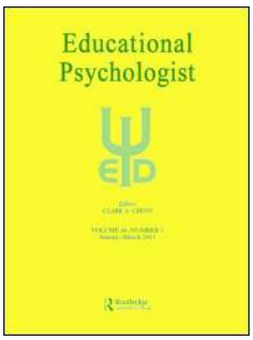

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Beyond Phonics: The Case for Teaching Children the Logic of the English Spelling System

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A large body of research supports the conclusion that early reading instruction in English should emphasize phonics, that is, the teaching of grapheme–phoneme correspondences. By contrast, we argue that instruction should be designed to make sense of spellings by teaching children that spellings are organized around the interrelation of morphology, etymology, and phonology. In this way, literacy can be taught as a scientific subject, where children form and test hypotheses about how their spelling system works. First, we review arguments put forward in support of phonics and then highlight significant problems with both theory and data. Second, we review the linguistics of English spellings and show that spellings are highly logical once all the relevant sublexical constraints are considered. Third, we provide theoretical and empirical arguments in support of the hypothesis that instruction should target all the cognitive skills necessary to understand the logic of the English spelling system.

The phrase "reading wars" refers to a long-standing debate regarding literacy instruction. At issue is whether early instruction should focus on sublexical grapheme–phoneme correspondences (*phonics*) or target meaning at the word level (*whole language instruction*). This controversy continues in some settings, but both theoretical analyses and empirical findings have led to the widespread view that phonics is the better approach. Indeed, phonics is now required in all UK state schools and is a standard teaching method in the United States and Canada.

Nevertheless, there is a growing realization that phonics instruction is not working for all children. It is estimated that 10%–15% of children who complete intense remedial phonological instruction continue to struggle (Compton, Miller, Elleman, & Steacy, 2014), and an unacceptably high number of children enter secondary school with very low levels of literacy skill (Higgins, Katsipataki, & Coleman, 2014). Indeed, individual differences in reading skills and vocabulary knowledge are enormous: In the United Kingdom, for example, the performance of children between 11 and 16 years of age ranges from floor to ceiling (age equivalence of 6–17 years; Stothard, Hulme, Clarke, Barmby, & Snowling, 2010). These disappointing outcomes have motivated the search for new methods (Compton et al., 2014; Snowling & Hulme, 2014).

Here we make a theoretical case for a very different form of instruction—what P. N. Bowers and Kirby (2010) called Structured Word Inquiry (SWI)—that takes key insights from both phonics and whole language but goes far beyond either approach. SWI is motivated by a fundamental insight from linguistics, namely, the English spelling system makes sense when the sublexical constraints of morphology, etymology, and phonology are considered in combination (see The English Spelling System section for a brief tutorial of the English writing system that includes a table with linguistic terms and definitions). Consistent with phonics, SWI agrees that it is important to teach sublexical grapheme–phoneme correspondences, but it emphasizes that English spellings are organized around the interrelation of morphology, etymology, and phonology and that it is not possible to accurately characterize grapheme–phoneme correspondences in isolation of these other sublexical constraints. Consistent with whole language, SWI emphasizes the importance of meaning in literacy instruction from the very start. Indeed, SWI exploits that fact that English spellings represent meaning in a consistent fashion, as reflected in morphology.

This approach is different from phonics, whole language, and all other approaches because SWI teaches word-level literacy knowledge much like other scientific disciplines (e.g., biology, physics). That is, children are

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engaged in generating and testing hypotheses about how the system works (thus the word *inquiry* in "structured word inquiry"). The goal is to get children to understand why words are spelled the way they are in order to improve literacy, measured in terms of reading words aloud, spelling words, improving vocabulary, and improving reading comprehension.

Our article is organized in three main sections. First, in the Phonics Instruction section, we describe the theory and practice of phonics, as well as summarize the evidence that supports phonics for children in general and struggling readers in particular. We then challenge these conclusions, in terms of both theory and practice: Too many readers struggle with phonology-focused instruction. Second, in the The English Spelling System section we explain the rationale for SWI by reviewing the linguistics of the English spelling system. We show that English orthography is a morphophonemic system in which spellings have evolved to represent sound (phonemes), meaning (morphemes), and history (etymology) in an orderly way.

Third, the Teaching Children the Logic of the English Spelling System section makes the theoretical and empirical case that literacy instruction should focus on teaching this logic. Theoretically, SWI ensures that children can exploit the well-established finding that memory is best when the to-be-learned information is organized in a meaningful and logical manner and when the learning context is characterized by generating and testing hypotheses. Empirically, we review the growing literature that suggests that morphological instruction is beneficial, and then summarize three studies that provide direct support of SWI. Table 1 summarizes the overall motivation of SWI. We hope these arguments will inspire teachers and researchers interested in literacy instruction to start paying more attention to the logic of the English spelling system when designing and testing new forms of instruction.

TABLE 1
Summary of SWI Motivation

1. Linguistic analyses show that English spellings are well ordered and understandable once the sublexical constraints of phonology, morphology, and etymology are jointly considered.
2. When designing literacy instruction, the default assumption should be that instruction is informed by correct understanding of the writing system.
3. There is a strong theoretical justification for SWI. This includes the findings that (a) learning is best when information is studies in a meaningful and organized manner, (b) learning is best when learners are able to reason and hypothesize about a structured system, and (c) children who struggle with phonics often have phonological deficits. They may especially benefit by methods that focus more heavily on their alternative skills, including the skills that are known to improve learning more generally.
4. Preliminary empirical investigations support SWI. This is especially true of struggling readers who benefit the least from phonics. But more empirical work is needed.

Note. SWI = Structured Word Inquiry.

PHONICS INSTRUCTION

Phonics instruction refers to a method of teaching reading that focuses on sublexical *grapheme–phoneme* correspondences with little or no reference to other constraints on spelling. Children are taught the most common ways that single letters or groups of letters (graphemes) map onto phonemes (e.g., the single letter grapheme <k> can be pronounced /k/ and the phoneme /k/ can be represented by the graphemes <c>, <k>, <ck>, <ch>, or <que>) and are instructed to blend the sounds associated with the letters together to produce approximate pronunciations of words. For example, when taught the sounds for the letters <d>, <o>, <g>, and <f>, the child can sound out the familiar word <dog> and less familiar or unknown words such as <fog>.

Phonics instruction has several versions. Practitioners of synthetic phonics, for example, teach children the pronunciations associated with graphemes in isolation and then coach students to blend the sounds together. A child might be taught to break up the written word <dog> into its component letters, pronounce each letter in turn—/d/, /ɔ/, /g/—then blend them together to form the spoken word *dog* (Bowey, 2006). By contrast, in analytic phonics, the phonemes of a given word are not read in isolation. Rather, children identify (analyze) words looking for a common target phoneme across a set of words. For instance, children are taught that <dog>, <dig>, and <dish> share the letter <d>, which is pronounced /d/ (Moustafa & Maldonado-Colon, 1998). In other words, synthetic goes from "parts to wholes," starting with letters and phonemes to build up words, whereas analytic phonics goes from "wholes to parts," starting with words and breaking them into their component parts, including onsets and rimes, as well as phonemes. Some researchers conclude that synthetic phonics is more effective (e.g., Rose, 2006), although often it is claimed that the two approaches are equally effective (National Reading Panel, 2000; Torgerson, Brooks, & Hall, 2006). On these as well as other versions, including analogy phonics and embedded phonics, the focus is on the associations between graphemes and phonemes.

Of course, children also need practice in reading meaningful text, and advocates of phonics emphasize the need to go beyond grapheme–phoneme correspondences. Indeed, the evidence strongly suggests that phonics is most effective in the context of a broader literacy curriculum (Camilli, Vargus, & Yurecko, 2003). But for advocates of phonics, this broader context rarely includes sublexical constraints other than grapheme–phoneme correspondences. As an example, the *Independent Review of the Teaching of Early Reading* (Rose, 2006) recommended that phonics should be the primary instructional approach but embedded within a broader language and literacy curriculum (p. 70). However, no consideration is given to the morphological or etymological constraints on spelling. And again, no mention of

morphology was made in Rose (2009). Similarly, the report of the National Reading Panel (2000) in the United States, entitled "Teaching Children to Read," emphasizes that phonics should be integrated with other forms of instruction, including phonemic awareness, fluency, and comprehension strategies, but the document fails to address the constraints imposed by morphology and etymology. So, although we find widespread acceptance that phonics needs to be supplemented by additional instruction, including reading words in meaningful text, phonics instruction is often the main or only way children are taught to identify individual words based on their spellings.

