Morphological Instruction and Literacy:

Binding Phonological, Orthographic, and Semantic Features of Words

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Abstract

There are a number of reasons why knowledge of morphology should be related to literacy outcomes: (a) English is fundamentally morphophonemic in nature, (b) various theories give morphology a role in word reading, (c) there is evidence that adults process morphological information automatically when they read words, even if they are not aware of it, and (d) there is considerable evidence that knowledge of morphology predicts literacy outcomes. We review the literature on morphological instruction and find that morphological instruction is generally beneficial, especially for younger and less able learners. We conclude by offering a number of design principles for morphological instruction, which also serve as hypotheses for future research examining which components of morphological instruction are most effective.
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If you asked average English-speaking adults about morphology, and even specified that you were talking about words, not anatomy or geology, they would express little familiarity with it, even if they were good readers. We work with teachers and teachers in training, and the same is true for them, unless they have taken a course in linguistics. So if good adult readers do not claim much knowledge of morphology, why do we think teaching it to children would help them in literacy?

These average adults know about adding –s to words to make them plural, know that –ed added to a (regular) verb makes it about the past. They also know that a novel word like *typeable* means something like “capable of being typed”, and that a *chicken-dance* is different from a *dance-chicken*. All of these require knowledge of morphology, but it seems that this knowledge is implicit or tacit rather than explicit. There has been a recent surge in interest in the role of morphological knowledge in literacy, and a number of meta-analyses and systematic reviews have been published (Bowers, Kirby & Deacon, 2010; Carlisle, 2010; Goodwin & Ahn, 2010, 2013; Reed, 2008). In this chapter we review research on the benefits for literacy of making this knowledge explicit.

Our main goals in this paper are to review the research on the effects on literacy of instruction about morphology and to draw conclusions for educational practice and further research. We begin by discussing what we mean by *morphological knowledge* and why morphological knowledge *should* be important in literacy. We consider both a logical argument
related to the nature of English, and indicate how morphological knowledge fits into a theory of reading. Although our primary focus is on instruction, we briefly review evidence that morphological knowledge predicts later literacy development, and that typical readers use morphological knowledge implicitly when they read.

The central section of the chapter reviews current evidence regarding the effects of morphological instruction on literacy (in particular on vocabulary, reading, and spelling). We build on the results of recent meta-analyses and systematic reviews, focus on more recent studies, and pay particular attention to the methods of instruction. We conclude the paper by posing design principles for morphological instruction which also serve as hypotheses in need of testing in future research.

**Morphological knowledge and why it should be related to literacy**

**Morphological knowledge.** Morphology essentially concerns *morphemes*, the smallest meaning-bearing units in oral or written language, and the ability to both combine morphemes to make words and decompose words into their component morphemes. Morphological knowledge refers to all of this, and varies along a continuum of explicitness (Deacon, Parrila, & Kirby, 2008). At the most implicit end of this continuum, the individual is unaware of the knowledge or of using it; examples of this are described in the following section on lexical decision studies. At the very explicit end of the continuum, the individual is aware of searching for and using the knowledge, for example when asked to indicate the morphemes that make up a particular word. In the middle of the continuum are more ambiguous situations in which the individual may have some degree of awareness of morphological knowledge and its use. Consider being asked which word best completes this sentence: *My brother is a chocolate (lovely, loving, lover)*. Although
some participants may explicitly ask themselves what part of speech should be there, conclude that it should be a noun, and observe that *lover* is the only noun in the list, many others, especially children, will just say that the sentence “sounds better” with *lover*. To add to the complexity, many tests may contain items that draw on different degrees of morphologically explicit knowledge, and any particular item may elicit explicit knowledge from some children and not others. It has not helped that many researchers have adopted the term *morphological awareness* when it is not clear that any form of explicit awareness is being measured.

Instructional researchers have the advantage of deliberately addressing and attempting to enhance explicit knowledge. In regular classroom instruction, most students are unlikely to encounter explicit morphological instruction, so their knowledge is very likely to be implicit; we discuss this issue further in the section on instructional studies.

The morphophonemic nature of English. It is important to understand that English is fundamentally *morphophonemic* in nature (Venezky, 1999); although the same can be said for other languages, the nature of the joint action of morphology and phonology on reading may differ across languages. In this paper we are primarily addressing English, in which the relatively high degree of phonological unpredictability may give morphology more of a role. Both oral words and their written representations are based on morphological and phonological considerations. As Venezky said about English orthography, it “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” (1967, p. 77). Morphemes and phonemes are thus the building blocks out of which words are built; many researchers and teachers believe that it is important for children to understand how their language works, and that doing so will facilitate their literacy learning. Just as the last few decades have yielded evidence regarding the
importance of phonological or phonemic factors for literacy success (e.g., Adams, 1990; Bradley & Bryant, 1983; Liberman, Shankweiler, Fischer, & Carter, 1974; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001), there is current interest in examining whether morphological factors should also be seen as critical for literacy (e.g., Carlisle & Stone, 2005; Nagy, Anderson, Schommer, Scott, & Stallman, 1989; Perfetti, 2011). If part of English’s nature is fundamentally morphological, this is one reason why understanding morphology should contribute to literacy.

C. Chomsky’s (1970) concept of a lexical spelling is relevant here. She used this term for the abstract meaning-based word forms that lie beneath surface phonetic realizations 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 have a psychological reality for the language user. She speculated that instruction about these underlying morphological structures and their conventional orthographic representations might have benefits for learning to read and spell. Carlisle (2010) lamented that these instructional recommendations have gone largely unheeded, but this appears to be changing. 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). In sum, the nature of language and of English in particular adds credence to the potential role of morphological instruction in learning to read.

