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How morphology impacts reading and spelling: Advancing the role of morphology in models of literacy development

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Abstract

A defining feature of language lies in its capacity to represent meaning across oral and written forms. Morphemes, the smallest units of meaning in a language, are the fundamental building blocks that encode meaning, and morphological skills enable their effective use in oral and written language. Increasing evidence indicates that morphological skills are linked to literacy outcomes, including word reading, spelling, and reading comprehension. Despite this evidence, the precise ways in which morphology influences the development of children's literacy skills remains largely underspecified in theoretical models of reading and spelling development. In this paper, we draw on the extensive empirical evidence base in English to explicitly detail how morphology might be integrated into models of reading and spelling development. In doing so, we build on the perspective that morphology is multidimensional in its support of literacy development. The culmination of our efforts is the *Morphological Pathways Framework*—an adapted framework that illuminates precise mechanisms by which morphology impacts word reading, spelling, and reading comprehension. Through this framework, we bring greater clarity and specificity on how the use of morphemes in oral and written language supports the development of children's literacy skills. We also highlight gaps in the literature, revealing important areas to focus future research to improve theoretical understanding. Furthermore, this paper provides valuable theoretical insight that will guide future empirical inquiries in identifying more precise morphological targets for intervention, which may have widespread implications for informing literacy practices in the classroom and educational policies more broadly.

Keywords: morphology; word reading; spelling; reading comprehension; theory

Implications for Practice

What is already known about this topic

- Longstanding evidence of a robust association between morphology (e.g., morphological awareness) and literacy skills such as word reading, spelling and reading comprehension in English-speaking children.
- Morphology is underrepresented in models of reading and spelling development; empirical research on this topic has largely outpaced detail on the placement of morphology in theory.

What this paper adds

- In this review, we use recent empirical evidence to specify the multiple roles of morphology in literacy development.
- We present the Morphological Pathways Framework, which identifies explicit mechanisms between morphology and literacy skills and guides its inclusion in theory.

Implications for theory, policy, or practice

- Advance the placement of morphology in models of literacy development.
- Identifying explicit mechanisms between morphology and literacy will help guide more precise empirical research and targeted instruction in the classroom.

How Morphology Impacts Reading and Spelling: Advancing the Role of Morphology in Models of Literacy Development

Following extensive empirical scrutiny, there is resounding consensus that morphology is critical to literacy development (Carlisle & Kearns, 2017; Castles et al., 2018; Duncan, 2018; Kuo & Anderson, 2006). This accumulating evidence has outpaced theories of reading and spelling (e.g., Rastle, 2018). We focus on English, detailing how morphology might be included in theories of word reading, spelling, and reading comprehension. Doing so answers repeated calls for articulating "the way or ways morphological awareness contributes to different areas of literacy" (Carlisle, 2010, p. 480; see also Frost et al., 2005), with theoretical precision needed to guide empirical inquiry and specify intervention targets.

We introduce the *Morphological Pathways Framework* (Figure 1). This is scaffolded by the Reading Systems Framework (Perfetti et al., 2005; Perfetti & Stafura, 2014), which delineates a broad set of distinct knowledge sources (Linguistic and Writing Systems, General Knowledge) interacting within a cognitive system to support reading comprehension processes. Founded in empirical evidence, we extend this framework to specify the roles of morphology and to processes in writing. As such, the Morphological Pathways Framework highlights the multidimensionality of morphology and details multiple morphological pathways contributing to literacy, across word reading, spelling, and reading comprehension.

Figure 1 about here

Founding this work on English means that our review reflects the status of morphology in a morphophonemic orthography, reflecting elements of both sound and meaning (Carlisle & Stone, 2005) within an opaque writing system (Seymour et al., 2003). Morphological regularities

in English carry meaning information even when letter–sound mappings are inconsistent. For instance, the spelling of the suffix *-ed* reliably denotes past tense in *poured, started*, and *dropped* even though pronunciation differs (/d/, /əd/, and /t/, respectively). Similarly, the suffixes *-ian* and *-ion* have the same pronunciation, with distinct spellings signaling different meanings (e.g., *electrician* vs. *production*). These examples also highlight the grammatical information carried by morphemes, with suffixes, for instance, providing word class information. These morphological regularities are pervasive in spoken and written language. Approximately 80% of English words contain multiple morphemes (Anglin, 1993; Hiebert et al., 2018), with morphologically complex words representing the bulk of unfamiliar words that children encounter in text (White et al., 1989). Morphology offers "islands of regularity" (Rastle, 2018, p. 3) in the otherwise opaque orthography of English (Sandra, 1994).

