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ARTICLE

Morphological awareness and word-level reading in early and middle elementary school years

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Abstract

We examined whether morphological awareness made a significant contribution to word-level reading across Grades 1 to 4. We test these relations specifically in a task measuring awareness of past-tense forms. A total of 375 children from Grades 1 to 4 completed tasks assessing past-tense morphological awareness along with real word and pseudoword reading. Children also completed control measures assessing phonological awareness, phonological short-term memory, sentence-level language skills, and nonverbal cognitive ability. After these controls, past-tense morphological awareness was a significant predictor of real word reading in Grades 1 and 2, but not in Grades 3 and 4. Further, following on all controls, past-tense morphological awareness was a consistent predictor of pseudoword reading across Grades 1 to 4. Morphological awareness, at least as measured with past-tense verbs, appears to have a role in word reading across the early to middle elementary school grades; for young readers, there are relations to reading of both known and novel words, and for older readers, relations are significant specifically in reading novel words. These findings are discussed within the context of theories of word reading development.

Keywords: morphological awareness; word-level reading

The English language has an alphabetic writing system that represents both phonemes and morphemes. For instance, spelling of the word *rocked* is based in part on phonology, in that the letters largely follow on the sounds in the word, and in part on morphology, in that the letters *–ed* are used to represent the past-tense morpheme, even though it has the sound /t/. A wealth of literature has documented the importance of children's awareness of phonemes in supporting their word-level reading (e.g., Bradley & Bryant, 1983; Wagner, Torgesen, & Rashotte, 1994). Far less work has explored the role of morphological awareness in word-level reading (e.g., Carlisle, 2010; Deacon, 2012). Morphological awareness is the ability to reflect on, analyze, and manipulate the smallest units of meaning in

language, or morphemes (Carlisle, 2010). A key theoretically driven question lies in the consistency of the contribution of morphological awareness to word-level reading across the early to middle elementary school years. We test this question here by examining whether morphological awareness assessed with past-tense verbs is related to skill in reading known and novel words in a cross-sectional study of English-speaking children in the early to middle elementary school years (Grades 1 to 4).

Potential changes across the early to middle elementary school years in the relations between morphological awareness and word-level reading are relevant for models of word reading. In her Phase Theory of Reading Development, Ehri describes word reading as developing through a sequence of four overlapping phases (Ehri, 1995, 2005, 2014; also see Seymour, 2005). Following on the first prealphabetic phase, children rely increasingly on phonological decoding in the next two phases. Only in the last phase, known as the consolidated alphabetic phase, are children thought to rely on letter patterns, including morphemes such as *–ed*, that occur frequently in written words. In this phase, children continue to have access to all the linguistic skills used in earlier phases. While phases are not tied directly to grades, in this theory, children are thought to reach the final phase in Grade 3. Likely influenced in part by this theory, much of the empirical literature on the relation between morphology and word-level reading is conducted with children in Grades 3 and up (see Carlisle & Kearns, 2017, for a review). However, Carlisle and Kearns (2017) suggest the relation between morphology and real word reading begins earlier in childhood than what was previously theorized. Moreover, there is some empirical evidence that younger children use morphological information when spelling and when making lexical decisions (Deacon & Bryant, 2006; Rabin & Deacon, 2008; Treiman, Cassar, & Zukowski, 1994).

Theories are less clear about the role of morphology in reading novel words. Ehri's suggestion that readers in the consolidated alphabetic phase have access to all linguistic skills leads to two possible predictions (Ehri, 1995, 2005, 2014). Children might rely heavily on phonological skills, an earlier developed skill, in the reading of novel words. This prediction is also supported by Ehri's speculation that letter patterns such as morphemes are useful in securing words in memory; this points to relations specifically for known words with such memory representations and not to novel words. This is likely the assumption to be made by many researchers; a well-known test of pseudoword reading (the TOWRE; Torgesen, Wagner, & Rashotte, 1999) is known as phonemic decoding, suggesting that it tests decoding by phonemes only. Yet, children in the consolidated phase in Ehri's theory might draw on all available linguistic skills in reading novel words, leading to a role for morphological awareness in reading both known and novel words. Children may segment morphemelike units from pseudowords (or from real words that are new to the child); consider, for instance, the fact that they might activate *–ing* and *–ful* in a pseudoword like *munsingful*. These ideas align with theorizing in the adult literature as to the role of morphemes as functional units of lexical access (e.g., Taft, 2004); novel words may not carry meaning on their own, but they contain meaningful semantic units that could influence processing (see Deacon & Kirby, 2004). Such processing could occur on the basis of morphemes as "beads on a string" or as convergence of codes (e.g., Seidenberg & Gonnerman, 2000). In addition, items like *munsingful* occur on commonly given tests of pseudoword reading, including in the word attack that we use in the present study (Woodcock, 2011). Given these

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theoretically plausible alternatives, we need empirical research contrasting relations between morphological awareness and the reading of known and novel words across the early to middle elementary school years.

Empirical evidence to date on the relations between morphological awareness, real word, and pseudoword reading

Further impetus to evaluate these relations comes from the relatively limited available research base. As a case in point, the authors of a recent meta-analysis (Ruan, Georgiou, Song, & Shu, 2018) remarked that the few available studies in English have covered either the lower or the upper elementary school grades. Certainly, there are several longitudinal studies, but by design, these often hold the time point of measurement of morphological awareness constant, while varying the point of measurement of reading outcomes (e.g., Deacon & Kirby, 2004); this means that findings of changes in contribution of morphological awareness are confounded with the amount of time passed from its point of measurement. In addition, we would note that studies targeting different age ranges have tended to use different measures of morphological awareness; this makes available literature hard to contrast solely on the basis of grade ranges. Because children with greater reading experience may be more inclined to use morphological information when reading (Ehri, 2014), it would be useful to contrast patterns in cross-sectional studies of children in lower elementary grades, such as Grades 1 and 2, and of older children, in Grades 3 and 4, who have completed the same measures of morphological awareness for all children. In the paragraphs that follow, we review the available studies that report on relations across different levels within the same study that cross this key theoretically important division.

In reviewing this evidence, we are careful to attend to the aspect of morphological awareness assessed because morphological awareness develops across the period during which children are learning to read. Inflections mark grammatical information on words, for instance, denoting plurality or tense and remaining within the same grammatical category. Derivational morphemes tend to change the meaning of a word as well as its grammatical category (e.g., *instruct–instructor*, *thirst–thirsty*). Inflectional morphology develops earlier and faster compared to derivational morphology (Berko, 1958; Nagy, Diabkidoy, & Anderson, 1993). There are simply far more derivations than inflections in English about which children can learn. The relatively consistent patterns of inflectional markers in the early elementary grades has been argued to provide a stable base from which to investigate potential changes in the contributions of morphological awareness to reading across grade levels (Deacon & Kirby, 2004). This is in part because, clearly, derivational morphology has a far more protracted period of development. Berninger, Abbott, Nagy, and Carlisle (2010) identified growth across several measures, tapping primarily derivational morphological awareness, across the entire elementary school period of Grades 1 to 6. Other researchers found continued growth beyond this point (e.g., Derwing & Baker, 1979, 1986; Tyler & Nagy, 1989; Windsor, 1994). These differing developmental trajectories might influence relations to word-level reading.