**The binding agent theory of morphological knowledge.** The second reason for thinking that morphology should contribute to literacy comes from theory. We see morphology as a *binding agent*, in that it relates semantics, orthography, and phonology to each other (see Figure
1). Semantics, orthography, and phonology are the fundamental aspects of word knowledge, represented in the triangle model shown in Figure 1 (cf. Seidenberg, 2005; see also Bahr, Silliman, Berninger & Dow, 2013; Richards et al., 2006). We adopt the binding agent construct from Perfetti’s lexical quality hypothesis (Perfetti, 2007), as something which relates the other components to each other, strengthens those connections, and enhances representational quality. More integrated mental representations convey many advantages (Perfetti, 2007; Goodwin, Gilbert, & Cho, 2013). We propose that morphology facilitates the integration of the mental representations of words. Morphology provides clues to meaning from both orthography and phonology, clues to how to write words (orthography) from both semantics and phonology, and clues to phonology (how to say a word) from both orthography and semantics. Beyond the single word level, morphology also contributes to syntax through helping specify the roles words play in sentences (McCutchen, Stull, Herrera, Lotas, & Evans, 2013). As a binding agent, it would make sense if knowledge of morphology contributed to better vocabulary learning, better word reading and spelling, and better reading comprehension; thus theory gives us another reason for expecting morphology to contribute to literacy.

Automatic morphological processing. A third reason for hypothesizing that morphological instruction will contribute to literacy comes from studies in which multimorphemic words (such as musician) prime the recognition of their bases (in this case, music). 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 (such as *vowel* – *vow*) (e.g., Feldman, 2000; Rastle, Davis, Marslen-Wilson, & Tyler, 2000), and this effect extends to word pairs such as *virus* – *viral* in which most
participants are unaware of the common base (Taft & Kougious, 2004). Such studies use a fast masked priming procedure, with presentations of less than 60 ms, thereby blocking the semantic processing. Gonnerman, Seidenberg, and Anderson (2007) showed that the morphological priming effect only occurred when prime-target pairs were close enough in both phonology and semantics. However, Gonnerman et al. presented their primes orally; written primes allow for faster orthographic/visual processing (Rastle & Davis, 2008). These priming studies suggest strongly that participants normally carry out some sort of morphological analysis when presented with multimorphemic words, so that they are faster to recognize the bases when they are presented. It is important to note that they do so without being asked to do any morphological analysis at all, but rather to indicate whether the target is a word or not. In the absence of deliberate morphological instruction, such tacit morphological knowledge can only have been acquired through exposure and (probably unconscious) learning of statistical associations. If typical adult readers normally carry out morphological analysis, then explicit morphological instruction may be helpful.

**Morphological knowledge predicts literacy skills.** By far the strongest reason for hypothesizing that morphological instruction will improve literacy skills comes from the growing literature showing that morphological knowledge (often termed morphological awareness) predicts reading skills, even after controlling factors such as general ability and phonological awareness (e.g., Carlisle & Stone, 2005; Deacon & Kirby, 2004; Kirby, Deacon, Bowers, Izenberg, Wade-Woolley, & Parrila, 2012; McBride-Chang, Wagner, Muse, Chow & Shu, 2005; Nunes & Bryant, 2006; see Carlisle’s chapter in this volume for an extensive review). Although these studies have controlled a number of relevant factors, they are still fundamentally correlational in nature and do not guarantee that morphological instruction will improve skills in
word reading, reading comprehension, spelling, and vocabulary. These predictive studies rely on children’s largely untaught morphological knowledge, which may function differently than deliberately taught morphological knowledge. Experimental instructional studies have an important role to play. We turn to them next.

Effects of Morphological Instruction

Morphological instruction, like phonologically-based instruction, explicitly teaches about sub-lexical features of words, with the goal that it will generalize to untaught words. The view that decoding instruction about (sub-lexical) letter-sound correspondences in some words would generalize to untaught words was the premise of Share’s (1995) hypothesis that decoding instruction provides a self-teaching function. More recently Share (2011) pointed out that the self-teaching mechanism has not yet been broadened to morphology. He noted, “More general insights into orthographic conventions concerning grammatical and derivational (typically bound) morphemes... [are] another critical dimension of orthographic learning” (2011, p. 64). As we have outlined earlier in this chapter, there are a number of good reasons for expecting morphological instruction to contribute to literacy. Numerous authors have hypothesized that morphological instruction will enhance vocabulary knowledge and learning (and thereby contribute to reading), in addition to directly improving word reading, spelling, and reading comprehension (e.g., Carlisle, 2010; Nunes & Bryant, 2006).

Investigating the effects of morphological instruction on literacy introduces a complex variety of practical and theoretical questions. One dimension to consider is the variety of literacy outcomes (word reading, reading comprehension, spelling, or vocabulary) that could be affected. Another concerns whether morphological instruction is more effective for certain kinds of
learners than others, for instance with respect to age or ability. A third dimension concerns how instruction should be designed, especially the extent to which it should be integrated with other aspects of literacy instruction. Finally there are questions of what to teach: to what extent should instruction focus on (a) inflections vs. derivations vs. compounds? (b) oral or written morphology? (c) suffixes or bases? (d) bases which can stand alone as words or “bound” bases, those which cannot (such as *struct* in structure)? and (e) complexities added by phonological, orthographic, or semantic opacity? So far the literature has focussed more on examining whether morphological instruction works rather than on how it would work best.

