Morphology in Reading and Writing

John R. Kirby

Queen's University, Kingston, Canada

This is the English version of a chapter that has been translated into Greek and submitted to appear in a book entitled *Morphological processing in written language acquisition for the Greek language*, edited by S. N. Tsesmeli and G. Manolitsis. Some changes will be made in the Greek version, to address aspects of Greek language and orthography.

Abstract

This chapter reviews current research about the contributions of morphological knowledge (or awareness) to literacy skills including vocabulary, word reading, spelling, and reading comprehension. The chapter presents a theoretical framework for understanding morphology's roles in literacy and describe how current knowledge about morphology can be applied to enhancing students' literacy attainments. Although the primary focus is on elementary school aged children, some results concerning older participants are also described.

The chapter has four main sections. The first section explains the various types of morphemes (bases, prefixes, and suffixes; inflectional and derivational morphemes) and how they are combined in words. This section also addresses the issue of transparency/opacity, in terms of phonology, orthography, and semantics. Morphological knowledge and morphological awareness are defined.

The second section presents a theoretical framework explaining the ways in which morphological knowledge or awareness can influence literacy skills. Three major paths will be described, with morphology contributing (a) to decoding, (b) to word meaning and then to vocabulary and reading comprehension, and (c) to grammar and then to reading comprehension.

The third section summarizes the results of correlational studies, in which measures of morphological knowledge or awareness are used to predict current or later literacy skills.

The final section reviews the effects of morphological instruction on literacy outcomes, both for typically developing children and those with special needs, specifically those with dyslexia or poor comprehension. Different instructional approaches and methods will be described.

The chapter ends with conclusions for future research and classroom applications.

Literacy remains one of our species' most remarkable cultural achievements. Whereas we are genetically programmed to speak and understand whatever oral language(s) to which we are exposed as children, more effort needs to be expended to acquire literacy, and there needs to be assistance to introduce and structure that learning. Despite the best efforts of parents and teachers, many children struggle to learn to read and write. Many children qualify as reading disabled, indicating they have extraordinary trouble either recognizing words (dyslexia) or understanding what they read (poor comprehension). Even the "normal" level of reading ability in any age group could stand to be improved. The last 40 years have seen an explosion in the amount of research devoted to uncovering how reading develops, what factors facilitate or impede this development, and how teaching can be designed to improve literacy. One factor that has seen a recent increase in interest is morphology, the study of the meaningful components of words. The purpose of this chapter is to review current research about the contributions of morphology to literacy skills including vocabulary, word reading, spelling, and reading comprehension.

Morphology is a basic component of language, both oral and written (Kirby & Bowers, 2017, 2018; Venezky, 1967), but most people are relatively unaware of how it works in their language. It has not often been taught (Nunes & Bryant, 2006), at least partly because teachers are not aware of it or its value. As will be seen later in this chapter, adults have an implicit knowledge of morphology which they use in understanding what they hear and read. In the last 20 years or so there has been a tremendous increase in the amount of research related to reading, and this research has begun to influence classroom practices and government-mandated curricula.

The remainder of the chapter is organized in four main sections. The first section defines what morphology is and describes the various types of morphemes and how they are combined in words. This section explains what is meant by morphological knowledge and morphological awareness and

discusses why some morphological constructions may be difficult for children to recognize. The second section presents a theoretical framework explaining the ways in which morphological knowledge or awareness can contribute to literacy skills. The third section reviews the results of correlational studies, in which measures of morphological knowledge or awareness are used to predict current or later literacy skills. The final section examines the effects of morphological instruction on literacy outcomes, both for typically developing children and those with special needs, specifically those with dyslexia or poor comprehension.

The Nature of Morphology in Language and Writing

Morphology concerns the internal structure of words, analyzing words into meaningful units called morphemes. It is a property of both oral and written language. Languages vary in how much they make use of morphology, some having few morphemes per word and others more (see Haspelmath & Sims, 2010, or other general linguistics texts for more on this). Morphology allows a large number of words to be generated from relatively few morphemes. For example, Nagy and Anderson (1984) estimated that the approximately 415,000 words that make up written English can be grouped into 88,500 morphological families. Hiebert et al. (2017) showed that 11,298 words in 2,451 morphological families account for 58% of the 19,500 most frequent words in written English. There are approximately 100,000 words in Greek, of which about 64,000 are derivations and compounds (Babiniotis, 2016). Derivations/compounds usually form large word classes, e.g., the verb "λέγω" /leɣo/ [speak] creates a family of 1530 words (Babiniotis, 2016, p. Π248), while its derived noun "-λόγος" /-loɣos/ [speech, discourse, reason] as a second word stem, creates a class of 242 words (Babiniotis, 2016, p. Π254), e.g., psycho + log + y, bio + log + y, etc.