As such, we keep in mind the aspect of morphology assessed as we review the evidence to date. We also focus our review on results from analyses that implement

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control variables, rather than zero-order relations, to be isolated effects from other known factors relevant to word-level reading (such as phonological awareness). Further, we review relations separately for reading of real and novel words, given the theoretical rationale for potential differences in children's treatment of these two types of words. As we will see, studies to date have identified a wide range of developmental patterns in the relation between morphological awareness and word-level reading.

Some studies find an increase in the size of the unique relation between morphological awareness and word-level reading across elementary school; this is the pattern that is widely touted in narrative reviews (e.g., Carlisle, 2000; Kuo & Anderson, 2006). In her empirical study, Carlisle (1995) found that morphological awareness assessed in Grade 1, but not in kindergarten, contributed unique variance to pseudoword reading in Grade 1 (see also Carlisle & Nomanbhoy, 1993). In that study, morphological awareness was assessed with both production and judgment tasks including both inflections and derivations. This study provides tentative support for a potential increase in the size of the unique contribution of morphological awareness to word-level reading, at least of pseudowords.

Other studies have found remarkable stability in unique contributions of morphological awareness to word-level reading for younger and older readers (e.g., Deacon, 2012; Deacon & Kirby, 2004). As an example, Deacon (2012) found morphological awareness, assessed with past-tense verbs, was a significant predictor of real word and pseudoword reading in first- and third-grade children once phonological awareness, vocabulary, and orthographic processing were controlled. There were no interactions with grade, suggesting consistency in the size of these relations at Grades 1 and 3 (see Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009). A somewhat similar pattern emerged in Deacon and Kirby's (2004) longitudinal study, in which morphological awareness was assessed with an analogy task with past-tense verbs. Morphological awareness at Grade 2 was a reasonably consistent predictor of word reading in Grades 3 to 5, ranging from accounting for 5% to 8% of the variance. Similarly, morphological awareness assessed at Grade 2 predicted 9% to 11% of the unique variance in pseudoword reading across Grades 3 to 5.

Finally, there is some evidence for a decline in size of the unique contribution of morphological awareness to word-level reading and other evidence pointing to null unique contributions. Declining relations emerge in Deacon, Wade-Woolley, and Kirby's (2007) study with children in French immersion, who completed a sentence analogy task focusing on past-tense. Given that the children all spoke English as a first language, results from the English measures are particularly relevant. In English, Grade 1 morphological awareness was related to real word reading in Grades 1 through 3 (at roughly 10% of unique variance), after controls for phonological awareness, vocabulary, and nonverbal cognitive ability. However, English morphological awareness measured at Grades 2 and 3 was not related to real word reading in either of these grades.[1] Of note, by Grade 3, performance on the English past-tense morphological awareness task was almost at ceiling. This may have limited the detection of a significant relation between past-tense morphological awareness and word reading. Nagy, Berringer, Abbott, Vaughan, and Vermeulen (2003) examined relations between morphological awareness and reading skills in at-risk children in Grades 2 and 4. Morphological awareness was measured broadly and

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included compounds, inflections, and derivations. Morphological awareness was not a significant predictor of word-level reading above and beyond the variance explained by control measures in either grade level. These results suggest that the influence of morphological awareness on word-level reading might decline over the early elementary school years or be difficult to detect when comprehensive controls are included.

This relatively mixed set of findings is highlighted by the findings of a recent meta-analysis. Ruan et al. (2018) conducted a meta-analysis of available studies conducted with either English- or Chinese-speaking children. They tested the potential influence of several moderators, including grade-level groupings, in the relation between morphological awareness and word reading. In doing so, they combined studies that measured morphological awareness in different ways (e.g., inflectional and derivational) and word-level reading in different ways (e.g., both real word and pseudoword reading). In addition, as with most meta-analyses, the analyses focused on zero-order correlations. For both English- and Chinese-speaking children, the meta-analysis identified a significant correlation between morphological awareness and each of word reading accuracy and fluency; these relations were moderate in size. Key to our work here, grade level was not a significant moderator in the relation between morphological awareness and word reading accuracy across the preschool to late elementary school period for English-speaking children. For word reading fluency, the relation was significant for advanced readers (Grade 5 and up), but not among younger readers (preschool through Grade 4). We think that further empirical inquiry needs to explore these relations within individual studies; as Ruan et al. pointed out, few studies include key grade levels of 1 through 4, age ranges directly relevant to Ehri's theory. We think that this is particularly useful in contrasting the nature of word-level reading, given that real word and pseudoword reading scores were combined in the meta-analysis.

The current study

The mixed evidence to date motivates further empirical inquiry into the relations between morphological awareness and word-level reading across the early to middle elementary school years. As mentioned earlier, this is a particularly important time period with respect to advances in reading skills. We examine this time period in a cross-sectional study across Grades 1 to 4, in which we can examine the relations between morphological awareness and word-level reading administered at the same point in development. Specifically, we contrast the relations observed at Grades 1 and 2 with those that emerge at Grade 3 and 4. As we explore these relations, we investigate real word reading and pseudoword reading as separate outcomes.

We measure morphological awareness with a sentence completion task involving the production of past-tense forms (Robertson, Joanisse, Desroches, & Terry, 2013). We chose to focus on past-tense for several reasons. As articulated by others (Brittain, 1970; Deacon & Kirby, 2004), we think that awareness of past-tense might provide a relatively stable base from which to capture relations between morphological awareness and word-level reading. This is in contrast to children's rapidly growing awareness of derivations. Awareness of past-tense has been used in a good

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deal of prior research in this age range (Deacon, 2012; Deacon & Kirby, 2004; Deacon et al., 2007), enabling our findings to build on this evidence base. In building on this evidence base, we note that there have been some potential ceiling effects in some prior studies, which might limit the ability to interpret null results (e.g., Deacon et al., 2007). For instance, the mean past-tense score for the Grade 3 children in Deacon et al.'s (2007) study was 76%. In addition, 22% of those children had a perfect score. It would be worthwhile to explore whether a test with a greater range of difficulty and items would yield the same pattern of results. This would clarify whether the results from prior studies reflect a developmental pattern rather than ceiling or floor effects. To ensure that our task is adequately challenging, we use both real words and pseudowords in our morphological awareness task focusing on the past tense. Most studies to date have used real verbs to measure past-tense morphological awareness (e.g., Deacon, 2012; Deacon et al., 2007). Adding pseudoverbs to the past-tense morphological awareness test may both increase difficulty and reduce confounds from other skills (see also Casalis & Louis-Alexandre, 2000). As such, we think that including both real words and pseudowords may help to accurately capture individual differences morphological awareness across our time period of investigation.

In investigating the relation between morphological awareness and word-level reading, we control for phonological awareness, given its known relation to word reading, and for nonverbal cognitive ability to remove the effects of general cognitive skills (e.g., Deacon, 2012; Deacon et al., 2007). We also control for phonological short-term memory, the temporary storage of verbal material in a phonological code (Gathercole & Baddeley, 1990). Success on the past-tense morphology task presumes that children can effectively store the verb so they can transform it into its past-tense; as a case in point, phonological short-term memory has been shown to be related to performance on a test of past-tense morphological awareness of real verbs and pseudoverbs in a sample of second- to fifth-grade children (Archibald, Joanisse, & Shepherd, 2008). Strong phonological short-term memory may even be more critical for forming the past tense of pseudoverbs because these are novel forms that are not stored in long-term memory. Like many others before us, we use nonword repetition to measure phonological short-term memory (e.g., Catts, Adlof, Hogan, & Ellis Weismer, 2005; Higgins, Penney, & Robertson, 2017). We do so to control for the demands of short-term memory specifically in the phonological domain as we explore whether past-tense morphological awareness is related to word reading.

