Applied Psycholinguistics **34** (2013), 697–725
doi:10.1017/S0142716411000920

Roles of morphological awareness in the reading comprehension of Spanish-speaking language minority learners: Exploring partial mediation by vocabulary and reading fluency

MICHAEL J. KIEFFER
Teachers College, Columbia University

GINA BIANCAROSA
University of Oregon

JEANNETTE MANCILLA-MARTINEZ
University of Illinois, Chicago

Received: September 11, 2010 Accepted for publication: April 2, 2011

ADDRESS FOR CORRESPONDENCE
Michael J. Kieffer, Teachers College, Columbia University, 525 West 120th Street, Box 66, New York, NY 10027. E-mail: mk3157@columbia.edu

ABSTRACT
This study investigated the direct and indirect roles of morphological awareness reading comprehension for Spanish-speaking language minority learners reading in English. Multivariate path analysis was used to investigate the unique contribution of derivational morphological awareness to reading comprehension as well as its indirect contributions via three hypothesized mediators for students in sixth, seventh, and eighth grade ($N = 101$). Results indicated a significant unique contribution of morphological awareness, controlling for phonemic decoding, listening comprehension, reading vocabulary, word reading fluency, and passage reading fluency. Results further indicated significant indirect contributions of morphological awareness via reading vocabulary and passage fluency, but not via word reading fluency. Findings suggest that morphological awareness may play multiple important roles in second-language reading comprehension.

Reading comprehension is a complex process that draws on a wide array of linguistic skills and knowledge (RAND Reading Study Group, 2002). Beyond the well-acknowledged roles of vocabulary knowledge and phonologically based decoding skills, recent research suggests that reading comprehension is also predicted by morphological awareness, that is, students' ability to reflect on and

manipulate the smaller meaningful units that form words (e.g., Carlisle, 2000; Deacon & Kirby, 2004; Nagy, Berninger, & Abbott, 2006). Findings from a handful of studies suggest a similar relationship between morphological awareness and reading for students from homes in which a language other than the societal language is spoken, a population known as language minority (LM) learners (Kieffer & Lesaux, 2008; Ramirez, Chen, Geva, & Kiefer, 2010). However, it is less clear what mechanisms underlie the observed relationship between morphological awareness and reading comprehension for this population.

Morphological awareness (MA) may contribute to reading comprehension via several possible routes (Kuo & Anderson, 2006). One possibility is that MA could facilitate the development of a broad vocabulary, which in turn promotes successful reading comprehension. In place of or in addition to this mechanism, MA could facilitate accurate, rapid reading of words and/or of connected text, thus freeing attentional resources for comprehension. Furthermore, MA could make a direct contribution to the reading comprehension process that is independent of these indirect mechanisms, by facilitating students' extraction of semantic and syntactic information from morphologically complex words during reading. Although researchers have acknowledged the possibility that MA may play multiple roles in reading comprehension, few studies have explicitly investigated the partially mediated, multivariate relationships by which direct and indirect contributions would occur.

The current study was designed to investigate the direct and mediated roles of English derivational MA in English reading comprehension for Spanish-speaking LM learners in sixth, seventh, and eighth grade. Using multivariate path analysis, we examined the unique contribution of MA to reading comprehension, controlling for key confounding language and reading skills, as well as the indirect contributions of MA via three potential mediators: reading vocabulary, sight word reading fluency, and passage reading fluency. By focusing on a population that is at elevated risk for reading comprehension difficulties (August & Shanahan, 2006), we aimed to clarify the linguistic sources of these difficulties. By examining these relationships in the middle school years, we seek to shed light on a developmental period during which the linguistic demands of reading comprehension are particularly pronounced (e.g., Carnegie Council on Adolescent Literacy, 2010; Fang & Schleppegrell, 2006), while building on and extending prior research that has concentrated largely on the elementary grades.

MORPHOLOGY AND READING IN NATIVE ENGLISH SPEAKERS AND LM LEARNERS

A large number of English words are constituted from two or more smaller meaningful units or morphemes, such as prefixes, suffixes, and roots (Anglin, 1993; Goulden, Nation, & Read, 1990; Nagy & Anderson, 1984). These morphologically complex words appear frequently in written text, more often than in spoken language (Chafe & Danielewicz, 1987), so it is not surprising that MA is implicated in reading. A review of research conducted with monolingual speakers of several languages concluded that MA contributes to reading comprehension, and that this contribution increases across the elementary school years (Kuo & Anderson,

2006). For monolingual English readers, this conclusion is supported by several studies that have found significant relationships between MA and reading comprehension, after controlling for students' phonological abilities and/or vocabulary (e.g., Carlisle, 1995; Carlisle, 2000; Deacon & Kirby, 2004; Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003; Nagy et al., 2006).

