning for untaught words that shared a base with taught words suggests the need to research whether this sub-lexical innovation provides benefits to literacy in addition to the gains found by Cunningham and Stanovich (1990) and Hulme and Bradley (1984).

Research is converging on ways to develop orthographic representations. In suggesting ways to expand the self-teaching hypothesis further, Share (2011) pointed out that to date the self-teaching mechanism has not yet been broadened to morphology. "More general insights into orthographic conventions concerning grammatical and derivational (typically bound) morphemes… [are] another critical dimension of orthographic learning" (2011, p. 64). Snow and Juel (2005) argued that the learner gains by imprinting the orthography via scrutinizing the internal phonological sub-lexical structure of words. The evidence from Studies 1 and 2 showed that instructional practices which guide learners to also attend to the lexical and sub-lexical morphological structure of words are worthy of further careful research. The research by Cunningham and Stanovich (1990) and Hulme and Bradley (1984) suggests that linking handwriting to the process of spelling affects orthographic learning for normally achieving students, and that for less-able students adding the mode of spelling-out provided additional benefits for orthographic memory.

This integration of multiple memory routes follows the recommendations of cognitive load theory as described by Schnotz & Kürschner (2007) and the long-standing focus on

multisensory based instruction that has long been the hallmark of Orton-Gillingham-based instruction (Birsh 2011; Henry, 2003/2010). The instructional strategies for spelling-out and writing-out word sums used in Study 1 combines the recommendations of this research and adds attention to lexical and sub-lexical morphological structure. The integration of these recommendations from research for instructional practice targets the development of what cognitive load theory describes as well-integrated mental representation of schemas in long term memory (Sweller, 1998: Sweller, et al., 1998; Schnotz & Kürschner, 2007). In this case, schemas represent linguistic structures that integrate the semantic, orthographic, and phonological aspects of words, which in turn determine lexical quality (Perfetti, 2007), and thus the efficient access to lexical items during literacy tasks. Study 1, however, did not manipulate these elements of instruction such that any conclusions can be drawn regarding which instructional components or combination of components are particularly effective for which group of students. The positive effects for vocabulary in Study 1, for experimental measures of reading and spelling from Bowers (2006), and the general positive effects found in Study 2 provide evidence that these are questions warranting further study.

Possible explanations for special benefits for less able readers. The discussion of Chapter 3 presented four plausible explanations for the finding that less able students gained more than typical students from sub-lexical morphological instruction. I revisit and expand on two of those explanations which have more direct instructional implications in this general discussion. Some of those implications are discussed in relation to the instructional tools of the word sum and the matrix that featured in Study 1.

One interpretation addressed in Chapter 3 is that morphology may provide a compensatory strategy for less able readers (e.g., Arnbak & Elbro, 2000; Casalis et al., 2004;

Elbro & Arnback, 1996; Perfetti, 2011). Deficits in phonological processing and the ability to make grapheme-phoneme mappings are hallmarks of dyslexic learners (Bowey, 2005; Snowling, 2000; Torgesen, et. al. 1999). Perfetti (2011) cited evidence from Carlisle and Stone (2005) and Elbro and Arnbak, 1996) in suggesting that morphology may provide younger and less able readers "a reading procedure to compensate for less-developed lexical and grapheme-phoneme strategies, which should be indifferent to the morphemic structure" (Perfetti, 2011, p. 158).

Unlike instruction that is mainly phonologically-based, instruction which addresses how the written word links phonology *and* morphology to word meanings provides learners with a point of triangulation for making sense of written words that does not specifically target the core deficit associated with dyslexia. Compared to typical learners, dyslexics may gain a greater benefit from instruction that explains the morphological basis for spellings that have grapheme-phoneme correspondences that are surprising without morphological information. For example, phonics-based instruction typically describes *does, done,* and *gone* as having unpredictable letter-sound correspondences. However, these words can be used as examples of how English spelling uses consistent spelling of morphemes despite pronunciation shifts (see Figure 4.1). Highlighting the spelling-meaning connections in such word families may alleviate spelling and reading difficulties associated with shift words in which the phonology of the base is not transparent (Carlisle, 2003). In line with the findings for less-able students in Study 2, such a benefit may be greatest for those with the literacy learning difficulties associated with dyslexia.

Motivation was another explanation presented in study 2 for the larger effects less able students gained from morphological instruction. The additional clarity morphological instruction

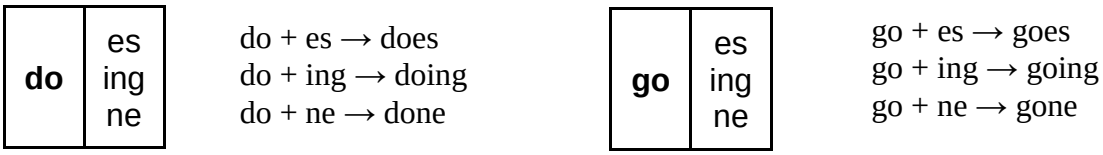

Figure 4.1. These matrices and word sums can be used to teach children that*, in coherence with the conventions of English orthography*, bases with consistent spelling can have varied pronunciations. The base pronounced /du:/ (in the words *do* and *doing*) and /dʌ/ (in *does* and *done*) is consistently spelled <do>. Similarly, <go> is the consistent spelling of the base pronounced /ɡoʊ/ (in the words *go, goes,* and *going*) and / ɡɔn/ (in *gone*). A video of a classroom lesson on this content can be viewed at this URL: http://youtu.be/ghhJfUbIp70.