In addition to these controls, we add sentence-level language skills as a control. Certainly, vocabulary is a common control in studies of the relation between morphological awareness and word-level reading (e.g., Deacon & Kirby, 2004), but we hoped to capture language beyond the single word level. A recent study suggested that the relation between morphological awareness and reading comprehension also remains even after removing the variance shared across morphological awareness, syntactic awareness, and vocabulary (Kieffer, Petscher, Proctor, & Silverman, 2016). Performance on sentence-level processing tasks has been shown to be related to performance on both inflectional morphological awareness (Archibald et al., 2008) and word reading in typically and atypically developing readers (e.g., Archibald et al., 2008; Fraser & Conti-Ramsden, 2008; Robertson, Joanisse, Desroches, & Ng, 2009). These patterns suggest sentence-level skills should be controlled if we want to know whether morphological awareness is a unique predictor of word-level

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reading. We build on the earlier studies by controlling for sentence-level language skills in a way that integrates vocabulary.

We use the formulated sentences subtest from the fourth edition of the Clinical Evaluation of Language Fundamentals as a broad measure of language production at both the word and sentence levels (Semel, Wiig, & Secord, 2003). In this test, children are given a key word to use in forming a spoken sentence to go with a displayed picture. As such, this task draws on children's knowledge of the meaning of the word along with their broader understanding of morphosyntactic constructions to communicate meaning. Controlling for sentence-level language skills in this way might be particularly important when considering the role of awareness of inflectional morphology in word reading. Inflectional morphology involves variations to a word stem to reflect grammatical constraints and is often tested with past-tense verbs in the elementary school years (e.g., Archibald et al., 2008; Deacon & Kirby, 2004; Robertson et al., 2013). Because the formulated sentence test requires children to produce sentences with good form and meaning, one could argue awareness of smaller units within sentences (morphemes) may be partially captured by this broader sentence-level processing task. If morphological awareness is still a significant predictor of word-level reading once such a measure of sentence-level language skill is controlled, it would provide stronger evidence that morphological awareness plays a unique role in word-level reading skills.

To summarize the goals of the current study, we examine if past-tense morphological awareness is a significant predictor of word-level reading once phonological awareness, phonological short-term memory, sentence-level language skills, and nonverbal cognitive ability are controlled. Adding the two new controls of phonological short-term memory and sentence-level language skills would provide a particularly stringent test of the relation between past-tense morphological awareness and word-level reading. In particular, we examine if the relation between past-tense morphological awareness and word-level reading changes across reading development in a sample of early and middle elementary school children. We do so in a study examining whether grade-related patterns are similar or different for reading real versus novel words.

Method

Participants

A total of 375 children from Grades 1 to 4 from seven elementary schools in Nova Scotia, Canada, participated (age range of 5 years, 9 months [5;9] to 10;9, $M = 8;0$, $SD = 14$ months, 209 females and 166 males). Two grade divisions were used that grouped Grades 1 and 2 for the younger group and Grades 3 and 4 for the older group. Divisions were based on grade rather than chronological age because age would present a confound with the amount of instruction received. For instance, a child could be 1 month older than another in chronological age and receive an extra 12 months of instruction. The younger group had 197 children with an age range of 5;9 to 8;11, and the older group consisted of 178 children with an age range of 7;10 to 10;9. To further break down the participant information by the four grades, there were 96 students in Grade 1 (age range of 5;9 to 7;10,

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Table 1. Mean raw scores (and standard deviations) of measures

Measure (Max)	Entire sample	Grade level	
		Grades 1 and 2	Grades 3 and 4
N	375	197	178
Age	8;0 (14 months)	7;1 (8 months)	9;1 (8 months)
Word identification (46)[a]	18.83 (8.78)	13.99 (8.13)	24.19 (5.90)
Word attack (26)[a]	9.23 (7.01)	6.08 (6.03)	12.72 (6.35)
PTMA total (46)	25.71 (9.56)	21.65 (9.07)	30.21 (7.96)
PTMA real verbs (24)	12.69 (5.74)	10.30 (5.07)	15.33 (5.27)
PTMA pseudoverbs (22)	13.03 (4.75)	11.35 (4.97)	14.89 (3.69)
Elision (20)[b]	9.99 (5.02)	8.05 (4.42)	12.13 (4.79)
Nonword repetition (18)[b]	8.49 (3.16)	7.79 (2.87)	9.26 (3.30)
Formulated sentences (54)[c]	26.64 (10.93)	21.02 (8.23)	32.87 (10.16)
Matrices (46)[d]	24.17 (6.78)	20.96 (5.88)	27.71 (5.86)

Note: Standard deviations are in parentheses. PTMA, past-tense morphological awareness. Analyses were based on the PTMA total score, and means for real verbs and pseudoverbs are only shown for descriptive purposes. [a]Woodcock Reading Mastery Tests—Third Edition (Woodcock, 2011). [b]Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999). [c]Clinical Evaluation of Language Fundamentals—Fourth Edition (Semel, Wiig, & Secord, 2003). [d]Kaufman Brief Intelligence Test—Second Edition (Kaufman & Kaufman, 2004).

$M = 6;6$, $SD = 5$ months), 101 in Grade 2 (age range of 6;6 to 8;11, $M = 7;6$, $SD = 5$ months), 105 in Grade 3 (age range of 7;10 to 9;7, $M = 8;8$, $SD = 5$ months), and 73 in Grade 4 (age range of 9;1 to 10;9, $M = 9;8$, $SD = 5$ months). Analyses were based on grouping Grades 1–2 in the younger group and Grades 3–4 in the older group. The means and standard deviations for the ages of each grade group are reported in Table 1. Curriculum in the province in which we worked follows a balanced approach that includes reading aloud, modeled and shared reading, guided instruction, and independent reading. All targeted instruction was embedded in continuous text. Reading for meaning begins in Grade 1, with an increasing emphasis on meaning extraction in the third-grade level and up. That said, in Grade 1, there is relatively more emphasis on decoding. The curriculum leaves room for teachers' independence in choosing emphasis based on the needs within their classroom.

All participating children spoke English as their first language, based on parental report. The region in which the data was collected was primarily English speaking, with English being the first language spoken in 98.71% of households (Census Canada, 2016). Data from the broader region from which the data was collected from Statistics Canada Census Profile (Census Canada, 2016) indicates that the three largest ethnic origin groups included European (73.09%), North American Aboriginal (9.06%), and North American other (primarily Canadian, 37.65%). Each household could report more than one ethnic origin, and accordingly these

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numbers do not add to 100% nor do they represent the entire list of groups. With respect to annual income, reports from the Census indicate that largest percentage (29.22%) of households fall within the range of $30,000 to $59,000.[2] According to the Census, the highest level of education completed by 24.14% of 25- to 65-year-olds was a college or other nonuniversity certificate or diploma, and another 24.01% had a bachelor's degree or higher (Census Canada, 2016).

Based on parental report, none of the participants had a neurological impairment, autism, a hearing impairment, or attention-deficit/hyperactivity disorder. Two additional children completed some of the measures but were removed from the sample and all analyses because they did not complete the Clinical Evaluation of Language Fundamentals formulated sentences or the Kaufman Brief Intelligence Test matrices subtests.

Measures

Past-tense morphological awareness

The task developed by Robertson et al. (2013) was used here with the authors' permission. A block of 24 real verbs was given first, and this was followed by a block of 22 pseudoverbs. The list of items is reported in the Robertson et al. (2013) paper. Verbs within each block were presented in a fixed order across participants.