How morphology works

There are several types of morpheme. In English, as in Greek, there are three types: bases, prefixes, and suffixes. Bases carry the central meaning of the word, for instance *read* in *reader*, *unread*, and *reading*. Prefixes and suffixes are attached at the beginnings or ends of words, for instance in *prereader* or *readability*. Some bases contain more than one morpheme; a base that cannot be analyzed further is called a root. To illustrate, the base of *readability* is *readable*, but its root is *read*. Other languages have other types of morphemes, such as infixes, in which a morpheme is inserted within the base (e.g., Arabic), or circumfixes, in which the added morpheme has two parts, one inserted before the base and the other after (e.g., German).

Morphemes are combined to make words in three ways: by inflecting, deriving, and compounding. Inflections change the grammatical nature of a base, such as number (in English, adding *-s* for plural), tense (adding *-ed* for the past tense), or gender (in French, *grand* (tall) is an adjective for masculine nouns, *grande* for feminine nouns). Languages vary greatly in how many inflections they have: English has relatively few, French many more. Derivations alter the meaning of the word, for instance from *act* to *action*, sometimes changing the grammatical category (from verb to noun in this case, though *act* may also be a noun). There are a very large number of derivational morphemes; in English, prefix derivational morphemes include *un-*, *re-*, *dis-*, *in-*, and *inter-*, while suffix derivational morphemes include *-y*, *-er*, *-ment*, and *-able*. For lists of productive derivational morphemes in English, see Lane et al. (2019). The third type of morphological construction is compounding, in which two bases are joined, English examples including *deadline*, *firewood*, and *bookshelf*. Languages such as Chinese make greater use of compounding than does English.

Another distinction that is important is that between free and bound morphemes. Free morphemes can stand alone as words, for instance *walk* or *read*. Bound morphemes cannot. Prefixes and suffixes

are not words by themselves, so they are bound morphemes by definition. In English there are many bound morphemes that are bases; for example, the base of *construction* is *-struct-* which is not a word by itself. Many of these bound bases have come to English from Latin and Greek (see Lane et al., 2019 for examples). In Greek, there are few free morphemes, mainly functional words, because Greek is a stem-based language (Ralli, 2013), meaning that the vast majority of Greek origin content words bear inflections.

Morphology and orthography

Oral languages are systems to connect sounds to meaning. Our species has been speaking and understanding for a very long time, probably as long as our species has existed, and perhaps earlier version of our species did too (Boë, et al., 2019). Written language is much more recent, with the oldest examples being about 4,500 years old. A writing system, or an orthography, is a means to connect visual material (print) to sounds and meaning, thus forming a triangle. The sides of this triangle are networks of connections whose complexity depends upon the nature of the language and orthography involved. For more on this connectionist model, see Castles et al. (2019) and Seidenberg (2005).

There are three basic types of orthographic systems: logographies, syllabaries, and alphabets. These differ in the ways they connect print to sounds and meaning. Logographies began as sets of pictures to represent simple nouns or actions, and thus are originally connections between print and meaning. The complexity and abstractness of the pictures developed as the orthography was used to represent more and more complex and abstract ideas. Because it is difficult to create pictures which represent all words, such systems tend to give hints to the reader about the sounds that are part of the words intended. Chinese is a good example of a modern logographic orthography, with complex characters containing sub-characters, some of which relate to meaning and others to sounds (the so-called semantic and phonetic radicals).

The second type of orthography, the syllabary, connects print to sound, but the sounds are whole syllables. Modern Japanese uses syllabic writing (*kanas*) to write words for which they do not have a *kanji* character. Syllabaries are ideal for oral languages that have a dominant consonant-vowel structure. Readers of this book may be interested to know that Mycenaean Greek (Linear B) was written as a syllabary, which because of its more complex syllables required some adjustments (wikipedia.org/wiki/Syllabary#Languages_using_syllabaries).