Empirical research into the role of morphology in literacy has largely focused on morphological awareness. *Morphological awareness* is the ability to reflect on and manipulate morphemes in spoken language (Carlisle, 2000; Nagy et al., 2014). In English-speaking children, there are reliable associations between morphological awareness and each of word reading (e.g., Kirby et al., 2012), spelling (e.g., Deacon et al., 2009), and reading comprehension (e.g., Levesque et al., 2017). These relations are robust to other known predictors of literacy (e.g., phonological awareness, vocabulary). This evidence supports including morphological awareness in the linguistic system, with direct and indirect influences on literacy skills, as represented in the top right of Figure 1. In what follows, we explore newer evidence of the multiple roles for morphology in children's literacy development, including its multidimensionality (Goodwin et al., 2017; Kirby & Bowers, 2017; Levesque et al., 2017; but see Spencer et al., 2015). In addition, we suggest that morphological regularities may support reading and spelling through both implicit and explicit processes. In delineating these ideas, we

use prominent theories of literacy development as a backdrop, evaluating their stance on morphology. We review compelling evidence guiding us towards precision in linking morphology to literacy in English, leading the reader through the Morphological Pathways Framework.

The Role of Morphology in Theories of Word Reading and Spelling

Word reading and spelling are closely related, yet distinct domains of literacy. For example, Ehri (2005) argued that children acquire the alphabetic principle through reading as they attempt to sound out words. Once children apply this to spelling, they learn that correct spelling in English requires integration across other regularities, such as morphological and orthographic patterns. Thus, learning to read depends upon the interplay between word reading and spelling. In reviewing evidence on these two domains, we illuminate different gaps in theory. In the Morphological Pathways Framework, we make the relationship between reading and spelling explicit (see left-most side of Figure 1) and all pathways are bidirectional.

According to the prominent Phase Theory of Reading Development (Ehri, 2005; 2014), morphological processes influence literacy once knowledge of the alphabetic principle is secure. After a *pre-alphabetic* phase, children begin to learn individual letter–sound correspondences (e.g., the letter '*b*' sounds like /b/). Children apply this to decode parts of words and then whole words (the *partial* and *full alphabetic* phases). In the *consolidated alphabetic* phase, phonological decoding occurs via increasingly large orthographic chunks; these include onsets and rimes (*quest*: [onset] *qu* + [rime] *est*), syllables (*ques* + *tion*), morphemes (*question* + *able*), and even whole words *(questionable*). Thus, morphemes impact word reading efficiency in that they recur in print and become consolidated orthographic chunks (Ehri, 2005), with, for instance, –*able* increasing reading efficiency across *questionable*, *walkable*, and *comfortable*. Thus, Phase

Theory considers the influence of morphology to be late emerging, treating morphemes (e.g., *able*) analogously to other letter patterns (e.g., *ight*).

Phase Theory aligns with theories of skilled word reading, such as Dual Route Theory, which argue for both direct and indirect routes from text to meaning (Coltheart, 2006; Grainger et al., 2012). The indirect route(s) enable decoding words in the speech vocabulary but not yet encountered in reading. The direct route allows for irregular word reading. Phase Theory describes the development of the indirect route (during partial and full alphabetic phases) and the later development of the direct route (during consolidated alphabetic phase). Extending these ideas, Grain Size Theory suggests that multiple routes are activated by multiple codes, varying in grain size from small (e.g., graphemes) to large (e.g., syllables, morphemes, and whole words; Grainger et al., 2012). Within the Morphological Pathways Framework, these Central Orthographic Processes are applied to Orthographic and Phonological units (Figure 1).

