Published in final edited form as:

J Learn Disabil. 2014 ; 47(1): . doi:10.1177/0022219413509966.

Multisyllabic Word Reading as a Moderator of Morphological Awareness and Reading Comprehension

Jennifer K. Gilbert¹, Amanda P. Goodwin¹, Donald L. Compton¹, and Devin M. Kearns²

¹Vanderbilt University

²Boston University

Abstract

The purpose of this study was to investigate whether the relation between morphological awareness on reading comprehension is moderated by multisyllabic word reading ability in fifth grade students ($N = 169$, 53.7% female, 65.2% minority status, 69.2% free/reduced lunch status), oversampled for poor reading skill, when controlling for general knowledge and vocabulary. Based on the lexical quality hypothesis (Perfetti, 2007), it was expected that morphological awareness would have a stronger effect on comprehension for children with poor word reading skills, suggesting possible use of morphological awareness for word identification support. Results indicated that neither morphological awareness nor word reading was uniquely associated with reading comprehension when both were included in the model along with vocabulary and general knowledge. Instead, the interaction between word reading and morphological awareness explained significant additional variance in reading comprehension. By probing this interaction, it was determined that the effect of morphological awareness on reading comprehension was significant for the 39% of the sample that had more difficulty reading multisyllabic words), but not for students at the higher end of the multisyllabic word reading continuum. We conclude from these results that the relation between morphological awareness and reading comprehension is moderated by multisyllabic word reading ability, providing support for the lexical quality hypothesis (Perfetti, 2007). Although we have only correlational data, we suggest tentative instructional practices for improving the reading skill of upper elementary struggling readers.

Current research suggests that morphological awareness, defined as knowledge of the morphemic structures of words and the ability to analyze and manipulate these structures (Carlisle, 1995, 2010), is related to reading comprehension (see Carlisle & Goodwin, in press, for an overview). Readers who are able to isolate and manipulate the smallest units of meaning (i.e., morphemes) tend to identify and assign meaning to individual words better (Carlisle, 2003; Kuo & Anderson, 2006), which allows them to ascribe meaning to phrases, sentences, and the text as a whole. The majority of studies show that the morphological awareness-comprehension relationship holds across a wide age span even when controlling for other linguistic and cognitive factors such as phonological awareness, intelligence, and vocabulary knowledge (Carlisle, 1995, 2000; Carlisle & Fleming, 2003; Casalis, Colé, & Sopo, 2004; Casalis & Louis-Alexandre, 2000; Deacon & Kirby, 2004; Elbro & Arnbak, 2006; Kieffer & Lesaux, 2008; Kirby, Deacon, Bowers, Ienber, & Wade-Woolley, 2012; Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003; Shankweiler, Crain, Katz, & Fowler, 1995; Siegel, 2008; Windsor, 2000).

Studies have begun to try and unravel the mechanisms underlying this morphological awareness-comprehension relationship, with initial findings suggesting that literacy skills such as word reading and vocabulary knowledge may *mediate* the relationship between morphological awareness and comprehension (Goodwin, 2011; Kieffer, Biancarosa, & Mancilla-Martinez, in press; Kieffer & Lesaux, 2012). What is unclear is whether there is a

level of these skills that *moderates* the effect of morphological awareness on reading comprehension. In other words, are there certain levels of these skills (i.e., word reading or vocabulary) where a student's morphological awareness becomes particularly important for achieving reading comprehension. In particular, the current study explores whether the relationship between morphological awareness and comprehension is moderated by word reading ability, or in other words, whether morphological awareness is particularly important for reading comprehension for word readers of certain abilities.

Partial independence of word reading and language skills as forecasters of individual differences in reading comprehension, referred to as the simple view of reading (Gough & Tunmer, 1986; Hoover & Gough, 1990), predicts that individuals with poor word reading skills are at a disadvantage when it comes to comprehending text. The lexical quality hypothesis (Perfetti, 1992, 2007; Perfetti & Hart, 2002) explains this link between poor word reading and poor comprehension. It postulates that poor word readers are likely to have a disproportionate number of lexical representations of low quality that when retrieved from long-term memory fail to fully capture codes representing orthographic, phonological, semantic, and morpho-syntactic information, which negatively affects text comprehension (for details see Perfetti, 2007). High quality lexical representations, on the other hand, are modular in the sense that all of the information that is specific to a word (e.g., orthography, phonology, meaning, and function) is encapsulated in the representation itself (Stanovich, 1990). Thus, retrieval of a high quality representation is more likely to be coherent, reliable, and efficient, which supports comprehension. In fact, retrieval of high quality representations tends to be instantaneous and not dependent on information other than the word's orthographic form when reading.

In contrast, when the word's lexical representation is of lower quality, its identification cannot be retrieved in an efficient and reliable manner directly from the orthographic representation. In these cases, individuals may rely on other forms of information to identify a word. For multimorphemic words in particular, we hypothesize that one source of information used to identify a word is the morphological information contained in the word's root and affix(es). So, persons with higher quality lexical representations are more likely to identify a word primarily from the word form itself (e.g., *fearful*), whereas persons with lower quality representations are more likely to draw on peripheral information, such as morphological information (e.g., identifying *fear* and/or *ful* within *fearful*), to achieve word identification (Carlisle, 2003, 2010; Perfetti, 2007; Schreuder & Baayen, 1995; Stanovich, 1990). Therefore, morphological awareness may account for differential variance in reading comprehension as a function of word reading skill. We do not argue that morphological information is unimportant for building the lexical representation, only that conscious analysis of morphological information becomes less important for word identification from an orthographic form once the representation of that form is of the highest quality.