Two theoretical arguments are commonly put forward in support of phonics, both for children in general and for struggling readers in particular. First, English spellings are claimed to be based on an alphabetic system in which the primary purpose of letters is to represent sounds (e.g., Byrne, 1998). The strong version of this hypothesis is that spellings are "parasitic on speech" (Mattingly, 1972), that is, the claim that spellings are entirely dependent on pronunciation of words. More recently, the analogy has been modified to the claim that spellings are "parasitic on language." This later phrase recognizes the fact that letters represent more than phonemes (Perfetti, 2003; Seidenberg, 2011); nevertheless, the role of these other factors is generally minimized or ignored when it comes to instruction. For instance, Snowling and Hulme (2005) claimed that Mattingly (1972) was "more or less right" (p. 397) and that recoding (translating orthography to phonology) is indeed parasitic on speech. In their view, additional features of language are more relevant to sentence comprehension than to single-word reading.

The common conclusion from this characterization of the English writing system is that all children should first be taught grapheme–phoneme correspondences. In this way children can learn to name aloud both familiar and unfamiliar written words and use their spoken vocabulary to identify and understand the words. As an example, although a child may not have read the word <cat> before, he or she will likely be familiar with its spoken form, and accordingly, he or she will be able to identify <cat> after decoding it. Once the familiar and unfamiliar written words can be decoded, then children can exploit the grammatical and semantic knowledge that support their language comprehension in general. In this view, phonics is the key for unlocking the child's existing verbal language skills.

The second theoretical argument in favor of phonics is specifically concerned with remedial instruction. A large number of studies provide evidence for a phonological theory of dyslexia. On this view, deficits in phonological skills (e.g., phonemic awareness, rime awareness, and verbal short-term memory) play a causal role in many reading deficits (Melby-Lervåg, Lyster, & Hulme, 2012). Phonemic awareness, the meta-linguistic ability to identify and manipulate phonemes (e.g., separating the spoken word *cat* into three distinct phonemes, /k/, /æ/, and /t/), has the strongest association with reading. This has led to the hypothesis that remedial instruction should target these skills to restore them (see Duff & Clarke, 2011; Fletcher, Lyon, Fuchs, & Barnes, 2007; Hulme & Snowling, 2009; Snowling & Hulme, 2011). Phonics targets relevant phonological skills by teaching children the mappings between graphemes and phonemes.

In addition to theory, a large empirical literature has assessed the efficacy of various methods on all aspects of literacy achievement. This includes accuracy in naming familiar and unfamiliar words, reading fluency, spelling, vocabulary knowledge, and reading comprehension. A key finding is that phonics is often more effective at teaching these skills than alternative methods that do not focus on grapheme–phoneme correspondences, for both children in general and struggling readers. For example, with regard to children in general, Ehri, Nunes, Stahl, and Willows (2001) compared systematic phonics instruction to unsystematic or no-phonics instruction on learning to read across 66 treatment-control comparisons derived from 38 experiments. Benefits from phonics were obtained for word reading, text comprehension, and spelling; effects persisted after instruction ended. Similarly, Torgerson et al. (2006) identified 20 randomized control trials concerned with the initial teaching of reading. Systematic phonics teaching was associated with better progress in reading accuracy across all ability levels compared to alternative teaching methods. With regards to remedial instruction, the effectiveness of different treatment approaches to reading disability was recently assessed in a meta-analysis of 22 randomized controlled trials (Galuschka, Ise, Krick, & Schulte-Koerne, 2014). Phonics was the only approach that had a significant effect on word reading ($g' = .32$) and spelling ($g' = .34$).

Some Problems With Phonics

The preceding findings support the conclusion that phonics is better than many alternative approaches to literacy instruction. However, theoretical and empirical evidence suggest that other forms of instruction may be better still. With regards to theory, the claim that English is an alphabetic system in which the primary purpose of letters is to represent sounds is incorrect. Rather, English is a morphophonemic system in which spellings have evolved to represent an interrelation of morphology, etymology, and phonology (see details that follow). As Venezky (1999) wrote, "English orthography is not a failed phonetic transcription system, invented out of madness or perversity. Instead, it is a more complex system that preserves bits of history (i.e., etymology), facilitates understanding, and also translates into sound" (p. 4).

This has implications for literacy instruction if we accept that instruction should be guided by the logic of the orthographic system, or as Rayner, Foorman, Perfetti, Pesetsky,

and Seidenberg (2001), put it, "The child learning how to read needs to learn how his or her writing system works" (p. 34). Indeed, if this claim is taken seriously, the proper conclusion is that literacy instruction should target the way orthography represents the interrelation of morphology, etymology, and phonology rather than selectively focus on orthography to phonology mappings.

In addition, the theoretical assertion that the most effective remedial instruction should target the weak phonological processes of struggling readers is an untested hypothesis. An equally plausible hypothesis is that remedial instruction should target the strongest skills of struggling readers that are relevant to reading. That is, remedial instruction may be best served by interventions that adopt a "compensatory" as opposed to a "restitutive" strategy of education (J. S. Bowers, 2016).[1] Indeed, this is the case with acquired disorders across a range of domains (Cicerone et al., 2005). Given the logical and meaningful structure of English spellings and given that dyslexia is often associated with a selective phonological deficit, a promising compensatory approach to instruction would target the semantic and logical skills of struggling readers that are left untapped by phonics. The finding that memory is best when information is encoded in a meaningful and structured manner (Bower, Clark, Lesgold, & Winzenz, 1969) makes this approach highly plausible, as detailed next.

It is currently unclear whether remedial literacy instruction should target compensatory or restitutive mechanisms. It may be that some reading difficulties are more effectively addressed with a compensatory approach and others more effectively addressed with a restitutive strategy. A potential important advantage of SWI is that it targets both phonological and semantic skills of children, and accordingly this approach may take advantage of both compensatory and restitutive mechanisms. Indeed, as we detail next, the best way to improve weak phonological skills may be to practice these skills in a meaningful context. Structural and meaning constraints clarify whether a letter sequence is analyzed as one set of graphemes or another (e.g., the <ea> sequence cannot be a digraph in <react> as these graphemes must be separate graphemes in the distinct morphemes <re-> and <act>).

With regard to the empirical evidence in support of phonics, it is important to emphasize that the effect sizes on literacy outcomes are generally small, and in many cases mixed. For example, McArthur et al. (2012) carried out a meta-analysis of all studies that compared a phonics intervention (phonics alone, phonics and phoneme awareness training, or phonics and irregular word reading training) to a control condition (untrained or an alternative training group, such as training in mathematics) with struggling readers. They identified 11 studies that met their criterion and reported a significant (moderate) effect on word and nonword reading accuracy, but no significant effect on word or nonword reading fluency and no significant overall effects on spelling or reading comprehension. Similarly, Torgerson et al. (2006) identified three randomized control trials (Lovett, Ransby, Hardwick, Johns, & Donaldson, 1989; Martinussen & Kirby, 1998; O'Connor & Padeliadu, 2000) that assessed the impact of phonics on spelling (the three studies in this analysis were all different from the two relevant studies included in the McArthur et al., 2012, review). The pooled estimate for these three trials was a nonsignificant effect size of 0.09. These findings regarding spelling and comprehension contrast with the Ehri et al. (2001) and Galuschka et al. (2014) studies. Finally, with regard to vocabulary development, we are not aware of any evidence that phonics is effective. Indeed, vocabulary instruction typically takes a different form altogether (Marulis & Neuman, 2010; Moore, Hammond, & Fetherston, 2014).

Even the most sophisticated phonological interventions show mixed results. For example, a variety of research suggests that interventions should go beyond standard systematic phonics instruction to include training in phonological awareness and reinforcing letter-sound knowledge in the context of reading text (e.g., Hatcher et al., 2006). Significant overall effects on single word reading were reported in these interventions; nevertheless, a substantial minority children fail to respond. Hatcher et al. (2006) found that failure to respond to the intervention (in terms of word naming as well as letter knowledge and phoneme awareness) was predicted by poor initial literacy skills. That is, the phonological intervention was least successful for those children who need the most help.

Furthermore, the two most recent intervention studies that directly compared phonics and "sight word" training failed to show an advantage for phonics. In sight word training condition, children carried out a variety of tasks designed to improve their ability to identify whole words rather than convert letters to sounds. In a quasi-randomized trial (McArthur et al., 2013) and a randomized controlled trial (McArthur et al., 2015), phonics and sight training produced similar outcomes across a range of reading outcomes.