There now exist several dozen studies in which morphological knowledge has been taught and literacy outcomes observed, and these studies have been the subject of at least five meta-analyses and systematic reviews (Bowers, Kirby & Deacon, 2010; Carlisle, 2010; Goodwin & Ahn, 2010, 2013; Reed, 2008). Although there is considerable overlap in the original papers included in these reviews, each had its own selection criteria so the overlap is far from complete. In the sections that follow, we draw on evidence from these studies, along with more recent morphological interventions in order to present some initial findings and informed suggestions for future study. Our review is structured in the following sections: How has morphology been taught? What are the overall effects? When should morphological instruction be introduced? For whom is morphological instruction appropriate? How should morphological instruction be integrated with other aspects of literacy instruction?

**How has morphology been taught?**

Bowers et al. (2010) reviewed the content and approaches used in 19 separate morphological instruction studies (see Table 1). Some studies restricted instruction to the oral domain, but most addressed oral and written morphology. All studies taught common affixes
(prefixes and suffixes), while only half targeted bases and only three studies addressed bound bases. Only five studies targeted the convention of consistent spellings of morphemes despite pronunciation shifts while nine addressed spelling changes due to suffixing changes (for instance, when the <y> in <carry> is changed to <i> when <age> is added). Morphological analysis (identifying morphemes within complex words) was addressed by all studies, but only 12 targeted morphological synthesis; only 8 employed morphological recognition tasks, such as sorting, or analogy. Only 4 studies deliberately addressed the issue of morphological “foils” (e.g., recognizing that there is no <disc> or <over> in <discover>, and that <literacy> is not <lite> and <racy>).

Bowers et al. (2010) also highlighted two instructional variations that stood out from the 19 studies. First, about a third used instruction that engaged students’ attention through problem solving or scientific inquiry based activities. Such activities might include setting challenges that involve applying morphological investigation to determine the reason for a <g> in <sign>, or providing evidence that two words share a base. A second distinction was between studies integrating morphology with other aspects of language (such as phonology) and those presenting it in isolation (i.e., as the sole focus of instruction). As we will describe in the final section of this chapter, many of these characteristics, and especially the last two, are ones that instructional designers should consider including in their programs. Bowers et al. and Goodwin and Ahn (2013) examined the integration-isolation factor in their reviews (see later section), but the effects of the other characteristics have not been assessed quantitatively. There is need for studies that explicitly contrast different instructional methods.

**Overall effects of morphological instruction**
General findings from recent reviews and meta-analyses are presented in Table 2. Reed (2008) examined the effect sizes on outcomes for word identification, spelling, vocabulary, and reading comprehension in seven studies. She highlighted the wide variety in the purpose, design, and effect sizes of the outcomes ($d$ ranging from -0.93 to 9.13). She noted that stronger effects were associated with instruction that targeted bases rather than affixes on their own. She also found morphological instruction to be beneficial in general, but that the effects were strongest in the three studies that targeted less able students. Carlisle (2010) reviewed 16 morphological interventions. She reported that morphological instruction was associated with improvements in word reading, spelling and morphological analysis of unfamiliar words. She also noted that children in kindergarten can improve in morphological awareness through instruction.

Three quantitative syntheses of morphological interventions have been reported (Bowers et al., 2010; Goodwin & Ahn, 2010, 2013). We draw mainly on the findings of Bowers et al., but augment our summary with the other reviews when appropriate.

Bowers et al. (2010) coded outcome measures according to three levels of lexical category: sub-lexical, lexical and supra-lexical. Sub-lexical outcomes were further divided into morphological and non-morphological outcomes. Lexical outcomes included measures of spelling, vocabulary and word reading. Supra-lexical outcomes were mostly reading comprehension measures, but also included measures of syntax and listening comprehension. They also analyzed the effects of morphological instruction compared to the performance of either control groups (C), which received standard classroom instruction, or alternative treatment groups (AT), which were primarily phonological interventions (plus some vocabulary interventions). Morphological instruction had the strongest effect on sub-lexical morphological skills, with an effect size of 0.65 (compared to C) and 0.51 when compared to the AT condition.
Morphological instruction also had an impact on sub-lexical phonological skills, with an effect size of 0.34 when compared to regular classroom instruction and .08 when compared to the AT condition. They found an effect size of 0.41 for lexical outcomes when morphological instruction was compared to regular classroom instruction, which reduced to 0.12 compared to AT. The same comparison for supra-lexical outcomes was 0.28, reducing to -0.08 compared to AT. When the lexical outcomes were divided into those of vocabulary, word reading, and spelling, the effect sizes were 0.35 for vocabulary (reducing to 0.20 for AT comparisons), 0.41 for reading (0.05), and 0.49 for spelling (0.05). Goodwin and Ahn (2013) found similar results for effect size on vocabulary (0.34), but somewhat higher effects on decoding (0.59) and lower ones for spelling (0.30). They found no significant effects on reading comprehension.

We see four main patterns in these effects of morphological instruction for the general population of students across all grades and abilities studied. First, when compared to regular classroom instruction (business as usual), morphological instruction had generally positive effects.

Second, effects of morphological instruction were roughly equal to those of alternative treatments. Though somewhat disappointing, it should be noted that the majority of these alternative treatments used well-established phonological instruction, or in the case of interventions targeting vocabulary, established approaches for vocabulary instruction. Thus, the comparison to alternative treatments shows that these initial attempts at morphological instruction are at least as effective as instruction that has benefited from refinements based on decades of research. Further experimenting with this relatively new instructional practice should result in increased effectiveness. Studying details of published interventions can generate hypotheses for the design of future interventions. For example, only five of the studies in the
Bowers et al. (2010) sample addressed the orthographic consistency of morphemes despite pronunciation shifts, and half of the studies only targeted affixes instead of bases which carry the main meaning of words; these are examples of morphological content that can be investigated further to improve instruction.

