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Morphological Awareness and Children's Writing: Accuracy, Error, and Invention

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Abstract

This study examined the relationship between children's morphological awareness and their ability to produce accurate morphological derivations in writing. Fifth-grade U.S. students ($n = 175$) completed two writing tasks that invited or required morphological manipulation of words. We examined both accuracy and error, specifically errors in spelling and errors of the sort we termed *morphological inventions*, which entailed inappropriate, novel pairings of stems and suffixes. Regressions were used to determine the relationship between morphological awareness, morphological accuracy, and spelling accuracy, as well as between morphological awareness and morphological inventions. Linear regressions revealed that morphological awareness uniquely predicted children's generation of accurate morphological derivations, regardless of whether or not accurate spelling was required. A logistic regression indicated that morphological awareness was also uniquely predictive of morphological invention, with higher morphological awareness increasing the probability of morphological invention. These findings suggest that morphological knowledge may not only assist children with spelling during writing, but may also assist with word production via generative experimentation with morphological rules during sentence generation. Implications are discussed for the development of children's morphological knowledge and relationships with writing.

Keywords

Morphology; Morphological awareness; Writing; Spelling

Morphological awareness, which is the metalinguistic insight that words consist of meaningful roots and affixes (i.e., morphemes) that can be isolated and manipulated, has been much studied in relation to children's developing literacy skills. Morphological insights can, for example, allow a child encountering an unfamiliar word such as *unhelpful* to infer the word's meaning based on potentially familiar components: the prefix *un-*, the stem *help*, and the suffix, *-ful*. Research has established morphological awareness as a predictor of reading ability, both word reading (Carlisle & Stone, 2005; Deacon & Kirby 2004; McCutchen, Green & Abbott, 2008, Singson, Mahony, & Mann, 2000; Tyler & Nagy, 1989) and reading comprehension (Carlisle, 2000; Foorman, Petscher, & Bishop, 2012; Kieffer & Lesaux, 2012; Nagy, Berninger, & Abbott, 2006). Furthermore, a causal connection is supported by recent meta-analyses showing that, across multiple studies, morphological

instruction improves literacy outcomes for students with typical levels of literacy achievement (Goodwin & Ahn, 2013), as well as students who struggle (Goodwin & Ahn, 2010)

Recently the role of morphological awareness in writing has gained increased research attention, and interest in factors that support writing development will no doubt grow as writing receives increased emphasis in the Common Core State Standards (CCSS; National Governors Association Center for Best Practices, 2010), which are changing expectations for student learning across the United States. Writing requires productive control of morphological forms and thus provides a unique view of children's developing morphological skills. One particular writing skill, spelling, has received considerable attention by morphology researchers (e.g., Goodwin & Ahn, 2013; Nunes & Bryant, 2006); however, interest is also growing in the relationship between children's morphological awareness and other aspects of writing.

Elementary children's spontaneous use of complex morphological forms in their written narratives reveals considerable room for growth, especially in control of derivational morphology. Carlisle (1996) observed that by third grade, most children used and spelled inflections appropriately (i.e., tense and plural markers such as *-ed*, *-ing*, and *-s*) and were beginning to use common derivational forms (i.e., morphological variations that change the grammatical category of words), such as *runner* derived from *run*. Green et al. (2003) found that almost all third and fourth graders used and spelled inflections correctly in written narratives; however, children's control of derivational forms was much less evident. Only a third of third graders and half of fourth graders generated *any* accurately spelled derivational forms.

In addition to spelling, morphological skills could figure prominently in other writing processes involved in turning ideas into actual words on a page. The seminal model of writing proposed by Hayes and Flower (1980) articulated three major processes: *planning*, which entails rhetorical planning, generating ideas and organizing them; *translating*, which entails turning plans into actual text; and *reviewing*, which includes editing and revising. Although much of the early work of Hayes and Flower focused on higher-level planning processes, from the beginning they emphasized the interactive nature of writing processes and acknowledged the importance of word- and sentence-level processes:

... Just as a title constrains the content of a paper and a topic sentence shapes the options of a paragraph, each word in the growing text determines and limits the choices of what can come next.

(Flower & Hayes, 1981, p. 371)

Recognizing the challenges faced by immature writers (whether young or just inexperienced) as they generate written text, Berninger and Swanson (1994) revised the Hayes and Flower (1980) model to differentiate processes within translating that are of special importance for immature writers: *transcription* and *text generation*. Transcription processes are specific to transcribing oral language into written text and include spelling (a focus in the present study), as well as the physical mode used to generate text (e.g.,

handwriting, keyboarding, secretarial shorthand, Morse code). Text generation entails more fundamental language generation processes such as word retrieval and sentence construction, which are shared across oral and written language (notwithstanding differences between spoken and written registers). Research suggests that children's morphological awareness can support spelling development, as well as processes such as word retrieval and sentence construction that are central to text generation.

Morphology and spelling

Although spelling may become very fluent for skilled adult writers using familiar vocabulary and a well-learned mode of transcription (Bourdin & Fayol, 1994; Fayol, 2012), the development of spelling skill reflects contributions of morphological knowledge, at least for writers of English. Unlike more phonologically transparent orthographies, the morphophonemic orthography of English does not map phonology directly, and spelling skills are related to writers' growing awareness of how orthography reflects both morphology and phonology (Carlisle, 1988; Ehri, 1992;). For example, Nunes and Bryant (2006) argued that morphological insights can demystify many peculiarities in English spelling (see also Moats, 2000), explaining why, for example, the same spelling is maintained across different pronunciations (*heal*, *health*) or the same sounds are spelled differently across words with different morphological structures (*lox*, *locks*). More advanced spelling skills have been linked to growing awareness of morphological aspects of orthography among children across a broad range of writing skill (Bourassa & Treiman, 2008; Treiman, 1993). In addition, recent meta-analyses have documented that morphological instruction improves children's spelling (Goodwin & Ahn, 2010, 2013).