The most common writing systems today are alphabets. They also connect print to sound, using smaller units than syllables; they connect graphemes (letters or combinations of them) to phonemes. All modern alphabets are thought to have originated in the Middle East about 3000 years ago, starting in the Western Desert of Egypt and moving to the lands of the Canaanites, Hebrews, Phoenicians, and Arameans (Flanders, 2020). Since that time, alphabets have spread in various directions, being applied to new oral languages and then adapted to fit those languages better. Alphabets reduce the number of written characters that need to be learned, but the resulting 20-30 characters do not always do a complete and efficient job of representing the sounds of any language. English for instance has 44 individual phonemes but only 26 letters. Greek has 25 phonemes (Triantafilidis, 1975; Tombaidis, 1995), represented by 24 letters.

Morphology has an interesting relationship to the triangle of phonology-semantics-orthography (Kirby & Bowers, 2017, 2018). Morphemes are clearly units of meaning, so they are intimately related to semantics. In most languages, morphemes have a very consistent spelling, so they are related to orthography. Morphemes also relate to how sequences of letters are pronounced, so they are related to phonology. More on this in the Theoretical Framework section.

Transparency

An important aspect of spoken or written words is transparency, the ease with which their meaning, sounds, or spelling can be deduced from the other dimensions. For instance, *phonological transparency* refers to how difficult it is to "sound the word out" from its letters; English has many examples of words with low phonological transparency (e.g., yacht), whereas Greek is very phonologically transparent (see Manolitsis & Tafa, 2011, for details). Orthographic transparency refers to how difficult it is to determine a word's spelling from its sounds or meaning; an English example would to the past tense of "buy" (bought) – even if you know its sounds, how do you spell it? Whereas English is often orthographically opaque, Greek is usually quite transparent; when several letters make the same sound, the choice is governed by orthographic rules (Manolitsis & Tafa, 2011). For morphology, orthographic transparency concerns how words' spellings change when affixes are added. In this sense, English is very transparent, with simple rules governing orthographic changes; for instance, final silent e's are dropped when suffixes beginning with a vowel are added, as in hope → hoped, whereas final consonants are doubled, as in hop → hopped). In Greek, affixes are also added with few spelling changes, and those are governed by rules. Finally semantic transparency refers to how difficult it is to see the meaning of a word from its sounds or written form. For morphology, this relates to how distant a derived word is from its root; while the relation between *sign* and *signage* is clear, that between *sign* and *assignment* is opaque. In general, transparency of all three types makes it easy to see morphological relationships between words, while opacity makes it difficult.

Morphological Awareness, Morphological Knowledge, and Explicitness

The terms morphological awareness and morphological knowledge are often used interchangeably, but sometimes an important distinction is made. Morphological awareness is usually defined as the combination of an individual's sensitivity to morphological and ability to manipulate morphological structures to achieve certain goals (see for instance Carlisle, 1995). Morphological

knowledge (or morphological processing) is a broader category, including morphological awareness, that concerns any knowledge the individual may have about morphology, even if it does not rise to the level of “awareness”. It is important to understand that anyone who has been exposed to oral or written language has some level of morphological knowledge, even if they are not aware of it, and even if they do not know the word “morphology”. Priming studies demonstrate this clearly (Armenta & Crepaldi, 2012). In these studies, participants are shown a series of words on a screen, one at a time, and asked to judge if each display is a real word (some are not). If the participants see a word consisting of two or more morphemes (say *readable*) and later see *read*, they are faster to respond to *read* than if they had not seen a word containing the morpheme *read* earlier. This is strong evidence that participants are analyzing the multimorphemic word *readable* into its constituent morphemes, even though they were not asked to do so and do not report having done so. This can also be shown in masked priming studies, in which the multimorphemic word is presented so briefly that the participant is unaware of having seen it (see Armenta & Crepaldi, 2012, for a review).