Third, as would be predicted by our binding agent theory, morphological instruction contributed to gains in phonological skills. Bowers et al. (2010) found that morphological instruction was about as effective for phonological outcomes as alternative treatments, even though the vast majority of those alternative treatments targeted phonological instruction (the effect size comparing morphological and alternative treatments was $d = 0.08$). Goodwin and Ahn (2013) found that the two largest effects of morphological instruction were for decoding (0.59) and phonological awareness (0.48). These effects were even larger than the effects on morphological knowledge (0.44). The effect of morphological instruction on phonological awareness deserves further attention: it may only indicate that improved word reading has allowed readers to perform phonological awareness tasks by visualizing the words more effectively, but alternatively it could show that morphological awareness provides an awareness of large sub-lexical units (morphemes), which assists some children in their use of smaller sublexical units (syllables, onsets, rimes, and phonemes) (cf. Goodwin & Ahn, 2013).

The fourth main pattern is that effects were strongest at sub-lexical levels, then lexical, and weakest at the supra-lexical levels (sub-lexical refers to parts of words, such as phonemes or morphemes; lexical to words; and supra-lexical to tasks beyond the word level, such as reading comprehension). On one hand, this is surprising due to findings from predictive studies that morphological awareness contributes more strongly to reading comprehension than to the other levels (e.g., Kirby et al., 2012). On the other hand, we note that that untaught morphological
knowledge was acquired over years of language learning. To have an effect on reading comprehension, morphological knowledge newly gained through explicit instruction may require more than the typical number of lessons of an intervention (approximately 20-30 sessions). Also, the morphological instruction in this sample of studies generally targeted lexical outcomes of reading, spelling, and/or vocabulary. Future morphological instruction studies should experiment with explicitly targeting ways to leverage morphological knowledge to improve reading comprehension.

**When should morphological instruction be introduced?**

It has long been thought that morphology should only be introduced in the later elementary years (e.g., Adams, 1990; Ehri, 1995; Ehri & McCormick, 1998). However, until recently this remained an untested hypothesis. Morphological instruction was not addressed in major reviews of literacy instruction such as the National Reading Panel Report (2000) and Rayner et al. (2001). This is despite Rayner et al. describing the role of morphology in oral and written language including the morphophonemic principle, the fact that morphemes maintain consistent spellings across words despite pronunciation shifts, and also the evidence that even Grade 1 children show sensitivity to morphology in their spelling (e.g., Treiman, 1993; Treiman & Cassar, 1996). Given that the morphophonemic nature of our language has long been understood (e.g., C. Chomsky, 1970; Venezky, 1967) and that morphology clearly plays a role in oral language at earlier ages (e.g., Berko, 1958), there is good reason to investigate whether morphological instruction could have benefits with young children.

Bowers et al. (2010) divided the studies in their review into those with participants up to and including grade 2 and those with participants from grades 3 to 8. Contrary to the long-held belief that morphological instruction should only be given to older children, the effect size for
lexical outcomes (vocabulary, word reading, and spelling) for younger students was 0.57, compared to 0.37 for the older participants. The effects were smaller but equivalent (0.27 vs. 0.29) for reading comprehension. All of these effects became small when morphological instruction was compared to established alternative treatments. But even that equal result between morphological instruction and alternative treatments counters the hypothesis that morphological instruction should be avoided in the early years. Goodwin and Ahn (2013) found larger effect sizes (0.68) for preschool and early education interventions than those in upper elementary (0.29), middle school (0.34), or high school (0.45).

One of the more intriguing early interventions was carried out by Lyster (1998), who taught oral morphology to Norwegian pre-school students and found positive effects on reading in Grades 2 and 3 (compared both to a control group and an alternative treatment group who were taught phonics). Six months after the instruction they found a very large effect on word reading through the morphology treatment (1.88) compared to the phonology treatment (0.82). Compared to controls, a significant difference on an orthographic coding task remained in Grades 2 and 3. Lyster, Lervég and Hulme (2014) have recently followed those participants into grade 6; controlling for initial levels of vocabulary, nonverbal ability, phoneme awareness, and mothers’ education, they found differences in a set of reading comprehension measures favoring the group initially taught morphology.

Devonshire, Morris, and Fluck (2013) compared an intervention which taught about morphology, etymology, phonology, and their interrelation to a phonics treatment for 5 to 7 year-olds. They found statistically significant effects on standardised measures of word reading and spelling for the integrated morphology treatment compared to the isolated phonics treatment. It is important to note that there are still only relatively few studies at the early grade levels, but these
results suggest that further studies of morphological instruction be conducted with young children.

**For whom is morphological instruction appropriate?**

There has also been a long-standing view that morphology is an advanced topic, not appropriate for those struggling with literacy, including those with dyslexia. For example, Adams (1990) explicitly recommended against teaching morphology to less able students, and the National Reading Panel (2000) neither recommended it for less able students nor drew attention to the lack of data regarding morphological instruction. Two reasons for this omission were the lack of published research and the concern that children with reading difficulties primarily needed instruction about phonological processing. For example, phonological processing is the main instructional focus of the Response to Intervention (RTI) approach (Fuchs, Mock, Morgan, & Young, 2003; Fuchs & Fuchs, 2006); we are not aware of references to morphological instruction in RTI research (e.g., Al Otaiba & Fuchs, 2006; Spear-Swerling & Cheesman, 2012) or curricular resources for teachers (e.g., Bender & Waller, 2011; Hall, 2008).