Among various aspects of MA, the ability to manipulate derivational affixes (i.e., affixes that change a word's part of speech or meaning, such as *-tion*, *-able*, and *re-*) may be particularly important to reading comprehension in middle school. Although the ability to manipulate inflectional suffixes (e.g., *-ing, -ed, -s)* is generally mastered in the primary grades, derivational MA continues to develop through the upper elementary grades and beyond (e.g., Mahony, 1994; Nagy, Diakidoy, & Anderson, 1993). In a foundational study in this area, Carlisle (2000) found that derivational MA significantly predicted reading comprehension in fifth grade after controlling for vocabulary and word reading. Similarly, Nagy and colleagues (2006) found that a composite MA measure that relied heavily on derivational skills made a significant unique contribution to reading comprehension in Grades 4 through 9, after controlling for phonological decoding, phonological memory, and vocabulary.

A growing number of studies suggest similar relationships between MA and reading for second-language learners, including elective bilingual populations (Deacon, Wade-Wooley, & Kirby, 2007; Saiegh-Hadadd & Geva, 2008; Schiff & Calif, 2007; Zhang et al., 2010) and LM learners (Kieffer & Lesaux, 2008; Ramirez et al., 2010; Wang, Cheng, & Chen, 2006; Wang, Yang, & Cheng, 2009). Although most of these studies have concentrated on awareness of inflections or compounds (e.g., *mailman*) in young children, a few have investigated derivational MA in older readers. Kieffer and Lesaux (2008) found that awareness of English derivational morphology predicted English reading comprehension for fifth-grade Spanish-speaking LM learners, after controlling for word reading fluency, oral vocabulary, and phonological skills. Similarly, Ramirez and colleagues (2010) found that, for Spanish-speaking LM learners in Grades 4 and 7, English derivational MA predicted English word reading, after controlling for phonological awareness, vocabulary knowledge, memory, and nonverbal ability. Although such evidence suggests that MA plays one or more roles in the process of reading comprehension, the extent of their direct and indirect contributions remains unclear.

INDIRECT CONTRIBUTIONS OF MA TO READING COMPREHENSION

MA may indirectly contribute to reading comprehension by at least three possible routes. First, MA may broaden students' reading vocabularies, which in turn facilitates subsequent reading comprehension. Developed MA may accelerate the acquisition of a broad vocabulary because the meaning of most morphologically complex words in English can be inferred based on the meanings of their parts (Nagy & Anderson, 1984). Studies conducted with native English speakers have supported this notion by demonstrating that MA predicts vocabulary size (Anglin, 1993; Carlisle, 2000; McBride-Chang, Wagner, Muse, Chow, & Shu, 2005; Nagy et al., 2006), a relationship that is likely to be reciprocal (Kieffer & Lesaux, in press-a; McBride-Chang et al., 2008). For instance, in a comparison of native

English speakers in first, third, and fifth grade, Anglin (1993) found that a large majority of the words known by fifth graders, but not third graders, were derived words. Support for a similar relationship for LM learners comes from Kieffer & Lesaux (in press-a), who followed a cohort of Spanish-speaking LM learners from Grades 4 through 7 and found that growth in English MA was closely related to growth in English vocabulary knowledge.

Given the well-established relationship between vocabulary and reading comprehension (Anderson & Freebody, 1981; RAND Reading Study Group, 2002), this broadening of vocabulary associated with developed MA should, in turn, yield improved reading comprehension. One study investigated this hypothesis using structural equation modeling in a sample of native English speakers in Grades 4 through 9 (Nagy et al., 2006). They found that much, although not all, of the contribution of MA to reading comprehension was indirect via its effect on reading vocabulary. By explicitly testing direct and indirect pathways, Nagy et al. (2006) provided a valuable approach for understanding the mechanisms underlying the correlations among these skills, but left open the question of whether their findings generalize to LM learners. Because many LM learners' reading comprehension is constrained by limited English vocabulary knowledge (e.g., August, Carlo, Dressler, & Snow, 2005; Carlo et al., 2004; Lesaux & Kieffer, 2010; Umbel, Pearson, Fernandez, & Oller, 1992), this mechanism may be particularly important for this population.

A second possibility is that MA facilitates efficient word reading, which in turn allows for successful reading comprehension. Written English is morphophonemic in that many words retain morphological information in their spelling even when such information conflicts with their phonetic pronunciations. For instance, a more transparently alphabetic spelling of *helped, turned,* and *landed* would indicate that these three words end in different sounds (perhaps with the spellings *helpt* and *turnd*); instead, the *ed* spelling pattern that is retained across these three words helps indicate to readers that the three sound patterns all represent the past tense marker. Similarly, for more phonologically transparent spellings, the letter pattern used to represent the second vowel in *method* and *methodical* would have to be different, as would those for the third vowel in *similar* and *similarity*. This consistency in the spelling of morphemes, despite shifts in pronunciation, yields words that are less phonetically decodable, but that carry more information about their semantic relationships to other words. As a result, MA may facilitate the automatic recognition of such words.