Regular and irregular past-tense real verbs were used in the real verb block. In forming the past-tense of regular real verb items, there are three types of endings that are added to the present tense form depending on the stem's phonological structure. The ending /t/ is added when the stem's final phoneme is a voiceless consonant (e.g., *talk–talked*, ending pronounced as /t/). When the stem's final phoneme is voiced, /d/ is added (e.g., *play–played*, ending pronounced as /d/), and when the stem's final phoneme is an alveolar stop, /Id/ is added (e.g., *test–tested*, ending pronounced as /Id/). Irregular verbs are less consistent in that there are a number of different changes made to the stem in order to form the past tense (e.g., *sleep–slept*; *swim–swam*; *stand–stood*).

Children were told they would hear a sentence and then they would be asked to help finish a second sentence by using a word from the first sentence. For example, the researcher said, "We play games. Yesterday, we did the same thing; we _____ (*played*) games." The child produced the past-tense form *played*. After completing two practice trials with feedback, the researcher reiterated the rules and children completed the test items without feedback. The test trials were shortened by removing the phrase "we did the same thing yesterday" to avoid redundancy and strains on phonological short-term memory, and to maintain interest. An example of a test trial is "We swim outside. Yesterday we _____ (*swam*)."

Next, the pseudoverb block was given. Children were told they would play the same game, but with made-up words. For example, "Jill can *blick*. Yesterday, she did the same thing; she _____ (*blicked*). The endings that are applied to form the past tense of pseudoverbs were the same as the three types of endings that applied to regular real verbs. Seven of the pseudoverbs employ the /t/ sound in their ending (e.g., *pash–pashed*, ending pronounced as /t/), 7 employ the /d/ sound in their ending (e.g., *murn–murned*, ending pronounced as /d/), and 8 employ the /Id/ sound in their ending (e.g., *sheed–sheeded*, ending pronounced as /Id/). Four practice trials

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were given with feedback before moving on to the test trials. The carrier sentence was kept short and remained the same across the pseudoword trials to reduce strain on phonological short-term memory. During the practice trials, it was emphasised that children were asked to say what Jill did yesterday by using the made-up word from the first sentence. Cronbach's α was 0.92, calculated across all items for the total number of items (real verbs and pseudoverbs) on the past-tense morphological task. All standardized tests were administered according to manual instructions.

Real word reading

The word identification subtest of the third edition of the Woodcock Reading Mastery Test, Form A assessed real word reading. Children read aloud isolated words of increasing difficulty and complexity (Woodcock, 2011). The internal reliability from the test manual is .91.

Pseudoword reading

The word attack subtest of the third edition of the Woodcock Reading Mastery Test, Form A assessed pseudoword reading, which requires phonological skills and structural analysis. Children read aloud isolated pseudowords of increasing difficulty and complexity (Woodcock, 2011). The internal reliability from the test's manual is .89.

Phonological awareness

The elision subtest of the Comprehensive Test of Phonological Processing assessed phonological awareness. Children had to repeat a word dictated by the researcher, and then delete a specific phoneme from that word (Wagner, Torgesen, & Rashotte, 1999). The internal reliability from the test's manual is .89.

Phonological short-term memory

The nonword repetition subtest of the Comprehensive Test of Phonological Processing assessed phonological short-term memory. Children heard a nonword and had to repeat it. Words were presented in order of increasing difficultly, from monosyllabic to multisyllabic words. The nonwords were prerecorded and presented binaurally through headphones. A score of 0 was given when a child did not repeat the word verbatim (Wagner et al., 1999). The internal reliability from the test's manual is .78

Sentence-level language skills

The formulated sentences subtest of the Clinical Evaluation of Language Fundamentals was given as a broad measure of sentence-level language skills. This task was administered according to the manual protocol. Participants viewed a number of pictures depicting various scenes; they were then given a key word by the researcher and asked to produce a syntactically and semantically intact sentence about each picture (Semel et al., 2003). A comparable example of the type of picture viewed and its key word would be a man and a woman walking in the park and the word "walking." Following on the manual, each sentence is scored as either 0, 1, or 2.

A score of 2 was given when the child's response was logical, syntactically and semantically correct. A logical response with one error in syntax or semantics received a score of 1. Finally, a response with two or more errors, an incomplete or illogical response, or a response that did not include the stimulus word was given a score of 0. The first author conducted several thorough training workshops with two research assistants before they collected the data. Detailed notes were provided to explain what would count as syntactic errors and semantic errors, and several examples were included. The research assistants were given thorough instructions on when to give a score of 0, 1, or 2. Prior to collecting data, they also practiced on each other and on the first author repeatedly, leading to very few inconsistencies across the scores. Research assistants met with the first author each week after collecting data to go over sentences that were difficult to score. Sentences were then scored independently by the second research assistant, and inconsistencies were examined carefully before making a final decision on the score. The internal reliability from the test's manual is .81.

Nonverbal cognitive ability

The matrices subtest of the second edition of the Kaufman Brief Intelligence Test was administered to assess nonverbal cognitive ability. Children were shown an image depicting a partial pattern as well as a series of single images and had to choose the correct image to complete the pattern (Kaufman & Kaufman, 2004). The internal reliability from the test's manual is .88.

Procedure

Procedures were approved by the university research ethics board and local school board prior to data collection. Informed and signed parental consent was obtained, and then children gave oral assent before beginning the tasks. All measures were administered in a fixed order, as is appropriate for analyses focusing on individual differences. All measures were completed over two separate sessions, and each session lasted approximately 30 min. Session 1 included the reading, phonological, and past-tense morphological measures and Session 2 included the sentence-level language skills and nonverbal cognitive ability tests.

Results

Descriptive statistics and zero-order bivariate correlations

Means and standard deviations for raw scores from all tests are shown in Table 1. A complete bivariate correlation matrix for the entire sample is shown in Table 2. In Table 3, bivariate correlations are broken down by younger (Grades 1 and 2) and older (Grades 3 and 4) samples. For the group as a whole and for each grade separately, all control measures were correlated with the outcome variables at ~.4 to .7. Correlations for past-tense morphological awareness and word-level reading outcomes were in the range of ~.4 to .6.

Prior to conducting linear regression analyses, we inspected skew and kurtosis values, and we also looked for univariate and bivariate outliers (as per

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Table 2. Pearson bivariate correlations across the entire sample of children (N = 375)

	1.	2.	3.	4.	5.	6.	7.
1. Word identification[a]	—						
2. Word attack[a]	.874*	—					
3. PTMA Total	.653*	.615*	—				
4. Elision[b]	.755*	.760*	.607*	—			
5. Nonword repetition[b]	.433*	.426*	.515*		—		
6. Formulated sentences[c]	.692*	.597*	.544*	.553*		—	
7. Matrices[d]	.558*	.483*	.472*	.450*	.260*	.496*	—

Note: Correlations are based on raw scores, with the exception of PTMA (past-tense morphological awareness), which are based on the square root transformation. Regressions are based on the PTMA total score. [a]Woodcock Reading Mastery Tests—Third Edition (Woodcock, 2011). [b]Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999). [c]Clinical Evaluation of Language Fundamentals—Fourth Edition (Semel, Wiig, & Secord, 2003). [d]Kaufman Brief Intelligence Test—Second Edition (Kaufman & Kaufman, 2004). *$p < .01$.