There are of course good reasons for the focus on phonology (especially in alphabetic orthographies), not least that phonology seems to be the locus of many poor readers’ difficulties and there is strong evidence that instruction in phonological processing produces gains in reading achievement (e.g., Hulme, Bowyer-Crane, Carroll, Duff, & Snowling, 2012; National Reading Panel, 2000). But neither of those arguments excludes the potential value of morphological instruction in conjunction with phonological instruction. Furthermore, some children struggle despite intensive phonics instruction; these “treatment resisters” or “nonresponders” (e.g., Blachman, 1994; Torgersen, 2000) highlight the need to look beyond phonological instruction. Al Otaiba and Fuchs (2006) concluded, “Our nonresponders clearly required a secondary level of
intervention, using a different method or combination of methods delivered with greater intensity than was available to our study participants” (p. 428). Although they did not mention morphological instruction, it is a clear candidate for instructional research with less able readers. Our binding agent theory suggests that morphological knowledge could act as a support for children with fundamentally poor phonological skills.

Bowers et al. (2010) and Goodwin and Ahn (2013) each addressed the effectiveness of morphological instruction for less able students. Findings showed that morphological instruction was more beneficial for the less able. Compared to control groups, Bowers et al. found the effect sizes for sub-lexical morphological outcomes were 0.99 for less able compared to 0.65 for undifferentiated samples. For non-morphological sub-lexical outcomes, the same comparison was 0.63 to 0.27. Effect sizes at the lexical and supra-lexical levels were 0.57 and 0.67 for the less able, compared to 0.40 and 0.27 for the undifferentiated samples; all of these became smaller when the comparison was made to alternative treatments, but those for the less able remained substantial (0.24 for lexical, 0.39 for supra-lexical). Goodwin and Ahn (2013) found overall effect sizes of 0.29 for typical achievers, 0.37 for children with learning disabilities, 0.35 for children characterized as poor readers or spellers, and 0.54 for children who were English language learners. Bowers et al. cautioned that many of the studies with less able learners employed smaller treatment groups than those with undifferentiated samples, so the effect may to some extent be due to group size. Goodwin and Ahn (2013) found that effect sizes varied by group size, 0.42 for individual participants, 0.35 for groups smaller than 12, and 0.29 for larger groups, but this difference was not statistically significant. Although some question remains about the effect of group size, the results support the use of morphological instruction with less able readers.
One example illustrates the value of morphological instruction for children with dyslexia. Berninger et al. (2003) randomly assigned grade 4 - 6 dyslexic students to either a phonological or a morphological treatment. They found that students from both treatments improved equally in accuracy of phonological decoding, but that those who received morphological instruction improved significantly more in efficiency of phonological decoding than did those in the phonology treatment. Berninger et al. suggested that this occurred because “decoding depends on an interaction between phonological and morphological awareness” (p. 403), which is exactly what the binding agent theory would predict.

Several recent non-experimental studies also provide evidence for the benefits of morphological instruction for students facing educational challenges. Wolter and Green (2013) reported a case study in which morphological instruction for one eight-year-old boy with speech, language, and literacy deficits led to what they described as clinically significant improvements in phonological awareness, vocabulary, and reading comprehension. In a feasibility study (no control group), Apel, Brimo, Diehm, and Apel (2013) reported medium to very large clinically significant gains in word reading, spelling and reading comprehension from a morphological intervention with Kindergarten, grade 1 and grade 2 students from low socioeconomic status homes. There is thus general support for the value of offering morphological instruction to learners with educational challenges (see also Wolter & Dilworth, 2014; Apel & Diehm, 2014).

It is not yet clear why morphological instruction works well with less able learners (see also Elbro & Arnbak, 1996). It may offer these students a compensatory strategy, allowing those with phonological deficits to rely more on relative cognitive strengths in orthography and meaning. Drawing attention to morphology may support the degraded phonological processing by clarifying some of the relationships between orthography and phonology. Rather than
describing many words as exceptions in need of memorizing, morphology may provide these students with a greater sense of the orderliness of English spelling. For less able students with less phonological skill, that increased sense of orderliness may facilitate perception of spelling-meaning-pronunciation connections, such as those between the words *cause* and *because* or *do* and *does*. Further research is warranted to determine the mechanism of the benefit of morphological instruction for less able learners.

**Integration of morphological instruction with other aspects of literacy instruction**

As is emphasized in our binding agent theory, a key feature of morphological knowledge is that it links the key systems in language and literacy (see Figure 1). Thus we expect morphological instruction to be most effective when integrated with other features of language and literacy instruction. Bowers et al. (2010) compared the effects of morphological instruction carried out in isolation to those when it was taught along with other language and literacy instruction, most typically phonological features of language. Effect sizes for integrated instruction were somewhat larger at the lexical (0.46) and supra-lexical (0.37) levels than they were for isolated instruction (0.38 lexical and 0.26 supra-lexical). Effect sizes were usually smaller when compared to alternative treatments, but those for integrated instruction remained substantial (0.22 for lexical, 0.39 for supra-lexical). Goodwin and Ahn (2013) investigated the effect of isolated versus integrated morphological instruction and found no difference (the effect size was 0.31 in each group). To our knowledge there have not been any studies which have explicitly compared integrated with isolated instruction, so these comparisons necessarily involve comparing studies which differed in many other respects. There may be complex interactions underlying these effects which there is not yet enough data to test. For example, integrated instruction may be more likely to have been delivered by regular classroom teachers...
than by researchers; while researchers may be more effective in teaching morphology per se, teachers may be more effective in teaching for transfer. Further, isolated instruction may be beneficial when introducing a new skill, but integration may be more effective over time. We remain optimistic that instruction which integrates morphology, phonology, and orthography will be shown to be superior to that which does not, but more precise studies are required.