It is important to consider how morphological awareness or knowledge is measured. Deacon et al. (2008) proposed three dimensions to consider as a taxonomy of the tasks used to measure morphological processing: modality of input/output, content, and process. Modality refers to the extent to which the task involves oral or written material and response. Written presentation may disadvantage those with reading difficulties, resulting in an underestimate of their morphological skill, but oral presentation may disadvantage those unfamiliar with the pronunciation used by the tester. Oral presentations or responses could also be challenging in situations where more than one dialect is employed (Tibi & Kirby, 2017). The task content has several aspects, including whether knowledge of bases or affixes is emphasized; whether real words or pseudowords, or high or low frequency words, are the stimuli; whether inflections, derivations or compounding is assessed; and extent to which the

morphological relations involve phonological, orthographic, or semantic transparency/opacity. The process dimension also has several aspects, including whether the task requires judgement (e.g., selecting one of three options) or production (creating a morphological derivation), and whether the task draws upon explicit or implicit knowledge (more explicit knowledge is required to identify the base of a complex word or explain the morphological relations among words, whereas less explicit knowledge is needed to indicate which of two provided words is correct. Other dimensions may be relevant, as is seen in the next section.

Is morphological awareness or knowledge multidimensional? As we will see in the following section, several authors have examined how different aspects of morphological knowledge relate to each other and to various types of reading ability. For instance, Levesque et al. (2021) have shown that morphological awareness contributes to morphological decoding and morphological analysis, which each then contribute, respectively, to word reading and reading comprehension. Goodwin et al. (2017) identified seven specific factors of morphological knowledge, each related to certain areas of reading or spelling. All of the various aspects of morphological awareness or knowledge are correlated with each other, so whether one employs the general factor or more specific ones should depend upon one's purpose. However, it seems clear that the various factors stem from a more general awareness of morphology, so instructional efforts, as outlined in a later section, should be aimed at this general skill first, and then to its specific applications. Furthermore, there is at least some evidence (Spencer et al., 2015) that morphological awareness and vocabulary form a single latent dimension. Even if this were true, it does not mean that individual aspects of the broader trait cannot be measured separately and targeted in interventions.

A Theoretical Framework for Morphology and Literacy

It is helpful to consider the ways in which morphological knowledge can contribute to word knowledge, reading, and writing. Earlier we saw the triangle model of reading, with the suggestion that morphology acts as a binding agent (Kirby & Bowers, 2017, 2018), helping to relate and integrate the phonological, orthographic, and semantic nodes in a network (see Figure 1). The lines in this model represent multiple bidirectional excitatory and inhibitory pathways with hidden units (Castles, et al., 2019; Seidenberg, 2005). In a transparent orthography, there may be relatively simple paths between graphemes and their corresponding phonemes, whereas in a more opaque orthography there may be multiple paths with contextual inputs from neighbouring graphemes. The activation of the network as a whole constitutes knowledge of a word; partial information from any node can compensate for missing information from the other nodes. As reading skill develops, the importance of individual connections should change: pronunciation of an unfamiliar word may require grapheme-by-grapheme decoding into sounds, before those sounds can be integrated into a word, but with increased familiarity the graphemes may be recognized in groups or as a whole word. With each encounter of a word, the network as a whole is strengthened and becomes faster and more automatic. As it becomes more automatic, the individual necessarily becomes less aware of its functioning.

Languages differ in whether particular syllables are stressed when the word is pronounced. In English, every multisyllabic word has a syllable that is stressed when it is pronounced (SYLlable, not sylLAble). Where stress is placed depends on the word's grammatical role (REcord is a noun, reCORD is a verb, and on morphology (the stress in eLECtric shifts when *ity* is added: elecTRICity). As in English, all multisyllabic Greek words have an accented syllable that is stressed when pronounced. Stress is also dependent on certain phonotactic rules in Greek. For stress issues in Greek, see Protopapas and Gerakaki (2009) and Grimani and Protopapas (2017). This is another way in which

morphology is related to phonology, but phonology at the suprasegmental level (Chan et al., 2019; Wade-Woolley & Heggie, 2015).