This link to conscious analysis (versus long term building of lexical representations) highlights differences between ability and tendency. Stanovich (2000) described a related phenomenon in that good readers have a stronger ability than poor readers to use context to identify an unfamiliar word when they are presented with a task that requires them to do so. He went on to say, however, that poor readers have a stronger tendency to use context to identify an unfamiliar word (albeit less effectively than good readers) when approaching text in a natural setting. Perhaps the same is true of morphological awareness. When specifically asked to identify and manipulate meaning units in words, individuals who are more skilled at word reading or comprehending show a stronger morphological awareness ability, on average, than less skilled readers or comprehenders (Kirby et al., 2012; Nation, Clarke, Marshall, & Durand, 2004). When reading text, though, good word readers may have less of a tendency to depend on morphological awareness to identify a word, as they are likely to

have high quality lexical representations that contain the word's identity in the representation itself. Poor word readers, on the other hand, have perhaps more frequent need to use morphological information to identify words (in order to comprehend the text) because many of their representations are likely to be of poor quality, such that the word's identity is not activated directly from encountering the orthographic form. In this way, some researchers have even regarded morphological awareness as a compensatory strategy for very poor word readers (Elbro & Arnbak, 1996; Casalis et al., 2004).

Morphological Awareness as a Compensatory Strategy for Poor Word Readers

Elbro and Arnbak (1996) found evidence for morphological compensation from two studies involving Danish children. In their first study, they found that a group of adolescents with dyslexia read a list of words with a morphological base (e.g., *sunburn*) faster than words with a pseudo morphological base (e.g., *window*); no such difference was found among good word readers (who were matched on comprehension). Furthermore, the relative dependence on morphological processing was correlated with comprehension for poor word readers but not for better word readers. In their second study, the compensation hypothesis was tested more directly. The authors presented sentences to children in different formats: letter-by-letter, phoneme-by-phoneme, syllable-by-syllable, morpheme-by-morpheme, and word-by-word. After sentence presentation, children were asked to select a picture that represented the meaning of the sentence. Dyslexics read faster in the morpheme than syllable condition whereas there was no difference in younger, proficient word readers. Taken together, the relative deficit that poor readers have in morphological awareness and the finding that poor word readers may actually use morphological processing to compensate for other reading-related weaknesses suggests that there may be a specific level of word reading skill where a student's morphological awareness is particularly related to reading comprehension.

Motivation for Current Study

The role of word reading in moderating the morphological awareness-comprehension relationship is likely to be particularly important for upper elementary students. By 5th grade, students have transitioned from learning to read to reading to learn (Chall, 1983), making proficiency in word reading increasingly important for academic success. Further, the texts that fifth graders are exposed to and expected to learn from have a greater proportion of multisyllabic and multimorphemic words than the texts from earlier grades (Hiebert, Martin, & Menon, 2005; Nagy & Anderson, 1984). This makes facility with complex words even more important because children who are unable to identify many of the words in a text are unlikely to comprehend the material, which hinders the acquisition of important academic information. Thus, elucidating the relations among word reading, morphological awareness, and comprehension is an important first step in ultimately addressing the poor reading skills of upper elementary children.

The primary question driving our study is whether morphological awareness has a differential relation to comprehension depending on multisyllabic word reading ability, controlling for other reading-related skills. In other words, we want to know whether word reading skill *moderates* the relation between morphological awareness and comprehension. To be concrete, in the current study the moderator is multisyllabic word reading, the independent variable is morphological awareness, the dependent variable is comprehension, and the control variables are academic knowledge and vocabulary. We use a continuous variable of multisyllabic word reading to avoid arbitrary cut-points for classifying students into groups of "good" and "poor" word readers. Instead, this approach allows us to detect a region of significance (Johnson & Neyman, 1936), which in our case is the value or range of

multisyllabic word reading ability for which there is a significant effect of morphological awareness on comprehension. We use academic knowledge and vocabulary knowledge as control variables in our study due to their documented relations with morphological awareness and/or word reading, and reading comprehension (e.g., Nagy, Berninger, & Abbott, 2006; O'Reilly, T., & McNamara, D. S., 2007; Savolainen, Ahonen, Aro, Tolvanen, & Holopainen, 2008). This allows us to focus singularly on multisyllabic word reading as a moderator, rather than allowing word reading to account for variance it shares with vocabulary and general knowledge. Leaving these variables out of the model would likely bias (i.e., overestimate) the estimates of our effects of interest (i.e., morphological awareness and its interaction with multisyllabic word reading).

Method

Participants and Procedure

Participants ($N = 169$) were two cohorts of fifth grade students who were part of a larger longitudinal study. Poor readers were overrepresented in this sample due to the goals of the larger project (Compton, D. L., Fuchs, D., & Fuchs, L. S. (2010). Predictors and Subtypes of Reading Disabilities: Implications for Instruction of "Late-Emergers". Funded by the Institute for Education Sciences, US Department of Education, [R305A100034]). Testing in grade 5 was primarily conducted in the student's school, although some students were assessed at the research laboratory in the case that a principal would not allow in-school testing. Participants ($N = 169$) were from 40 schools and 95 teachers.