can bring to the written word may have a corresponding motivational effect for study of the written word. As Treiman and Kessler (2005) argued, "Teachers who consider English a chaotic and unprincipled writing system likely foster a similar view among their students. Such pupils may not be motivated to look for patterns in the system because they believe that few exist to be discovered. Teachers who appreciate the writing system can help students find its patterns, fostering a positive attitude about spelling" (p. 133). This dynamic may have a more significant effect for less able students who are likely to suffer greater frustration by confusing letter-sound correspondences. In a morphophonemic language like English, it is difficult to imagine how teachers can *avoid* fostering the sense that English spelling is chaotic and unprincipled unless their teacher training and resources explicitly explain the role of morphology in spelling from the start of schooling. Currently there is little evidence of such instruction in schools. For example, in a study about teacher knowledge of oral and written word structure, Roehrig, Duggar, Moats, Glover, and Mincey (2008) studied 139 primary grade teachers. Despite the fact that these were teachers from schools in which DIBELS assessment (Good & Kaminski, 2005) had been mandatory for at least 1 year, their sample showed disappointing levels of word knowledge overall. However, describing the results of that study (Moats, 2009) noted that "The greatest knowledge gaps occurred on all questions having to do with knowledge of morphology" (Moats, 2009, p. 391). Clearly, if teachers know little about morphology then they are unable to help students use morphology to help motivate students to use morphology to make sense of letter-sound correspondences. This lack of teacher knowledge may be particularly problematic for less able students who, according to the results of Study 2, have the most to gain from this instruction.

Given the scarcity of explicit morphological instruction in schools, it is likely that the morphological instruction in the interventions analysed in Study 2 represented the first opportunity most students had to gain from instruction which explicitly targeted morphological cues. Less able students likely began these interventions with a larger bank of "confusing words" (words of poor lexical quality) than more able students. If so, the introduction of morphological instruction had the potential to bring clarity to more words for less-able students than for more able students. For the less able reader, a new way of making sense of the spelling of words previously treated as irregular could have had a significant effect on not only their knowledge of written words, but on their motivation to look inside words for patterns and clues.

Lexical quality hypothesis. One way of understanding the results of morphological instruction is through the lens of Perfetti's (2007) lexical quality hypothesis. According to Perfetti, the richer the quality of any of several word features and the more closely those features are bound together, the more easily words are retrieved. Efficient word retrieval during reading reduces the load on working memory and thus supports reading comprehension. Consistent with this view, morphological instruction facilitated access to word meanings, even for untaught words related to taught bases (Study 1) and it showed positive effects for lexical and supra-lexical outcomes (Study 2). If lexical or supra-lexical outcomes had not been affected, the hypothesis that morphological knowledge influences lexical quality would be weakened.

More recently Perfetti (2011) emphasized the role of morphology in the lexical quality hypothesis noting that morpheme knowledge is decomposable into spelling, pronunciation, and meaning. One interpretation of the results of Study 1 is that the morphological instruction had the effect of developing and binding the lexical features of words and word families at *the sub-lexical level*. The organization of orthographic morphological families is at the sub-lexical level

as illustrated by the word matrix and Carol Chomsky's (1970) concept of lexical spelling. If morphological sub-lexical instruction develops orthographic, phonological and semantic representations for sub-lexical morphemic elements, this could have the effect of organizing the learner's lexicon according to the way morphological families are structured. This increased lexical quality at the sub-lexical level may be a means by which learners could develop better access to meaning cues within words that they were not explicitly taught, but for which explicit instruction resulted in better lexical quality for some of the constituent morphemes. As Perfetti (2011) argued, "In the case of a morphemically complex word, knowledge of a constituent morpheme may exceed knowledge at the word-as-a-whole level. Thus a reader with generally low lexical quality may sometimes rely on morpheme knowledge to make up for weaknesses in other aspects of lexical knowledge" (Perfetti, 2011, p. 158).

To investigate the hypothesis that sub-lexical morphological instruction provides a constituent binding function according to Perfetti's (2007) lexical quality hypothesis requires fine grained measures of lexical access. One possibility for such research may be found via studies using a priming methodology to study the on-line processing of written single words. Morphological priming effects for adults have long been established (Frost, Grainger, & Rastle, 2005). Researchers have also found morphological priming effects in elementary students (e.g., Deacon, et al., 2010; Giraudo, 1999; Feldman, Rueckl, et al., 2002; Rabin & Deacon, 2008). Intervention studies could be designed with pre- and post-test morphological priming tasks in an attempt to discern whether explicit morphological instruction has a detectible effect on the internal organization of the lexicon. Such studies could be designed to control for non-morphological orthographic patterns. Study 1 and 2 are unable to determine how much the instruction about orthographic morphology brings its effect through attention to orthographic

morphological structure, and how much of that effect is simply the result of attention to orthographic "chunks" of any kind. Morphological priming studies like that of Rabin and Deacon (2008) which carefully contrast morphological (e.g. *add-adding*) and non-morphological orthographic chunks (e.g., *addition-address*) offer researchers a means to address this important question that was not resolved by Studies 1 and 2.

Exposure to oral and/or written stimuli is necessary for the development of the mental morphological representations that have been demonstrated through priming studies with adults and children. The frequency of exposure to words which provide sufficient co-occurrences of morphological word forms (phonological and/or orthographic) and meanings is critical to the development of high quality lexical (and sub-lexcial) representations in memory (e.g., Perfetti, 2007; Rastle & Davis, 2007; Reichle and Perfetti, 2003; Schreuder & Baayen, 1995). Relying on frequency of exposure to morphologically complex words as the means of developing high quality morphological representations, however, is a poor instructional strategy that invites a Matthew effect. Able readers and those with socio-economic advantages, with the attendant greater access to books and rich language, will be exposed to more oral and written words than their disadvantaged peers (Hart & Risley, 1995). Instead of relying on exposure to polymorphemic words, instruction could be designed to alter the *quality* of the exposure to these sub-lexical features of words as a means to build morphological representations. Perhaps such morphological instruction could help disadvantaged students reach a threshold of lexical representations that facilitates a virtuous cycle of reading success. Intervention studies which controlled the number of exposures to morphological representations, but varied how those exposures were presented (e.g., with and without word sums) to different groups (more able and less able readers) could help researchers calibrate morphological instruction according to meet

students needs.