Morphology and text generation

Additional research suggests roles for morphological awareness that extend beyond spelling to include aspects of text generation as well. Researchers have speculated that the explosive growth in children's vocabulary knowledge between grades three and five is related to children's ability to leverage their recognition of morphological relationships across words, expanding vocabulary and increasing fluency of word retrieval (Anglin, 1993; Derwing, Smith, & Wiebe, 1995; Nagy & Anderson, 1984; Nagy & Scott, 2000; Nagy et al., 2006). A computational model proposed by Reichle and Perfetti (2003) simulated how encounters with morphologically related words can enhance lexical representations and thereby facilitate lexical access. Consistent with such accounts, struggling writers were found to be slower than their higher-skilled peers in accessing individual words (McCutchen, Covill, Hoyne & Mildes, 1994), although no morphological assessments were included as part of the study.

In addition to fluency in retrieving words from the lexicon, morphological awareness may also help expand the lexicon and thus improve writers' ability to choose precisely the right word to convey their semantic intent. Evidence suggests that children can use morphological knowledge to bootstrap vocabulary growth as they encounter unfamiliar words composed of familiar morphemes (Baumann et al., 2002; Baumann, Edwards, Boland, Olejnik, &

Kame'enui, 2003; McCutchen & Logan, 2011; Wysocki & Jenkins, 1987), and with richer vocabulary, writers should be better able to match their word choice to their intent.

Working memory constraints during writing might also be reduced by fluent syntactic sentence generation (McCutchen, 2000; Sandler & Graham, 2005), which theoretically could be facilitated by morphological manipulations at the word level, for example, as verbs need to be changed into nominalizations. In their examination of the length of language “bursts” during writing, Chenoweth and Hayes (2001) documented that more fluent language generation processes (i.e., longer bursts) were related to higher quality texts (see also Dellerman, Coirier & Marchand, 1996). In addition, higher quality texts were found to contain more varied syntactic patterns (Myhill, 2008), further suggesting that syntactic flexibility may contribute to good writing.

Research on speech production suggests considerable interplay among semantic, syntactic, and lexical processes during oral sentence generation (Fromkin, 1980; Garrett, 1980; Levelt, 1994), and protocols suggest similar interactions during writing (McCutchen, 1984). Imagine the case of a writer who, while drafting a sentence in which the phrase *turn into a solid* seems too awkward, seeks a more concise phrasing and retrieves the word *solidify*. Knowledge of derivational morphology could thus help a writer fluently manipulate word forms as sentence syntax is revised during composing. Berninger, Nagy and Beers (2011) documented that measures of children's morphological awareness predicted sentence generation (see also Rubin, Patterson & Kantor, 1991). Furthermore, morphologically-based instruction has been found to improve children's ability to produce complex written morphological forms and spell them accurately (McCutchen, Stull, Herrera, Lota & Evans, 2014).

In addition to facilitating word *retrieval* via increased fluency accessing an expanded vocabulary, morphological knowledge may also assist young writers with word *construction* as they try to approximate the syntax and required lexical forms that are characteristic of the academic register. Let us revisit the writer described previously and imagine that our writer does not know the word *solidify* and instead uses morphological rules generatively to construct a plausible but erroneous alternative, such as *solidize* (by analogy with *crystalize*). Invented forms such as *solidize* violate rules of derivational morphology, specifically *distributional* morphological rules (i.e., rules governing the linguistically acceptable concatenation of stems and affixes), which Tyler and Nagy distinguished from less sophisticated *relational* and *syntactic* morphological knowledge. Tyler and Nagy (1989) found that sixth grade students considered many such invented words meaningful when presented in a reading task, suggesting students' internalization and overgeneralization of derivational morphological rules. Interestingly, Tyler and Nagy also found that both fourth graders and college students were far less likely than sixth graders to consider such invented words as meaningful, evidence that the later elementary years are an important period in the refinement of children's knowledge of the distributional constraints inherent in derivational morphology. Thus, analogous with young children's over-generalizations of inflectional forms (Bowerman, 1982) and the well-documented phenomenon of children's invented spelling (Clarke, 1988), such derivational errors may imply a progression toward competency where errors appear then disappear as competency increases (Clarke, 1988;

Gentry, 1982; McBride-Chang, 1998; Ouellette & Sénéchal, 2008; Rieben, Ntamakiliro, Gonthier, & Fayol, 2005; Torgesen & Davis, 1996). As such, children's morphological errors may be as informative about their developing morphological skills as their accurate word usage.

The present study

In the present study we examined how children's morphological awareness may contribute to children's spelling and production of morphologically complex words. We focused on students in U.S. grade five (ages 10-11) because by this age children's vocabularies are rapidly expanding (Anglin, 1993) and they are expected to read and write more complex text (Lawrence, White & Snow, 2010). Also, Tyler and Nagy (1989) found that acceptance of morphological inventions in a reading task peaked near this age, suggesting the continuing consolidation of derivational morphological knowledge in the later elementary years. The specific research questions guiding the study were:

1. Does children's morphological awareness predict accurate production of morphologically complex words during writing, as reflected in their generation of appropriate morphologically complex English words?
2. Does children's morphological awareness predict accurate spelling of morphologically complex words?
3. Does children's morphological awareness predict generative construction of novel derivational forms during writing, as reflected in morphological inventions?

Method

Participants

Participants were 175 5th grade students, 48% female, from eight classrooms drawn from five public schools in an urban area in the U.S. Pacific Northwest; all students participated with parent consent. The racial composition of the sample was 45% European American, 32% Asian American, 9% African American, 2% Pacific Islander, and 8% multiracial, with 3% not reporting. The average age of participants was 10 years 11 months. Teachers reported that 7.4% of the students were receiving special education services and 8.0% were receiving or recently exited English language services, although all students were sufficiently fluent in conversational English to complete the research tasks without assistance. The schools were representative of the district, which reported an average of 40.5% students receiving free or reduced lunch.