Multiple regression analysis was conducted to answer our research question. Prior to reporting and interpreting the results, model residuals were checked to detect nonlinearity, heteroscedasticity, nonnormality, and outliers (Cohen, Cohen, West, & Aiken, 2003). Remedial steps were taken in the case of model assumption violation. In our primary model, five outliers as indexed by extreme values of leverage, discrepancy, and/or influence (Cohen et al., 2003) were detected. To prevent these extreme cases from having an undue influence on the regression model, the cases were removed and the model was re-run. Post hoc residual checking of this model revealed no outliers and no evidence that the assumptions of linearity, homoscedasticity, and normality had been violated.

The final sample ($n = 164$) comprised 53.66% female students, 69.17% students receiving a free or reduced price lunch, and 65.24% students of a minority ethnicity status. The final sample was nearly identical to the original sample on demographic characteristics and average test scores. See Table 1 for a more complete description of the final sample.

Measures

Academic knowledge—General academic knowledge was assessed with the Academic Knowledge subtest of Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001). This measure comprises questions from three content areas: science, social studies, and humanities. Questions are administered by page and are ordered by increasing difficulty; testing ends when students incorrectly answer the three highest numbered items on a page. The total score is the sum of all correctly answered items from the three content areas. Test-retest reliability was reported in the testing manual as .83 for 8-10 year olds and .85 for 11-13 year olds.

Morphological awareness—A morphological awareness composite score was derived by averaging the z-scores of four measures. Multiple measures were used to index morphological awareness because recent reviews of morphological research highlight the many measurement problems within the field (Berthiaume & Daigle, 2012; Bowers et al.,

2010; Carlisle, 2010; Carlisle & Goodwin, in press). Furthermore, combining measures addresses the multi-faceted nature of morphological awareness and increases reliability (Shadish, Cook, & Campbell, 2002). Three of four measures were suffix choice tests (Berninger & Nagy, 1999). In all three, the item stimuli and answer choices were read aloud (individually to students) to eliminate the effect of decoding on test performance. For the first test, children saw 25 incomplete sentences and were asked to choose the form of the word with the correct derivational suffix that completed the sentence (e.g., *Did you hear the [directs, directions, directing, directed]?*) For the second test, children were presented five pseudo-derived words (e.g., *dogless*) and four sentences using the pseudo-derived word. Students were asked to choose the sentence that used the word correctly (e.g., *When he got a new puppy, he was no longer dogless.*). For the third test, students were presented 14 incomplete sentences and asked to choose the nonword that best fit the sentence. Each nonword option contained grammatical information (e.g., *jittling, jittles, jittled, jittle*). The fourth measure was the morphological relatedness test (adapted from Derwing, 1976, as used in Nagy et al., 2003). After two example items, test administrators read 12 pairs of words aloud (while students had visual access to the items) and asked students to judge whether one word (e.g., *quickly*) comes from another word (e.g., *quick*). Foils were pairs of orthographically but not semantically related (e.g., *mother, moth*). No reliability information is available for our sample, but a review of the literature suggests tasks are reliable (nonword: $\alpha=.73$, Lesaux & Kieffer, 2010; combined real and nonword: $\alpha=.77$, Ramirez, Chen, Geva, & Kiefer, 2010; relatedness combined with multiple tasks: $\alpha=.92$, Goodwin et al., 2013; $\alpha=.79$ McCutchen, Green, & Abbott, 2008).

Multisyllabic word reading—Multisyllabic word reading was assessed with a 30-item experimenter-created list of words. All words were morphologically complex, which means they all contained more than one unit of meaning (i.e., root word plus suffix). These words are particularly relevant for fifth grade students because academic texts for students of this age include a majority of words that are morphologically complex in nature (Bar-Ilan & Berman, 2007; Nagy & Anderson, 1984). Data from the participants and words described in Carlisle and Katz (2006) served as a basis for the present word list; percent correct was calculated for each word as an indication of word difficulty. To ensure the word list would produce variability in terms of student performance, we selected words that fit into a 2x2 matrix: opaque vs. transparent relation to a corresponding root word and regular vs. irregular body of the basic orthographic syllabic structure (BOB; Taft, 1992). Within each cell, we controlled for base word frequency and chose words with a range of difficulties. We added five words to the irregular BOB category because not enough were available on the Carlisle and Katz list. Students were presented the list of words and asked to read the words aloud one at a time. Correct pronunciations were scored 1 and incorrect pronunciations were scored 0. The total score was the sum of correct items. The internal consistency reliability for this test for our sample was .94.

Reading comprehension—Comprehension scores were derived from questions answered after students read fifth-grade passages from the Qualitative Reading Inventory (QRI-3; Leslie & Caldwell, 2001). After reading each of two passages, comprehension was assessed with six corresponding questions. Three of the questions ask about information that was explicitly stated in the text whereas the other three questions ask about information that was implied in the text. Students were required to provide oral answers to the comprehension questions; scores of correct (1) and incorrect (0) were assigned according to rubric found in the testing manual and inter-rater reliability of 20% of the tests exceeded .93.

Vocabulary knowledge—The Peabody Picture Vocabulary Test (Dunn & Dunn, 2007) was used to measure receptive vocabulary knowledge. Test administrators orally presented

stimulus words and asked students to point to one of four pictures that depict the meaning of the word. Test items are presented in sets of 12 that increase in difficulty; students enter the test at the item most appropriate for their age as set by the testing manual. After a basal of zero or one errors in a set is established, testing continues until a ceiling of eight or more errors in a set is reached. Test-retest reliability reported in the testing manual was .93 for 7-14 year olds.