These sorts of results have led many supporters of phonics to highlight the need to explore additional methods. However, the hypothesis that instruction should be designed to teach children the logic of their writing system is rarely considered. For example, Al Otaiba and Fuchs (2006) wrote that "a different method or combination of methods" (p. 428) is needed for these children, but the authors do not consider the possibility that these children should be taught about morphology, let alone about the interrelation of morphology, etymology, and phonology in explaining spellings.

[1]The term "restitutive" is used in the context of acquired disorders in which a person has lost a previously acquired skill. In the case of developmental disorders, perhaps a better term is "ameliorative" as the instruction is attempting to improve the impaired skill.

More recently, Compton et al. (2014) highlighted the limited success of phonics in remedial instruction and suggested some possible ways to improve phonics, including teaching children that letter-sound correspondences depend on the position of letters within words as well as the surrounding letters ("context-dependent" decoding relationships). They hypothesized that this might be achieved by carefully designing training corpora that capture these positional dependences so that children can implicitly learn these mappings with practice. This is worth considering, but we would emphasize that morphological constraints are again ignored despite the fact that morphology plays a key role in constraining grapheme–phoneme correspondences. Indeed, unlike the position constraints, morphological constraints can easily be taught explicitly (e.g., instruction can highlight the fact that multiletter graphemes cannot straddle a morpheme border; see next for more details).

Similarly, Snowling and Hulme (2014) highlighted the disappointing results of some phonology-based intervention studies and considered what should be done. In addition to suggesting more intensive phonics, they emphasized the need to improve pupil motivation. But again, the authors did not suggest that instruction should highlight the role that morphology and etymology play in constraining spelling. We agree that it is important to make literacy instruction more enjoyable, and we expect that teaching children to generate and test hypotheses in order to make sense of the English spelling system will be more engaging than additional remedial phonics. Indeed, the SWI approach fits well with Dewey's (1913, p. 14) characterization of the conditions that generate "genuine interest," as well as reports from teachers and children regarding the importance of experiments, demonstrations, and explanations for generating interest in a subject (Freeman, McPhail, & Berndt, 2002; Shulman, 1986; Zahorik, 1996).

To summarize, there is growing consensus that phonics instruction is not working for all children and little or no evidence that phonics is effective for spelling, vocabulary, and reading comprehension. Even some of the strongest proponents of phonics are now acknowledging that new methods are needed. In the next section we describe how the English orthographic system is organized. This provides the context for a possible alternative approach to literacy instruction.

THE ENGLISH SPELLING SYSTEM

It is widely assumed that the primary role of letters in English is to represent sounds, and the many "exception" words are generally taken to reflect a poorly designed spelling system. However, this reflects a misunderstanding. In fact, the English spelling system is designed to encode both pronunciation and meaning of words, and as a consequence, English word spellings are constrained by phonology, morphology, and etymology. Rather than a perverse system that needs reform, some linguists call English spelling "near optimal" (Chomsky & Halle, 1968). Whether or not English spellings are near optimal, the key claim we would make is that English spellings are logical and can be investigated like other scientific subjects given that the English spelling system is systematic.

How can it be argued that English spelling system is sensible and systematic? In this section we provide a brief tutorial that highlights the role that meaning plays in constraining spelling, the consistent way that bases are spelled across a morphological family, the regular manner in which affixes are added to bases, and the way in which almost all English spellings can be understood. We also highlight how phonics fails to explain all these aspects of the English spelling system, and indeed does a poor job in explaining how words are pronounced (the task for which it was designed). See Table 2 for a list of key linguistic terms that are needed for this tutorial. This sets the stage for the final section, Teaching Children the Logic of the English Spelling System, where we make the case that literacy instruction should be informed by the logical structure of the English spelling system.

As a first illustration of the role that meaning plays in constraining spelling, consider the homophone principle (Venezky, 1999). English is rich with homophonic words—those that share a pronunciation but differ in meaning. If the prime purpose of spellings is to encode sounds, we should expect homophonic words to be spelled the same. It turns out that the opposite is true. As Venezky (1999) noted, when two words can share a pronunciation, they tend to differ in spelling to signal a difference in meaning. The different spellings of <to>, <too>, and <two> is not an example of irregular spellings, but rather is an example of how English spellings code for distinctions in meaning.

The fact that we have many ways of writing the same phonemes is usually identified as a burden to learning to read and write. However, given that English has many homophones, it is necessary to have multiple graphemes for a given phoneme in order to mark meaning distinctions. That is, having many ways to write the same sound is a feature—not a bug of the writing system. The grapheme that is best suited for each member of a homophone pair can often be understood by considering words related in meaning and spellings that evolved at the same time—*synchronic etymology*. For example, the spellings <here>, <there>, and <where> all signal information about location, and that similar meaning is marked with the common letter sequence <here>. This group of spellings distinguishes <here> from its homophone <hear>, the latter of which uses a spelling linking it to the word <ear>. Similarly, the spelling <their> serves to separate it from its homophones and links it to related words <them> and <they>. In a phonics approach, *<thay> would be a more "regular" spelling than <they>. But, the <ay> digraph in *<thay>

TABLE 2
Linguistic Terms and Definitions

Term	*Definition*
Orthography	*Orthography* is the writing system of that evolves to represent the meaning of a language to those who already speak that language.
Phonology	*Phonology* is the system by which speech sounds of a language represent meaning to those who speak that language.
Phoneme and grapheme	A phoneme is a minimal distinctive unit of speech than affects meaning. A *grapheme* is a single letter or combination of letters that represent a phoneme. Most graphemes can represent more than one phoneme, and most phonemes can be represented by more than one grapheme. Graphemes occur within morphemes.
Morpheme and morphology	*Morphemes* are the meaning-bearing structures of words. *Morphemes* are bases or affixes (prefixes, suffixes and connecting vowel letters). Morphology is the system by which morphemes combine to represent the meaning of words. Every word is either a base or a base with another morpheme fixed to it.
Morphophonemic principle	The *morphophonemic principle* refers to the fact that morphemes can vary widely in their phonological representation across related words. Relevance for literacy: English orthography has evolved to favor consistent representation of morphology over phonology to mark connections in meaning across words (e.g. consider the pronunciation of the base <sign> in the words <sign>, <signal>, or <design>).
Etymology	*Etymology* refers to the origins of words and the way in which their meanings and oral and written forms have changed over time.
Diachronic etymology	*Diachronic etymology* refers to the influence roots of words (e.g. Latin, Greek, Old English) have on the meanings and spellings of current words.
Synchronic etymology	Synchronic Etymology refers to ways in which letters mark connections (<two>, <twin>, <twice>) or distinctions of meaning (<two>, <too>, <to>) between spellings of words that evolved at the same time.
Orthographic marker	An *orthographic marker* is a letter or combination of letters that may or may not play a phonological role (may not be a grapheme); for example, the plural cancelling <e> of <please> and the etymological marker letter <w> in <two>. Relevance for literacy: Many common spellings can only be investigated and understood with the recognition that letters and letter combinations can have meaningful jobs without playing a phonological role.
Base and root	A *base* is the morpheme that carries the main kernel of meaning in a word. The base is what is left when all affixes are removed. A *root* by contrast is the historical origin of a word (diachronic etymology). For example, the base of <unhelpful> is <help> whereas the root is the Old English word *helpan*. We restrict the term "base" to morphology and "root" to etymology.

would destroy the spelling link between the meaningfully related words *them, their*, and *they*. Further, although <ey> is not as common as <ay> for the /eɪ/ phoneme, it is one of many available spellings for this phoneme as demonstrated by <obey> (linking to <obedient>) and <prey> (linking to <predator> and distinguishing from the homophone <pray>).

In addition, and in contrast with the alphabetic principle assumed in phonics, letters often have functions that have nothing to do with representing the sounds of words. For example, one of the jobs of the single, silent (i.e., nonsyllabic) <e> is to serve as an orthographic marker letter for the plural cancelling function in words like <please> or <nurse> (Venezky, 1999), that is, <e> can be used in order to avoid words falsely appearing plural. Letters can also serve as etymological markers that link words related in meaning. The <w> in the word <two> is an etymological marker linking it to words having to do with two things, such as *twice, twin, twenty, between*. This marker also distinguishes it from its homophones <to> and <too>. Similarly, the <o> in <people> serves as a cue to the link to words related in meaning like <popular> or <population>. If these spelling markers were investigated in the early years of schooling, it would help make children aware that there is almost always a meaningful explanation for a word's spelling. By contrast, instruction that fails to highlight that letters have numerous jobs, including jobs that have nothing to do with pronunciation, results in words like <house> and <please> or <two> and <people> being classified as "irregular words." Once children understand that there is reason behind these spellings, it is hard to imagine a pedagogically sound rationale for describing these words as exceptions that just have to be memorized by rote.