To investigate this question more carefully, studies could be conducted to compare integrated and isolated instruction explicitly, or to compare the effects of phonological instruction alone, morphological instruction alone, and a combination of morphological and phonological instruction. The recent study by Devonshire et al. (2013) provides important results concerning the effect of integration. Their study of 5 to 7 year-old students compared instruction about morphology, etymology, phonology, and their interrelation with instruction in phonics only. They found significant advantages for the integrated instruction on the word reading and spelling measures. We address this and other studies, and the topic of integrated instruction in terms of theory and practice further in the next section.

**Designing Morphological Instruction: Theory and Practice**

The evidence reviewed here supports the conclusions that morphological instruction (a) contributes positively to literacy outcomes compared to typical classroom instruction and does no harm, (b) performs at least as well as, and often better than, other experimental treatments, (c) is effective, and even more effective, with younger and less able learners, and (d) may work more effectively when combined with other aspects of literacy instruction. These conclusions are consistent with the morphophonemic nature of English, with the binding agent theory of morphology, and with other non-experimental evidence described in the first part of this chapter. We conclude that there is sufficient scientific evidence to recommend that teachers should
include explicit instruction in morphology in their literacy classes, especially for younger and less able learners. Although there have been suggestions that morphological instruction may be helpful for children with dyslexia (e.g., Elbro & Arnbak, 1996), the dominant message in the educational literature has been to the contrary. The results of this review support the recent growth in interest in providing morphological instruction to less able learners (e.g., Nagy, Carlisle, & Goodwin, 2013). McCutchen et al. (2013) found transfer of morphological instruction to improved use and spelling of morphologically complex words in sentence writing tasks, with particular benefits for less able students. They hypothesized that less able students may be less effective in spontaneously generating insights about morphological structure and semantic-orthographic relationships, and thus may gain more from explicit morphological instruction.

Integrating morphology into literacy instruction also has a strong logical and theoretical basis. English is morphophonemic. For instruction to accurately represent orthography it must address the interrelation of morphology and phonology. The connectionist triangle model (Seidenberg, 2005), triple word form theory (Berninger & Richards, 2002; Richards et al., 2006), the lexical quality hypothesis (Perfetti, 2007), and our binding agent theory emphasize that learning to read and spell involves coordinating phonological, orthographic, and semantic features of words. Morphological knowledge helps bind these features together and explain how oral and written language are related. Berninger et al. (2003, 2008) cited this interrelatedness of oral and written language to explain the positive effects of morphological instruction not only on word-level measures, but also on phonological outcomes. Bowers and Kirby (2010) argued that children who had received morphological instruction were more able to overcome the hindering effects of phonological and orthographic opacity when defining multimorphemic words. These
forms of opacity are barriers to the integration of orthographic, phonological, and semantic information (Carlisle, 2003); examples of opacity include phonological shifts (e.g., heal – health) and spelling changes (e.g., carry – carriage) between morphological relatives.

But how should morphological knowledge be taught? The main focus of the morphological instruction research so far has been to determine whether it is effective; we suggest that research and application attention needs to turn away from does it work, to how does it work, and how could it work better. We first consider general features of the approach to instruction, and several instructional tools that we find useful. We then turn to the research and curriculum design questions that need to be addressed in applying what has been learned so far and in improving the effectiveness of morphological instruction.

**General approach to morphological instruction**

One of the potential benefits that morphological instruction offers is that it can be motivating when presented as a problem solving process with understanding as the objective. Anglin (1993) described morphological problem solving as a process by which individuals analyze unfamiliar morphologically complex words into constituent meaning elements (bases, prefixes, and suffixes) and use that information to deduce the meanings of those words. This problem solving orientation to morphological word study has been cited as a way of increasing student motivation for learning in a number of morphological interventions. Studies by Baumann Edwards, Boland, Olejnik, and Kame’enui (2003), Berninger et al. (2003), Bowers and Kirby (2010), and Tomesen and Aarnoutse (1998) each used the theme of students acting as “detectives” to frame their instruction. Each reported anecdotally that they saw children enjoying this problem-solving process of working with morphology.
Understanding is cognitively and intrinsically motivating. If limited to phonological information, instruction treats as irregular many spellings that can be understood when the interrelation of morphology and phonology is addressed. Treiman and Kessler (2005, p. 133) noted, “Teachers who consider English a chaotic and unprincipled writing system likely foster a similar view among their students. Such pupils may not 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.”

Another tactic is to make use of morphological instruction in a variety of curriculum areas, not just language arts. This will strengthen the morphological knowledge acquired, by increasing the number of exposures and representations, and also by demonstrating usefulness. Furthermore, many school subjects, such as science, require the learning of extensive new vocabulary; given that morphological instruction can provide generative vocabulary learning (e.g., Baumann, Edwards, Font, Tereshinski, Kame'enui, & Olejnik, 2002; Baumann et al., 2003; Bowers & Kirby, 2010), it should also provide a means of building understanding of concepts and terms of any subject area. So far few researchers have explicitly embedded morphological instruction within particular subject areas. Baumann et al. (2003) integrated their instruction with Social Studies and found vocabulary benefits from morphological instruction. McCutchen et al. (2013) made use of science for their intervention for Grade 5 students. Infusing morphological thinking across the curriculum may be difficult for researchers to accomplish by themselves, but is something that skilled teachers who understand morphology could do.

It is important to add that the teachers who will deliver the morphological instruction need to be convinced of its effectiveness and need to learn about morphology and its role in literacy.
We know of no research on the explicit morphological knowledge of teachers but our informal observations suggest that it is low.