The network strengthens through experience and through instruction. Experience leads to statistical learning (Steacy, et al., 2017), perhaps without conscious awareness. Repeated encounters of the orthographic sequence *r-e-a-d* in various words (reader, reading, readable, prereader, etc.) lead to its being processed as a single orthographic unit, and the shared meaning of those words develop the unit as a morpheme. Subsequent encounters of that morpheme in unfamiliar words (misread or readout) will generate inferences about pronunciation and meaning. Encountering the same grapheme string in unrelated words (e.g., ready) will help to tune the network, making it take semantic context into account. Given the lack of deliberate instruction in morphology, it is likely that the morphological knowledge revealed in priming studies (Armenta & Crepaldi, 2012) is largely due to experiential statistical learning. Development of the network also responds to deliberate instruction, though it may be a slower process than most teachers think.

Levesque et al. (2021) have elaborated on a comprehensive model for how morphology contributes to reading and writing, the Morphological Pathways Framework. They review evidence that morphological awareness has three effects on reading; the first is a direct effect on reading comprehension, the second an effect of morphological awareness on morphological decoding, which then affects word reading, which then contributes to reading comprehension; and the third is an effect of morphological awareness on morphological analysis, which then contributes to reading comprehension (see also Deacon et al., 2014; Levesque et al., 2017, 2019). Goodwin et al. (2017) concurred with these three components and their effects, but added an important fourth component of morphological awareness of syntax. It is important to note that this fourth component goes beyond recognition of inflectional verb endings. It includes understanding of the grammatical roles of words

once certain derivational suffixes have been added; for example, govern (verb) can become governor or government (nouns), or governable (adjective). Grammatical roles have implications for how sentences are parsed and thus how texts are comprehended.

Combining across these two approaches, we can see four basic components of morphological knowledge and their application in literacy. I suggest that these four components not be seen as independent entities, but rather as interdependent aspects a coherent whole. The four components are shown in Figure 2 as they contribute to word reading and reading comprehension, but they could be adjusted to show how they contribute to word spelling, listening comprehension, and writing. The four components are:

1. Morphological awareness (following Carlisle (1995) and many others) is the basic component, on which the others depend. It comprises individuals' sensitivity to morphological structures in oral and written words and ability to manipulate morphemes to make new words.

2. Morphological decoding is the application of morphological awareness to pronouncing written words. It operates by recognizing morphemic units in words, retrieving pronunciations for those units, and then blending them. As such it integrates phonology and orthography with morphology.

3. Morphological analysis is the application of morphological knowledge to help infer the meaning of new words from their morphemes. This links morphology to word meaning and leads to improved reading comprehension.

4. Morpho-syntax is the application of morphological awareness to understanding the grammatical roles of words as a result of their suffixes. It includes understanding how inflections affect meaning (e.g., present vs past tense vs future tense, or subjunctive mood, in languages that use suffixes

to indicate these variations) and how derivational suffixes indicate the grammatical roles of words. Morpho-syntax therefore contributes to reading comprehension.

All four of these components could work in both directions. For example, morphological analysis would usually go from the presented word to its morphemes' meanings to the word's meaning, but you could start with a meaning to express and search your memory for a morpheme that represents part of that meaning, and then add suffixes to fine-tune the word.

It is also interesting to consider how these components develop and how they may transfer across languages. Tacit, untutored morphological knowledge almost certainly develops over many exposures to multiple words containing frequent morphemes, and this then spreads to the four morphological components. Explicit instruction is required to develop the components further, especially the last three, and especially in orthographies where the morphological units are "disguised" by the three forms of opacity or by distance between parts of the morphemes (as in Arabic).

As for cross-linguistic transfer, I would argue that this may occur at two levels. If one has learned morphology in a first language, then one will expect other languages to behave similarly; the first level is thus only a general sense that morphology should exist. But that first level is not very helpful in practice unless can recognize the actual morphemes. Thus I would expect more transfer between languages that share many cognates (such as English and the European Romance languages) and much less between more distant languages (such as English and Finnish). Differences in alphabet or orthographic system will also make transfer more difficult. Explicit instruction will again help.