Practical Implications

Practical implications from the studies presented here have been discussed at some length in both studies and will only be reiterated and expanded upon briefly here. The finding of generative vocabulary learning via morphological instruction in Study 1 suggested that the structured word inquiry approach to the investigation of members of morphological word families offers important advantages. It is a way to meet the recommendations of both the "deep and rich" instruction recommended by Beck, et al. (2002) and the "shallow and wide" instruction recommended by Biemiller and Boote (2006). This first use of lexical word sums and the morphological matrix to investigate the interrelation of structure and meaning of orthographic morphological families in an intervention study demonstrates that these instructional tools can be used in effective morphological instruction. Although these tools have been used by a growing number of educators with children as young as Grade 1 and with dyslexic students in tutoring situations (see www.wordworkskingston.com, www.realspellers.org, http://blogs.zis.ch/dallen/, http://wordsavviness.wordpress.com), research is needed to test the most effective use of these tools in groups of varying ages and abilities.

Perhaps the most important practical implication comes from Study 2, in which it was found that morphological instruction is effective from the beginning of schooling, and that it is especially beneficial for less able students. The heated debate between whole language and systematic phonics instruction (discussed in Chapter 1) resulted in a focus on phonological sub-lexical features of words and lack of attention to morphology. When morphology was addressed in past research it was argued that because the role of phonology is so important, morphology should not be taught until upper elementary if at all (e.g., Adams, 1990). Evidence contradicting

that assumption from research using principles of systematic review should encourage researchers and teachers to experiment with morphological instruction with young and less able students. We know that early intervention with phonologically based sub-lexical features of words is important for literacy success (National Reading Panel, 2000); in a morphophonemic system like English, there is good reason to believe that early instruction of how morphology and phonology work could be similarly important.

These results also have immediate implications for the influential response to intervention (RTI) research and related curricular resources. A central premise of RTI is that the classroom is the first level of intervention, and that it is crucial that children receive the best possible research-based instruction in this setting before identifying those who have difficulties requiring small group instruction in the second tier. Despite the growing research evidence regarding the role of morphology and morphological instruction for literacy learning, this aspect of the language does not feature in RTI research (e.g., Fuchs & Fuchs, 2006; Al Otaiba & Fuchs, 2006; Spear-Swerling & Cheesman, 2012) or in RTI curricular resources for teachers (e.g., Bender & Waller, 2011; Hall, 2008). The evidence reported here makes it clear that RTI research needs to take a close look at morphology instruction in all three tiers of instruction.

Limitations and Needed Research

The main limitation to the research presented in this dissertation relates to the ability to make recommendations about how best to teach about morphology in general, and how that instruction can be best adapted to meet the needs of learners of different ages and abilities. Study 2 described the range of morphological content and instructional approaches that have been used in intervention studies, but provides no means of comparing which are more successful. Study 1 emphasized the use of the word sums and the matrix, but without manipulating the use of these

tools across different experimental groups, no evidence-based conclusions about whether these tools are more effective than other approaches, or how best to use them, can be drawn. Having established that morphology instruction is effective for a wide range of ages and abilities, researchers should now begin the more targeted work of how best to implement this instruction and how best to integrate it with other aspects of literacy instruction.

Neither the existing research, nor the two studies reported here are able to clarify *how* the morphological instruction brings its effect with any specificity. For example, the two studies here are not able to determine whether benefits gained from lexical and sub-lexical morphological instruction are distinct in nature from the gains that have been long found via sub-lexical phonological instruction. Study 1 had no phonological alternative treatment. The varied nature of the studies in the quantitative synthesis of Study 2 do not allow for such fine grained analyses. Research using multiple alternative treatments with careful manipulation of phonological and morphological treatments is needed to address this question.

Another limitation of these studies is that they do not help untangle how much of the effect of morphological instruction can be attributed to orthographic learning and how much can be attributed specifically to morphological learning. Intervention research controlling these factors is needed to better understand this relationship.

An important limitation of Study 1 was that the selection of words for the outcome measures did not address word frequency, base frequency, morphological family size, the part of speech, and other linguistic features. Future studies of this type should balance words on these criteria in order to bring greater precision and confidence in the findings.

The conclusions of chapter 4 would have been stronger if a full meta-analysis had been completed. If future investigations of the effects of morphological interventions use the full

conventions of meta-analysis, including measuring the significance of differences between effect sizes, calculating heterogeneity estimates and confidence intervals, and the testing of moderator effects, educators and researchers will have a stronger foundation on which to base decisions about morphological research and instruction.

Conclusion

Considering the studies presented here in light of the trajectory of research on literacy instruction over time helps paint a coherent picture of how research has succeeded in moving instructional practice forward. From the whole language versus phonics debates, research showed that instruction which draws learners' attention to the internal phonologically-based structures of words results in more effective literacy learning than instructional practices that do not. However, at least in English, failing to base sub-lexical instruction on the established facts of how orthography systems integrate cues to both phonology and morphology meant that phonologically-based sub-lexical instruction could not accurately teach children how their writing system works. Drawing on the well-established understanding of English orthography from linguistics as a guide for instructional design has proven to be productive. The more instruction matches the established facts of the writing system, the more effective that instruction is for a wider population of students. This is a lesson researchers can continue to use to guide the instruction they test. Once researchers and educators understand the facts of the writing system, they can explore and test which of these facts can be effectively investigated in the classroom or tutoring situations for children of varied ages and abilities. Carol Chomsky's (1970) recommendations for instruction were based on a well-established understanding of English orthography which had yet to be tested by intervention studies. Evidence confirming those recommendations all these years later makes her work a good place to start.