**Tools for morphological instruction**

There are several instructional tools that have not been used widely but merit mention because we think they are potentially very effective regardless of how instruction is designed (Bowers & Kirby, 2010). The first tool is the word sum, in which words are decomposed into morphemes or alternatively reconstituted from morphemes (see Figure 2 for examples); some of the conventions shown in these word sums, such as the deleting of final es and the doubling of final consonants, provide structured ways for students to remember simple procedures. The second is the word matrix, which shows some of the prefixes and suffixes that can be used with a particular base (see Figure 2). A word matrix represents members of a morphological family around a central base. Figure 2 shows examples of matrices appropriate for students across the elementary years. See Bowers and Cooke (2012) for more on how the word matrices correspond to C. Chomsky’s (1970) abstract concept of a lexical spelling. These tools were highlighted by Henry (2003/2010), but were not incorporated into interventions until Bowers and Kirby’s (2010) study. Devonshire et al. (2013) used word sums and word matrices in their intervention with 5-7 year olds (Devonshire, personal communication, January 20, 2015). Both of these tools provide concrete representations of morphological structure. They encourage the formation of integrated memory representations and decrease unnecessary cognitive load (Schnotz & Kürschner, 2007; Sweller, Ayres & Kalyuga, 2011).

------ Insert Figure 2 about here ------
For a problem-solving approach to work, students need ways to determine if their morphological analyses are supported or rejected by the evidence. We have found what we call the structure and meaning tests to be useful; for an analysis to be accepted, both tests must be passed. In the structure test, students must make a coherent word sum to support their analysis; for example, \( \text{dis} + \text{ease} \rightarrow \text{disease} \) and \( \text{un} + \text{help} + \text{ful} \rightarrow \text{unhelpful} \). These structural analyses would support \text{disease} being part of the \text{ease} word matrix and \text{unhelpful} being part of the \text{help} matrix. To be coherent, each morpheme must be shown to have a similar purpose in another word, and all suffixing conventions (replacing single, silent \(<e>\)s, doubling final, single consonants, and changing \(<y>\) to \(<i>\)) must be followed. By contrast, the hypothesis of a \(<\text{-tion}>\) suffix in \text{relation} is rejected when tested with a word sum that proves to be incoherent (\( \ast \text{rela} + \text{tion} \rightarrow \text{relation} \)). Rejecting this hypothesis motivates seeking an alternative such as \(<\text{-ion}>\), which is then confirmed as structurally coherent (\( \text{relate/} + \text{ion} \rightarrow \text{relation} \)).

However students could also come up with \( \text{disco} + \text{very} \rightarrow \text{discovery} \), or \( \text{lite} + \text{racy} \rightarrow \text{literacy} \); both of these would pass the structure test. The meaning test, intended to reject such hypotheses, asks students to use etymological references (such as a good dictionary or www.etymonline.com) to see if the word in question shares a common root origin with the other words formed by a matrix. Investigation of the roots of \text{disco} and \text{very} shows that there is no historical meaning connection between these words and discovery, just as \text{lite} and \text{racy} share no connection with literacy. Students and their teachers may enjoy discovering that words that seem related, such as \text{display} and \text{playful}, or \text{able} and \text{capable}, or \text{pencil} and \text{pen}, do not share the same roots and thus should not appear in the same word matrices. For more about the structure and meaning tests and instructional examples, see Bowers (no date).

**Design principles and research questions for morphological instruction**
In designing instructional programs, a large number of tactical and strategic choices must be made; some sense of the range of instructional methods may be seen in Table 1, and others are available on several websites (http://wordsinbogor.blogspot.ca/, and https://www.WordWorksKingston.com). Ideally, each of these choices should be supported empirically, but the sheer number of choices and their interactions, plus the need to assess them at various age levels and with different content, makes this unlikely to happen. We would encourage both teachers and researchers to experiment, both formally and informally, with methods of morphological instruction. A great deal more evidence is required, even if truly comprehensive evidence is unfeasible. Existing research and theory provide a basis for extracting hypotheses about principles underlying the design of morphological instruction. Although none of these hypotheses has been tested formally and extensively, they nonetheless constitute design principles on which instruction could be based. Each is both a proposal for instructional designers to use and a hypothesis for researchers to test. Accordingly, we conclude this chapter with a set of design principles/hypotheses about developing and refining morphological instruction.

1. Integrate morphological instruction with other aspects of literacy instruction.

   Specifically, show how morphology helps to explain or consolidate phonology, orthography, and semantics, and binds these dimensions to form enhanced representations of words. The evidence about the effectiveness of integration is at best mixed, as Bowers et al. (2010) found a small advantage to it but Goodwin and Ahn (2013) found none. There is a need for studies designed to test this hypothesis explicitly.
2. Extend morphological instruction to include etymology (Devonshire et al., 2013) and other aspects of word study. If morphological instruction has a motivating effect through increased understanding of words, extending it to include other sources of knowledge about words should help, as long as that information is not presented in an overwhelming manner. Understanding how to use etymological information is necessary for carrying out the meaning test described earlier. Demonstrating relationships to other languages could be particularly helpful for English language learners coming from language backgrounds that are strongly related to English’s Latin, French, and Germanic roots.

3. Integrate morphological instruction with subject area learning. As we argued earlier, understanding of morphology should contribute to subjects such as science which require the acquisition of complex new vocabulary. Using morphology in different contexts should enhance skills through practice and strengthen mental representations.

4. Employ an inquiry-based, problem-solving approach. This should involve teaching students to develop and test hypotheses about the morphology of words, and how to reject plausible foils. Teach how to use the word sums, word matrices, and the structure and meaning tests.

5. Morphological instruction should address the meanings and uses of prefixes and suffixes, but should also target the meanings of words and bases, including bound bases. Knowledge of morphology is an aspect of vocabulary depth (Li & Kirby, in press), and should be integrated with other aspects such as polysemy.
6. Teach morphological families (i.e., those represented in word matrices) rather than isolated morphemes.