Morphology plays a more central role in constraining grapheme choice given that written morphemes in English use consistent spellings across words with varied pronunciations. Take for example the words *sign, signal, design*, and *signature*. In oral language English speakers are exposed to varied pronunciations of the base <sign>: /sɪgn/ (in <signal> and <signature>), /zaɪn/ (in <design>), and /saɪn/ (in <sign>). But the spelling <sign> is consistent. The morphological relation between these spoken words is opaque *phonologically* but transparent *orthographically*. The fact that the <gn> in <sign> and <signature> maps onto different pronunciations is not evidence of a poor spelling system; rather this is evidence that a key organizing principle of English spelling is to mark connections in meaning.

The consistent spelling of morphemes can be highlighted using the word matrix and word sums depicted in Figure 1. The morphemic elements in the matrix correspond to the morphemic elements in the word sum. These written morphemes are *abstract representations* because they show the underlying lexical spelling that may or may not surface in a complete word. For example, in Figure 1 the full written form of the <-ate> suffix is found in the matrix and the relevant word

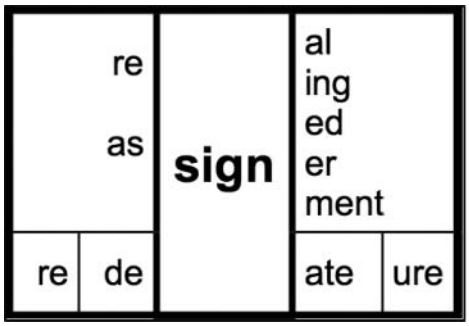

FIGURE 1 Word matrix and word sums for the base <sign>.

sums. However, only the surface realization of <designate> includes the full <-ate> suffix. In <signature>, the forward slash in the word sum marks the fact that the final, nonsyllabic <e> of the <-ate> suffix is replaced by the vowel suffix <-ure> in conformity with the reliable convention of adding vowel suffixes. The matrix and the word sum reveal the underlying abstract spellings of members of a morphological family and show how they resolve into the surface orthographic representation. Henry (2003) was the first to point to the matrix in the instructional research literature. P. N. Bowers and Cooke (2012) argued that these tools provide a concrete representation of Carol Chomsky's (1970) concept of "lexical spelling."

Investigating the <do> and <go> word families with the matrices in Figure 2 provides another good illustration of how lexical spelling can explain the spelling of the word <does>, which is typically described as an irregular "sight" word. The <o> grapheme is pronounced /u:/ in the stand-alone word <do>, whereas it is pronounced /ʌ/ when the <-es> suffix is added to form the word <does>. Instruction based on the alphabetic principle can describe <does> only as an example of the perversity of the English writing system (on phonics, a more appropriate spelling would be *<duz>). However, the parallel morphological structure of the <do> and <go> families shows the logic of these spellings. It makes no sense to claim that <goes> is a "regular" word whereas <does> is "irregular" when instruction reflects the actual interrelation of morphology and phonology in English.

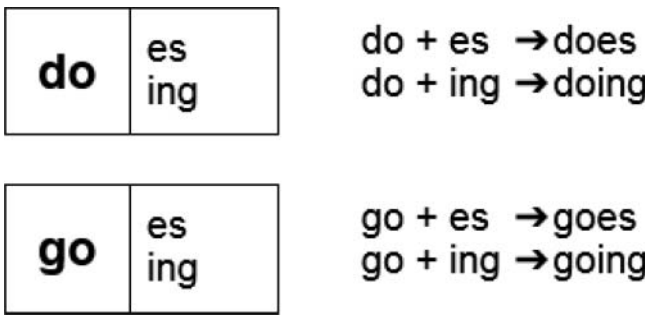

FIGURE 2 Word matrices and word sums for the bases <do> and <go>.

It is important to emphasize that morphology, etymology, and phonology interact. For example, morphology constrains grapheme–phoneme correspondences because graphemes cannot straddle morphemic boundaries. Consider the letter sequence <ea> in the words <reach> and <react>. In the word <reach> the <ea> falls within a morpheme so it is a digraph, which in this case represents the /i:/ phoneme. However, the same <ea> sequence straddles a morpheme in <re + act>, and accordingly the <e> and <a> must belong to different graphemes that map onto separate phonemes. Because phonics fails to consider the role of morphology in constraining grapheme–phoneme correspondences, many words are considered irregular that in fact have a perfectly good explanation.

Another important interaction is found between morphology and diachronic etymology. Diachronic etymology refers to the historical influences of word origins on the spelling and meaning of current words, with each word having the same origin (a common root). To conclude that two words are part of the same morphological family (e.g., as is the case with <sign> and <design>), two criteria must be established. An analysis with a word sum must show that the two words have an underlying morphological structure that reveals both words share a base of identical spelling (e.g., de + sign → design). In addition, there must be evidence that the two words share the same root—the same *diachronic etymology* (e.g., the root of both <sign> and <design> is from Latin root *signare* for "mark, token"). Discovering that the underlying meaning of "mark, token" is echoed in both of these words can deepen the understanding of both words and their spellings. In some cases, words that might appear to be members of the same morphological family (e.g., <play> and <display>) are not relatives because they do not share a root (e.g., <display> derives from the Latin root *plicare* "to fold," whereas the free base <play> goes back to the unrelated Old English root *plegan, plegian* for "frolic, mock, perform").

The fact that all words in a morphological family share a root is important because it means that words in a morphological family share some meaning. In many cases, the meaning relations are transparent (e.g., <sign> and <signal>) and in other cases, the relations are less obvious

(e.g., <sign> and <resign>), but in most cases it is possible to see how morphological relatives are related in meaning to the root meaning (e.g., in the case of <resign> you sign a "letter of resignation"). Of course, it is often possible to propose meaningful relations between words (e.g., <play> and <display> both involve action). The only way to ensure that two words share a common root is to consult an etymological dictionary. As detailed next, diachronic etymology and etymological dictionaries play a central role in SWI.

In sum, the English spelling system is designed to represent both pronunciation and meaning, and the spelling of most if not all English words can be explained once the constraints of phonology, morphology, and etymology are jointly considered. The claim that English is full of exception words that just have to be remembered (so-called sight words) reflects a fundamental misunderstanding of the writing system, and as we detail next, this misunderstanding precludes forms of instruction that emphasize reasoning and hypothesis testing in order to teach children that their writing system is logical.

Is the Theory Underpinning Phonics a Close Enough Approximation to the English Spelling System?

A possible response to the preceding analysis is to agree that English spellings are organized by phonology, morphology, and etymology but at the same time maintain that the overwhelming constraint on English spellings is phonology (e.g., Byrne, 1998). In such a case, it might be tempting to conclude that morphology and etymology can be safely ignored (at least at the start of instruction) so that children can focus on the critical factor, namely, grapheme–phoneme correspondences.

But this greatly underestimates the role of morphology and etymology in shaping spellings. In fact, grapheme–phoneme correspondences by themselves fail to explain the pronunciation of a relatively high percentage of words. Consider the Dual Route Cascaded model of word naming that includes sublexical grapheme–phoneme correspondences (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). The sublexical route mispronounces (i.e., generates the wrong phonological transcription for) 16% of the 8,000 monosyllabic words in the model's vocabulary (i.e., only 84% of these monosyllabic words are regular). Similarly, 16% of the monosyllabic words included in the The Children's Printed Word Database are mispronounced by the sublexical route.[2] It is possible to explain the pronunciation of a higher percentage of monosyllable words if larger sublexical letter-sound correspondences are included, such as rimes (the vowel and following consonants; Kessler & Treiman, 2001), but additional sources of irregularity arise when considering multisyllabic words (that constitute more than 90% of word types in English; Baayen, Piepenbrock, & van Rijn, 1993). For instance, how is a child to know that stress should be placed on the second syllable of <begin>, <commit>, and <control> despite the fact that most English words are pronounced with first syllable stress?

Furthermore, it is not the case that children first learn words for which the most frequent grapheme–phoneme correspondences apply. In fact the high-frequency words included in children's text are more likely to be irregular (according to phonics) compared to the low-frequency words in adult text; the majority of the words in The Children's Printed Word Database are multisyllabic (77%), and the majority of words from third-grade text are morphologically complex (60%–80%; Anglin, 1993). Accordingly, children are being taught phonics in a context in which perfect performance will lead to many errors. And given that struggling readers have phonological deficits, they will presumably not be able to fully exploit these sublexical regularities.