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APPENDIX A: DETAILED ACCOUNT OF WORKINGS OF ENGLISH ORTHOGRAPHY

Affixing and compounding are the two main morphological word formation processes. A compound word is formed with the combination of at least two bases, both of which inform the meaning of the resulting word. Compounds can consist of just bases (e.g. birth + day → birthday) or more than one base along with an additional affix or affixes (e.g., day + dream + ing → daydreaming). Affixing generates words by the addition of one or more affixes to a base or an already complex word. Affixed words are of two categories, derivations and inflections. Inflections use suffixes such as *-s, -ed, -ing,-en,* and *-er/-est,* that mark the grammatical function (i.e., person, tense, or number) but do not change a word's class (i.e., verbs remain verbs, etc.). Inflectional suffixes cause such a small semantic shift on a base that inflected words are sometimes considered different forms of the same lexical item. For example, when counting vocabulary size in a text or for individuals, inflections such as *play*, *plays*, and *playing* may be treated as one word (Anglin 1993). Derivational morphology, on the other hand, involves affixing that may cause only a slight semantic shift (e.g. *help/helpful*) or a more dramatic one (e.g., *ease/disease*). Unlike an inflectional suffix, derivational affixes can change the class of the word. For instance, adding the suffix *–ly* to the base *sad* changes the adjective *sad* into the adverb *sadly,* whereas adding the suffix *–ness* to *sad* generates then noun *sadness*. In all cases, the base has a connection in structure and meaning to the complex word in which it is found.

Some bases stand on their own as mono-morphemic (morphologically simple) words. Most bases can combine with other morphemes to form morphologically complex words. The term *stem* can be used to refer to a morphologically complex word form to which additional morphemes are fixed (Crystal, 2008). For example, it is accurate to describe the word *enjoy* as the stem of *enjoyment*. It would be inaccurate to describe *enjoy* as a base because this word itself

is constructed on a base and a prefix. The orthographic morphological structure of this word can be presented in a word sum: *en* + *joy* + *ment* → *enjoyment*. A synthetic word sum assembles morphemes separated by plus signs on the left of the process arrow (or "rewrite arrow"). The result of that combination of morphemes is represented on the right of the rewrite arrow. An analytic word sum begins with a morphologically complex word on the left of the rewrite arrow and the right side reveals the result of morphological analysis of that complex word into its constituent morphemes. Word sums can be partially analysed (e.g. *enjoy* + *ment* → *enjoyment*) or fully analysed (e.g. *en* + *joy* + *ment* → *enjoyment*)

The process of affixing and compounding results in complex words with morphemes that have both oral and orthographic representations. For example, to mark the past tense most verbs use a suffix pronounced /d/, /ɪd/ or /t/ which is represented orthographically as *-ed*. Such verbs are known as "regular" verbs in schools or "weak" verbs in linguistics. Some verbs, however, are described as "irregular" (termed "strong" verbs in linguistics) because they use an unpredictable shift in pronunciation of the vowel (e.g., *run/ran, sit/sat*). Words like these with a stem vowel change are still considered to use a past tense morpheme, but that morpheme does not have an orthographic representation. Linguistics uses curly brackets in a word sum for morphological information that is not marked orthographically. For example, the phonologically unpredictable past tense of *ring* is presented like this: *ring* + {*past tense*} → *rang*. The consistent symbols of the word sum help distinguish between morphological information that is represented orthographically and that which is not.

Morphemes are classed as *bound* or *free.* Affixes are always *bound* morphemes because they are sub-lexical structures that never stand on their own as a word. They must always be bound to at least a base morpheme. Bases can be either *free* or *bound* morphemes. Bases like

help, *sign*, or *please* are free morphemes because they are free to stand on their own as words. Many bases, however, never act as words unless associated with other morphemes and are classified as *bound* morphemes. For example the bound base *rupt* from the Latin root *rumpere* for "break" does not occur as a word, but morphological analysis shows that it (a) carries the underlying denotation of words in which it is found such as *rupture, corruption, interrupt,* and *erupt*, and (b) remains as the "highest common factor" (Crystal, 2008, p. 50) after all affixes are removed from this set of words.

An important feature of how English spelling represents morphology is that spelling changes sometimes occur at the end of a base or stem to which a suffix is added. There are three main suffixing changes: (a) replacing a final, single, silent *e*, (b) doubling a final, single consonant, and (c) changing a final *y* to *i*. Because these suffixing changes follow conventions that are extremely reliable, the vast majority of these conventions can be represented by the flowchart like the one produced by Ramsden (2001) shown in Appendix C. These suffixing changes can be marked in orthographic word sums. The letter immediately following a forward slash replaces the letter immediately preceding that slash. Parentheses mark a "doubled" consonant.

hope/ + ed → hoped

hop(p) + ed → hopped

try/i + ed → tried

The base is not only the central morpheme for a complex word, it also functions as the central morpheme for all the members of a *morphological family* which is defined as all the words linked in structure and meaning to a common base (Carlisle, 2003). The base for a set of related words can be determined by identifying the "highest common factor" in a set of

morphologically related words (Crystal, 2008, p. 50). Thus, the orthographic word sum is a tool that can be used to (a) perform orthographic morphological analysis to reveal the base of a complex word, and (b) test for words that can be categorised as members of a single orthographic morphological family. For example, given a set of words related in meaning such as *pleasing, pleasure, pleasantly, unpleasantness,* and *displease,* morphological analysis with word sums proves that these words are members of the morphological family bound to the base *please* as seen in Figure 2.