Table 3. Pearson bivariate correlations across younger (above the diagonal, N = 197) and older (below the diagonal, N = 178) children

	1.	2.	3.	4.	5.	6.	7.
1. Word identification[a]	—	.855*	.559*	.752*	.339*	.567*	.369*
2. Word attack[a]	.843*	—	.546*	.760*	.339*	.462*	.289*
3. PTMA Total	.532*	.474*	—	.570*	.415*	.417*	.244*
4. Elision[b]	.656*	.653*	.472*	—	.397*	.487*	.283*
5. Nonword repetition[b]	.451*	398*	.522*	.375*	—	.270*	.060
6. Formulated sentences[c]	.576*	.460*	.377*	.391*	.218*	—	.326*
7. Matrices[d]	.409*	.359*	.386*	.344*	.280*	.299*	—

Note: PTMA, past-tense morphological awareness. The younger sample is above the diagonal and the older group is below. [a]Woodcock Reading Mastery Tests—Third Edition Woodcock, (2011). [b]Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999). [c]Clinical Evaluation of Language Fundamentals—Fourth Edition (Semel, Wiig, & Secord, 2003). [d]Kaufman Brief Intelligence Test—Second Edition (Kaufman & Kaufman, 2004). *$p < .01$.

Tabachnick & Fidell, 2013). We also inspected for issues of multicollinearity. Tolerance and variance inflation factor values for each independent variable, none of which supported the presence of multicollinearity (tolerance > .2; variance inflation factor < 10). Correlations were also all below .8, with the exception of word identification and word attack, which are not included in the same analysis.

The only concern that emerged was in negative skew for the past-tense morphological awareness task. A square root transformation corrected this, and so this transformed score was used in all subsequent analyses. In addition to this, we confirmed the patterns when raw scores were used instead; the same patterns emerged in both. We use raw scores for all other measures, and the raw scores on the

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Table 4. Hierarchical multiple regression with past-tense morphological awareness predicting real word reading (word identification) across the full sample and by grade group

		Full sample		Grades 1 and 2		Grades 3 and 4	
Steps	Variables	β	R^2 change	β	R^2 change	β	R^2 change
1	Elision	.407***	.704***	.538***	.632***	.389***	.598***
	Nonword repetition	.049		.005		.149**	
	Formulated sentences	.295***		.209***		.320***	
	Matrices	.148***		.116*		.093†	
2	PTMA Total	.266***	.011***	.135*	.011*	.114†	.008†
3	PTMA Total × Grade Group	.150**	.009**				

Note: PTMA, past-tense morphological awareness. Standardized beta weights are for each variable within the full model with all variables entered. R^2 change reflects whether each step as a whole is significant. Unstandardized beta weights and standard errors are available from the authors upon request. *$p < .05$. **$p < .01$. ***$p < .001$. †, $p < .10$

past-tense morphological test are reported in Table 1. Regression analyses are based only on the past-tense morphological total square root transformation.

Past-tense morphological awareness predicting real word and pseudoword reading

Hierarchical multiple regression analyses were conducted to examine the relations between past-tense morphological awareness and real word and pseudoword reading. To do so, we conducted two separate regression analyses: one with real word reading scores as the criterion, and the second with pseudoword reading as the criterion. In Step 1, we included phonological awareness, phonological short-term memory, sentence-level language skills, and nonverbal cognitive ability. We then entered our predictor of interest in Step 2: the past-tense morphological awareness total score. In the final step, the interactions between grade group and the past-tense morphological awareness total score was included to evaluate stability in relations across our grade groups.

Results for the analyses with real word reading as the outcome are presented in the left column of Table 4. In the full sample, control variables explained 70.4% of the variance in real word reading. Standardized beta weights show that most of the variance in control measures was taken up by phonological awareness, followed by sentence-level language skills. Following on these controls, past-tense morphological awareness explained an additional 1.1% in Step 2, with a standardized beta weight comparable to that of sentence-level language skills. The interaction with grade group was significant in Step 3 (an additional 0.9% of variance). As such, we conducted separate regression analyses with the data for Grades 1 and 2 and for those in Grades 3 and 4. The results of these analyses are reported in the right columns of Table 4.

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Table 5. Hierarchical multiple regression results for past-tense morphological awareness predicting pseudoword reading (word attack) across the full sample

Steps	Variables	β	R^2 change
1	Elision	.515***	.637***
	Nonword repetition	.052	
	Formulated sentences	.177***	
	Matrices	.084**	
2	PTMA Total	.173**	.010**
3	PTMA Total × Grade Group	.043	.001

Note: PTMA, past-tense morphological awareness. Standardized beta weights are for each variable within the full model with all variables entered. R^2 change reflects whether each step as a whole is significant. Unstandardized beta weights and standard errors are available from the authors upon request. **$p < .01$. ***$p < .001$.

With the younger group, when entered at Step 2, past-tense morphological awareness explained additional significant variance in real word reading (1.1%) beyond the 63.2% of the variance that was explained by the four controls variables. Standardized beta weights put the unique contribution of past-tense morphological awareness as larger in size than that of nonverbal ability, albeit smaller than that of sentence-level language skills. With the older group, when entered at Step 2, there was a trend toward a unique contribution of past-tense morphological awareness to real word reading (0.8%, $p < .10$), beyond the substantial contribution of the control variables (59.8%). This reduction in significance might be related to the larger contributions of phonological short-term memory and sentence-level language skills in Grades 3 and 4 than at Grades 1 and 2. Taken together, results suggest a role for past-tense morphological awareness that emerges beyond sentence-level language skills in Grades 1 and 2 but not necessarily at Grades 3 and 4.

Results for the analyses with pseudoword reading as the outcome are presented in Table 5. The control variables accounted for a significant 63.7% of the variance in pseudoword reading. Critically, when entered at Step 2, past-tense morphological awareness explained additional significant variance (1%) in pseudoword reading. There were no interactions between grade group and past-tense morphological awareness scores in Step 3, suggesting consistency in these relations across the grades investigated here.

Discussion

Our research goal was to examine whether there were differences across theoretically relevant elementary school grades in the relations between morphological awareness and word-level reading, investigating if such changes applied to both real word and pseudoword reading. In testing these relations, we controlled for phonological awareness, phonological short-term memory, sentence-level language skills, and nonverbal cognitive ability. Contrasting relations at Grades 1 and 2 with those at Grades 3 and 4 provided a test of these relations across a key predicted transition

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in theories of word reading development (e.g., Ehri, 2014). To summarize our results, we found that morphological awareness, as assessed with past-tense verbs, made a significant contribution to word reading at Grades 1 and 2—one that did not remain significant in Grades 3 and 4—and a consistent contribution to pseudoword reading across Grades 1–4.

Our findings build on prior studies. As reviewed earlier, there are mixed results on developmental changes underlying the relation between morphological awareness and word-level reading. Some studies suggest the relation between morphological awareness and word reading gets stronger (e.g., Carlisle, 1995; Carlisle & Nomanbhoy, 1993), declines (e.g., Deacon et al., 2007), and or remains stable (e.g., Deacon, 2012; Deacon & Kirby, 2004) across the elementary school years. In an effort to address the mixed results, we ensured that our morphological awareness task focusing on past-tense verbs widely used with younger readers was also adequately challenging for older children (see, e.g., Deacon et al., 2007, for ceiling effects). We increased the number of items and included pseudoverbs. Performance on the current task suggests it was challenging even for third- and fourth-grade children. Even with increased task difficulty, our results are consistent with those reported in earlier studies: past-tense morphological awareness was a significant predictor of real word reading in Grade 1 and 2 children, but not in Grade 3 and 4 children (see, e.g., Deacon et al., 2007). However, morphological awareness was a stable predictor of pseudoword reading across Grades 1 to 4.