In our view, morphemes support word reading beyond their role as simple letter-patterns or syllables (Diependaele et al., 2012; Nunes & Bryant, 2011), contrary to both Phase Theory and theories of skilled word reading. Accumulating evidence shows that English-speaking children engage in *morphological decoding*, or use morphemes in word reading (Deacon et al., 2017; Nagy et al., 2006; see also morphological decomposition, Verhoeven & Perfetti, 2011). For instance, children in lower and upper elementary grades are more accurate in reading two- versus one-morpheme words (e.g., *shady–lady*; Carlisle & Stone, 2005), even when word-pairs are matched on ending spelling, word length, and frequency (see also Kearns, 2015); such effects also appear to extend to word reading speed (Deacon et al., 2011). Children's use of morphemes in reading appears to be separable from their use of other orthographic units (Nunes et al., 2012; see also Goodwin et al., 2017) and from broader word reading skills (Levesque et al., 2017). For instance, children's morphological and orthographic decoding have been shown to be unique

predictors of reading comprehension, reading rate, and word reading fluency (Nunes et al., 2012). In our view, morphological decoding is one of the precise ways in which morphology contributes to word reading development (Carlisle & Kearns, 2017; Kuo & Anderson, 2006). Hence, in the Morphological Pathways Framework, knowledge about morphemes as critical writing units is part of the Orthographic System (top left in Figure 1). By using these units for reading, morphological decoding offers a pathway through Central Orthographic Processes to Lexical Representations.

Morphemes might offer stronger and more efficient chunks than orthographic patterns for English word reading for several reasons. Firstly, by carrying meaning, they might support a more direct pathway from print to meaning. Online meaning activation has been implicated in word reading by prompting top-down semantic activation enabling faster and more accurate word reading (Frost, 2012; Nation, 2009). This might be especially useful in languages with irregular spelling–sound mappings like English (Rastle, 2018; Taft, 2003). Secondly, morphemes carry multidimensional information, acting as binding agent between form (phonology, orthography) and meaning (semantics; Kirby & Bowers, 2017). This aligns with the idea that high quality lexical representations contain overlapping phonological, orthographic, semantic, and syntactic information (Perfetti, 2007)—all of which are inherent in morphemes. Knowledge about morphemes might increase the quality of lexical representations by adding semantic information and reflecting overlap between sources of lexical information. Hence, in the Morphological Pathways Framework we include morphology within the Lexical Representations of individual words (see center of Figure 1).

As we build on these ideas of morphology as multidimensional, we argue that morphological decoding begins early in children's reading development. Most studies of morphological decoding and morphological processing in reading have only included mid-

elementary-aged children (~8 years) and up (e.g., Beyersmann et al., 2012; Dawson et al., 2018; Levesque et al., 2017), in keeping with Ehri's predictions. Yet, evidence of earlier morphological processing comes from overt priming tasks with children in Grade 1 (Rabin & Deacon, 2008), and from evidence of morphological effects on young children's spelling (discussed later; Treiman & Kessler, 2014). Certainly, we think that the morphological structure and regularities supports the transition from novice to expert reading (Castles et al., 2018), but we think that its role has much earlier emerging origins in children's reading development.

A second question is when does morphological processing occur during the time course of reading process itself? Starting at around adolescence, priming studies reveal blind morphological segmentation; words appear to be reflexively processed into constituent morphemes based on the mere appearance of morphological complexity—morpho-orthographic processing (e.g., *corner* = *corn* + *-er*; Beyersmann et al., 2016; Dawson et al., 2018). Later processing of morphemes incorporates semantic information—morpho-semantic processing (Rastle & Davis, 2008). A point of debate lies in whether children's fast segmentation of morphologically complex words incorporates semantic information (Beyersmann et al., 2012) or not (Quémart et al., 2011), or is best explained by graded convergence of both codes (Quémart et al., 2018). Developmental changes in the time course of these processes might also be at play. Studies to date have focused on ages 8 and up (e.g., see Schiff et al., 2012, for evidence in Hebrew, a language with a rich and complex morphology). In the Morphological Pathways Framework, we include morpho-orthographic and morpho-semantic processing as connecting Central Orthographic Processes and Lexical Representations in word reading (mid-left of Figure 1).

The distinction between morpho-orthographic and morpho-semantic segmentation aligns with discussions about morphological decoding and morphological analysis. Morphological

decoding operates at the level of word form, providing a pathway from knowledge about morphemes to decomposition of morphologically complex words. *Morphological analysis* operates at the level of word meaning, enabling constituent morphemes to support understanding of morphologically complex words (Baumann et al., 2002; Carlisle, 2007; Pacheco & Goodwin, 2013). As such, morphological analysis is key to word-level comprehension (morpho-semantic; e.g., Crosson & McKeown, 2016; Goodwin et al., 2012). In the Morphological Pathways Framework, morphological decoding and morphological analysis are separate word-level processes (dashed and dash-dot arrows in Figure 1, respectively), distinguishable from morphological awareness (Deacon et al., 2017; Levesque et al., 2017, 2019). Both morphological decoding and morphological analysis are key mechanisms for lexical access, with implications for broader text comprehension that we detail later.