In addition to the word sum, another linguistic tool, called the morphological matrix (www.realspelling.com) has been introduced for representing orthographic morphological families. The matrix shown in Figure 2 was constructed to represent all five members of the *please* morphological family that are presented with word sums in that same figure. The matrix achieves an elegant representation of the interrelations of structure and meaning in any orthographic morphological family. By means of specified conventions, orthographic representations of morphemes are arranged into cells around a base that binds a morphological family.

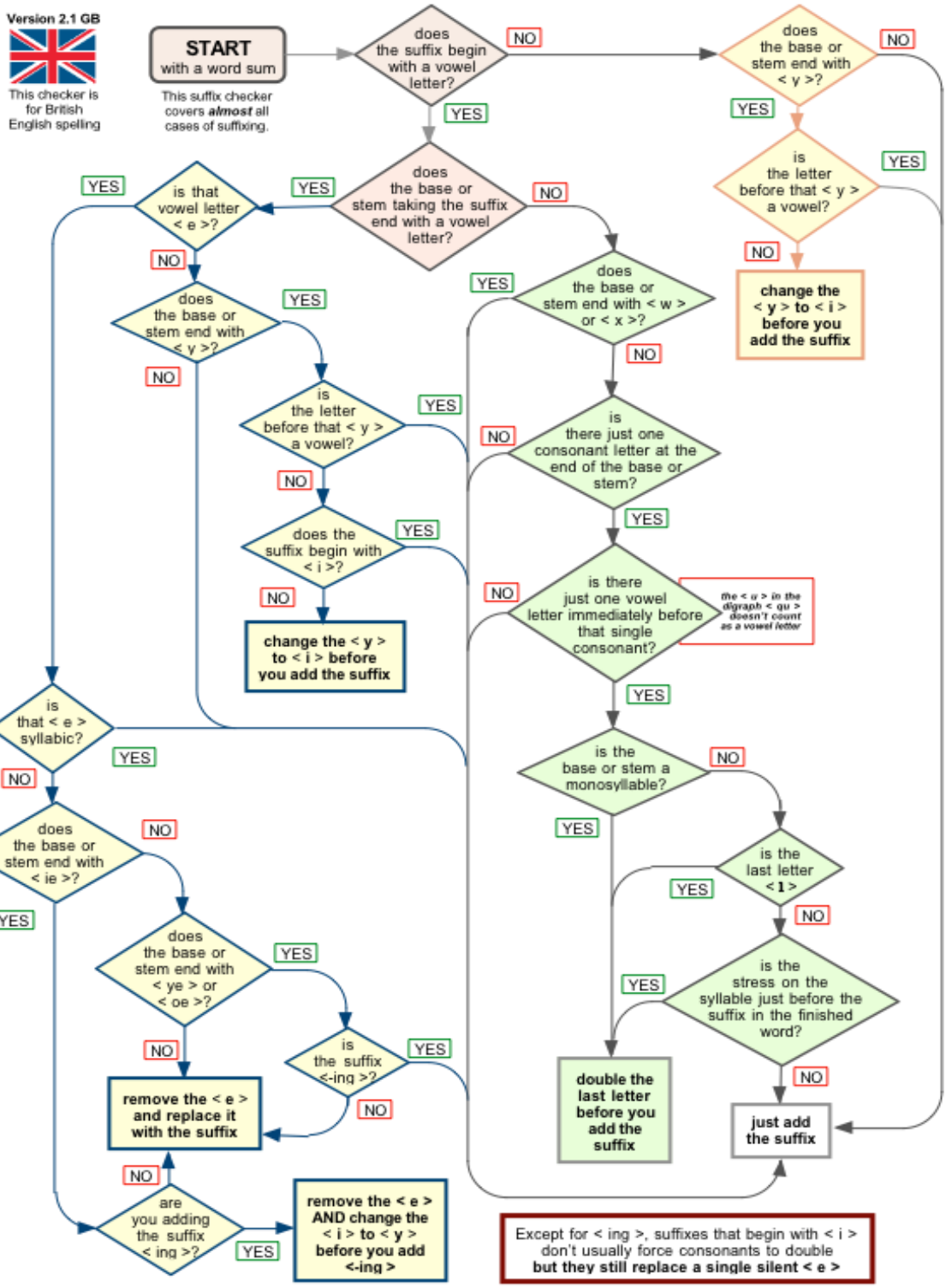
Since the matrix is built on orthographic morphological conventions, it represents only interrelations of *orthographic* morphological families. Morphological relations that extend beyond the scope of orthographic morphological representations are from the same *oral* morphological family but not of the same *orthographic* morphological family. Examples of morphological relations that extend beyond orthographic morphological families include morphological alterations in which a form change occurs, such as a stem vowel change (*man* + {*plural*} → *men*), and suppletion, in which there is no phonological correspondence between morphologically related forms at all (*go* + {*past tense*} → *went*).