Data Analysis

We first ran an unconditional multilevel regression model to account for potential school clustering effects; we note here that school effects were not anticipated because we administered the assessments in the fall of grade 5, which is the first grade of middle school for the present sample. Our analyses were run in Stata 12.1. The likelihood ratio test between a model with and without the school effect was nonsignificant, $\chi^2(1) = 1.94, p = .08$, so we proceeded with a regular hierarchical regression analysis.

Hierarchical regression analysis was conducted as a means of providing effect sizes for both main effects of morphological awareness and multisyllabic word reading as well as the interaction of the two. To accomplish this, two sets of hierarchical regressions were completed. In the first, we regressed reading comprehension on four blocks: 1) academic knowledge and vocabulary knowledge, 2) morphological awareness, 3) multisyllabic word reading, and then 4) the interaction between the morphological awareness and multisyllabic word reading. In the second, the order of morphological awareness and multisyllabic word reading was reversed so that reading comprehension was regressed on: 1) academic knowledge and vocabulary knowledge, 2) multisyllabic word reading, 3) morphological awareness, and then 4) the interaction between the morphological awareness and multisyllabic word reading. Reversing the order of morphological awareness and multisyllabic word reading allows us to calculate the unique variance explained by each after accounting for the other, which helps determine if either is important for explaining variability in reading comprehension after the other has been taken into account. Each variable was centered about its mean prior to model entry. Post hoc probing of the interaction for a region of significance was completed via the online tools described in Preacher, Curran, and Bauer (2006). The region of significance is defined as the range of the moderator variable (i.e., multisyllabic word reading) in which the relation between the independent variable (i.e., morphological awareness) and the dependent variable (reading comprehension) is significant.

Results

Dependent and independent variable means and standard deviations are in Table 1. Standard scores are presented for the general knowledge and vocabulary knowledge assessments to provide a broader context for the functioning of our sample, although raw scores of these same tests were used in the analyses because the other tests in our analyses were limited to raw scores. The standard scores of 90.31 ($SD = 13.70$) and 93.09 ($SD = 15.20$) for knowledge and vocabulary, respectively, confirm that our sample was somewhat low achieving. The means of the comprehension (7.43, $SD = 2.24$) and word reading (17.65, $SD = 8.11$) measures indicated that the sample was averaging slightly more than half the items correct on each test. Correlations among the variables are in Table 2. All correlations were moderate, in the .4 - .6 range, with the exception of a .79 correlation between general knowledge and vocabulary knowledge.

Although the main research question concerned the interaction between morphological awareness and multisyllabic word reading, we also explored main effects. As described previously we ran two sets of hierarchical regression models in which the entry order of

morphological awareness and multisyllabic word reading was alternated. Hierarchical regression results are reported in Table 3. Results from Model 1 show that morphological awareness explains a significant amount of variance in reading comprehension after controlling for knowledge and vocabulary (Step2: $\Delta R^2 = 0.016$) but results from Model 2 show that it does not explain unique variance after also controlling for multisyllabic word reading (Step 3: $\Delta R^2 = 0.009$). Multisyllabic word reading, on the other hand, did not account for unique variance after controlling for knowledge and vocabulary (Model 2, Step 2: $\Delta R^2 = 0.008$) or knowledge, vocabulary, and morphological awareness (Model 1, Step 3: $\Delta R^2 = 0.001$). When entered together, and when controlling for knowledge and vocabulary, neither morphological awareness nor multisyllabic word reading account for unique variance in reading comprehension. Null main effects do not preclude a significant interaction, which we tested in Step 4 of both models.

In Step 4, the independent variables (all main and interaction effects) accounted for 58.45% of the variance in reading comprehension which was significantly different than zero, $F(5, 158) = 44.46, p < .001$. The control variables were both positive and significantly related to reading comprehension, $\hat{B} = 0.15, p < .001$ for academic knowledge and $\hat{B} = 0.03, p < .001$ for vocabulary knowledge. And, although neither main effect of morphological awareness or multisyllabic word reading was significant controlling for knowledge and vocabulary, the interaction between them was, $\hat{B} = -0.06, p = .001$ (Models 1 and 2, Step 4: $\Delta R^2 = 0.031$). To aid in the interpretation of the interaction, see Figure 1. The three lines represent three levels of word reading ability: poor word reading (10th percentile), average word reading (50th percentile), skilled word reading (90th percentile). These levels were chosen arbitrarily to illustrate the difference of the morphological awareness effect for different levels of word readers. There is clearly a positive relation between morphological awareness and reading comprehension for word readers at the 10th percentile (solid line; slope is significantly different from zero, $p < .001$) but no relation for word readers at the 50th percentile (dotted line; slope is not significantly different from zero, $p = .191$) or the 90th percentile (dashed line; slope is not significantly different from zero, $p = .402$). Preacher et al.'s (2006) online tools provide a way to determine the region of word reading for which the effect of morphological awareness transitions from non-significance to significance. In the present sample, the effect of morphological awareness was significant when multisyllabic word reading was less than 16.60, which includes 39% of the students in the present study.

Discussion

Though past research has suggested a clear relationship between morphological awareness and reading comprehension (Carlisle & Goodwin, in press), findings from the current analysis indicate this overall relationship is only part of the story. Results suggest there are certain circumstances under which morphological awareness is particularly important for comprehension. Although it is likely that morphological awareness contributes to reading comprehension by helping to build high quality lexical representations (Cho, Gilbert, & Goodwin, in press), results of the current study suggest when controlling for general vocabulary and academic knowledge, the association of morphological awareness and reading comprehension was moderated by multisyllabic word reading skill. Specifically, morphological awareness appeared to have a significant positive relation with reading comprehension only for relatively poor multi-syllabic word readers (controlling for knowledge and vocabulary).