Measures

To examine the unique contribution of morphological awareness to spelling and word production during writing, we deemed it necessary to take into account other related measures of literacy skills. Word reading correlates highly with spelling skill (e.g., Green et al., 2003; Moats, 2000), and both word reading and vocabulary correlate with morphological awareness (McCutchen & Logan, 2011). Therefore, we asked students in the present study to complete standardized measures of word reading and oral vocabulary. Students also

completed a researcher-developed morphological awareness task modeled after tasks used frequently in the research literature. The primary measure of students' written production was derived from student responses on a researcher-developed sentence-combining task that invited morphological manipulations of words during sentence construction. To tap a larger corpus of students' written productions, we expanded our analysis of morphological inventions to include student responses to a researcher-developed sentence completion task that required morphological manipulations of single words. The measures are described below in more detail.

Word reading—Students completed the *Woodcock Reading Mastery Tests-Revised* (WRMT-R) Word Identification subtest as a measure of their concurrent word reading ability (Woodcock, 1987). This untimed measure of children's accuracy reading isolated words was administered individually. The test manual reported a split-half reliability of .87 for fifth graders.

Oral vocabulary—Students completed the individually administered picture vocabulary subtest from the *Woodcock Johnson III Tests of Achievement* (Woodcock, McGrew, & Mather, 2001), which required student to provide names for pictures. The test manual reported a test-retest reliability of .89.

Morphological awareness—Students completed a group administered, nonstandardized morphological awareness task taken from Singson et al. (2000), similar to many experimenter-developed morphological tasks used in the literature (e.g., Carlisle, 1995; Fowler & Liberman, 1995; Siegel, 2008). The measure was a multiple-choice recognition task in which children were asked to complete sentences by choosing the most appropriate morphological form of a word from four alternatives. Half of the 20 items included variations of real words, while the other half included variations of non-words with real suffixes. Test-retest reliability was .73 (Pearson's *r*) among 171 students from the present study assessed approximately three months apart. One of the real-word items follows:

A famous doctor performed the _____.

- A. operation.
- B. operational
- C. operative
- D. operationalize

Morphological sentence combining—Because derivational morphological forms can be infrequent in children's spontaneous writing (Carlisle, 1996; Green et al., 2003), our primary writing measure was a sentence combining task that invited morphological manipulations (see O'Hare, 1973; Saddler & Graham, 2005). The researcher-developed measure included eight items, each requiring students to read several short, simple sentences ("kernel" sentences) and rewrite them as one longer sentence. Although the instructions did not specify a response strategy, we encouraged children to combine phrases without using the word *and*, and we provided examples that included morphological manipulations to

create more conceptually dense sentences. For example, one of the test items included the following kernel sentences:

The snake was slow.

The snake moved his coils down the tree.

The tree had moss.

The coils glistened.

Morphological changes potentially generated from this example include “moved slowly,” “the coiled snake,” or “glistening coils.” The task assessed students’ ability to generate morphologically complex words, and the open-ended format allowed for a variety of responses. Although it is difficult to determine an exact total of possible morphological changes, we estimated that a realistic maximum was 21 within the 29 short sentences. For example, one student responded to the above item by writing, “The snake was slowly moveing slowly down the mossy tree while glistening.” She was credited with correctly spelled changes in *slowly* (once only), *mossy*, and *glistening*; and in a second scoring scheme (described more fully below), she was also given credit for the incorrectly spelled change in *moveing*. The sample internal consistency (Cronbach's alpha) of the sentence combining task was calculated at .90 with misspellings allowed, and .87 with correct spelling required (see below). Students completed the sentence combining task twice, once at same time as the word reading and vocabulary tasks, and again approximately twelve weeks later.

Two scores were derived from children's written responses in the sentence-combining task. One score required correctly spelled derivational changes and thus reflected both spelling (a transcription skill) as well as word retrieval (a text generation skill). A second score reflected the number of correct derivational changes made, allowing for phonological misspellings that still clearly signaled the intended appropriate English word. That is, we evaluated any pseudoword that children generated, and if the pseudoword contained an error in a single letter (e.g., *solidfy* for *solidify*) or if its pronunciation were a close dialectical variation of the appropriate morphological form (e.g., *glisning* for *glistening*), we scored it as a phonologically accurate misspelling and considered it a correct response in the second scoring scheme. A 30% random sample of sentence combining responses was double-scored, and inter-rater reliability between two scorers was .99 (Pearson's *r*) with correct spellings required and .98 with phonologically accurate misspellings allowed.

Sentence Completion—The researcher-developed sentence completion task consisted of 20 fill-in-the-blank sentences and a word bank containing 20 words taken from the district's curriculum. Students were instructed to match each word from the word bank to a sentence in which it fit semantically and change the word's form to fit the sentence. Each word was to be used only once. For example, with an appropriate morphological change, the word *conserve* constituted an acceptable fit for the following sentence:

There had been very little rain that year, so volunteers were talking to people about water *conservation*.

The sample internal consistency (Cronbach's alpha) for the sentence completion task was .92. Like many morphological awareness tasks used in the research literature, this task required students to construct morphologically derived forms to fit a given sentence context, but it did not require production of a complete sentence or allow for the variety in responses that was elicited with the sentence combining task. Because of the structural similarity of the sentence completion task and the morphological awareness task used in the present study, we used the sentence completion task only as an additional source of errors in the analysis of morphological inventions.

In contrast to the pseudowords resulting from phonologically accurate misspellings of appropriate morphological forms, morphological inventions resulted when children combined a recognizable stem with an English suffix that was not appropriate for the stem (as in *solidize*). Theoretically, morphological inventions provide evidence of students' generative use of morphological rules, since morphological inventions result in novel forms. Due to the relatively low frequency of such morphological inventions in students' writing, data on their occurrences were derived from both the sentence combining task (the primary writing outcome measure) and the sentence completion task. Based on a sample of 30% of the sentence-combining data, inter-rater reliability between two scorers was .98 (Pearson's *r*) distinguishing morphological inventions from other errors (e.g., misspellings).