7. Target instruction to reduce the effects of phonological and orthographic opacity. Teach the consistent underlying spelling of morphemes, despite pronunciation shifts, and the patterns for spelling changes due to suffixing.

Our final two design principles concern the transfer of morphological knowledge to word reading and spelling and reading comprehension. Transfer is a much-esteemed quality in education, but it requires careful planning to occur. Salomon and Perkins (1989) described several paths to successful transfer, one a low road requiring extensive guided practice and the other a high road involving mindful abstraction. Both are recommended.

8. Target transfer to reading and spelling of unknown words. Use of morphological knowledge, whether acquired tacitly or deliberately through instruction, in reading and spelling words requires both practice and insight. Examples and exercises should demonstrate the multiple pathways in Figure 1.

9. Target use of morphology in interpreting sentences and paragraphs. We know from predictive studies (e.g., Kirby et al., 2012) that morphological knowledge has a particularly powerful effect on reading comprehension, but this does not show up strongly in the meta-analyses (Bowers et al., 2010; Goodwin & Ahn, 2010, 2013). Explicit instruction and extensive practice is likely required to insure that transfer occurs. In this case, instruction should focus on the semantic and syntactic clues yielded by morphological analysis of unfamiliar words or sentence structures.

Conclusion
Morphological instruction offers considerable potential to contribute to literacy outcomes. This review has shown that morphological instruction is beneficial for word reading, spelling, vocabulary, and reading comprehension, and is particularly beneficial for younger and less able learners. Morphology has been largely ignored in literacy instruction until recently (Nunes & Bryant, 2006). As Perfetti argued, “… because attention to morphology has travelled on the wake of an ascendant phonology, its importance has been a bit obscured” (2011, p. 159). It is important to emphasize that there is no suggestion here that morphology replace phonologically-oriented instruction. Instead we suggest that morphological instruction be integrated with phonological instruction, and that together they will enhance literacy; morphological and phonological knowledge are complementary, not contrary. The essence of our binding agent theory is that morphology is not yet another topic to add to a crowded curriculum but instead a linking process that helps learners make sense of the key components of semantics, phonology, and orthography and their interrelationships. The evidence for the effectiveness of morphological instruction is promising, but there is still need to determine how to optimize both the methods and content of morphological instruction. We suggest that researchers and teachers turn their attention now to refining and improving morphological instruction, for instance by investigating the validity and implementation of the design principles offered above.
References


Table 1.

*Characteristics of morphological instruction (adapted from Bowers, Kirby, & Deacon, 2010).*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Feature</th>
<th>Count (out of 22 studies)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphological Content</td>
<td>Integrated morphology with other aspects of literacy instruction</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Targeted prefixes and/or suffixes</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Targeted bases or stems</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Targeted bases or stems for word meaning</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Targeted bound bases</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Targeted compound words</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Targeted word origin</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Oral morphology only</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Oral and written morphology</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Targeted consistent spelling of morphemes despite phonological shifts</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Targeted patterns of orthographic shifts in suffixing patterns</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Explicit link of morphology and grammar</td>
<td>4</td>
</tr>
<tr>
<td>Morphological tasks</td>
<td>Morphological analysis</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Morphological synthesis</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Morphological recognition (sorting, selecting)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Morphological production (cloze, analogy)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Morphological analysis with morphological foils</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Morphological problem solving approach</td>
<td>6</td>
</tr>
</tbody>
</table>

Note: See Bowers et al. (2010) for details.
### Table 2

**Reviews of Morphological Instruction.**

<table>
<thead>
<tr>
<th>Source</th>
<th>Sample</th>
<th>Findings</th>
</tr>
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<tbody>
<tr>
<td>Reed (2008)</td>
<td>7 studies</td>
<td>Benefits overall</td>
</tr>
<tr>
<td></td>
<td>K to Grade 12</td>
<td>Especially less able</td>
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<td></td>
<td>Undifferentiated</td>
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<tr>
<td>Bowers, Kirby &amp; Deacon (2010)</td>
<td>19 studies</td>
<td>Benefits overall</td>
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<tr>
<td></td>
<td>Pre-school to Grade 8</td>
<td>Larger effect for less able</td>
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<tr>
<td></td>
<td>Undifferentiated</td>
<td>Larger effect for younger</td>
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<tr>
<td>Goodwin &amp; Ahn (2010)</td>
<td>17 studies</td>
<td>Significant effects for less able</td>
</tr>
<tr>
<td></td>
<td>Pre-school to Grade 12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Children identified with learning disabilities</td>
<td></td>
</tr>
<tr>
<td>Carlisle (2010)</td>
<td>16 studies</td>
<td>Benefits overall even with youngest students</td>
</tr>
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<td></td>
<td>K to Grade 12</td>
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<td></td>
<td>Undifferentiated</td>
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<tr>
<td>Goodwin &amp; Ahn (2013)</td>
<td>30 studies</td>
<td>Significant differences in effects</td>
</tr>
<tr>
<td></td>
<td>Pre-School to Grade 12</td>
<td>Larger effect with younger</td>
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<td>Undifferentiated</td>
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Figure 1. Model showing morphology as a binding agent relating semantics, orthography, and phonology.
Matrices of orthographic morphological word families

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**Figure 2.** Examples of word matrices and word sums. Each matrix represents an orthographic morphological word family (words that share a written base). A matrix can include more than one base as in the compound *<bankrupt>*. The forward slash in a word sum signals the suffixing change that occurs when vowel suffixes are added to a base or stem (a base with at least one suffix) with a final, single, silent <e>. That same slash can also be used to show <y/>/<i> changes (e.g., try/ + es ➔ tries). Parentheses can be used to show doubled consonants (e.g., hop(p) + ing ➔ hopping).