While at first this finding may seem counterintuitive due to the documented relationship between morphological awareness and comprehension (i.e., stronger readers have tended to demonstrate higher levels of morphological awareness; Carlisle, 2003; Carlisle & Goodwin, in press; Kuo & Anderson, 2006), it instead deepens understanding of the circumstances

under which morphological information is significantly related to reading comprehension. Because these data are correlational, it is not possible to ascertain the exact mechanism for this differential relationship. However, one explanation can be made from the viewpoint of the lexical quality hypothesis that poor word readers may have weaker lexical representations of words, which may force them to rely on morphological information to identify words and ultimately comprehend text. To state it differently, better word readers are more likely to have encapsulated word representations in which a word's orthographic form contains the word's phonological and semantic information. This means that better word readers (who we assume have more high quality lexical representations) do not consciously rely on morphological information when building text meaning from the individual words in the text because the words themselves carry the meaning. Poorer word readers, on the other hand, are less likely to have a sufficient number of encapsulated representations. In this case, auxiliary information (e.g., information about the words' roots or affixes) may be necessary to identify words in the text. Perhaps morphological awareness acts as a tool for acquiring lexical representations akin to the way phonological awareness facilitates the acquisition of phonological representations. Both types of awareness are important early building blocks for acquiring high quality lexical representations, which in turn become the primary facilitators of fluent word reading and text comprehension.

Acknowledging the risks associated with making causal inferences based on correlational designs, the findings of the current study can tentatively be linked to instruction in one of two ways, described in further detail below. In either case, it is our theoretical perspective that the goal of remediation programs is to help readers build high enough quality lexical representations that their identification of words is automatic and not reliant on ancillary or sub-lexical information (the pattern we see in this study for better word readers who showed no association between morphological awareness and comprehension).

One way in which our findings could inform instruction is to suggest that morphological instruction deserves consideration to address the poor reading skills of advanced elementary students. Morphological instructional recommendations have been explored more thoroughly in meta-analyses, with two analyses in particular showing that morphological instruction supports literacy achievement for poor readers (Bowers, Kirby, & Deacon, 2010; Goodwin & Ahn, 2010). Taken together with the findings of the current study, it seems likely that an effective way to support comprehension for poor readers might be through explicit instruction in identifying morphological relationships between words and using information contained within common affixes and root words to support word identification and therefore reading comprehension. The exact nature of such instruction is unclear, although we recommend that morphological training take place in the context of graphemic forms of the words, roots, and affixes being taught so that the quality of the lexical representations of these units of meaning would be enhanced.

This recommendation to potentially add morphology instruction to the remedial instruction program for poor readers is in no way intended to diminish the importance of other remedial instruction approaches such as comprehension strategies or phonics, fluency, and vocabulary training. This leads to a second, alternative instructional recommendation. It could very well be the case that instruction that does not include morphological training but builds up the orthographic, phonological, and semantic information of words by other means may be beneficial for helping children build high quality lexical representations such that reliance on morphological awareness is no longer necessary to comprehend text; thus, mimicking what we see for adequate word readers. Experimental training studies contrasting these two types of instruction are needed to reveal a clearer recommendation.

Limitations of the Present Study

One limitation of the present study is that we did not administer a standardized, norm-referenced measure of multisyllabic word reading. Norm-referenced standard scores and percentile ranks would provide a broader context with which to understand the portion of the word reading distribution for which morphological awareness is related to reading comprehension. However, we have reason to believe that the results we found using the experimenter-created word list would be similar to what might have been found using a standardized measure. In grade 4, our participants were assessed with the Woodcock Word Identification subtest (Woodcock, 1998). The correlation between the raw score of the test of multisyllabic word reading administered in grade 5 and the standard score of the grade 4 Word Identification subtest was .86. Though the correlation is less than perfect, we can extrapolate the Word Identification standard score that corresponds to a raw score of 16 on the grade 5 experimental word list (16 was the cut-off for detecting a significant relation between morphological awareness and comprehension). After regressing Word Identification onto multisyllabic word reading, we determined that the predicted Word Identification score of individuals who scored 16 on the grade 5 multisyllabic word list was 92.42. This further corroborates the conclusion that morphological awareness affects reading comprehension only for *poor* word readers.

Another limitation of the study is that our analysis is based on global measures of morphological awareness and comprehension. Thus, we have made the assumption that morphological awareness is influencing comprehension at the level of individual words. Future work in this area might be directed toward item- or passage-level analyses to (dis)confirm this notion. In a more fine-grained analysis, variance in the comprehension of a passage is potentially explained by word identification and morphological awareness of the words in that actual passage rather than words that are unrelated to the outcome of interest. Some work of this nature has already begun (Goodwin, Gilbert, & Cho, 2013).

Conclusions

A major goal of the current study was to explore the role of multisyllabic word reading in the morphological awareness-comprehension relationship. To focus on word reading as a moderator, we controlled for other reading related skills like vocabulary and general knowledge that are correlated with morphological awareness and word reading. We then extended prior work on the lexical quality hypothesis to include morphological awareness, finding that indeed good and poor readers may approach word identification differently when attempting to comprehend text. Poor readers with more low quality lexical representations may require various sources of information including orthographic, phonological, grammatical, and semantic information to identify that word. Our findings suggest that morphological information is one of these sources: Poor readers identify unknown words as they comprehend texts in part by using their knowledge of morphological structures. In contrast, good readers seem to have enough information encapsulated in the orthographic representation to identify the multisyllabic words, resulting in no relationship between individual differences in morphological awareness and reading comprehension at this higher end of word reading ability.