In the Morphological Pathways Framework, morphological awareness contributes to Word Identification Processes (word reading), consistent with the literature (e.g., Kirby et al., 2012). One way is through morphological analysis, providing a pathway from morphological awareness (in the Linguistic System) to Lexical Representations of words (dash-dot arrow in Figure 1), engaging semantics in support of word reading. Another way is by helping children map morphemes from spoken to written language (solid arrow), which enables morphological decoding (dashed arrow). The solid arrow between morphological awareness (in the Linguistic System) and morpheme units (in the Orthographic System) remains unnamed; research needs to determine whether this path is part of morphological decoding or a separate morphological mechanism that supports the discovery and mapping of morphemes from speech to print. Likewise, research needs to understand the link between morphological awareness and nonword decoding (e.g., Deacon & Kirby, 2004; Kirby et al., 2012), delineating whether this reflects morphological processing or a by-product of metalinguistic awareness acting on word

identification processes more broadly (Kuo & Anderson, 2006). Nevertheless, morphological awareness likely influences both morphological decoding and morphological analysis; as readers become increasingly aware and attuned to morphological regularities, distinct form- and meaning-related morphological mechanisms help children read and understand morphologically complex words. Further empirical investigation is necessary to determine whether morphological decoding and morphological analysis involve implicit or explicit morphological processing (see Nagy et al., 2014). Regardless of the nature of the processing, morphological decoding and morphological analysis likely occur because the lexicon is attuned to morphological regularities.

Turning to spelling, most empirical evidence relating to morphology in English has examined the product of spelling processes, focusing on morphological decoding. This work shows that even young children demonstrate sensitivity to morphological regularities. Five to seven-year-old children are more accurate in spelling the final sounds of two-morpheme than one-morpheme words (e.g., *kicked* versus *collect*; Treiman & Cassar, 1996; see also Kemp, 2006; Treiman et al., 1994). Six-year-olds are more accurate at spelling letters that form a root morpheme compared to the same letters in unrelated words (e.g., *add* in *addition* versus *address*; Deacon, 2008; Deacon & Bryant, 2006). Hence, morphological structure facilitates spelling accuracy early in development, contrary to predictions from Phase Theory.

The next question is when, during the process of producing a spelling, do these morphological effects occur? Theories of spelling development describe how children's knowledge about spelling changes over the time course of development, but do not explain when this knowledge influences the process of producing a spelling. As a result, theories of development do not align with theories of skilled spelling. Theories of skilled spelling argue that spelling involves the combination of three complex processes: input identification, central and peripheral orthographic processes (Bonin et al., 2015; Olive, 2014). Morphological

representations might impact on any part of these processes. Whereas a large body of empirical evidence has explored how and when morphological processes influence skilled word reading (Amenta & Crepaldi, 2012; see also Beyersmann et al., 2012; Quémart et al., 2011 for research with children), this question has only begun to be explored in children's spelling. Ideas from theories of skilled spelling guide empirical questions that will, in turn, clarify the time course of morphological processing in spelling over development.

A core issue lies in delineating how the processes involved in input identification depend upon the task. Input identification is the process from the prompt to spell to word identification. Spelling-to-dictation and copying rely on auditory and visual word recognition processes, respectively. In free writing this phase involves conceptualization. Hence, the nature of the task might influence use of morphological decoding and/or analysis. It seems reasonable to assume (at least for adults) that morphological processing occurs during input identification, given that morphological structure impacts lexical access, lexical organization, and the quality of the representations within the lexicon (Perfetti, 2007; Sandra, 1994). Indeed, the quality of lexical representations might be even more important for English spelling, where incomplete or underspecified representations will lead to misspellings.