Sound-to-spelling (as opposed to spelling-to-sound) correspondences are even more irregular when instruction is based on the alphabetic principle. For example, Hanna, Hanna, Hodges, and Rudorf (1966) developed a complex set of phoneme–grapheme correspondences in an attempt to provide an estimate of the best possible sublexical spelling performance. They found that their algorithm could correctly spell only 49.9% of the words taken from a database of 17,000 words: 36.4% of the words were spelled with one error, 11.4% with two errors, and 2.3% with three spelling errors. More recently, Kreiner (1992) estimated that 60% of all words are irregular for spelling, and Crystal (2003) estimated that 56% of words can be predicted by phonological rules.

Given the limitations of sublexical grapheme-to-phoneme and phoneme-to-grapheme correspondences, it is clear that children need to learn many lexical-orthographic representations early on. How is this best achieved? Because it is widely assumed that there is little or no logic to these spellings, children are typically expected to remember them by rote, often on a case-by-case basis (e.g., learning to spell words through the "Look, say, cover, write, check" method). However, given that most words' spellings can be understood when morphology, etymology, and phonology are jointly considered, it is possible that lexical-orthographic forms might be learned through more meaningful instruction. We consider this possibility next.

Teaching Children the Logic of the English Spelling System

We are advancing the hypothesis that children should be taught the logic of the English writing system. In this way, literacy instruction can be designed much like instruction in

[2]These percentages are based on the DRC 2.0.0-beta.3511's vocabulary and GPC rules. I thank Max Coltheart and Steven Saunders for providing us this information.

other systematic domains that are studied scientifically (e.g., biology, physics). That is, children can be engaged in generating and testing hypotheses about how the system works.

In this final section we support this hypothesis on both theoretical and empirical grounds. Our main theoretical argument is that the learning processes encouraged by SWI are the very same learning processes that are known to support effective learning more generally. We then review empirical evidence that supports SWI. Although only a few studies have directly tested SWI, the results are promising, especially in the context of a growing literature highlighting the successes of morphological interventions, and most important in the context of the theoretical motivation of SWI.

Theoretical Motivations for Structured Word Inquiry

A key insight from psychology that helps motivate structured word inquiry is that information is better remembered if it is encoded in an elaborative and organized manner. For example, Craik and Tulving (1975) manipulated the extent to which participants encoded the meanings of words during the study phase of a memory experiment. Memory was best for words encoded in a meaningful manner. Furthermore, memory is better when the to-be-learned words are presented in a format that highlights the relations between items. Bower et al. (1969) carried out a memory experiment in which a set of words were displayed within a hierarchy that highlighted the meaning and the interrelations between words, as depicted in Figure 3, or alternatively, words were presented in an unstructured manner by placing them randomly within the hierarchy. Memory was approximately 3 times better when the words were presented in an organized manner. Visual memory is also dramatically better when meaning can be attached to the to-be-remembered pattern (Konkle, Brady, Alvarez, & Oliva, 2010; Wiseman & Neisser, 1974).

These findings are relevant given that morphological instruction requires children to focus on the meaning and interrelations between words. Consider the word matrices in Figures 1 and 2 that highlight how word spellings are organized by meaning. There is every reason to think that studying a set of words in a matrix will improve memory because it highlights the meaningful relations between words, much as the method used by Bower et al. (1969). Indeed, given the role that meaning has in visual memory (e.g., Konkle et al., 2010), it should be expected that the meaningful study of written words will help children remember the visual forms of words (i.e., their spellings). By contrast, in standard phonics instruction many words in a morphological family will be encountered separately from one another, with little or no consideration of how words relate to one another, much like the random condition in Bower et al. (1969) memory study.

A second insight from psychology that motivates structured word inquiry is that memory and learning benefit from a strategy labeled "explanatory questioning." Roediger and Pyc (2012) introduced this term to describe two related techniques, namely, elaborative interrogation and self-explanation. Elaborative interrogation involves generating plausible explanations as to why some stated fact is true. Roediger and Pyc gave the example of a student being told that it takes longer for Neptune to revolve around the sun than it takes Mars. Students should ask themselves why this is the case. By answering the question why, they are better able to remember this information. Self-explanation involves students monitoring their learning and reflecting on some features of their learning. For example, while reading a new page of text, a child might ask him- or herself, What facts do I already know? What facts are new? Both strategies encourage students to be active learners, and both

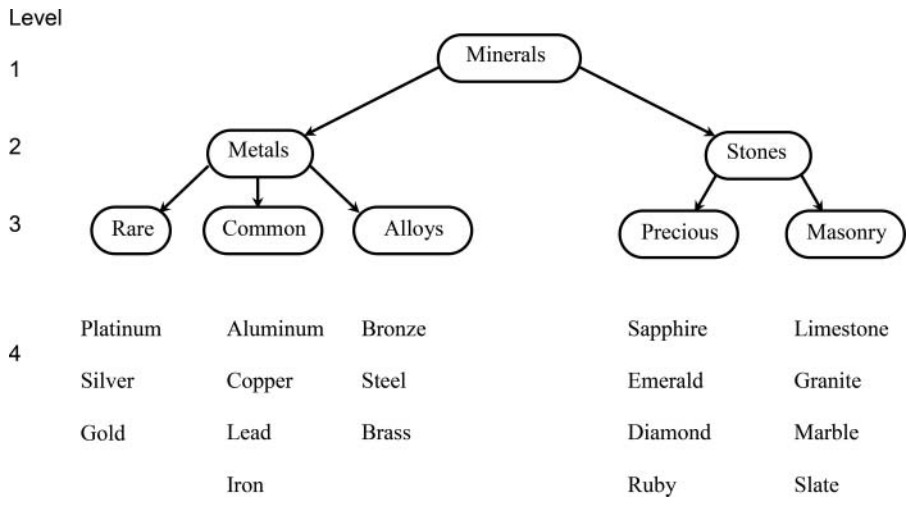

FIGURE 3 To-be-remembered words displayed in hierarchy.

are effective (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013).

Structured word inquiry is well suited to inspiring explanatory questioning. Rich classroom discussions can grow from questions about the structure–meaning connections of complex words and their morphological relatives. For example, children can be presented with words such as *play, playful, replay, plays, plane, playmate*, and *say* and investigate the structure and meaning of these words with word sums and matrices to develop and test hypotheses about which words are from the same morphological family and which are not.

Consider instruction that explores the question of whether <play> and <display> belong to the same morphological family. A word sum shows that there is a possible structural connection given <dis + play → display>. But is the base <play> part of <display>? How can we know? Here children can be introduced to the idea that words that share the same base must *also* share the same root. Using an etymological dictionary, the teacher can help children see that <display> derives from the Latin root *plicare* "to fold." So to "display" something is to "unfold" it. However, the free base <play> goes back to the unrelated Old English root *plegan, plegian* for "frolic, mock, perform." In this way, the hypothesis that <play> and <display> belong to a common morphological family can be rejected. A lesson organized this way underscores the relationship between morphology and etymology.

Kirby and Bowers (in press) used the phrase "structure and meaning test" to describe the scientific process of using word sums and etymological references to test a hypothesis of whether any two words share a base element. Teachers and students learn that in order to draw a conclusion about whether two words like <display> and <play> are related, they need evidence from both structural analysis with a word sum (morphology) and historical (etymology) connections. In this way, the structure and meaning test provides a method to draw a principled conclusion based on objective criteria. We would like to emphasize that studying words through a linguistic analysis exploits explanatory questioning that is well documented to support excellent memory and learning.

A third motivation for structured word inquiry comes from theories of reading. Almost all theories and models of word identification and naming assume that skilled reading involves identifying words lexically (unmediated by letter-sound correspondences). This includes the dual route cascaded model (Coltheart et al., 2001), the connectionist dual process model (Perry, Ziegler, & Zorzi, 2007), as well as the interactive activation model (McClelland & Rumelhart, 1981) and the spatial coding model (Davis, 2010), among many others. Similarly, parallel distributed processing models of word naming (Seidenberg & McClelland, 1989) are typically developed within the "triangle model" framework that includes mappings from orthography to meaning (separate from mappings linking orthography to phonology). These models are all consistent with the strong evidence that orthographic word knowledge can be accessed independently of first computing grapheme–phoneme correspondences and that orthographic word knowledge can directly access semantic knowledge (J. S. Bowers, Davis, & Hanley, 2005; Hino, Lupker, & Taylor, 2012; Taft, & van Graan, 1998), even in children (Nation & Cocksey, 2009).