In order to improve both the word reading skills and text comprehension ability of adolescent students, increasing the quantity of high quality lexical representations is paramount. One potential way to accomplish this may be to add a morphological awareness component to remedial reading instruction so that students have the opportunity and are encouraged to use morphological information to build high quality lexical representations that will eventually serve as the efficient mechanism by which meanings are assigned to words, which become the building blocks for comprehending entire texts. Of course,

training studies are required to determine the exact nature of instruction that best helps individuals build high quality lexical representations.

Acknowledgments

This research was supported in part by Grants R324G060036 and R305A100034 from the Institute of Education Sciences (IES) in the U. S. Department of Education, and by Core Grant HD15052 and Grant 5R01HD067254-04 from the Eunice Kennedy Shriver National Institute of Child Health & Human Development (NICHD), all to Vanderbilt University. The content is solely the responsibility of the authors and does not necessarily represent the official view of IES or NICHD.

References

- Bar-Ilan L, A Berman, R. Developing register differentiation: The Latinate-Germanic divide in English. *Linguistics*. 2007; 45(1):1–35. Retrieved from <https://login.proxy.library.vanderbilt.edu/login?url=http://search.proquest.com/docview/85646462?accountid=14816>.
- Berninger, V.; Nagy, W. Unpublished experimental test battery. Seattle, WA: 1999. University of Washington Morphological Awareness Battery
- Berthiaume, R.; Daigle, D. Issues in word morphology processing: Resetting the picture for future research; Paper presented at the 2012 Annual Society for Scientific Study of Reading Conference; Montreal, Canada. 2012, July; 7/11-14/2012
- Bowers PN, Kirby JR, Deacon SH. The effects of morphological instruction on literacy skills: A systematic review of the literature. *Review of Educational Research*. 2010; 80:144–179. doi: 10.3102/0034654309359353.
- Carlisle, JF. Morphological awareness and early reading achievement. In: Feldman, LB., editor. *Morphological aspects of language processing*. Erlbaum; Hillsdale, NJ: 1995. p. 189-209.
- Carlisle, J. F. Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading and Writing*. 2000; 12(3):169–190. doi: 10.1023/A:1008131926604.
- Carlisle JF. Morphology matters in learning to read: A commentary. *Reading Psychology*. 2003; 24:291–322. doi: 10.1080/02702710390227369.
- Carlisle JA. Effects of instruction in morphological awareness of literacy achievement: An integrative review. *Reading Research Quarterly*. 2010; 45:464–487. Retrieved from <http://dx.doi.org/10.1598/RRQ.45.4.5>.
- Carlisle JF, Fleming J. Lexical processing of morphologically complex words in the elementary years. *Scientific Studies of Reading*. 2003; 7(3):239–253. Retrieved from <http://search.proquest.com/docview/85578968?accountid=14816>.
- Carlisle J, P Goodwin, A. Morphemes Matter: How Morphological Knowledge Contributes to Reading and Writing. Chapter in press for the second edition of the *Handbook on Language and Literacy: Development and Disorders*. in press. Guilford Press.
- F, Carlisle, J.; A, Katz, L. Effects of word and morpheme familiarity on reading of derived words. *Reading and Writing*. 2006; 19(7):669–693. doi: 10.1007/s11145-005-5766-2.
- Carlisle JF, Stone CA. Exploring the role of morphemes in word reading. *Reading Research Quarterly*. 2005; 40(4):428–449. Retrieved from <http://search.proquest.com/docview/212124182?accountid=14816>.
- Carlisle JF, Stone CA, Katz LA. The effects of phonological transparency on reading derived words. *Annals of Dyslexia*. 2001; 51:249–274. Retrieved from <http://search.proquest.com/docview/85622108?accountid=14816>.
- Casalis S, Colé P, Sopo D. Morphological awareness in developmental dyslexia. *Annals of Dyslexia*. 2004; 54(1):114–38. Retrieved from <http://search.proquest.com/docview/225374147?accountid=14816>. [PubMed: 15765006]
- Casalis S, & Louis-Alexandre M. Morphological analysis, phonological analysis and learning to read French: A longitudinal study. *Reading and Writing: An Interdisciplinary Journal*. 2000; 12(3-4): 303–335. Retrieved from <http://search.proquest.com/docview/62437099?accountid=14816>.
- Chall, JS. *Stages of reading development*. McGraw-Hill; New York: 1983.