Descriptive statistics for the reading, vocabulary and sentence combining measures are provided in Table 1, and examples of phonological misspellings and morphological inventions are provided in Table 2. (Recall that the sentence combining scores in Table 1 reflect combined scores from two administrations of the measure, completed several weeks apart.)

Results

Data analysis strategy

We adopted regression as our primary analytic tool. We employed linear regression when the data approximated a normal distribution and logistic regression when the data were highly skewed and we had reason to expect a nonlinear relationship. Due to incomplete data, not all students were included in all analyses.

Morphological awareness and accurate morphological production

Linear regressions examined the relationship between children's morphological awareness, assessed by the multiple choice task (Singson et al., 2000), and their ability to generate morphologically complex words in the sentence combining task, the more open-ended of our writing tasks. Although the sentence combining task was somewhat contrived, it still provided a more accurate measure of morphological changes that children chose to make as they were generating a sentence (in contrast to the sentence completion task that required the generation of only a single word). Due to missing data, 165 students were included in these analyses, 94% of the original sample.

In one analysis, the sentence combining outcome measure was operationalized as the number of correctly spelled morphological changes to words within the kernel sentences, In

a second analysis, we also included as correct responses phonologically accurate misspellings of appropriate morphological changes. Data from both administrations of the sentence combining measure were combined in these analyses. Because of documented relationships between morphological awareness and reading (Deacon & Kirby, 2004; McCutchen & Logan, 2011), and between reading and spelling of morphologically complex forms (e.g., Green et al., 2003; Moats, 2000), we also included word identification and vocabulary as factors in the regressions to examine the unique contribution of morphological awareness. Table 3 presents the zero-order correlations among the measures used in the regression. Correlations among all measures were statistically significant. Table 4 presents results of the regression analyses.

The analysis including only correct spellings is summarized in the top panels of Table 4, and the analysis allowing phonologically accurate misspellings is summarized in the bottom panels. For each outcome measure, we performed a two-block hierarchical regression, forcing the scores for word identification and vocabulary in the initial block (Model 1) and adding the morphological awareness scores in the second block (Model 2) to examine the unique contribution of morphological awareness to students' ability to generate accurate complex morphological forms in their writing.

In the analysis of correctly spelled morphological changes (top panels of Table 4), Model 1, which included only measures of word identification and vocabulary, was statistically significant, $F(2,162) = 92.69$, $MSE = 5646.28$, $p < .001$, and accounted for 53.4% of the variance in accurately spelled morphological forms in sentence combining. Not surprisingly, word identification ($b = .540$, $p < .001$) and vocabulary ($b = .655$, $p < .001$) both accounted for unique variance of correctly spelled complex morphological forms. With the addition of the morphological awareness scores, Model 2 also resulted in a statistically significant overall model, $F(1,161) = 86.95$, $MSE = 4361.55$, $p < .001$ and accounted for a statistically significant additional 8.4% of the variance in accurately spelled complex morphological forms, $F(1,161) = 35.73$, $p < .001$. Word identification ($b = .262$, $p < .01$) and vocabulary ($b = .586$, $p < .001$) both continued to account for unique variance, with morphological awareness also accounting for unique variance even in the presence of the other two well-documented predictors of spelling ($b = 1.554$, $p < .001$). Thus, children's morphological awareness was related to their ability to accurately spell complex morphological forms during sentence generation.

The analysis of morphological changes that included phonologically accurate misspellings (bottom panels of Table 4) yielded essentially the same results. Model 1, which included only word reading and vocabulary, was statistically significant, $F(2,162) = 90.51$, $MSE = 6272.41$, $p < .001$, and accounted for 52.8% of the variance in phonologically accurate morphological forms in sentence combining. Word identification ($b = .482$, $p < .001$) and vocabulary ($b = .911$, $p < .001$) both accounted for unique variance. With the addition of the morphological awareness scores, Model 2 again resulted in a statistically significant overall model, $F(1,161) = 32.39$, $MSE = 4808.43$, $p < .001$ and accounted for a statistically significant additional 7.9% of the variance in accurately formed (although not always accurately spelled) complex morphological forms, $F(1,161) = 35.73$, $p < .001$. Word identification ($b = .196$, $p < .05$) and vocabulary ($b = .839$, $p < .001$) both continued to

account for unique variance, as did morphological awareness ($b = 1.592, p < .001$). Children's morphological awareness was thus related to production of complex morphological forms regardless of whether or not correct spelling was required. In both analyses, the additional variance accounted for by the inclusion of morphological awareness was modest but statistically significant, and similar in magnitude to unique variance accounted for by morphological awareness in regressions of reading skill (e.g., Singson et al., 2000).

Morphological awareness and morphological invention

Misspellings of appropriate morphological forms could theoretically result when children have access to the word in the lexicon but lack a precise orthographic representation, whereas morphological inventions suggest that when an appropriate word is not present in the lexicon, children use morphological skills generatively to construct a word to match their semantic intent. Such morphological inventions indicate the internalization and generative use of morphological rules (Tyler & Nagy, 1989) during text generation.

Although all students made spelling errors, many students generated no morphological inventions ($n=73$), resulting in a highly skewed distribution and far fewer morphological inventions than misspellings. Because of the low frequency of morphological inventions, we combined occurrences of morphological inventions across the sentence combining and sentence completion tasks in the analysis that follows. The overall frequencies of the two error types are summarized in Table 5 (separated by task in the table but combined in the analysis).

Given the skewed distribution for number of morphological inventions, the linear correlation between morphological awareness and number of morphological inventions was very low (Pearson's $r = .09$). Moreover, based on Tyler and Nagy's (1989) data on students' acceptance of morphological inventions during reading, we had *a priori* expectations that the relationship between morphological awareness and morphological invention may be markedly nonlinear. Just as Tyler and Nagy found that sixth grade students were more accepting of morphological inventions than either younger or older students, we hypothesized that children's invented morphology might reflect substantial, yet incomplete, morphological knowledge. Thus, we hypothesized that we would not see morphological inventions from the students scoring lowest on the morphological awareness measure, because these students possessed insufficient morphological knowledge to support such experimentation; nor did we expect to see such inventions from those scoring highest, because these students would know and retrieve the correct complex forms (and probably spell them correctly).