This raises the question of how to best learn orthographic word forms (in addition to grapheme–phoneme correspondences). We have no doubt that learning grapheme–phoneme correspondences is essential, with phonological codes serving as a "teacher" to the orthographic system (Share, 1995; Ziegler, Perry, & Zorzi, 2014). But there is every reason to believe that instruction directed at highlighting the meaning relations between morphological forms of words would be helpful in learning lexical orthographic forms as well. Indeed, given that almost everyone agrees that skilled reading involves both converting graphemes to phonemes and accessing lexical-orthographic representations directly, it makes good theoretical sense to develop instruction that targets both processes. Whereas phonics targets only the former processes, structured word inquiry targets both. In line with this view, Share (2011) recently proposed that the self-teaching hypothesis that originally emphasized phonological recoding as the central means by which readers acquire lexical-orthographic representations should also incorporate morphological knowledge in the process.

Consistent with this analysis, Kirby and Bowers (in press) proposed a theoretical framework that motivates instruction designed to strengthen the links between morphological, phonological, orthographic, and semantic representations. They described morphology as a *binding agent* given that it is the one representation that is directly linked to semantics, orthography, and phonology. Their binding agent theory draws explicitly from Perfetti's (2007) lexical quality hypothesis. In this view, the key to literacy includes not only the quality of separate language representations but also the quality of the *interrelation* of the representations. There are many advantages to well-integrated mental representations (Perfetti, 2007). Kirby and Bowers proposed that morphology offers an agent for better integration of the mental representations of words by facilitating clues to meaning from both orthography and phonology.

Structured word inquiry is promising for a fourth reason: In principle, it can support robust and widespread generalization, such that learning one word provides insights into how to spell and understand many related words. Surprisingly little evidence addresses what types of learning conditions engender useful transfer (Roediger, Finn, & Weinstein, 2012), but generalization is possible only in conditions in which information is organized and systematic such that previous learning is relevant to new

situations. In a completely arbitrary world, no generalization is possible. Thus it is highly relevant that the structured word inquiry approach highlights how the English writing system is structured for meaning and details the spelling rules that explain how affixes are added to bases. Thus structured word inquiry is well suited to support Kirby and Lawson's (2012) definition of high-quality learning: "learning that results in knowledge that is extensive, integrative and generative so that it supports transfer" (p. 3). By contrast, phonics instruction fails to represent (and mischaracterizes) many of these key rules, including grapheme–phoneme correspondences, and as a consequence, less generalization is possible.

Consistent with these analyses, preliminary evidence suggests that morphological instruction supports generalization in children. P. N. Bowers and Kirby (2010) used the structured word inquiry approach in Grade 4/5 classrooms with matrices and word sums to investigate the morphological structure of word families. They found the experimental group was better than controls at defining untaught words that shared a base with taught words. The results of this study are described in more detail in the next section.

Finally, we would like to make a more general point. Because structured word inquiry teaches literacy as a scientific subject, the complexity of study—as in any other scientific subject—can vary from rudimentary to advanced. Accordingly, this form of instruction is appropriate for all age ranges, from young children (as early as Grade 1; Devonshire, Morris, & Fluck, 2013, as discussed next) to adults interested in understanding the linguistics of the English writing system. By contrast, phonics is intended only as a short-term form of instruction that, if all goes well, is abandoned in Grade 3. With older "treatment resistors" who are struggling, relatively little is offered at present other than more phonics and more practice reading text. Structured word inquiry opens up a wide range of possibilities for older children, with meaningful scientific investigations that have the potential to be far more interesting.

Empirical Evidence in Support of SWI

Our main goal has been to advance a theoretical argument in support of SWI with the hope that it will motivate more empirical research. But there is also growing empirical evidence for this approach, both indirectly from morphological intervention studies and directly through a small number of studies that have carried out SWI interventions. We consider these two data sets in turn.

Morphological intervention studies: Review of the research. Researchers in psychology have noted for quite some time that English spellings are constrained by morphology and argued that morphology should play a more prominent role in literacy instruction (Bryant & Nunes, 2004; Henderson, 1984; Henderson, & Templeton, 1986; Henry, 1989, 2003/2010; Nunes, Bryant, & Olsson, 2003; Stephens & Hudson, 1984). In addition, it has become clear that young children draw on untaught morphological knowledge during the process of becoming literate. For example, untaught morphological awareness explains unique variance for reading (Carlisle, 2000; Deacon & Kirby, 2004), vocabulary learning (Nagy, Berninger, & Abbot, 2006; Stahl & Nagy, 2006), and spelling (Deacon & Bryant, 2006a, 2006b; Kemp, 2006; Perry, Ziegler, & Coltheart, 2002). But only recently have a sufficient number of morphological intervention studies been carried out to support reviews and meta-analyses (P. N. Bowers, Kirby, & Deacon, 2010; Carlisle, 2010; Goodwin & Ahn, 2010, 2013; Reed, 2008).

Here we focus on two meta-analyses of Goodwin and Ahn (2010, 2013) who assessed the statistical significance of effect sizes. First, Goodwin and Ahn (2010) looked specifically at studies focusing on populations with learning disabilities. The authors searched for both published and unpublished literature from 1980 to 2010 relying on a variety of databases, with keywords including *morphology, morphemes, morphological awareness, intervention, instruction, learning disabilities, student characteristics, language impairments, reading difficulties, reading ability, vocabulary development, reading, structural analysis*, and *language processing*. They synthesized 79 standardized mean-change differences between control and treatment groups from 17 independent studies. These studies varied in a number of ways, including the nature of the intervention (some interventions included only morphological instruction, others included morphological instruction as part of larger intervention), the nature of the control condition (control groups included participants who received other types of instruction with no morphological components, e.g., contextual instruction or phonological instruction), the design of the study (experimental designs with random assignment, quasi-experimental design, or nonexperimental design), the number of students in an instructional group, the length of the intervention, and the nature of the language difficulty (such as speech and language delay or poor spelling). This makes it difficult to make any strong conclusions, but nevertheless a number of statistically significant results did emerge that highlight the promise of morphological instruction.

Overall morphological instruction showed a moderate and significant improvement on literacy achievement ($d = 0.33$). Breaking down the outcome measures, they reported the largest effects on the metalinguistic tasks of phonological awareness ($d = 0.49$) and morphological awareness ($d = 0.40$) but also reported significant effects across a range of literacy measures, namely, vocabulary ($d = 0.40$), reading comprehension ($d = 0.24$), and spelling ($d = 0.20$). There were no significant advantages on word decoding ($d = 0.23$) or fluency ($d = –.28$). Important to note, morphological instruction was effective for children categorized with a wide range of language disorders.

Specially, children with speech and language delay showed the largest improvement averaging overall all outcome measures ($d = 0.77$), followed by children learning English as a second language ($d = 0.62$), followed by struggling readers ($d = 0.46$), poor spellers ($d = 0.24$), children with learning disabilities ($d = 0.22$), and children with reading disabilities ($d = 0.17$).

In addition, Goodwin and Ahn (2013) carried out a meta-analysis of morphological studies carried out on students from the general population. Again, the authors searched for both published and unpublished literature relying on a variety of databases, with keywords including morph∗, intervention, instruction, vocab∗, read∗, spell∗, decod∗, fluency, structural analysis, and language processing. They synthesized 92 standardized mean differences (d) from 30 independent studies that again varied in many ways (e.g., nature of the intervention, control group, design of the study, age of student population, etc.). Once again the authors reported a moderate overall effect of morphological instruction ($d = 0.32$). Breaking down performance, the analyses revealed significant intervention effects on morphological knowledge ($d = 0.44$), phonological awareness ($d = 0.48$), as well as the literacy outcome measures of decoding (d = 0.59; that was not significant in the previous meta-analysis), vocabulary ($d = 0.34$), and spelling ($d = 0.30$). However, in this meta-analysis (unlike the pervious meta-analysis), no overall effect on reading comprehension ($d = 0.09$) was observed. Nevertheless, it is worth noting that a moderate effect on reading comprehension was obtained for interventions of more than 20 hr ($d = 0.40$), for small-group interventions ($d = 0.38$), and for interventions with preschool/early elementary students ($d = 0.40$).

Important to note, the greatest overall effect was obtained for children in preschool/early elementary grades (.68) compared to upper elementary (.29) and middle school (.34), suggesting that morphological interventions should start early. In addition, and broadly consistent with the earlier Goodwin and Ahn (2010) study, children learning English as a second language showed the largest intervention effect ($d = 0.54$), followed by children with learning disabilities ($d = 0.37$), then poor readers/spellers ($d = 0.35$), with typical achievers benefiting the least ($d = 0.29$).