- Cho SJ, Gilbert JK, Goodwin AP. Explanatory multidimensional multilevel random item response model: An application to simultaneous investigation of word and person contributions to multidimensional lexical quality. *Psychometrika*. in press. Advance online publication. doi: 10.1007/s11336-013-9333-5.
- Cohen, J.; Cohen, P.; West, PG.; Aiken, LS. *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*. 3rd ed.. Erlbaum; Mahwah, NJ: 2003.
- Deacon SH, Kirby JR. Morphological awareness: Just “more phonological”? The roles of morphological and phonological awareness in reading development. *Applied Psycholinguistics*. 2004; 25(2):223. Retrieved from <http://search.proquest.com/docview/200951172?accountid=14816>.
- Derwing B. Morpheme recognition and the learning of rules for derivational morphology. *The Canadian Journal of Linguistics*. 1976; 21:38–66. Retrieved from <http://search.proquest.com.proxy.library.vanderbilt.edu/docview/85440444?accountid=14816>.
- Dunn, LM.; Dunn, DM. *Peabody Picture Vocabulary Test-4*. Pearson; San Antonio, TX: 2007.
- Elbro C, Arnbak E. The role of morpheme recognition and morphological awareness in dyslexia. *Annals of Dyslexia*. 1996; 46:209–240. doi: 10.1007/BF02648177. [PubMed: 24234273]
- Goodwin AP. Does meaning matter for reading achievement? Untangling the role of phonological recoding and morphological awareness in predicting reading and vocabulary achievement for Spanish-speaking English language learners. 60th Yearbook of the Literacy Research Association. 2011:77–94.
- 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. doi: 10.1007/s11881-010-0041-x. [PubMed: 20799003]
- Goodwin AP, Gilbert JK, Cho SJ. Morphological contributions to adolescent word reading: An item response approach. *Reading Research Quarterly*. 2013; 48(1):39–60. doi: 10.1002/rrq.037.
- Gough PB, Tunmer WE. Decoding, reading, and reading disability. *RASE: Remedial & Special Education*. 1986; 7(1):6–10. doi: 10.1177/074193258600700104.
- Hiebert EH, Martin LA, Menon S. Are there alternatives in reading textbooks? An examination of three reading programs. *Reading & Writing Quarterly*. 2005; 21:7–32. Retrieved from <http://search.proquest.com.proxy.library.vanderbilt.edu/docview/85638575?accountid=14816>.
- Hoover WA, Gough PB. The simple view of reading. *Reading and Writing: An Interdisciplinary Journal*. 1990; 2(2):127–160. Retrieved from <http://search.proquest.com/docview/62767450?accountid=14816>.
- Johnson PO, Neyman J. Tests of certain linear hypotheses and their applications to some educational problems. *Statistical Research Memoirs*. 1936; 1:57–93. Retrieved from <https://login.proxy.library.vanderbilt.edu/login?url=http://search.proquest.com/docview/615048518?accountid=14816>.
- Kieffer MJ, Biancarosa G, Mancilla-Martinez J. Roles of morphological awareness in English reading comprehension for Spanish-speaking language minority learners: Exploring partial mediation by vocabulary and reading fluency. *Applied Psycholinguistics*. in press. Advanced online publication. DOI:10.1017/S0142716411000920.
- Kieffer MJ, Lesaux NK. The role of derivational morphology in the reading comprehension of Spanish-speaking English language learners. *Reading and Writing*. 2008; 21(8):783–804. doi: 10.1007/s11145-007-9092-8.
- Kieffer MJ, Lesaux NK. Direct and indirect roles of morphological awareness in the English reading comprehension of native Spanish, Filipino, Vietnamese, and English speakers. *Language Learning*. 2012; 62:1170–1204.
- Kirby JR, Deacon SH, Bowers PN, Izenberg L, Wade-Woolley L, Parrila R. Children’s morphological awareness and reading ability. *Reading and Writing*. 2012; 25(2):389–410. doi: 10.1007/s11145-010-9276-5.
- Kuo LJ, Anderson RC. Morphological awareness and learning to read: A cross-language perspective. *Educational Psychologist*. 2006; 41:161–180.