APPENDIX B: TABLE OF ORTHOGRAPHIC TERMS

Terms	Definition
affix	A morpheme that is not a base -- a prefix or suffix. Affixes are by definition bound morphemes.
asterisk symbol (*)	On occasion to explain a point, an incorrect spelling or word sum is presented. The asterisk symbol (*) marks the fact that any spelling or word sum immediately follows it, is incorrect.
base	A base is the morpheme that carries the main kernel of meaning in any word. Every word is either a base, or a base with at least one other morpheme fixed to it.
bound and free morphemes	A morpheme that is not free to stand on its own as a word, but must be bound to at least one other morpheme to be a part of a word is a bound morpheme. Prefixes and suffixes are always bound morphemes. Bases such as *love, heal,* and *please* are morphemes that can stand on their own as words, and are thus *free morphemes*. Bases such as *rupt* or *struct* are bound morphemes because they never occur as a word on their own, but they are bases of complex words (e.g. *rupture, disrupt* and *structure, destruction*)
complex and simple words	A simple word has one morpheme, which must be a base. A complex word includes more than one morpheme.
morpheme	Morphemes are smallest structural unit of meaning in a word called bases, prefixes or suffixes.
morphological awareness	Morphological awareness refers to knowledge about morphology which is conscious and the ability to reflect on and manipulate that knowledge.
morphological awareness	The process of analysing complex words into constituent morphemes.
morphological family	Words that share a common oral or written base. The words *run* and *ran* are of the same morphological family, but because they do not share the same spelling of the base, they are not part of the same orthographic morphological family.
morphological processing	Morphological processing describes the role of morphological knowledge on a person's access to lexical items. It is usually measured by implicit tasks such as lexical decision.

Terms	Definition
morphological synthesis	The process of synthesising constituent morphemes into a complex word.
morphological knowledge	Morphological knowledge is used as an umbrella term that includes both implicit and explicit knowledge about oral or written morphological features of words that can influence the processing of lexical items during language based activities.
orthographic morphological family	Any word that shares a common written base is a member of the same orthographic morphological family. Any word that can be included in a matrix is by definition part of the same orthographic morphological family.
root	Although this term is attested as both a morphological and an etymological term, in this dissertation, "root" is used only as an etymological term. The root is the historical origin of a word. The root of a base provides the underlying denotation of that base. That denotation is echoed in the connotations of any of the words constructed on that base.
stem	A morphological term for an already complex word to which another morpheme is being added. For example, enjoy is the stem of enjoyment. The word enjoy cannot be called a base as it is already complex. The term stem allows us to refer to complex word structures during morphological analysis and synthesis.
words sum	A tool for linguistic analysis of complex words into their constituent morphemes. Orthographic word sums reveal the underlying full form of the written morphemes of a word including any surface spelling changes that may occur due to suffixing conventions. The synthetic word sum shows the constituent morphemes on the left side of the rewrite arrow and synthesizes those elements into the surface orthographic representation on the right. Analytic word sums start with a complex word on the left of the rewrite arrow which is analyzed into the complete written forms of the constituent morphemes including suffixing changes are marked on the right.

APPENDIX C: FLOW CHART FOR SUFFIXING CONVENTIONS IN BRITISH ENGLISH (www.realspelling.com) Reprinted with permission of author.



APPENDIX D: CONVENTIONS OF THE ORTHOGRAPHIC MORPHOLOGICAL MATRIX

The orthographic morphological matrix is a rectangular array of cells, each of which contains one or more morphemes arranged such that each morpheme can be bound directly (or indirectly through another morpheme) to the one central base to form a complex word. The principles of the matrix, including the conventions for arranging morphemes around a base and synthesising those morphemes into words, are listed below.

(a) A matrix represents the abstract morphological substructure of complex words. Like the left side of a synthetic word sum, the matrix shows the full orthographic form of morphemes. Suffixing changes for individual words are not shown. (i.e., the full spelling of the base *please* is used in the matrix in Figure 2 even though the final *e* is not realized in many of the words this matrix represents).

(b) Words represented by a matrix are "read" cell-by-cell left to right (one morpheme per cell), and cells cannot be skipped when synthesising morphemes into complex words.

(c) Multiple morphemes are included in single cells where possible. (i.e., In the *please* matrix in Figure 1 the suffixes -*ly* and -*ness* are in the same cell as they can both follow the -*ant* suffix to form attested words.)

(d) A word formed from a matrix need not begin with a prefix (i.e. *pleasant, pleasure, pleasing)* or use a suffix (i.e. *displease*) but it must include the central base.

APPENDIX E: LETTER OF INFORMATION

Letter of Information
Queen's University, Faculty of Education
Teaching Word Structure

Dear Parent,

I am a Faculty of Education graduate student at Queen's University with over ten years of teaching experience (grades 4 to 6). Your child's class is participating in research that I am leading which seeks to develop improved literacy instruction. For this project, I will teach (along with your child's teacher) twenty 45-minute lessons that focus on word structure and its connection to meaning. The instruction is based on a literacy program I piloted in a Grade 4 classroom that brought great enthusiasm from students, parents and fellow teachers. This research has been cleared through the official ethics process at Queen's University, and also by your school board.

The content I will teach links directly to the Balanced Literacy Curriculum and is supported by recent research showing that knowledge of how words are built connects to literacy skills. Many 'irregular' words have a logical structure that can be learned. For example, the *'g'* in *sign* makes sense when we understand how this base builds words such as *signal*, *signature*, or *designate*. The word *business* is built by joining the word *busy* with the suffix *-ness* that forces the *y*/*i* shift. Understanding how words are structured makes sense of countless 'irregular' words, reveals meaning cues and can be taught. Research suggests that this type of instruction improves spelling and reading comprehension.

In conjunction with this research, we are seeking permission for children's participation in a session of pretest assessments and two posttest sessions over the course of the study. During these sessions children will be asked to complete oral and written tasks that allow us to assess the impact of the intervention. A qualified member of the research team will administer these tasks during the school day. It will take about 70 minutes to complete pretest assessments (not in one sitting), and about 40 minutes to complete the two posttest sessions. The results of these assessments are purely for research purposes, will remain confidential and have no impact on students' grades. Only members of the research team will handle these data, and they will be stored in a locked office at Queen's University. We are also asking for permission to use work that students do during the intervention classes as additional data to help assess the effectiveness of the program. Unlike the pre- and posttests, the intervention lessons are part of the language arts curriculum, and teachers will have access to this work as they would any other work students do during class time. Teachers may choose to evaluate this classwork as they would other work students do in class. It is important to add, however, that if examples from student notebooks are used as illustrations of the kind of work students did during the intervention, no individual child or school will ever be identified in publication of the research.