We would like to highlight two findings from these meta-analyses. First, morphological instruction consistently produced greatest benefits with struggling readers (not only in Goodwin and Ahn, 2010, 2013, but also in the P. N. Bowers et al., 2010, as well as the Reed, 2008, analyses). Why might struggling readers tend to benefit most from morphological instruction (whereas struggling readers tend to benefit least with phonics; Hatcher et al., 2006)? One obvious point to note is that most struggling readers are typically failing in the context of a curriculum that already emphasizes grapheme–phoneme correspondences. It may be that the continued emphasis on phonological training is less than optimal, especially for those children who have poor phonological-processing skills. By contrast, morphological instruction emphasizes the role that meaning plays in organizing spellings, and accordingly, morphological interventions for struggling readers may take advantage of compensatory, as opposed to restitutive, processes.

Second, morphological instruction was effective, and often most effective, with younger children (this was also found by P. N. Bowers et al., 2010; Carlisle, 2010). This directly contradicts the common claim that morphology should be taught only, if at all, following phonics (Adams, 1990; Ehri & McCormick, 1998; Larkin & Snowling, 2008). Again, this may reflect the fact that learning and memory are best when information is encoded in a meaningful and organized manner. As far as we are aware, this is true for everyone.

Structured word inquiry: Initial research. The preceding studies provide some evidence that teaching children about morphology, especially young and struggling readers, is beneficial. This lends some indirect support to SWI given that SWI emphasizes the importance of morphology for instruction. Nevertheless, these morphological interventions differ from the SWI approach in a number of important ways.

First, most morphological studies are not designed to teach children the logic of the writing system. For example, P. N. Bowers et al. (2010) reported that of the 22 studies in their meta-analysis, only four (excluding SWI studies) explicitly targeted the fact that the spellings of a base within a morphological family are consistent despite pronunciation changes (as in <sign> and <signal>). Although morphology has evolved to represent meaning with consistent spelling, the failure to teach this foundational fact of the English spelling system is widespread even when morphology is included in instructions. For example, the document "English Programmes of Study: Key Stages 1 and 2. National Curriculum in England" (Department for Education, 2013) includes a list of affixes that legally must be taught (e.g., –ment, –ness, –ful, –less, etc.) to Year 2 students (pp. 46–47). Then on page 48, a list of common "exception" words is provided, including the words "because," "Christmas," and "children." But in fact, these words highlight the regular nature of spellings: be + cause → because; Christ + mas → Christmas; child + ren → children. This list of irregular words reflects a failure to understand the logic of orthographic morphology, as the following quote at the bottom of the exception word list shows: "Note: 'children' is not an exception to what has been taught so far but is included because of its relationship with 'child'" (p. 48).

Second, as far as we can tell, none of the morphological studies (apart from the SWI studies) taught words in the context of their morphological families (e.g., teaching the

stem <sign> alongside a set of its morphological relatives, such as <resign>, <design>, <signal>, <signaling>). Rather, interventions tended to include pairs of words (e.g., <sign>–<signing>), often focusing on the fact that a given affix can be added to many different words (e.g., <sign>–<signing>, <play>–<playing>, <jump>–<jumping>). This is far from ideal because it fails to highlight the meaning relations between words in a morphological family. In addition, selecting morphological pairs is less likely to highlight phonological shifts in the pronunciation of the base than when multiple affixes are studied in association with one base (explaining why there is a <g> in <sign>). As just noted, memory is best when materials can be studied in a meaningful and organized manner (Bower et al., 1969), and nevertheless, most morphological study fails to exploit this fact.

Third, many morphological intervention studies teach morphology in isolation, separate from phonological and etymological constraints. For example, the P. N. Bowers and Kirby (2010) meta-analysis of morphological interventions found 11 of 22 studies selectively focused on morphology, with no consideration of other sublexical constraints on spelling, let alone how morphology, etymology, and phonology interact. A central tenet of SWI is that children need to study the interrelation between morphology, etymology, and phonology in order to understand the writing system.

Fourth, because most morphological studies fail to explain the logic of the writing system, it is not possible for children to carry out word investigations, making generating and testing hypotheses about what words belong to a morphological family. That is, these morphological interventions all failed to exploit explanatory questioning that is another robust way to improve learning (Roediger & Pyc, 2012). It is encouraging that the existing morphological intervention studies show promising results, but for the reasons just stated, we predict that SWI will prove to be far more effective.

In fact, we know of only three SWI interventions. First, Devonshire and Fluck (2010) assessed the impact of SWI on spelling in groups of Year 3 and Year 4 children in the United Kingdom ranging 7–9 years (M age = 8 years 5 months). The study employed a quasi-randomized design, with 38 children from a Year 3 and Year 4 class completing the SWI intervention, and 34 children taken from another Year 3 and Year 4 class carrying out an alternative reading intervention described next. The school contained mixed ability children from a predominantly middle-class background. The intervention involved 9 × 35-min lessons. In the SWI condition children were taught to identify base words and affixes and to combine morphemes (e.g., drop the final <e> from a base word when adding a vocalic suffix: love/ + ing → loving). Children were also taught about basic etymology, such as the fact that certain silent letters are etymological markers linking words that share a root (e.g., the <w> in <two> serves to link the words <twin>, <twice>, <twelve>, and <twenty>). The control group worked through the Nelson Spelling Scheme (Jackman, 1997). This requires children to complete different written activities. Critically, it employs phonic strategies and does not explicitly teach morphemic segmentation or identification. The emphasis is on teaching children spelling patterns that represent a particular sound (e.g., that *tion* makes the sound /ʃən/).

On a preintervention test, children were matched on a customized spelling test that included morphologically complex words as well as the standardized Schonell Spelling Test (Schonell & Goodacre, 1971). Both groups improved at postintervention, but the children in the SWI condition outperformed the control group in both tests with the interaction between time of testing and intervention group significant for both tests, $F(1, 66) = 4.56$, $p = .036$, partial $\eta^2 = .06$; $F(1, 66) = 25.99$, $p < .001$, partial $\eta^2 = .28$, respectively.

More recently, Devonshire et al. (2013) assessed the impact of SWI on spelling and naming aloud words in a fully randomized control study with 120 children. In this case Year 1 and Year 2 mixed ability children in the United Kingdom ranging in age from 5 to 7 were assigned to the intervention first condition (first exposed to SWI and then standard classroom instruction) or the intervention second condition (first given standard classroom instruction followed by SWI). The intervention was composed of daily 15- to 25-min lessons over the 6 weeks. In these sessions children were taught the logic of English spelling, with explicit instruction on morphology, etymology, and phonology, and the key rules that guide spellings. Children learned how the spelling of a base word is retained in derived and inflected words even when the pronunciation changes, as in <magic> and <magician>. By contrast, in the standard classroom instruction condition children were taught phonics ("business as usual" condition).

Testing took place prior to the intervention, halfway through the intervention (after the "intervention first" group completed 6 weeks of instruction), and at the end of the intervention. Before the intervention the two groups performed similarly on a customized spelling test that included morphologically complex words as well as the standardized Schonell spelling test and the standardized Schonell reading test. After 6 weeks, children in the intervention first condition outperformed the children in the intervention second group on all three measures; in the final test (after both groups had completed the SWI intervention), both groups performed equally well. Once again, robust interactions were found between time of testing and intervention group for all tests. Most important, on the second test (when only the intervention first group had received morphological instruction), the intervention first group performed better than the intervention second group on all measures: Schonell Spelling effect size $d = .63$, customized spelling effect size $d = .84$, and Schonell Reading effect size $d = .52$.

Finally, P. N. Bowers and Kirby (2010) carried out an intervention that assessed the impact of structured word

inquiry on vocabulary acquisition in a quasi-randomized intervention study in which two Grade 4 and two Grade 5 classes (81 children) were randomly assigned to the structured word inquiry and control condition, with the constraint that each condition included one Grade 4 and one Grade 5 class. The control group classes continued with typical instruction while the structured word inquiry group classes participated in three or four 50-min lessons each week until 20 sessions were completed.

The structured word inquiry group investigated word families with word sums and matrices. Participants learned to develop and test hypotheses about spelling–meaning connections between words. Among the topics covered, the lessons explained three suffixing changes (replacing final, single, silent <e>s; doubling final, single consonants; and <y> / <i> changes), explained the difference between bound and free base elements, explained the difference between etymological families (share a root) and morphological families (share a root and a base element), and highlighted that the underlying spelling of morphemes as shown by the matrix and the word sum are consistent despite pronunciation shifts across related words.