To deal with such nonlinearity in the morphological invention data, we used a logistic regression to examine the relationship between morphological awareness and the probability of generating at least one morphological invention across the sentence completion and sentence combining tasks. We coded students according to those who generated morphological inventions ($n = 102$) and those who did not ($n = 73$), with that dichotomized variable becoming the dependent variable in the logistic regression. Analogous to the second step in each of the linear regressions of accurate morphological production (see each Model

2, Table 4), we included morphological awareness, word identification and vocabulary as simultaneous predictors.

A test of the full model with all three predictors was statistically significant, $\chi^2(3) = 9.732$, $p < .05$, although the improvement in fit was modest (Nagelkerke $R^2 = .073$). Morphological awareness was uniquely predictive of the occurrence of morphological inventions, $b = .133$, $p < .02$. In contrast to the analysis of accurate morphological production, neither word identification, $b = .003$, $p > .80$, nor vocabulary, $b < .001$, $p > .90$, were unique predictors of morphological inventions (see Table 6). As indicated by the positive coefficient, students with higher levels of morphological awareness were more likely than their lower-performing peers to construct at least one morphological invention.

Discussion

It is relatively well-documented that students who are sensitive to morphological information may be able to use encounters with morphologically complex words to extend their vocabulary (Baumann et al., 2002, 2003), with potential implications for comprehension (McCutchen & Logan, 2011). Results of the present study suggest that such sensitivity to morphological structure may also have important implications for students' writing skills, documenting important but understudied productive aspects children's morphological knowledge.

Regarding the first research question, results indicate that the morphological awareness of fifth grade students is related to their accurate production of morphologically complex forms in their written sentence combining responses, even when word reading and vocabulary are taken into account. The result held when accurate spelling was required, thus addressing the second research question and providing further evidence linking increased morphological knowledge and improved spelling skill (Nunes & Bryant, 2006). Although causal relationships cannot be determined from the correlational data reported here, causal inferences are supported by other studies showing that morphologically based instruction improves children's spelling of complex forms in a similar sentence combining task (McCutchen, Stull, Herrera, Lotas, & Evans, 2014), as well as in other contexts (Berninger et al., 2008; Henry, 1989; Nunes & Bryant, 2006).

In addition to facilitating production of complex morphological forms and accurate spelling, morphological awareness may also assist young writers with word construction, perhaps a distinct text generation skill resulting from interactions between word and sentence level processes. The results of the analysis of morphological invention suggest that even incomplete morphological knowledge may support children's generative experimentation with morphological rules. Moreover, word identification and vocabulary were not unique predictors of morphological invention, further suggesting that it is productive morphological knowledge (albeit incomplete) that contributes to morphological invention.

The results of the present study further clarify the developmental trajectory of children's morphological knowledge. Tyler and Nagy (1989) argued that complete understanding of derivation morphology entails at least three aspects of morphological knowledge: relational,

syntactic, and distributional. Relational knowledge, the most basic, is the recognition that words may share a common morpheme (e.g., recognizing that *farmer* and *farm* are related in a way than *corner* and *corn* are not). Syntactic knowledge is the understanding that derivational suffixes indicate grammatical category (e.g., understanding that *-ion* marks *operation* as a noun whereas *-ize* marks *operationalize* as a verb). Distributional knowledge, which Tyler and Nagy argued is acquired after relational and syntactic, is an understanding of rules governing allowable pairings of stems and suffixes (e.g., understanding that *-ly* attaches to adjectives but not to verbs).

Research on children's writing, including the present study, provides evidence that is consistent with the developmental sequence proposed by Tyler and Nagy (1989). Children with more basic derivational morphological knowledge may not yet be able to use it generatively and so do little experimenting with complex derivational forms (invented or otherwise) in their writing (Carlisle, 1996; Green et al., 2003). However, children who have acquired some level of relational and syntactic knowledge and are developing distributional knowledge (but not yet near mastery) may be more likely to overgeneralize and invent derivational forms during writing. As children's morphological knowledge deepens, their understanding of distributional constraints becomes more complete, both in terms of how suffixes can be used appropriately across grammatical categories (allowing for *quietly* but not *runly*) and within grammatical categories (allowing for *solidify* but not *solidize*). With deeper distributional knowledge, children's morphological inventions again become less frequent, as indicated by the nonlinear relationship between morphological awareness and morphological invention in writing (see also Tyler and Nagy's (1989) similar finding in reading). Children with high levels of morphological knowledge are increasingly able to produce appropriate complex morphological forms and eventually spell them correctly.

Thus, increased morphological knowledge may be useful in development of broader writing skills that include, but are not limited to, spelling. Although novice writers (young or not) typically do little tinkering with language as they move from the retrieval of ideas to the generation of text (Bereiter & Scardamalia, 1987; McCutchen, 1988), skilled writers often do considerable revision -- from the text level to the word level -- to ensure that the final written expressions conform to their authorial intent (Hayes & Flower, 1980; McCutchen, 1984, 1988). Morphology reflects the intersection of semantics and syntax, and the ability to manipulate the morphological structure of words to fit evolving syntactic contexts during text generation may provide a foundation that allows students to become more precise in their word choice and flexible in their syntax (McCutchen, 1988), as well as more accurate in their spelling (Ehri 1992; Treiman, 1993), and through such varied syntax and word choice, more successful in their production of high quality texts (Myhill, 2008). Although the sentence combining and sentence completions tasks used in the present study may be criticized for not requiring authentic, extended written discourse, they do elicit more complex morphological forms than are typical in children's written narratives (Carlisle, 1996; Green et al., 2003). Moreover, accurate use of complex morphological forms in a sentence combining task has been shown to correlate with essay quality scores on a standardized test of writing (Northey, McCutchen, & Sanders, 2014).