There is some evidence to suggest that morphological structure impacts spelling during input identification. Both adults and children begin to write morphologically complex words more quickly than matched monomorphemic words (e.g., *tricked* versus *trickle*; Breadmore & Deacon, 2019; Kandel et al., 2008; Kandel et al., 2012; Quémart & Lambert, 2019). Changes in handwriting speed during spelling could also provide evidence of morphological effects during central and peripheral processes. The few studies that have explored this are less consistent and methodological differences make it difficult to draw conclusions across studies. Even so, there is emerging evidence suggesting that potential developmental changes in the time course of

morphological processing in spelling deserve further attention. Both adults and older children (12-year-olds) slow down around morpheme boundaries (Kandel et al., 2008; Kandel et al., 2012; Quémart & Lambert, 2019). However, these effects have yet to be observed in young children (Breadmore & Deacon, 2019). Further research is needed to understand how these processes change over the course of development, whether they result from morphological decoding and/or analysis, and how they are affected by individual, item, and language differences.

Once the target word has been identified and the lexical representation is activated, central orthographic processes prepare the orthographic representation of the word that will be held in working memory during spelling. These processes have been the focus of developmental theory. Peripheral orthographic processes then convert orthographic representations into motor responses, producing the pen or keyboard strokes necessary to transcribe the word. Note that in the Morphological Pathways Framework we also include Peripheral and Motor Processes for reading—eye movements, for example. Information can cascade through central and peripheral processes in parallel, and motor responses can begin before the processes involved in retrieving the orthographic representation of the word are complete (Olive, 2014). Hence, as represented in the Morphological Pathways Framework, morphological structure could influence skilled spellers because of the pathways between Lexical Representations and Central Orthographic Processes, or because of the processing of morphemes within Central Orthographic Processes.

Descriptions of central orthographic processes assume that the same cognitive architecture is used for word reading and spelling, essentially acting in reverse. In spelling, as in reading, dual route theories have prevailed. The links from the lexical to the graphemic representation of the written form can be made through direct or indirect routes (Bonin et al., 2015; Tainturier & Rapp, 2001). These theories help clarify how spelling transitions from

conscious use of strategies (sublexical, indirect route) to more automatized spelling processes (lexical, direct route). However, like dual route models of word reading, such theories do not make the role of morphology explicit. We suggest that the multidimensionality of morphemes might facilitate spelling because high quality lexical representations of morphologically complex words are comprised of overlapping sources of information supporting multiple routes to spelling production. In the Morphological Pathways Framework, we infer that knowledge about morphemes originating from both Orthographic System and Lexical Representations provides an additional code to hold the word in working memory during execution of peripheral orthographic processes—essentially, morphological decoding uses prior knowledge about the orthography and lexical memory in service of spelling production. Indeed, the working memory demands and the nature of motor responses necessary during the transcription process might increase reliance on decomposition in spelling compared to reading. Units such as morphemes, that are intermediate between words and letters, might be particularly helpful in reducing cognitive load during spelling production.

The importance of the multidimensionality of morphemes for spelling resonates with statistical learning theories. These argue that development broadly depends upon a single mechanism that is sensitive to regularities in the environment (Treiman & Kessler, 2014; Deacon et al., 2008). For spelling specifically, development is driven by exposure to the regularities within the language (Deacon & Leung, 2012; Treiman & Kessler, 2006). As a result, children may use multiple sources of information simultaneously throughout development. The extent to which spellers rely on different sources of information is affected by the structure of the language and experience, which control the amount of exposure to different regularities (Pollo et al., 2009). These theories suggest that sensitivity to high frequency morphemes should guide spelling early in development. Meanwhile sensitivity to lower frequency or inconsistent

morphological regularities would develop over time. In line with this, children's use of morphological regularities in spelling increases with age (Deacon & Dhooge, 2010), and use of morphology in spelling is influenced by both child- and item-level factors (Casalis et al., 2011).

Moving forward and building on these foundations, we must seriously consider morphological decoding and analysis as mechanisms supporting literacy development, both in reading and spelling. In doing so, we need to understand the impact of the multidimensional nature of morphemes, including the potential roles of semantic weighting (Quémart et al., 2011) and syntactic information (Kirby & Bowers, 2017). With consideration for both form and meaning, this then opens the door to exploring the time course of morphological decoding and morphological analysis, both in word reading and spelling, and how this might change developmentally.

The Role of Morphology in Theories of Reading Comprehension

Moving from word-level to text-level processing, we now consider the status of morphology in models of reading comprehension. Despite strong empirical interest in the role of morphology in reading comprehension, many models provide limited detail of how morphology might influence the development of reading comprehension. For example, the widely cited Simple View of Reading (Gough & Tunmer, 1986) does not mention morphology, although some advocate its inclusion within the oral language component (Kirby & Savage, 2008). The Reading Systems Framework (Perfetti et al., 2005; Perfetti & Stafura, 2014) is particularly useful in that it sets the stage for multiple roles for morphology in reading comprehension. We build on this to articulate more precisely the potential roles of morphology during reading comprehension, which inspired the Morphological Pathways Framework.