We recognize the small size of the contribution of morphological awareness to word-level reading. There was a small amount of variance explained by past-tense morphological awareness, at 1%. This 1% must be considered in light of the fact that there remained only 30% to 40% of the variance, undoubtedly the more difficult part of the variance to explain. In further analyses in which when we removed formulated sentences as a control, past-tense morphological awareness accounted for 2.6% of the variance. This size of contribution is more similar to that in prior studies (e.g., Deacon & Kirby, 2004; Mota, Freitas Junior, & Deacon, 2018). It is possible then that some of the contribution in prior studies might have been from broader language skills, particularly when the morphological awareness task included sentences, such as Carlisle's (1988) sentence completion task. Further still, betas in the main analyses across all children quantify the contribution of morphological awareness as similar to that of sentence-level language skills, even though the former has more controls implemented. Taken together, although the significant contribution from past-tense morphological awareness to both real word and pseudoword reading is relatively small, it remains both theoretically and empirically interesting.

These findings run directly counter to predictions from the phase theory of early reading as dominated by phonology (Ehri, 2014). The contribution of past-tense morphological awareness survives controls for awareness, perception, and short-term memory of phonological structures, as assessed by phonological awareness and phonological short-term memory. In our view, these findings point to the importance of a direct empirical contrast across these age ranges. Our findings support Carlisle and Kearns's (2017) idea that readers use morphological awareness when reading in earlier grades than what was previously expected, and is consistent with findings from spelling and priming tasks in young readers (e.g., Deacon & Bryant, 2006; Rabin & Deacon, 2008; Treiman et al., 1994). Our findings are also consistent

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with predictions from Treiman and Kessler's (2014) Integration of Multiple Patterns. This theory suggests that morphology may be a source of patterns that help even young children secure spellings in memory (see Gonnerman, Seidenberg, & Anderson, 2007). It seems that even less experienced readers take advantage of their awareness of morphology in the oral domain and do not rely solely on phonological awareness as they read words.

Another contribution of our findings to ongoing theory discussions lies in our finding that past-tense morphological awareness predicted pseudoword reading across the entire age range of Grades 1 to 4. One explanation for this finding lies in the flexibility of children. Across Grades 1 to 4, children may use all the linguistic skills at their disposal, including morphological awareness, when the reading task is demanding, as it is with pseudowords. We also need to consider this finding in light of the fact that pseudowords can contain morphemes (e.g., *praced* and *munsingful*, respectively). The existence of these pseudowords (including in the pseudoword reading task we used here) forces reconsideration of pseudoword reading as entirely phonological; for instance, the term "phonemic decoding" to refer to a pseudoword reading task (e.g., Torgesen et al., 1999) might be too restrictive. Recent analyses identify a role of awareness of morphology in precisely that task (e.g., Levesque, Kieffer, & Deacon, 2018; see also Deacon & Kirby, 2004), and distinguish morphological awareness from morphological decoding (see Deacon, Tong, & Francis, 2017). Stepping back further, the activation of morphemes in pseudoword tasks has now been identified in both child (e.g., Dawson, Rastle, & Ricketts, 2018) and adult research (e.g., Taft, 2004), and pseudowords have long been used in morphological awareness tasks (Berko, 1958). Overall, these findings need to be integrated into theories of reading development, such that we can identify when morphemes are activated in the reading process. It seems that they operate more than in securing words in memory (as suggested by Ehri, 2005) because morphological effects emerge for pseudowords that do not yet have a store in memory. Building on Taft (2004), it seems likely that morphemes have a role in the input phase of word identification, such that they are useful across new and old words alike. We think that future studies could explore whether such effects of morphemes emerge as independent morpheme units or as a convergence of codes (e.g., Quémart, Gonnerman, Downing, & Deacon, 2017; Seidenberg & Gonnerman, 2000).

There are at least two ways to understand the grade-level differences in the relation of past-tense morphological awareness to word-level reading. A simple one is that the interaction emerged from changing effects at Step 1; the effect was significant in Grades 1 and 2, and it approached significance at Grades 3 and 4. This reduction to nonsignificance could be associated with the rise in the contribution of sentence-level language skills (as evident in increased beta weight for formulated sentences at Step 1). Grade 3 and 4 children might rely more on comprehension of words and sentences in general and less on morphological awareness in supporting real word reading than do children in Grades 1 and 2. This shift might result in part from a shift from learning to read to reading to learn (Chall, 1983) and increased exposure to texts with rich greater morphosyntactic complexity and vocabulary (e.g., Snow, 2010). An increase in the influence of sentence-level processing skills is also consistent with the simple view of reading, according to which reading comprehension is the product of oral language comprehension and word reading

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(Gough & Tunmer, 1986). Alternatively, a relation between morphological awareness and real word reading might emerge for older children if the measure assessed derivations (as in, e.g., Mahony, Singson, & Mann, 2000). There is growth of derivational morphological awareness during this time period (e.g., Berringer et al., 2010) and increased exposure to derived forms while reading (Nagy & Anderson, 1984; also see Roman et al., 2009). Future studies can investigate this possibility by contrasting the roles of inflectional and derivational morphological awareness on real word and pseudoword reading across development. That said, the current study provides empirical evidence of potential differences in patterns of relations of past-tense morphological awareness for real word and pseudoword reading across this key developmental period.

The implications of this work also need to be considered in line with the linguistic context within which they emerged: English. There has long been speculation of greater contributions of morphological awareness in morphosyllabic orthographies and smaller contributions in more phonologically transparent orthographies (e.g., Kuo & Anderson, 2006). Yet similar-sized contributions of morphological awareness to word-level reading have appeared across degrees of phonological transparency (e.g., Deacon & Kirby, 2004; Mota et al., 2018; Rispens, McBride-Chang, & Reitsma, 2008; Rothou & Padeliadu, 2014). This leads us to consider that the findings here might apply to other orthographies, bearing in mind of course that morphology varies in its representation in different oral languages and in their written forms.

We also need to review limitations. A first lies in the limited demographic data available for the specific sample recruited; data on ethnic origin, income, and education were not collected from individual participants and families in the current study. Prior work has suggested that relations between morphological awareness and reading are similar for children of low and high socioeconomic backgrounds (e.g., Apel, Brimo, Diehm, & Apel, 2013); that said, we think that potential differences across this factor are worth exploring. Another point worth considering lies in the choice of control measures. Unlike some previous studies, we did not use receptive vocabulary as a control (e.g., Deacon & Kirby, 2004; Deacon et al., 2007). However, in our view, the sentence-level language skills test we employed, the formulated sentences subtest from the Clinical Evaluation of Language Fundamentals, captures vocabulary knowledge. In this task, children need to show they understand the meaning of the given word in order to apply it to the context of the picture when formulating a sentence. Moreover, this test is a rich measure of linguistic knowledge because it also involves morphosyntactic and semantic processing. As such, it is likely that variance that would be explained by a vocabulary measure was captured by the test of sentence-level language skills. Our measure of sentence-level language skills also incorporated word-level comprehension, and when it was controlled, past-tense morphological awareness still emerged as a significant predictor of word reading. Another limitation of our study is that it is correlational. Our conclusions are specific to changes with grade level, not necessarily with age. Similarly, we captured two rather large grade bands and lacked power to do more fine-grained analysis. A longitudinal study with a larger sample would be better suited to addressing causal relations (e.g., Kruk & Bergman, 2013).