Instructional implications

As discussed previously, children are known to experiment with linguistic rules as they acquire them, evidenced by young children's invented spellings (Clarke, 1988) and overgeneralizations of inflectional morphology (Bowerman, 1982). Although such errors reflect incomplete knowledge, they suggest a developing understanding of how linguistic rules function (Ouellette & Senechal, 2008; Rieben et al., 2005). Similarly, the morphological inventions documented in the present study represent children's experimentation with derivational morphology (Tyler & Nagy, 1989).

With an understanding that morphological inventions suggest considerable yet incomplete morphological knowledge, teachers might expect to see morphological inventions in student writing and view them as signs that students are attempting to make sense of the linguistic conventions they are acquiring. Although morphological inventions are indeed errors, they can provide valuable instructional opportunities, and Lawrence et al. (2010) recommend that teachers support such experimentation by their students. Just as teachers are often encouraged to provide feedback to young writers by comparing their invented spellings to actual spellings (Ouellette & Senechal, 2008; Rieben et al., 2005), teachers can make similar use of morphological inventions. When teachers notice morphological inventions in their students' writing, they can engage students in comparisons with the correct forms. For example, teachers could acknowledge that *denty* could be a logical construction because nouns can legally be turned into adjectives with the addition of *-y* (as in *rusty*), although the word *dented* is generally used. Similarly, *describements* could be a logical construction, were it not for the preferred use of the suffix *-tion* to generate abstract nouns, leading instead to *descriptions*. By helping students understand the nuances of distributional morphology, teachers can validate students' partial knowledge and further demystify morphological spellings and preferred stem-affix pairings (Nunes & Bryant, 2006). Such instruction does not require decontextualized drills on stems and suffixes. Instead, open-ended writing tasks that invite sophisticated sentence structures and morphological manipulations may provide opportunities for such conversations in the context of authentic texts.

Conclusions

The present study adds to the literature on the development of children's distributional morphological knowledge, documenting important productive aspects of morphological knowledge. In addition, the study provides a perspective for interpreting erroneous morphological forms in elementary students' writing. Such research holds potential to provide teachers with an improved understanding of how to interpret the writing produced by older elementary students and effectively guide students in developing the skill to write the morphologically complex academic language that is necessary for later academic success.

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References

- Anglin J. Vocabulary development: A morphological analysis. Monographs of the Society for Research in Child Development. 1993; 58(10) Serial No. 238.
- Baumann JF, Edwards EC, Boland EM, Olejnik S, Kame'enui EJ. Vocabulary tricks: Effects of instruction in morphology and context on fifth-grade students' ability to derive and infer word meanings. *American Educational Research Journal*. 2003; 40:447–494.
- Baumann JF, Edwards EC, Font G, Tereshinski CA, Kame'enui EJ, Olejnik S. Teaching morphemic and contextual analysis to fifth-grade students. *Reading Research Quarterly*. 2002; 37:150–176.
- Bereiter, C.; Scardamalia, M. The psychology of written composition. Erlbaum; Hillsdale, NJ: 1987.
- Berninger VW, Nagy W, Beers S. Child writers' construction and reconstruction of single sentences and construction of multi-sentence texts: Contributions of syntax and transcription to translation. *Reading and Writing: An Interdisciplinary Journal*. 2011; 24:151–182.
- Berninger, VW.; Swanson, HL. Modifying Hayes and Flower's model of skilled writing to explain beginning and developing writing.. In: Carlson, JS.; Butterfield, EC., editors. *Advances in cognition and educational practice, Vol.2: Children's writing: Toward a process theory of the development of skilled writing*. JAI Press; Greenwich, CN: 1994. p. 57-81.
- Berninger VW, Winn WD, Stock P, Abbott RD, Eschen K, Lin S-J, Nagy W. Tier 3 specialized writing instruction for students with dyslexia. *Reading and Writing: An Interdisciplinary Journal*. 2008; 21:95–129.
- Bourdin B, Fayol M. Is written language production really more difficult than oral language production? *International Journal of Psychology*. 1994; 29:591–620.
- Bowerman, M. Starting to talk worse: Clues to language acquisition from children's late speech errors.. In: Strauss, S., editor. *U-shaped behavioral growth*. Academic Press; New York, NY: 1982. p. 101-145.
- Clarke LK. Invented versus traditional spelling in first graders' writings: Effects on learning to spell and read. *Research in the Teaching of English*. 1988; 22:281–309.
- Carlisle JF. Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics*. 1988; 9:247–266.
- Carlisle, JF. Morphological awareness and early reading achievement.. In: Feldman, LB., editor. *Morphological aspects of language processing*. Lawrence Elbaum; Hillsdale, NJ: 1995. p. 189-209.
- Carlisle JF. An exploratory study of morphological errors in children's written stories. *Reading And Writing: An Interdisciplinary Journal*. 1996; 8:61–72.
- Carlisle JF. Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading and Writing: An Interdisciplinary Journal*. 2000; 12:169–190.
- Carlisle JF, Stone CA. Exploring the roles of morphemes in word reading. *Reading Research Quarterly*. 2005; 40:428–449.
- Chenoweth NA, Hayes JR. Fluency in writing: Generating text in L1 and L2. *Written Communication*. 2001; 18:80–98.
- Deacon SH, Kirby JR. Morphological awareness: Just “more phonological”? The roles of morphological and phonological awareness in reading development. *Applied Psycholinguistics*. 2004; 25:223–238.
- Dellerman, P.; Coirier, P.; Marchand, E. Planning and expertise in argumentative composition.. In: Rijlaarsdam, G.; van den Bergh, H.; Couzijn, M., editors. *Theories, models, and methods in writing research*. Amsterdam University Press; Amsterdam: 1996. p. 182-195.
- Derwing, BL.; Smith, ML.; Wiebe, GE. On the role of spelling in morpheme recognition: Experimental studies with children and adults.. In: Feldman, LB., editor. *Morphological aspects of language processing*. Erlbaum; Hillsdale, NJ: 1995. p. 3-27.