Evidence from Correlational Studies

There is now a great deal of evidence in a variety of languages that morphological awareness is positively and moderately-to-strongly correlated with literacy performance (examples: in Arabic: Tibi & Kirby, 2019; Chinese:Liu et al., 2012; Dutch: Verhoeven & Van Leeuwe, 2009;English: Kirby et al.,

2012; French:Casalis & Louis-Alexandre, (2000); Fejzo, 2016). These effects are for a range of literacy variables, including spelling, word and pseudoword reading, word reading speed, vocabulary, text reading speed, and reading comprehension. Furthermore and most importantly, these effects survive the control of other key predictors, including socioeconomic status, verbal and nonverbal ability, phonological awareness, orthographic knowledge, and vocabulary (see Kirby & Bowers, 2017, 2018, for details). These controls are important because they show, for instance, that morphology's effects are not merely due to its correlations with other predictors: it adds unique variance.

There is a growing literature on morphology's predictive value in Greek. For example, Pittas and Nunes (2014) showed that for grade 1 and 3 children, morphological awareness predicted unique variance in reading (a measure of fluency and comprehension), and also in two spelling measures in grade 3, after controlling vocabulary and phonological awareness. Manolitsis et al. (2017) found morphological awareness assessed in kindergarten and grade 1 predicted reading comprehension in grade 2, but not reading fluency, after controlling vocabulary and rapid automatized naming speed. Diamanti et al. (2017) found significant effects of kindergarten morphological awareness on grade 1 word and pseudoword reading accuracy, spelling, and reading comprehension, but again not word reading fluency, after controlling vocabulary and phonological awareness. Although there is some variability in these results, it seems clear that morphological awareness predicts reading comprehension and survives the usual controls. The lack of effect on word reading fluency may be due to the phonological transparency of Greek, but Manolitsis et al. (2017) suggested that the effect does appear when the items on the fluency test are morphologically complex. More studies are called for, especially with older children; it may be that further significant relations develop with greater reading development.

Overall, the strongest predictive effects have been on reading comprehension, but most studies, except perhaps for those in Greek, also show effects on word and pseudoword reading, reading fluency, and spelling. These results make sense in terms of the models described in the previous section, supporting the effect of general morphological awareness on a range of literacy measures. More detailed analyses, presented by the authors of the models (Deacon et al., 2014; Goodwin et al., 2017; Levesque et al., 2017, 2019, 2021) provide support for specific roles of the individual morphological factors in particular aspects of literacy (see details in the previous section).

Evidence from Instructional Studies

There has been a considerable number of experimental studies, primarily of English-speaking children, in which the effects of morphological instruction have been compared to those of control, business as usual, or alternative treatment conditions. These studies have been examined in meta-analyses and other reviews (Bowers et al., 2010; Carlisle, 2010; Goodwin & Ahn, 2010, 2013; Kirby & Bowers, 2017, 2018; Reed, 2008). The overall conclusion is that instruction in morphology contributes to language and literacy outcomes, though the effects vary by the nature of the outcome measures, the age and ability levels of the participants, and how the instruction was designed and delivered. Some of the key points are that morphological instruction was more effective for younger and less able children, and for word reading, spelling and vocabulary as opposed to reading comprehension. This last result contrasts with the correlational research, where the effect of morphological awareness on reading comprehension was the largest effect. Possible explanations of this are that it takes much longer for word level knowledge to generalize up to reading comprehension, that more deliberate instruction is required, and that exposure to multiple texts in which morphology helps comprehension is needed.

These results are consistent with the general outlines of the binding agent theory (Kirby & Bowers, 2017, 2018) and the Levesque et al. (2021) and Goodwin et al. (2017) models. To my

knowledge, there have not been instructional studies that systematically varied the specific target processes in morphology (see Figure 2) or the instructional methods. Therefore, while we can be confident that morphological instruction can be effective, it is not yet clear exactly how it should take place. Kirby and Bowers (2017, 2018) have described guidelines for the design of morphological instruction, but these await detailed validation.

So far there are relatively few studies in Greek of morphological instruction. Manolitsis (2017) examined its effects on kindergarten children's morphological awareness, phonological awareness, and vocabulary; he found improvements in morphological awareness, but the only effects on print knowledge came when morphological instruction was combined with phonological instruction. Manolitsis et al. (2018) compared oral and oral/written combined instruction with a control group in kindergarten, finding that that both treatment groups showed beneficial effects on grade 1 reading comprehension and spelling. However, they did not find that adding the written component had any additional benefit beyond that of the oral instruction. Tsesmeli (2010; Tsesmeli & Tsirozi, 2015) showed that morphological instruction improves the spelling of derivations by Greek children with spelling difficulties, and Tsesmeli (2017) found that morphological instruction helped Greek grade 1 and 2 children spell and understand the meaning of compound words.