Finally, we turn to practical implications. Findings of unique contributions of morphological awareness to word-level reading point to the possible benefits of

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including teaching of morphology in the classroom. In addition, intervention studies to date often show similar-sized contributions of morphological awareness to other approaches to teaching, such as phonological awareness (e.g., Bowers, Kirby, & Deacon, 2010). Nevertheless, there are remarkably few studies investigating the effects of morphological awareness on word-level reading outcomes (e.g., Goodwin & Ahn, 2013); there are far more studies on reading comprehension. This leads us to be cautious in drawing practical implications. Further caution comes from the size of contributions; they are small. Similarly, intervention studies need to tease apart the effects of semantics from those of morphology, as has begun in the experimental research (Quémart et al., 2017). Further still, in addition to uncovering how to teach children, more work needs to be done on how to support the development of teacher knowledge, given evidence of low levels of morphology knowledge in some studies of teachers (Joshi et al., 2009; Spear-Swerling & Brucker, 2005). Clearly, further studies of both individual differences and intervention approaches are needed to specify whether and how morphological instruction might benefit word reading in the elementary grade levels.

In summary, we found that morphological awareness, as measured with past-tense verbs, played a unique role in beginning readers' real word reading and a unique, stable role in pseudoword reading across middle childhood. These contributions emerged beyond phonological awareness, phonological short-term memory, sentence-level language skills, and nonverbal cognitive ability. The size of these contributions was small, potentially as a result of the broad language skills that we controlled for here. We think that these findings remind us that theories of word reading need to include a role for morphological awareness, if they are to be comprehensive in capturing the full range of skills that children bring to the challenging task of reading.

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Notes

1. Of interest here, French morphological awareness was related to French word reading at both Grades 2 and 3 (Deacon et al., 2007).

2. A detailed breakdown of income reported from Statistics Canada Census (Census Canada, 2016) indicates that 28.03% of households had an annual income of $29,000 or lower, 29.22% reported $30,000 to 59,000, 22.40% had $60,000 to $99,000, 12.86% had $100,000 to $149,000, 4.73% had $150,000 to $199,000, and 2.70% reported $200,000 or over (Census Canada, 2016). Reports on highest level of education completed indicate that 11.46% had no certificate, diploma, or degree; 25.56% had a secondary (high) school diploma or the equivalent; 11.43% had an apprenticeship or trades certificate or diploma; 24.14% had a college or other nonuniversity certificate or diploma; 2.29% had a university certificate or diploma below the bachelor level; 16.40% had a bachelor's degree; 1.65% had a university certificate or diploma above the bachelor level; 0.92% had a degree in medicine, dentistry, veterinary medicine, or optometry; 4.18% had a master's degree; and 0.86% had an earned doctorate (Census Canada, 2016).

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References

Apel, K., Brimo, D., Diehm, E., & Apel, L. (2013). Morphological awareness intervention with kindergarten, first, and second grade students from low SES homes: A feasibility study. *Language, Speech, and Hearing Services in Schools*, **44**, 161–173. doi: 10.1044/0161-1461(2012/12-0042)

Archibald, L. M. D., Joanisse, M. F., & Shepherd, M. (2008). Associations between key language-related measures in typically developing school-aged children. *Journal of Psychology*, **216**, 161–171.

Berko, J. (1958). The child's learning of English morphology. *Word*, **14**, 150–177.

Berninger, V. W., Abbott, R. D., Nagy, W., & Carlisle, J. F. (2010). Growth in phonological, orthographic, and morphological awareness in grades 1 to 6. *Journal of Psycholinguistic Research*, **39**, 141–163.

Bowers, P. N., Kirby, J. R., & Deacon, S. H. (2010). The effects of morphological instruction on literacy skills: A systematic review of the literature. *Review of Educational Research*, **80**, 144–179.

Bradley, L., & Bryant, P. E. (1983). Categorizing sounds and learning to read—A causal connection. *Nature*, **301**, 419–421.

Brittain, M. M. (1970). Inflectional performance and early reading achievement. *Reading Research Quarterly*, **6**, 34–48.

Carlisle, J. F. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics*, **9**, 247–266.

Carlisle, J. F. (1995). Morphological awareness and early reading achievement. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 189–209). Hillsdale, NJ: Erlbaum.

Carlisle, J. F. (2000). Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading and Writing*, **12**, 169–190.

Carlisle, J. F. (2010). Effects of instruction in morphological awareness on literacy achievement: An integrative review. *Reading Research Quarterly, 45*, 464–487.

Carlisle, J. F., & Kearns, D. M. (2017). Learning to read morphologically complex words. In K. Cain, D. L. Compton, & R. K. Parilla (Eds.), *Theories of reading development*. Amsterdam: Benjamins.

Carlisle, J., & Nomanbhoy, D. M. (1993). Phonological and morphological awareness in first graders. *Applied Psycholinguistics*, **14**, 177–195.

Casalis, S., & Louis-Alexandre, M. F. (2000). Morphological analysis, phonological analysis, and learning to read French: A longitudinal study. *Reading and Writing*, **12**, 303–335.

Catts, H. W., Adlof, S. M., Hogan, T. P., & Ellis Weismer, S. (2005). Are specific language impairment and dyslexia distinct disorders? *Journal of Speech, Language, and Hearing Research*, **48**, 1378–1396.

Census Canada. (2016). *Statistics Canada*. Retrieved from https://www12.statcan.gc.ca/census-recensement/index-eng.cfm

Chall, J. S. (1983). *Stages of reading development*. New York: McGraw-Hill.

Dawson, N., Rastle, K., & Ricketts, J. (2018). Morphological effects in visual word recognition: Children, adolescents, and adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **44**, 645–654.

Deacon, S. H. (2012). Sounds, letters, and meanings: The independent influences of phonological, morphological, and orthographic skills on early word reading accuracy. *Journal of Research in Reading*, **35**, 456–475.

Deacon, S. H., & Bryant, P. (2006). Getting to the root: Young writers' sensitivity to the role of root morphemes in the spelling of inflected and derived words. *Journal of Child Language*, **33**, 401. doi: 10.1017/s0305000906007409

Deacon, S. H., & Kirby, J. R. (2004). Morphological awareness: Just "more phonological"? The roles of morphological and phonological awareness in reading development. *Applied Psycholinguistics*, **25**, 223–238.

Deacon, S. H., Tong, X., & Francis, K. (2017). The relationship of morphological analysis and morphological decoding to reading comprehension. *Journal of Research in Reading*, **40**, 1–16. doi: 10.1111/1467-9817.12056

Deacon, S. H., Wade-Woolley, L., & Kirby, J. R. (2007). Crossover: The role of morphological awareness in French immersion children's reading. *Developmental Psychology*, **43**, 732–746.

Derwing, B. L., & Baker, W. J. (1979). Recent research on the acquisition of English morphology. In P. Fletcher, & M. Garman (Eds.), *Language acquisition* (pp. 209–223). Cambridge: Cambridge University Press.

Derwing, B. L., & Baker, W. J. (1986). Assessing morphological development. In P. J. Fletcher, & M. Garman (Eds.), *Language acquisition: Studies in first language development* (2nd ed., pp. 326–338). Cambridge: Cambridge University Press.

Ehri, L. C. (1995). Phases of development in learning to read words by sight. *Journal of Research in Reading*, **18**, 116–125.

Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading*, **9**, 167–188.