- Ehri, LC. Reconceptualizing the development of sight word reading and its relationship to recoding.. In: Gough, PB.; Ehri, LC.; Treiman, R., editors. *Reading acquisition*. Routledge; New York, NY: 1992. p. 107-143.
- Fayol, M. Cognitive processes of children and adults in translating thought in written language in real time: Perspectives from 30 years of programmatic cognitive psychology and linguistics research.. In: Berninger, VW., editor. *Past, present, and future contributions of cognitive writing research to cognitive psychology*. Psychology Press; New York, NY: 2012. p. 27-59.
- Flower L, Hayes JR. The pregnant pause: An inquiry into the nature of planning. *Research in the Teaching of English*. 1981; 15:229–244.
- Foorman BR, Petscher Y, Bishop MD. The incremental variance of morphological knowledge to reading comprehension in grades 3-10 beyond prior reading comprehension, spelling, and text. *Learning and Individual Differences*. 2012; 22:792–798.
- Fowler, AE.; Liberman, IY. The role of phonology and orthography in morphological awareness.. In: Feldman, LB., editor. *Morphological aspects of language processing*. Erlbaum; Hillsdale, NJ: 1995. p. 157-188.
- Fromkin, VA. *Errors in linguistic performance*. Academic Press; New York, NY: 1980.
- Garrett, MF. Levels of processing in sentence production.. In: Butterworth, B., editor. *Language production*. Academic Press; New York, NY: 1980. p. 177-220.
- Gentry JR. An analysis of developmental spelling in GNYS at WRK. *The Reading Teacher*. 1982; 36:192–200.
- Goodwin AP, Ahn S. A meta-analysis of morphological interventions: Effects on literacy achievement of children with literacy difficulties. *Annals of Dyslexia*. 2010; 60:183–208. [PubMed: 20799003]
- Goodwin AP, Ahn S. A meta-analysis of morphological interventions in English: Effects on literacy outcomes for school-age children. *Scientific Studies of Reading*. 2013; 17:257–285.
- Green L, McCutchen D, Schwiebert C, Quinlan T, Eva-Wood A, Juelis J. Morphological development in children's writing. *Journal of Educational Psychology*. 2003; 95:752–761.
- Hayes, JR.; Flower, LS. Identifying the organization of writing processes.. In: Gregg, LW.; Steinberg, ER., editors. *Cognitive processes in writing*. Erlbaum; Hillsdale, NJ: 1980. p. 3-30.
- Henry MK. Children's word structure knowledge: Implications for spelling and decoding instruction. *Reading and Writing: An Interdisciplinary Journal*. 1989; 1:135–152.
- Kieffer MJ, Lesaux KK. Direct and indirect roles of morphological awareness in the English reading comprehension of native English, Spanish, Filipino, and Vietnamese speakers. *Language Learning*. 2012; 62:1170–1204.
- Lawrence JF, White C, Snow CE. The words students need. *Educational Leadership*. 2010; 68:23–26.
- Levelt, WJM. The skill of speaking.. In: Bertelson, P.; Eelen, P.; d'Ydewalle, G., editors. *International perspectives on cognitive science*. Vol. 1. Erlbaum; Hillsdale, NJ: 1994. p. 89-103.
- McBride-Chang C. The development of invented spelling. *Early Education and Development*. 1998; 9:147–160.
- McCutchen D. Knowledge acquisition, processing efficiency, and working memory: Implications for a theory of writing. *Educational Psychologist*. 2000; 35:13–23.
- McCutchen D. "Functional automaticity" in children's writing: A problem of metacognitive control. *Written Communication*. 1988; 5:306–324.
- McCutchen D. Writing as a linguistic problem. *Educational Psychologist*. 1984; 19:226–238.
- McCutchen D, Covill A, Hoyne SH, Mildes K. Individual differences in writing skill: Implications of translating fluency. *Journal of Educational Psychology*. 1994; 86:256–266.
- McCutchen D, Green L, Abbott RD. Children's morphological knowledge: Links to literacy. *Reading Psychology*. 2008; 29:289–314.
- McCutchen D, Logan B. Inside incidental word learning: Children's strategic use of morphological information to infer word meanings. *Reading Research Quarterly*. 2011; 46:334–349.
- McCutchen D, Stull C, Herrera BL, Lotas S, Evans S. Putting words to word: Effects of morphological instruction on children's writing. *Journal of Learning Disabilities*. 2014; 47:86–97. [PubMed: 24306461]