We do not foresee any risks connected to your child's participation in the study. Giving your permission is completely voluntary and choosing not to participate will not result in any adverse consequences. Further you are free to chose, without reason or consequence, to change you mind about your child's participation at any time.

If you have any questions regarding the research please contact Peter Bowers at (613) 546-2718 (email bowersp@kos.net) or his supervisor, Dr. John Kirby at (613) 533-6000, ext 77231. Questions, concerns, or complaints about the ethical aspects of the research can be forwarded to the Dean of Education, Dr. Rosa Bruno-Jofré, (613-533-6210) or the chair of the General Research Ethics Board, Dr. Joan Stevenson (613-533-6081 or email stevensj@post.queensu.ca).

Thank you for your consideration,

Peter Bowers
M.Ed. candidate
Faculty of Education, Queen's University

APPENDIX F: CONSENT FORM

Consent Form for "Teaching Word Structure"

I have read and retained a copy of the letter of information and I have had any questions answered to my satisfaction.

I understand that I am being asked to allow my child to participate in the research project entitled "Teaching Word Structure" and that the purpose of the study is to test the effect of a unit of word structure instruction on children's reading and writing skills.

I understand that my child's participation in this research will take the form of (1) oral and written tasks that will take a total of approximately 150 minutes to complete over the course of three separate assessment periods, and (2) class work in the intervention lessons during his/her regular class time. My responses and signature below indicate whether or not I give permission for my child to participate in the three assessment periods and/or for work completed by my child during the instruction to be analyzed by the researcher.

I understand that confidentiality of the pre- and posttest assessments will be protected by appropriate storage of data in a locked office at Queen's University and that only members of the research team will have access to these data. No school or individual will be identified in any way in any future publication of this research.

I understand that there are no known risks, associated with my child's participation in this research.

I understand that I can withdraw my child from the study at any time and request the removal of all or part of my child's data, without consequences.

I understand that I can contact Peter Bowers, (tel: 613-546-2718 or email: bowersp@kos.net) the principal investigator with questions about the study, or his supervisor, Dr. John Kirby (613-533-6000, ext. 77231). I understand that for questions, concerns or complaints about the research ethics of this study, I can contact the Dean of the Faculty of Education, Dr. Rosa Bruno-Jofré, (613-533-6210) or the chair of the General Research Ethics Board, Dr. Joan Stevenson, (tel: 613-533-6081 or e-mail stevensj@post.queensu.ca).

Please circle *'yes'* or *'no'* to indicate your response to each statement below:

I consent for my child's participation in the oral and written assessments. Yes No

I consent for the work my child completes during the intervention lessons Yes No
to be used by the researchers to assess the program.

Name of parent/guardian: (please print) _____

Signature of Parent/Guardian: _____

Date: _____

APPENDIX G: DESCRIPTION OF BASE IDENTIFICATION AND

MORPHOLOGICAL VOCABULARY TASKS

Instructions for: Circling Main Part of the Word

The student **MUST** do the ***Reading Accuracy*** task **BEFORE** this task.

Circling Main Part of the Word:
The student will be using a new booklet for this activity, but you need your **"Reading Accuracy Score Sheet"** as the student goes through these same words for the new tasks.

It is important that you do not use the words **prefix**, **suffix** or **base**, even though kids may use them. For the base you, say: *"main part of the word"*

For prefixes or suffixes, say: *parts of words, or the beginning / ending part of a word.*

Say*:*
For this activity, I will ask you to look carefully at the words that we just read, but this time I am asking you to circle the main part of each word. Let's try the practice.

If a child is messy in their circling, try to emphasize that it is important to be as neat as possible, so that someone else can tell exactly what letters they wanted circled.

<books>

Use a blank sheet to cover all words except *books.*

What part of 'books' would you circle as the main part?

If student has trouble – go ahead and circle *book*, and say, *"Do you see now "book" is the main part of "books"?*

<making>

Ask the student to move the sheet down to next word. If the student circles anything other than m-a-k, show them the correct answer.

Say:
Can you see how m-a-k are the letters from make, which is the main part of this word?

- If the student shows the missing <e> and asks if you want them to do that, just say "*that would be fine", but don't emphasize it as a good or bad thing to do.*
- If the student wants to circle the <i> or asks about the missing <e> just say "*The <e> in the word **make** isn't in **making**, so all you can do is circle **m-a-k**.*
- If the student circles k-i-n-g. say: "***King*** is a word, but it doesn't have anything to do with the word ***making***. For this activity, you have to circle *m-a-k* from the word ***make***.

<runner>

Ask the student to move the sheet down to next word. If the student circles anything other than r-u-n, show the correct answer.

- If the student circles both <r>'s just say: "*The main part of **runner** is **run**, so you can only circle the first <r>.*

<enjoyment>

Ask the student to move sheet down to next word.