Ehri, L. C. (2014). Orthographic mapping in the acquisition of sight word reading, spelling, memory, and vocabulary learning. *Scientific Studies of Reading, 1*, 5–21.

Fraser, J., & Conti-Ramsden, G. (2008). Contribution of phonological and broader language skills to literacy. *International Journal of Communication Disorders*, **43**, 552–569.

Gathercole, S. E., & Baddeley, A. D. (1990). Phonological memory deficits in language disordered children: Is there a causal connection? *Journal of Memory and Language*, **29**, 336–360.

Goodwin, A. P., & Ahn, S. (2013). A meta-analysis of morphological interventions in English: Effects on literacy outcomes for school-age children. *Scientific Studies of Reading*, **17**, 257–285.

Gonnerman, L. M., Seidenberg, M. S., & Anderson, E. S. (2007). Graded semantic and phonological similarity effects in priming: Evidence for a distributed connectionist approach to morphology. *Journal of Experimental Psychology: General*, **136**, 323–345. doi: 10.1037/0096-3445.136.2.323

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education*, **7**, 6–10.

Higgins, M. H., Penney, S. B., & Robertson, E. K. (2017). The effects of phonological short-term memory and speech perception on spoken sentence comprehension in children: Simulating deficits in an experimental design. *Journal of Psycholinguistic Research*, **46**, 1213–1235.

Joshi, M., Binks, E., Hougen, M., Dahlgren, M. E., Ocker-Dean, E., & Smith, D. L. (2009). Why elementary teachers might be inadequately prepared to teach reading. *Journal of Learning Disabilities*, **42**, 392–402. doi: 10.1177/0022219409338736

Kaufman, A. S., & Kaufman, N. L. (2004). *Kaufman Brief Intelligence Test* (2nd ed.). Bloomington, MN: Pearson.

Kieffer, M. J., Petscher, Y., Proctor, C. P., & Silverman, R. D. (2016). Is the whole greater than the sum of its parts? Modeling the contributions of language comprehension skills to reading comprehension in the upper elementary grades. *Scientific Studies of Reading*, **20**, 436–454.

Kruck, R. S., & Bergman, K. (2013). The reciprocal relations between morphological processes and reading. *Journal of Experimental Child Psychology*, **114**, 10–34.

Kuo, L., & Anderson, R. C. (2006). Morphological awareness and learning to read: A cross-language perspective. *Educational Psychologist*, **41**, 161–180.

Levesque, K. C., Kieffer, M. J., & Deacon, S. H. (2018). Inferring meaning from meaningful parts: The contributions of morphological skills to the development of children's reading comprehension. *Reading Research Quarterly*, **54**(1), 63–80.

Mahony, D., Singson, M., & Mann, V. (2000). Reading ability and sensitivity to morphological relations. *Reading and Writing*, **12**, 191–218.

Mota, M. M. P. E., Freitas Junior, P. V., & Deacon, S. H. (2018). Morphological awareness, word reading and reading comprehension in Portuguese. *Applied Psycholinguistics*, **39**, 507–525. doi: 10.1017/S0142716417000479

Nagy, W., & Anderson, R. C. (1984). How many words are there in printed school English? *Reading Research Quarterly*, **19**, 304–330.

Nagy, W., Berringer, V., Abbott, R., Vaughan, K., & Vermeulen, K. (2003). Relationship of morphology and other language skills to literacy skills in at-risk second-grade readers and at-risk fourth-grade writers. *Journal of Educational Psychology*, **95**, 730–742.

Nagy, W. E., Diabkidoy, I. A., & Anderson, R. C. (1993). The acquisition of morphology: Learning the contribution of the suffixes to the meaning of derivations. *Journal of Reading Behavior*, **23**, 155–170.

Quémart, P., Gonnerman, L. M., Downing, J., & Deacon, S. H. (2017). The development of morphological representations in young readers: A cross-modal priming study. *Developmental Science*, **21**, e12607. doi: 10.1111/desc.12607

Rabin, J., & Deacon, S. H. (2008). The representation of morphologically complex words in the developing lexicon. *Journal of Child Language*, **35**, 453–465. doi: 10.1017/S0305000907008525

Rispens, J. E., McBride-Chang, C., & Reitsma, P. (2008). Morphological awareness and advanced word recognition and spelling in Dutch. *Reading and Writing*, **21**, 587–607.

Robertson, E. K., Joanisse, M. F., Desroches, A. S., & Ng, S. (2009). Categorical speech perception deficits distinguish language and reading impairments in children. *Developmental Science*, **12**, 753–767.

Robertson, E. K., Joanisse, M. F., Desroches, A. S., & Terry, A. (2013). Past-tense morphology and phonological deficits in children with dyslexia and children with language impairments. *Journal of Learning Disabilities*, **46**, 230–240.

Roman, A. A., Kirby, J. R., Parrila, R. K., Wade-Woolley, L., & Deacon, S. H. (2009). Toward a comprehensive view of the skills involved in word reading in Grades 4, 6, and 8. *Journal of Experimental Child Psychology*, **102**, 96–113.

Rothou, K. M., & Padeliadu, S. (2014). Inflectional morphological awareness and word reading and reading comprehension in Greek. *Applied Psycholinguistics*, **36**, 1007–1027.

Ruan, Y., Georgiou, G. K., Song, S., Li, Y., & Shu, H. (2018). Does writing system influence the associations between phonological awareness, morphological awareness, and reading? A meta-analysis. *Journal of Educational Psychology*, **110**, 180–202.

Seidenberg, M. S., & Gonnerman, L. M. (2000). Explaining derivational morphology as the convergence of codes. *Trends in Cognitive Sciences*, **4**, 353–361.

Semel, E. M., Wiig, E. H., & Secord, W. (2003). *Clinical Evaluation of Language Fundamentals* (4th ed.). San Antonio, TX: Psychological Corporation.

Seymour, P. H. (2005). Early reading development in European orthographies. In M. J. Snowling, and C. Hulme (Eds.), *The science of reading: A handbook* (pp. 296–315). Oxford: Blackwell.

Snow, C. E. (2010). Academic language and the challenge of reading. *Science*, **5977**, 328.

Spear-Swerling, L., & Brucker, P. (2005). Teachers' literacy-related knowledge and self-perceptions in relation to preparation and experience. *Annals of Dyslexia*, **55**, 332–364.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using Multivariate Statistics* (6th ed.). Boston: Pearson.

Taft, M. (2004). Morphological decomposition and the reverse base frequency effect. *Quarterly Journal of Experimental Psychology*, **57A**, 745–765.

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1999). *Test of Word Reading Efficiency*. Austin: PRO-ED.

Treiman, R., Cassar, M., & Zukowski, A. (1994). What types of linguistic information do children use in spelling? The case of flaps. *Child Development*, **65**, 1318–1337.

Treiman, R., & Kessler, B. (2014). *How children learn to write words*. New York: Oxford University Press.

Tyler, A., & Nagy, W. (1989). The acquisition of English derivational morphology. *Journal of Memory and Language*, **28**, 649–667.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1994). Development of reading-related phonological processing abilities: New evidence of bidirectional causality from a latent variable longitudinal study. *Developmental Psychology*, **30**, 73–87.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). *Comprehensive Test of Phonological Processing*. Austin, TX: Pro-Ed.

Windsor, J. (1994). Children's comprehension and production of derivational suffixes. *Journal of Speech and Hearing Research*, **37**, 408–417.

Woodcock, R. W. (2011). *Woodcock Reading Mastery Tests—Revised Normative Update*. Circle Pines, MN: American Guidance Service.

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