Morphology appears in two separate systems within the Reading Systems Framework: the linguistic system and the lexicon (Perfetti & Stafura, 2014). Morphology is included in the

linguistic system alongside phonology and syntax, offering a direct pathway between morphology and reading comprehension. In addition, the linguistic system feeds into many other components of the framework. This implicates an indirect morphological pathway, beginning in the linguistic system and moving through word reading to reading comprehension. Elsewhere in the Reading Systems Framework, morphology is included in the lexicon (Lexical Representations in Figure 1); this implicates another indirect morphological pathway, beginning in the linguistic systems going to the lexicon which, in turn, contributes to reading comprehension. We suggest that these three distinct pathways reflect empirically distinguishable dimensions of morphology (Goodwin et al., 2017; Levesque et al., 2017, 2019), each with distinctive contributions to reading comprehension. We review evidence from studies of English in support of these multiple morphological pathways to reading comprehension.

Morphological awareness is likely to underpin the direct morphological pathway to reading comprehension. Morphological awareness explains unique variance in reading comprehension beyond such skills as phonological awareness, nonverbal intelligence, vocabulary, and word reading skills—each of which are strong predictors of reading comprehension in their own right (e.g., Deacon & Kirby, 2004; Roman et al., 2009). Morphological awareness also predicts gains in reading comprehension over time (e.g., Deacon et al., 2014; Foorman et al., 2012; Kruk & Bergman, 2013). This enduring contribution of morphological awareness beyond numerous language and literacy factors suggests a deeply rooted metalinguistic skill that integrates fundamental semantic, phonological, and syntactic processes (Carlisle & Goodwin, 2013; Kieffer et al., 2016; Perfetti et al., 2005). This aligns with a dimension of morphology housed in the linguistic system, one having widespread influence through various pathways of the framework. Hence, in the Morphological Pathways Framework,

we include morphological awareness in the Linguistic System, with a direct path to reading comprehension (dotted arrow in Figure 1).

Extending our previous discussion of word reading, we suggest that morphological awareness also impacts on the indirect pathways that support children's reading comprehension—through morphological decoding and morphological analysis during reading. We propose that the first indirect morphological pathway to reading comprehension reflects morphological decoding. One of the few studies to explore this in the context of reading comprehension suggests that morphological decoding, but *not* morphological awareness, predicted unique variance in reading comprehension for English-speaking children in the mid-to-late elementary grades (Deacon et al., 2017). Levesque et al. (2017) found that morphological awareness contributed both directly and indirectly to reading comprehension (via a morphological decoding pathway) in 9-year-old children. These results suggest that morphological decoding is the likely mechanism operating within the indirect word reading pathway that links morphological awareness and reading comprehension. This important morphological decoding pathway is reflected in the Morphological Pathways Framework (dashed arrow in Figure 1).

A second indirect morphological pathway to reading comprehension is through morphological analysis, the mechanism that supports understanding multimorphemic words. Supports this view, a recent study of 9-year-old demonstrated a significant direct contribution of morphological awareness to reading comprehension as well as an indirect contribution via morphological analysis (Levesque et al., 2017). Notably, these paths were observed beyond morphological decoding and broader word reading skills, vocabulary, phonological awareness, and nonverbal ability. Building on this work, Levesque and colleague (2019) found that morphological awareness in grade 3 contributed to gains in morphological analysis from grade 3

to 4. Yet, only morphological analysis supported gains in reading comprehension from grade 3 to 4. Taken together, these results showed that morphological analysis fully mediated the contribution of morphological awareness to gains in reading comprehension over time. This helps to specify the nature of the indirect morphological pathway through the lexicon. Reflecting this in the Morphological Pathways Framework, morphological analysis is a pathway by which knowledge of morphology informs meaning of lexical representations which, in turn, supports reading comprehension (dash-dot arrow in Figure 1).