Student circles <**joy**>. Say:

*Good. The word **joy** is the main part of **enjoyment**. Some people would circle **enjoy** as the main word. That would be OK, because **enjoy** is a main part of **enjoyment** too. However, since **joy** is the smallest main part of **enjoyment**, **joy** is the best answer.*

Student circles <**enjoy**>. Say:

*Good. The word **enjoy** is a main part of **enjoyment**. However,* (circle ***joy*** as you say): *can you see how **joy** is the <u>smallest</u> main part of **enjoyment**? While **enjoy** is a good answer, **joy** is the best answer for this activity.*

Student circles <**joyment**>. Say:

Good try. The only problem is that I don't think joyment is a word.
Circle enjoy as you say…*You could circle **enjoy** since that is a main part of enjoyment. However, there is an even better answer.* (Circle ***joy*** as you say): *Can you see how **joy** is the <u>smallest</u> main part of **enjoyment**? While **enjoy** is a good answer, **joy** is the best answer for this activity.*

<bookstore>

Ask the student to move the sheet down to next word. If the student circles anything other than b-o-o-k AND s-t-o-r-e, show that for this word they have to circle both. DO NOT SAY THE WORD COMPOUND WORD. It's fine if the student does.

Say: *This word has two main parts, so you have to circle them both.*

- If the student circles both <books>'s just say: "*There is a word <**books**> but you can't circle that one in this word because you also need to circle the other main part <**store**>.*"

"OK, let's start…"

<u>Start Circling Task</u> (REMEMBER to point to words, but never read them out loud!)

Turn the page and cover all but the first word.
Say: *Circle what you think is the main part of this first word.*

Student circles part, all of the word or decides to pass.

If the line of their circle goes through a letter and it is not clear, ask the student to say the letters then wanted in their circle. Carefully circle what the student tells you on your record sheet.

Circle the main part of the word.

Practice Page

books

making

runner

enjoyment

bookstore

Test Booklet

Page 1:	Page 2	Page 3
busily	victoriously	educated
reproduce	decreasing	vacuum
refereeing	precautions	conscious
staring	ruder	vacuous
condensed	prearranged	acknowledgement
starring	adaptation	condensation
insensitive	insignificance	responsibilities
architecture	reelected	restructured
socially	incorruptible	happenstance
scarred	stared	accompanying

APPENDIX H: WORDS FOR BASE IDENTIFICATION AND MORPHOLOGICAL VOCABULARY TASKS OF STUDY 2

Word Taught	Base Taught	Affixes Taught
1. busily	1. reproduce	1.refereeing
2. staring	2. condensed	2.insensitive
3. architecture	3. socially	3.decreasing
4. victoriously	4. ruder	4.precautions
5. adaptation	5. insignificance	5.prearranged
6. educated	6. incorruptible	6.reelected
7. vacuum	7. stared	7.acknowledgement
8. conscious	8. restructured	8.responsibilities
9. condensation	9. vacuous	9.accompanying
10. starring	10. happenstance	10. scarred

APPENDIX I: DETAILS ON SCORING FOR BASE IDENTIFICATION TASK

The guiding principles for the scoring system were (a) to reward evidence of more accurate written morphological awareness, (b) to ensure consistency of scoring and, (c) to avoid giving an unfair advantage to the training group over the control group. The additional scoring criteria are described below.

1) There was no penalty for incorrectly including the letter *e* of the beginning of a suffix (e.g., *-ed*, or *-er*) as being part of a base or stem if that base or stem ended in a single silent *e.* Strictly speaking, in such a case the silent *e* of the base has been replaced by the vowel suffix, and therefore that *e* should not be identified as being part of the base or stem. For example, for the word *educated* (*e+**duce**/+ate/+ed*), circling *educate*, *educat*, *or duc* all score 2 points. The second *e* in *educated* is part of the vowel suffix *–ed* which has replaced the silent *e* of *educate* and, therefore, is not part the stem. However, only the experimental group would have been taught such specific information. To make the test fair to both the control and experimental group, circling *educate* was accepted as being worth 2 points even thought it leaves only the letter *d* of the *–ed* suffix uncircled and thus breaks a morphemic boundary. The bound base of *educate* is *duce* for 'lead, bring'. Here the silent *e* at the end of this bound base is replaced by the *e* of the vowel suffix *–ate*, meaning that the child who knows about bound bases can only indicate that knowledge in the word *educated* by circling *duc.*

2) If the base or stem ends in a letter *y* that has been changed to *i* due to suffixing, the letter *i* must be circled as part of the base or stem. Unlike the silent *e* of a base or stem that is replaced by a vowel suffix, the *y/i* shift occurs within the base of a word and cannot be treated as part of the suffix. For example, consider the word *busily* which uses the base *busy* and the suffix *–ly* as revealed by the word sum *busy/i+ly* → *busily*. For *busily*, circling *bus* is incorrect and

scores 0. This response suggests the base word *bus*, which is unrelated to the word *busily* and *ily* as a suffix which it cannot be. (Despite the fact that some resources identify letter strings such as *–ily*, and *-ies* as suffixes, these are in fact the suffixes –ly or –es causing the final *y* of a stem to change to *i.*) The base of *busily* can only be accurately indicated in this activity by circling *busi.* The only possible scores for this word were 0 or 2 as only one affix could be removed by circling.

3) The scoring of compounds needed special consideration, as trained and untrained students had different levels of understanding of what a compound was. For example, to the trained student, the word *architecture* is a kind of compound word. This word contains two bases, the free base, *arch* 'leader, chief' and the bound base *tect 'carpenter, builder'.* The structure *arch + i + tect + ure* joins these two bases with the *i* connector vowel. Only students with explicit instruction could be reasonably expected to recognize *tect* as a base, and therefore identify *architect* as a compound word. Scoring was designed to prevent such special explicit knowledge from helping only the scores of children in the training group. As a result it was decided that for all compounds in this activity (*architecture*, *acknowledgement*, *happenstance*) circling either of the bases scored the same as circling both bases. Thus for the word *architecture*, circling the letters *arch* or *tect*, scored 2 points as did circling both *arch* and *tect.* Circling *architect* scored 1 point because it is not the smallest base or stem that can stand on its own as a word. The base *arch* is a free base that stands on its own as a word as seen it the sentence, "Superman has an *arch* enemy."