After the intervention, children were tested on definitions of three categories of words: (a) "Word Taught" words that children may (but not necessarily) have been exposed to over the course of the 20 lessons, (b) "Base Taught" words that were never presented in lessons but that shared a base with a "Word Taught" word, and (c) "Affix Taught" words that included trained affixes but with bases that had been carefully avoided. Regression analysis controlling for initial vocabulary showed that not only was the experimental group better at defining the words they may have been exposed to, $F(1, 79) = 10.4$, $p < .01$, partial $\eta^2 = .12$, but they were better at defining "Base Taught" words, $F(1, 79) = 6.01$, $p < .05$, partial $\eta^2 = .07$. For example, they were better at defining a word like <significant> that was never addressed in the instruction but was related to the <sign> family that was addressed. No advantage was obtained in the Affix taught condition.

The generalization afforded by the structured word inquiry relates to a controversy concerning vocabulary instruction. Some researchers (Beck, McKeown, & Kucan, 2002; Beck, Perfetti, & McKeown, 1982) have argued for vocabulary instruction that is *deep and rich*. They have argued that instruction should provide opportunities for deeper processing in order for the vocabulary learning to be effective. Others (Biemiller & Boote, 2006) have argued for instruction that is *shallow and wide*. They have provided evidence that if children were exposed briefly to many words in the context of meaningful experiences, children with impoverished vocabularies could start to catch up to more advantaged peers. However, P. N. Bowers and Kirby (2010) argued that morphological instruction investigating word families with the matrix provides a way to meet both of these seemingly contradictory goals and more. They pointed out that in studying a matrix, the teacher can offer deep and rich instruction for a few words in a matrix and, at the same time, show how their spelling and meaning relate to other words (and potential words) in the matrix, providing instruction that is wide (and that supports generalization).

Together, these structured word inquiry intervention studies not only show that children can learn about the logical structure of words but also provide some preliminary evidence that learning about the phonological, morphological, and etymological constraints on English spelling improves decoding (Devonshire et al., 2013), spelling (Devonshire & Fluck, 2010), and vocabulary knowledge (P. N. Bowers & Kirby, 2010).

Possible Objection to Structured Word Inquiry

One possible objection to SWI is that young children in Grade 1 who are just starting to read do not have the cognitive skills necessary to explore the interrelations between orthography, phonology, morphology, and etymology. Indeed, it is often claimed that morphological instruction should occur only after phonics (Adams, 1990; Ehri & McCormick, 1998; Larkin & Snowling, 2008). For example, Ehri's influential developmental model (Ehri & McCormick, 1998) posited five phases of learning to read: prealphabetic, partial alphabetic, full alphabetic, consolidated alphabetic, and automatic. Instructional recommendations were offered for each stage. Morphology does not appear until the fourth phase. Similarly, Larkin and Snowling (2008) cited the stage models of reading by Frith (1985) and Ehri (1995) to support the conclusion that teaching should have an initial focus on teaching grapheme–phoneme mappings rather than morphology. Consistent with these conclusions, a number of authors have noted that some morphological skills emerge long after children master phonics. For example, Nunes, Bryant, and Bindman (1997) suggested that 7- and 8-year-old children are entering the morphemic stage in spelling (children in Grades 2 and 3). Henderson and Templeton (1986) suggested that children do not start applying morphological principles to derivational spelling until around age 10 or 11. These findings might also be taken as evidence that SWI instruction is not appropriate in beginning readers in Grade 1.

However, these claims and findings provide no evidence against the claim that SWI should be adopted from the very beginning. First, the claim that morphological instruction should be introduced only in older children (e.g., Adams, 1990) is challenged by the multiple meta-analyses showing that morphological interventions are more effective with younger children, including preschool and elementary students (P. N. Bowers et al., 2010; Goodwin & Ahn, 2010, 2013). As noted earlier, a successful SWI intervention has recently been carried out with children between ages 5 and 7 (Devonshire et al., 2013). It is also worth noting that children

from Grade 1 on are successfully completing these investigations in a growing number of public and private schools. For example, see http://tinyurl.com/ox4c68b for a video of a Grade 1 class investigating <cardiovascular> using an etymological dictionary and http://tinyurl.com/pv2qroq for a video of 7-year-olds working with an etymological dictionary. Also see http://tinyurl.com/zlr27pn for a video of a more basic lesson in public school Grade 1 classroom that illustrates how morphology and graphemes interact using word sums. We fully acknowledge that these illustrations are only anecdotal, but the videos show that structured word inquiry is possible in younger children and, most important, give the reader a more concrete idea of how these lessons can be implemented in practice.

Second, the finding that morphology does not constrain how Grade 1 students spell (e.g., Henderson, 1984; Nunes et al., 1997) provides no evidence that SWI is too challenging for these students given that they were not taught about morphology. The relevant question is not when children acquire morphological knowledge implicitly, but rather when children should be given explicit instruction regarding morphology, etymology, and phonology. The Devonshire et al. (2013) study provides some preliminary evidence that SWI instruction is effective for beginning readers between ages 5 and 7.

Another possible objection is that structured word inquiry will be difficult to implement with struggling readers who exhibit more general learning difficulties. For example, specific language impairment is manifest as a difficulty in acquiring language despite otherwise normal IQ, normal hearing, and an adequate learning environment. The cognitive deficits extend beyond phonology to include deficits in semantics, syntax, and discourse. Important for present purposes, approximately one third of children with specific language impairment in kindergarten are dyslexic in later grades (Catts, Adlof, Hogan, & Weismer, 2005), with some estimates higher still (McArthur, Hogben, Edwards, Heath, & Mengler, 2000; Snowling, Bishop, & Stothard, 2000). Other cases of reading disorders will be attributed to even broader deficits, including low IQs. This raises the question as to whether SWI is appropriate for these populations of children.

We agree that future research is needed to answer this question, but there is every reason to believe our theoretical arguments for structured word inquiry apply to these populations as well. Indeed, as far as we are aware, memory and learning is best when information is encoded in a meaningful and organized manner for all individuals. In general support of this claim, meta-analyses show that morphological intervention are more effective for struggling readers (P. N. Bowers et al., 2010; Goodwin & Ahn, 2010, 2013). In our view the default assumption should be that all subgroups of learners will benefit from instruction that correctly represents the writing system.

Finally, a skeptic might note that the empirical evidence in direct support of SWI is limited, with only three published SWI intervention studies in total and only one carried out with young children (ages 5–7; Devonshire et al., 2013). In fact, we agree that caution is warranted at present. But given the strong theoretical motivation for SWI that we have just detailed, the growing evidence that morphological instruction is useful, especially for young and struggling readers, and the promising initial evidence for SWI, we think it is time to carry out more empirical research on SWI. This is our goal: to motivate future empirical studies of SWI in order to assess whether indeed this method is more effective than phonics that is currently failing too many children.

SUMMARY

In contrast with the vast amount of empirical research on phonics, the research on SWI is only beginning. Nevertheless, we would argue that the theoretical motivation for SWI is extremely strong (see Table 1). Furthermore, the empirical evidence is highly promising. Morphological instruction is a central feature of SWI, and the evidence from the three meta-analyses of morphological instruction (P. N. Bowers et al., 2010; Goodwin and Ahn, 2010, 2013) show that morphological instruction benefits all students, but it is particularly beneficial for less able and younger students. In addition, the three existing SWI studies report improvements in decoding (Devonshire et al., 2013), spelling (Devonshire & Fluck, 2010), and vocabulary knowledge (P. N. Bowers & Kirby, 2010), with morphological instruction directed at children as young as 5 years of age (Devonshire et al., 2013).

Although there is now growing evidence that literacy instruction should be designed to make sense of the English spelling system, little evidence is available concerning *how* to best teach these facts. Nevertheless, we are now in a position to see a promising path forward. Psychological theories of learning highlight the importance of organizing information in meaningful ways, as well as the importance of explanatory questioning in which students generate plausible explanations as to why some stated fact is true, as well as monitoring and reflecting on their learning. These findings motivate the use of tools such as morphological matrices and word sums that highlight the meaningful relations between words and etymological dictionaries that allow hypotheses to be tested. Clearly more research is needed to assess the efficacy of these specific tools, and the approach more generally. Our main goal here is to help inspire more research into teaching children the logic of their spelling system (also see Crystal, 2013; Henderson, 1984; Venezky, 1999).

DISCLOSURE

Peter N. Bowers runs the company WordWorks, where he uses Structured Word Inquiry to teach children literacy.

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