The importance of both morphological decoding and morphological analysis cannot be overstated, given the increasing prevalence of morphologically complex words in children's texts across the school grades (White et al., 1989). It is clear that an inability or struggle to read and/or understand multimorphemic words in texts would pose a considerable barrier to children's reading comprehension. From this tangible perspective, we interpret the mechanisms of morphological decoding and morphological analysis as having more proximal contribution to reading comprehension compared to morphological awareness (a broader metalinguistic skill). With that said, we suggest that morphological awareness serves as the foundation of knowledge that enables these proximal morphological mechanisms to operate. In other words, the extent to which morphological decoding and morphological analysis can facilitate reading and understanding of complex words is limited by a child's awareness of and sensitivity to morphemes in language. Additional research is needed to better understand the interplay between these morphological skills and to further quantify their shared and unique contributions to the development of reading comprehension.

In the Morphological Pathways Framework, we surmise that morphology influences text generation through the same three pathways as for reading comprehension, essentially acting in reverse. Writing composition has additional task demands, however, such as idea generation,

planning, editing, and revising text (Berninger et al., 1996). Here we focus on explaining the role of morphology in word spelling and text generation. Very little empirical research has examined the role of morphology in writing composition, although here too some research indicates that morphological knowledge uniquely predicts attainment (Northey et al., 2016).

The Morphological Pathways Framework beyond English

Beyond the goals for future research previously mentioned, we also see a need for research to clarify the fundamental ways in which morphology supports literacy development across languages. We focused this paper at the outset on the extensive evidence base in English, a language whose morphology brings a measure of consistency to an otherwise opaque and idiosyncratic writing system. Thus, the generalizability of the Morphological Pathways Framework to other languages must be considered with this Anglocentric limitation in mind. Still, there is reason to believe that the Morphological Pathways Framework extends to languages beyond English. For starters, there is a consensus that morphology is central in the organization of the mental lexicon across languages (Frost, 2012; Lehtonen & Bryant, 2005; Sandra, 1994). Moreover, the study of morphology over the last two decades has revealed robust effects on word reading, spelling, and reading comprehension across a wide array of languages (for review see Deacon et al., 2019). These include languages represented with alphabets that are highly phonologically transparent, such as Finnish (e.g., Bertram et al., 2000; Lehtonen & Bryant, 2005), Spanish (e.g., D'Alessio et al., 2018; Suárez-Coalla et al., 2017), and Italian (e.g., Angelelli et al., 2017) and those that are less so, such as French (Quémart et al., 2011). This extends to languages with more complex syllable structure, such as German (e.g., Hasenäcker et al., 2017) and those less so, such as Greek (e.g., Diamanti et al. 2017; Manolitsis et al., 2017) and Portuguese (e.g., Oliveira et al., 2020). It also extends to languages represented with abjads, such as Hebrew (e.g., Schiff et al., 2012), and those with morphosyllabic writing systems, such

as Chinese (e.g., Tong et al., 2017). This growing empirical literature speaks strongly to the universal presence of a role for morphology in literacy development irrespective of the writing system.

In the face of this universality, we think that it is highly likely that the specific morphological processes in the Morphological Pathways Framework respond to cross-linguistic variations. For instance, the relative importance of morphological skills to other linguistic skills may be greater for languages with opaque orthographies, especially those with a morphologically rich writing system (e.g., McBride-Chang et al., 2005). And yet, effects of morphological processing on literacy skills may be observable in younger children for transparent orthographies where grapheme-phoneme correspondences are mastered earlier in development than in English (Hasenäcker et al., 2017; Lehtonen & Bryant, 2005). Relatedly, questions remain in transparent orthographies as to whether morphology influences reading and spelling accuracy (e.g., Angelelli et al., 2017; Oliveira et al., 2020) or whether effects are more clearly observed on fluency (e.g., Burani et al., 2008; D'Alessio et al., 2018; Marcolini et al., 2011; but see Diamanti et al., 2017; Manolitsis et al., 2017). Further still, the division of labor between morpho-orthographic and morpho-semantic segmentation is a likely candidate for cross-linguistic differences, with unanswered questions pertaining to how much the semantic properties of morphemes support reading and spelling in transparent versus opaque languages across development (e.g., Beyersmann et al., 2012; Feldman et al., 2009; Schiff et al., 2012). These ideas clearly need testing to fully appreciate the relevance of the Morphological Pathways Framework for theory and empirical research beyond English.