- Moats, L.; C.. Speech to print: Language essentials for teachers. Brookes Publishing; Baltimore, MD: 2000.
- Myhill D. Towards a linguistic model of sentence development in writing. *Language and Education*. 2008; 22:271–288.
- Nagy WE, Anderson R. How many words are there in printed school English? *Reading Research Quarterly*. 1984; 19:304–330.
- Nagy W, Berninger VW, Abbott RD. Contributions of morphology beyond phonology to literacy outcomes of upper elementary and middle-school students. *Journal of Educational Psychology*. 2006; 98:134–147.
- Nagy, WE.; Scott, JA. Vocabulary processes.. In: Kamil, ML.; Mosenthal, PB.; Pearson, PD.; Barr, R., editors. *Handbook of reading research*. Vol. 3. Erlbaum; Mahwah, NJ: 2000. p. 269–284.
- National Governors Association Center for Best Practices. Common Core State Standards. National Governors Association Center for Best Practices, Council of Chief State School Officers; Washington DC: 2010. Retrieved from <http://www.corestandards.org/the-standards>
- Northey, M.; McCutchen, D.; Sanders, E. Control of morphological forms during writing predicts essay quality.. Paper presented at the meeting of the American Educational Research Association; Philadelphia, PA.. Apr. 2014
- Nunes, T.; Bryant, P. Improving literacy by teaching morphemes. Routledge; New York, NY: 2006.
- O'Hare, F. Sentence combining. National Council of Teachers of English; Champaign, IL: 1973.
- Ouellette G, Sénéchal M. Pathways to literacy: A study of invented spelling and its role in learning to read. *Child Development*. 2008; 79:899–913. [PubMed: 18717897]
- Reichle ED, Perfetti CA. Morphology in word identification: A word experience model that accounts for morpheme frequency effects. *Scientific Studies of Reading*. 2003; 7:219–237.
- Rieben L, Ntamakiliro L, Gonthier B, Fayol M. Effects of various early writing practices on reading and spelling. *Scientific Studies of Reading*. 2005; 9:145–166.
- Rubin H, Patterson P, Kantor M. Morphological development and writing ability in children and adults. *Language, Speech, and Hearing Services in Schools*. 1991; 22:228–235.
- Saddler B, Graham S. The effects of peer-assisted sentence-combining instruction on the writing performance of more and less skilled young writers. *Journal of Educational Psychology*. 2005; 97:43–54.
- Siegel LS. Morphological awareness skills of English language learners and children with dyslexia. *Topics in Language Disorders*. 2008; 28:15–27.
- Singson M, Mahony D, Mann V. The relation between reading ability and morphological skills: Evidence from derivational suffixes. *Reading and Writing: An Interdisciplinary Journal*. 2000; 12:219–252.
- Torgesen JK, Davis C. Individual difference variables that predict response to training in phonological awareness. *Journal of Experimental Child Psychology*. 1996; 63:1–21. [PubMed: 8812025]
- Treiman, R. Beginning to spell: A study of first-grade children. Oxford University Press; New York, NY US: 1993.
- Tyler A, Nagy W. The acquisition of English derivational morphology. *Journal of Memory and Language*. 1989; 28:649–667.
- Woodcock, R. Woodcock Reading Mastery Tests-Revised. AGS Publishing; Circle Pines, MN: 1987.
- Woodcock, R.; McGrew, K.; Mather, N. Woodcock-Johnson III Tests of Achievement. Riverside; Itasca, IL: 2001.
- Wysocki K, Jenkins JR. Deriving word meanings through morphological generalization. *Reading Research Quarterly*. 1987; 22:66–81.

Table 1

Means (and Standard Deviations) of Observed and Standard Scores

Measure	Observed	Standard	Percent Missing
WRMT-R Word ID	78.99 (11.06)	106.26 (13.83)	0
WJ-III Vocabulary	26.14 (4.76)	101.18 (14.55)	0
Morph Awareness	12.54 (3.09)	-----	2
Sentence Combining (correct spellings only)	19.78 (11.33)	-----	6
Sentence Combining (misspellings allowed)	23.72 (12.00)	-----	6

Table 2

Examples of Derivations, Phonological Misspellings, and Morphological Inventions

Original stem	Correct derivation	Phonological Misspelling	Morphological Invention
mystery	mysterious	mysterus	mysterical
solid	solidify	solidfy	solidize
			solidate
terror	terrified	terrorfied	terrored
flavor	flavorful		flavorish
			flavorous
			flavory
gravity	gravitational	gravatasenel	gravital
		gravitasional	gravitarial
		gravitashinol	
dent	dented		denty
condense	condensation	condenseation	condensify
		condensashon	
describe	descriptive	discriptiv	describful
	descriptions		describements
prevent	preventable	prevantable	preventful
glisten	glistening	glisning	glistenly

Table 3

Correlations among Word Reading, Vocabulary, Morphological Awareness and Both Scorings of Morphological Changes in Sentence Combining

Variable	1	2	3	4	5
1. WRMT-R Word ID	---	.688**	.701**	.704**	.679**
2. WJ-III Vocabulary		---	.519**	.626**	.654**
3. Morphological Awareness			---	.608**	.689**
4. Morphological Changes (correct spellings required)				---	.950**
5. Sentence Combining (misspellings allowed)					---

Note:

**
p .001

Table 4

Linear Regressions of Accurate Morphological Changes in Sentence Combining

	<i>b</i>	<i>SE</i>	β	<i>t</i>	<i>R</i> ²
Correct Spelling Required					
Model 1:					.534 ^{**}
Constant	−40.386	4.514		−8.947 ^{**}	
Word Identification	0.540	0.077	.518	7.009 ^{**}	
Vocabulary	0.655	0.179	.270	3.657 ^{**}	
Model 2:					.618 ^{**}
Constant	−36.113	4.158		−8.685 ^{***}	
Word Identification	0.262	0.084	.251	3.111 ^{**}	
Vocabulary	0.586	0.163	.242	3.593 ^{***}	
Morph Awareness	1.554	0.260	.409	5.977 ^{***}	
Phonologically Accurate Misspellings Allowed					
Model 1:					.528 ^{***}
Constant	−38.507	4.815		−7.998 ^{***}	
Word Identification	0.482	0.082	.436	5.859 ^{***}	
Vocabulary	0.911	0.191	.354	4.766 ^{***}	
Model 2:					.607 ^{***}
Constant	−34.130	4.473		−7.630 ^{***}	
Word Identification	0.196	0.090	.177	2.169 [*]	
Vocabulary	0.839	0.175	.327	4.788 ^{***}	
Morph Awareness	1.592	0.280	.395	5.691 ^{***}	

Note:

* *p* .05

** *p* .01

*** *p* .001

Table 5

Summary of Writing Errors, Totals (and Percentages)

Error Type	Task	
	Sentence Combining	Sentence Completion
Morphological Inventions	106 (2.8%)	101 (19.4%)
Phonologically Accurate Misspellings	3679 (97.2%)	420 (80.6%)

Table 6

Logistic Regression of Morphological Invention

	<i>b</i>	<i>SE</i>	$\chi^2(1)$	Exp(B)
Word Identification	0.003	0.015	.030	1.003
Vocabulary	<0.001	0.014	<.001	1.000
Morphological Awareness	0.133	0.054	5.977*	1.142
Constant	-1.534	1.322	1.348	.216

*
 $p < .05$