- Lesaux NK, Kieffer MJ. Exploring sources of reading comprehension difficulties among language minority learners and their classmates in early adolescence. *American Educational Research Journal*. 2010; 47:596–632. doi: <http://dx.doi.org/10.3102/0002831209355469>.
- Leslie, L.; Caldwell, J. *Qualitative reading inventory-3 (QRI-3)*. Longman; New York: 2001.
- McCutchen D, Green L, Abbott RD. Children's morphological knowledge: Links to literacy. *Reading Psychology*. 2008; 29:289–314. Retrieved from <http://search.proquest.com.proxy.library.vanderbilt.edu/docview/61997454?accountid=14816>.
- Nagy WE, Anderson RC. How many words are there in printed school english? *Reading Research Quarterly*. 1984; 19(3):304–330. Retrieved from <http://search.proquest.com/docview/63450364?accountid=14816>.
- 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. doi: 10.1037/0022-0663.98.1.134.
- Nagy W, Berninger V, Abbott R, Vaughan K, Vermeulen K. 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*. 2003; 95(4):730–742. Retrieved from <http://search.proquest.com/docview/85587508?accountid=14816>.
- Nation K, Clarke P, Marshall CM, Durand M. Hidden language impairments in children: Parallels between poor reading comprehension and specific language impairment. *Journal of Speech, Language, and Hearing Research*. 2004; 47:199–211. Retrieved from <http://search.proquest.com.proxy.library.vanderbilt.edu/docview/85629513?accountid=14816>.
- O'Reilly T, McNamara DS. The impact of science knowledge, reading skill, and reading strategy knowledge on more traditional "high-stakes" measures of high school students' science achievement. *American Educational Research Journal*. 2007; 44:161–196. doi: 10.3102/0002831206298171.
- Perfetti, CA. The representation problem in reading acquisition. In: Gough, PB.; Ehri, L.; Treiman, R., editors. *Reading Acquisition*. Erlbaum; Hillsdale, NJ: 1992. p. 145-74.
- Perfetti CA. Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading*. 2007; 11:357–383. doi: 10.1080/10888430701530730.
- Perfetti, CA.; Hart, L. The lexical quality hypothesis. In: Verhoeven, L.; Elbro, C.; Reitsma, P., editors. *Precursors of Functional Literacy*. John Benjamins; Amsterdam, The Netherlands: 2002. p. 189-213.
- Preacher KJ, Curran PJ, Bauer DJ. Computational tools for probing interaction effects in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics*. 2006; 31:437–448. Retrieved from <https://login.proxy.library.vanderbilt.edu/login?url=http://search.proquest.com/docview/62014911?accountid=14816>.
- Ramirez G, Chen X, Geva E, Kiefer H. Morphological awareness in spanish-speaking english language learners: Within and cross-language effects on word reading. *Reading and Writing*. 2010; 23:337–358. doi: <http://dx.doi.org/10.1007/s11145-009-9203-9>.
- Schreuder, R.; Baayen, RH. Modeling morphological processing. In: Feldman, LB., editor. *Morphological aspects of language processing*. Erlbaum; Hillsdale, NJ: 1995. p. 131-154.
- Shadish, WR.; Cook, TD.; Campbell, DT. *Experimental and quasi-experimental designs for generalized causal inference*. Houghton Mifflin; Boston, MA: 2002.
- Shankweiler D, Crain S, Katz L, Fowler AE. Cognitive profiles of reading-disabled children: Comparison of language skills in phonology, morphology, and syntax. *Psychological Science*. 1995; 6(3):149–156. doi: 10.1111/j.1467-9280.1995.tb00324.x.
- Siegel LS. Morphological awareness skills of English language learners and children with dyslexia. *Topics in Language Disorders*. 2008; 28(1):15–27. Retrieved from <http://search.proquest.com/docview/85674449?accountid=14816>.
- Silverman RD, Speece DL, Harring JR, Richey KD. Fluency has a role in the simple view of reading. *Scientific Studies of Reading*. 2013; 17:108–133.
- Stanovich KE. Concepts in developmental theories of reading skill: Cognitive resources, automaticity, and modularity. *Developmental Review*. 1990; 10(1):72–100. doi: 10.1016/0273-2297(90)90005.

- Taft M. The body of the BOSS: Subsyllabic units in the lexical processing of polysyllabic words. *Journal of Experimental Psychology: Human Perception and Performance*. 1992; 18:1004–1014. doi: <http://dx.doi.org/10.1037/0096-1523.18.4.1004>.
- Windsor J. The role of phonological opacity in reading achievement. *Journal of Speech, Language, and Hearing Research*. 2000; 43(1):50–61. Retrieved from <http://search.proquest.com/docview/85533472?accountid=14816>.
- Woodcock, RW. Woodcock Reading Mastery Test -Revised/Normative Update. AGS; Circle Pines, MN: 1998.
- Woodcock, RW.; McGrew, KS.; Mather, N. Woodcock-Johnson III. Riverside; Itasca, IL: 2001.

Figure 1.

Table 1
Descriptive Statistics for Final Sample

Variable	Final Sample (<i>n</i> = 164)	
	<i>f</i>	%
Female	88	53.66
Free/reduced lunch status	92 ^a	69.17
Minority Status	107	65.24
	<i>M</i>	<i>SD</i>
General Knowledge (standard score)	90.22	13.80
Morphological Awareness Composite (z-score based)	0.00	0.74
Multisyllabic word reading (number correct out of 30)	17.65	8.16
Reading Comprehension (number correct out of 12)	7.51	2.17
Vocabulary Knowledge (standard score)	92.99	15.41

^a
n = 133.

Table 2
Correlations among Variables for Final Sample ($n = 164$)

Measure	1	2	3	4	5
1. Morphological Awareness	—				
2. General Knowledge	.62	—			
3. Reading Comprehension	.56	.71	—		
4. Vocabulary Knowledge	.58	.79	.68	—	
5. Multisyllabic Word Reading	.66	.49	.43	.41	—

Note. All correlations are significant at the α level of .001.

Table 3
Hierarchical Regression Model Results with Reading Comprehension as the Outcome (n = 164)

Model	Variable	Step 1 $\hat{B}$	Step 2 $\hat{B}$	Step 3 $\hat{B}$	Step 4 $\hat{B}$
1					
	Intercept	7.51***	7.51***	7.51***	7.75***
	Knowledge	0.20***	0.17***	0.16***	0.15***
	Vocabulary	0.03***	0.03**	0.03**	0.03***
	Morph. awareness		0.48*	0.42	0.39
	Multisyllabic WR			0.01	-0.00
	Morph. Awareness				
	X Multisyllabic WR				-0.06**
	Total R ²	0.537	0.553	.554	0.585
	ΔR^2	0.537***	0.016*	0.001	0.031**
2					
	Intercept	7.51***	7.51***	7.51***	7.75***
	Knowledge	0.20***	0.18***	0.16***	0.15***
	Vocabulary	0.03***	0.03***	0.03**	0.03***
	Multisyllabic WR		0.03	0.01	-0.00
	Morph. awareness			0.42	0.39
	Morph. awareness X				
	Multisyllabic WR				-0.06**
	Total R ²	0.537	0.545	0.554	0.585
	ΔR^2	0.537***	0.008	0.009	0.031**

Note. $\hat{B}$ = estimated unstandardized regression coefficient.

 $p < .001$

**
 $p < .01$

*
 $p < .05$