Conclusions

In this review, we have detailed our views and provided supporting evidence of how the multiple dimensions of morphology influence word reading, spelling, and reading

comprehension. We have situated morphology within a dynamic framework—the Morphological Pathways Framework. This framework specifies key morphological mechanisms that operate bidirectionally and in parallel to support children's literacy development. Indeed, this is the detail that researchers and educators need. Just as we need to move beyond asking teachers to teach 'language', we also need to move beyond asking them to teach 'morphology'. We need clear answers as to what aspects, to whom, when, and how. We hope that the detail provided in this review and in our new framework focuses attention for research to provide these much-needed answers.

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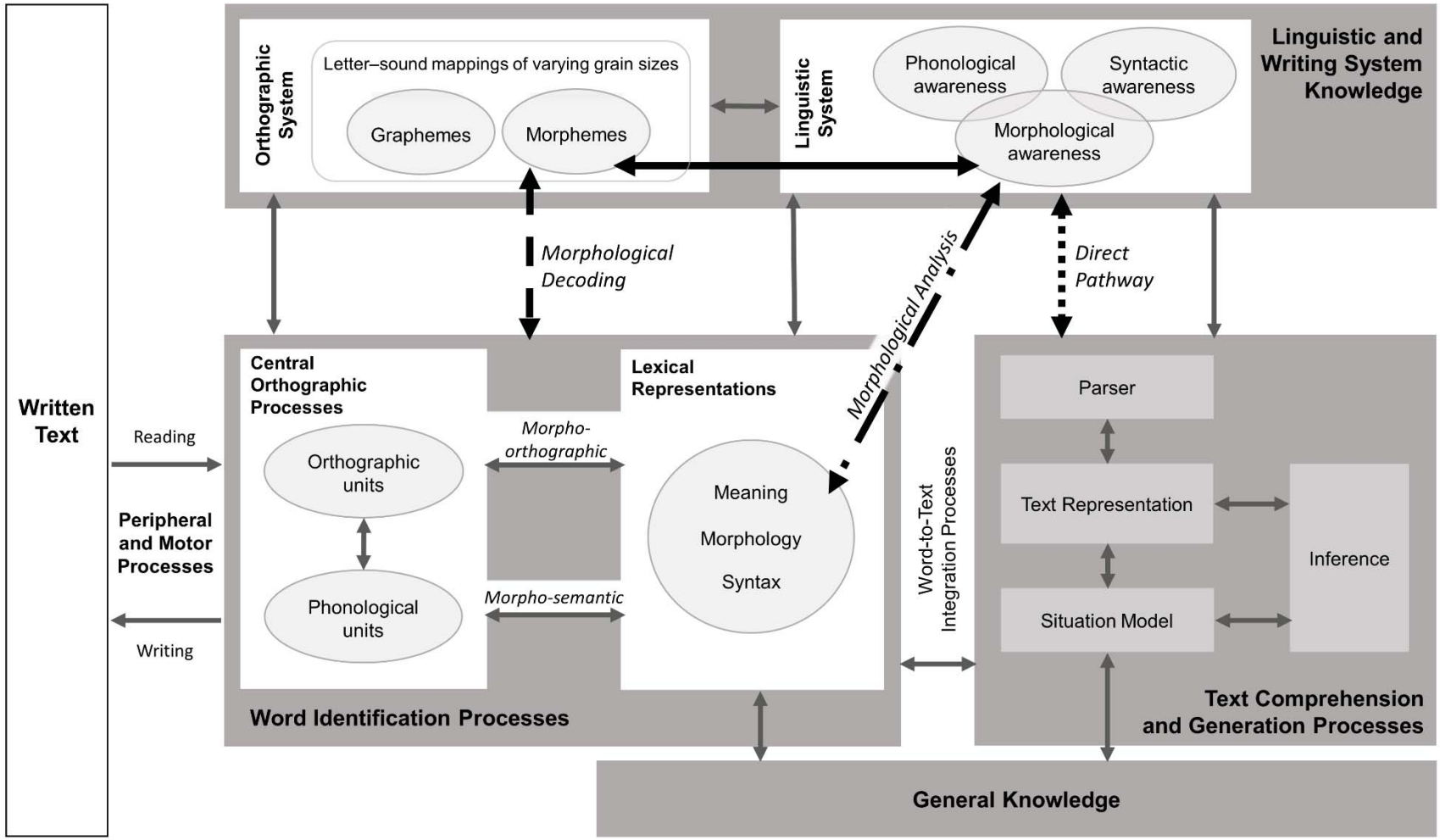

Figure 1. The Morphological Pathways Framework