There is now sufficient evidence to support the inclusion of morphological instruction in literacy education. The form of this instruction should depend upon the level and skills of the students involved. Instruction for children who have not yet begun reading instruction should begin orally (Lyster, et al., 2016), but quickly include written material once literacy instruction has begun. The relation of morphology to the phonological, orthographic, and semantic components should be the goal, but of course complications should be introduced slowly, with opportunities for a great deal of practice. In addition to general morphological awareness, the three intermediate processes of morphological

decoding, morphological analysis, and morpho-syntax should be taught. Both affixes and bases need to be included in instruction, and care should be taken that new units be introduced slowly, with considerable practice. Four components of morphological instruction suggested by Kirby and Bowers (2017, 2018) are word sums, word matrices, and the structure and meaning tests; see Figure 3 for an example of a Greek word matrix and the associated word sums. Morphological issues should be addressed at all levels of education, to simplify the introduction of complex words (Kotzer et al., 2021) and to encourage students to explore the words of their language (Kirby, 2019).

Conclusions

It has been exciting to see the tremendous increase in interest in morphology, not only by researchers but also by teachers and students. It is amazing, at least in English, that it has taken so long for insights from linguistics to infuse education. There is no suggestion that morphology should replace phonology in literacy education: the message here is that the phonological, orthographic, semantic, and morphological parts of the reading and writing network need to be collectively facilitated and integrated. Children with weaknesses in one component, such as dyslexics with phonological deficits, may benefit from compensatory instructional helping them to rely more on other components (Elbro & Arnbak, 1996; Law et al., 2018, Quémart & Casalis, 2018), but the primary goal is for children to develop a fully integrated network.

The next steps are to (a) improve methods of assessing morphological awareness and the other morphological components, (b) develop comprehensive methods for teaching morphological awareness and the other morphological components, (c) carry out further research to test and improve the cognitive models, (d) include more morphology in teacher education, and (e) continue to extend studies beyond English, for instance further studies in Greek.

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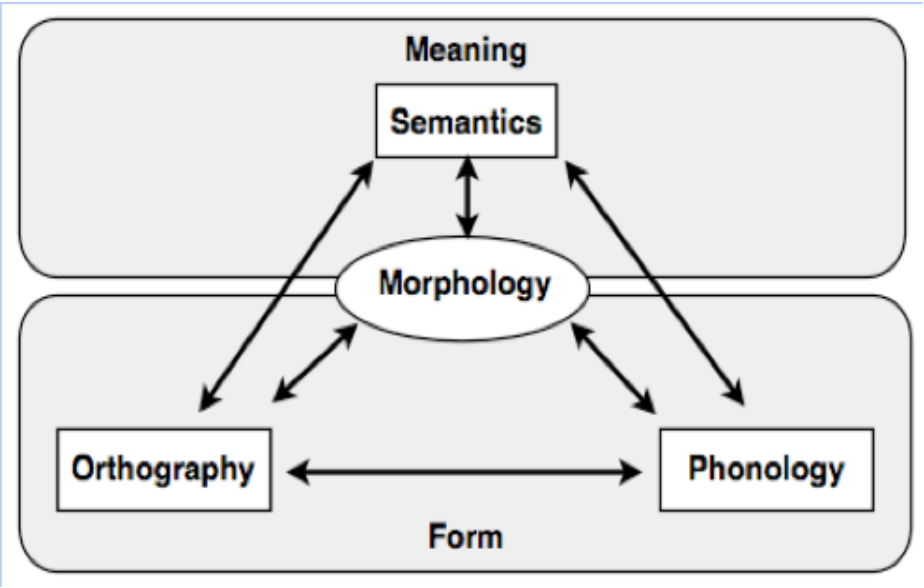

Figure 1. Morphology added to the Triangle Model of Reading, helping to integrate the network.

Figure 2. The four morphological components and how they contribute to reading.

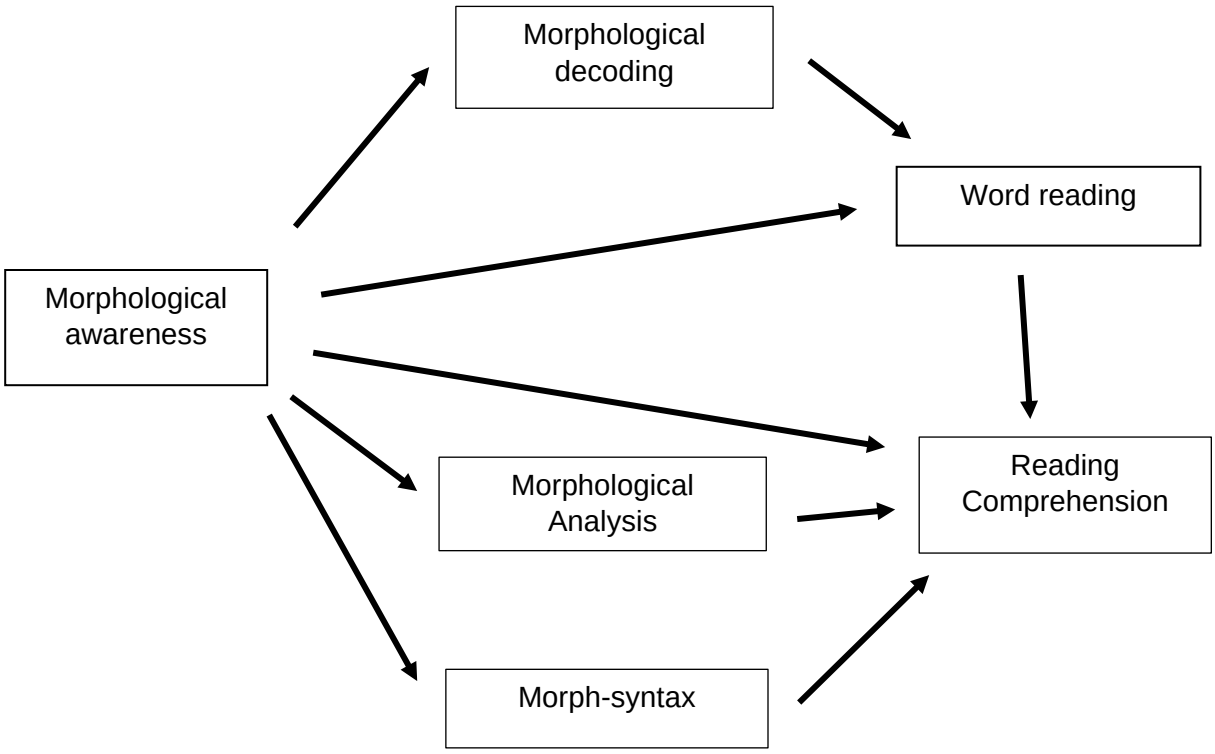

Figure 3. Example of a Greek word matrix and its associated word sums.

Word matrix

δυσ ευ α	**τυχ**	ημέν ισμέν ερ	ος η ο
από επί		η ία	

Word sums

Word sums	**Surface spelling of base**	**Surface pronunciation of base**	**Underlying lexical spelling of base**	**English translation**
τυχ + ερ + ός → τυχερός	τυχ	/tih/	τύχη	lucky
τύχ + η → τύχη	τύχ	/tih/	τύχη	luck
ευ + τυχ + ία → ευτυχ	τυχ	/tih/	τύχη	happiness
α + τυχ + ία → ατυχία	τυχ	/tih/	τύχη	bad luck
δυσ + τυχ + ισμέν + ος → δυστυχισμένος	τυχ	/tih/	τύχη	unhappy
από + τυχ + ημέν + ος → απότυχημένος	τυχ	/tih/	τύχη	failed
επι + τυχ + ημέν + ος → επιτυχημένος	τυχ	/tih/	τύχη	successful
από + τυχ + ία → απότυχία	τυχ	/tih/	τύχη	failure
ευ + τυχ + ισμέν + ος → ευτυχισμένος	τυχ	/tih/	τύχη	happy
δυσ + τυχ + ία → δυστυχία	τυχ	/tih/	τύχη	unhappiness
επι + τυχ + ία→ επιτυχ ία	τυχ	/tih/	τύχη	success