This possibility is supported by the robust relationship between MA and word reading abilities found in several studies of native English speakers (Berninger, Abbott, Billingsley, & Nagy, 2001; Carlisle, 2000; Carlisle & Stone, 2005; Deacon & Kirby, 2004; Mahony, Singson, & Mann, 2000; Nagy et al., 2006). In addition to these studies that have investigated interindividual differences in word reading ability and explicit awareness of morphology, experimental studies utilizing priming and frequency effects have demonstrated that rapid word reading in English is facilitated by the implicit processing of morphological information (e.g., Deacon, Campbell, Tamminga, & Kirby, 2010; Deacon, Parrila, & Kirby, 2006; Nagy, Anderson, Schommer, Scott, & Stallman, 1989). Given that skilled word reading is a prerequisite for reading comprehension (Gough & Tunmer, 1986; Perfetti,

1988), it seems reasonable that these gains from morphologically based word reading would translate into improved reading comprehension. However, empirical data on this question remain limited, in large part because most studies in this area view word reading and reading comprehension as two independent outcomes to be predicted separately by MA. Thus, few, if any, studies have tested explicitly whether word reading skill mediates MA's influence on reading comprehension. A few studies conducted with LM learners (Ramirez et al., 2010) and elective bilinguals (e.g., Deacon et al., 2007; Saiegh-Haddad & Geva, 2008) demonstrate a relationship between MA and word reading, but it is unclear whether this pathway ultimately explains the reading comprehension difficulties common among LM learners.

A third, related possibility is that MA facilitates efficient reading of connected text that in turn allows for successful text comprehension. If MA facilitates accurate and rapid reading of individual words as described above, then these effects may accumulate as students read connected texts, yielding meaningful gains in fluency at the passage level. In addition, because MA provides readers with greater insight into the syntactic structure of clauses and sentences, it may facilitate more rapid and efficient reading of not only words but also larger units of text. Such facilitation of automatic reading would thereby free attentional resources for processing the text base and making the inferences across propositions required to construct a situation model (Kintsch, 1998, 2004; Kintsch & van Dijk, 1978; Reynolds, 2000).

Substantial research demonstrates the extent to which passage reading fluency is a robust predictor of, or proxy for, text comprehension (for reviews, see Fuchs, Fuchs, Hosp, & Jenkins, 2001; Kuhn & Stahl, 2003), and a growing number of studies have investigated the range of linguistic abilities that compose and predict fluent reading (e.g., Barth, Catts, & Anthony, 2009; Berninger et al., 2010; Katzir et al., 2006; Klauda & Guthrie, 2008; Levasseur, Macaruso, Palumbo, & Shankweiler, 2006; Mokhtari & Thompson, 2006; Wood, 2009). Despite theoretical reasons for suspecting that MA may contribute to reading comprehension by accelerating reading of connected text, very few studies have investigated the relationship between MA and passage reading fluency in either native English or LM populations. One of the only studies we could locate that investigated this relationship in any language found that native Hebrew speakers in fifth grade demonstrated a significant relationship between their performance on an inflectional morphological task and passage reading fluency, controlling for phonological awareness and memory (Cohen-Mimran, 2009). The lack of research on this question may be because MA is traditionally thought of as a word-level skill, which would be unlikely to play a role in reading that extends beyond word-level processes. In light of evidence that MA continues to predict text comprehension after controlling for word-level reading skills, there is a need to investigate the extent to which this relationship is explained by the facilitation of text-level reading fluency by MA.

Each of these three hypothesized routes for the indirect contributions of MA have some "piece-meal" empirical support from studies showing that MA predicts intermediate reading skills, combined with separate studies demonstrating the intermediate skills' importance to reading comprehension. However, a complete model of mediated pathways has not been examined to our knowledge. The current study uses path analysis to test whether these three hypothesized mediated

pathways yield significant contributions to reading comprehension in the growing population of LM learners.

DIRECT CONTRIBUTIONS OF MA TO READING COMPREHENSION

Although indirect routes likely explain much of the correlation between MA and reading comprehension, MA may make a unique contribution to reading comprehension above and beyond these mediated relationships. Nagy (2007) has argued that MA, as a facet of general metalinguistic ability, plays a role in constructing sentence-level meaning during the reading comprehension process that is independent of any role it may also play in vocabulary acquisition. In particular, derivational MA may help students decipher the meaning of novel words during a reading event, in what Nagy calls "on-the-spot vocabulary learning" (p. 64). For instance, readers with well-developed MA who first encounter words such as *similarity, methodological,* or *characterization* in text may be better able to extract the meaning of these words by recognizing their relationship with the meanings of more common morphologically similar words like *similar*, *method*, and *character*. This process may be valuable to real-time comprehension regardless of whether it facilitates any long-term broadening of vocabulary.

In addition, MA may enable readers to use syntactic clues that are encoded in suffixes to comprehend complex sentence structures (Nagy, 2007). Readers who recognize the syntactic differences between *character, characterization, characterize,* and *characterized* may be better equipped to extract meaning from written texts; for instance, they may understand more readily that a *character* is a person, a *characterization* is a constructed abstraction, to *characterize* is an action that a named agent takes, and *to be characterized* in some way is describing that which is characterized by an unnamed agent. Such insights may be particularly important for proposition-level comprehension (Kintsch, 1998; Kintsch & van Dijk, 1978) and thus may be valuable in comprehension processing, independent of any use of syntactic information to facilitate rapid reading. This role of MA may be increasingly important as students move through the middle grades and encounter academic texts with increasingly sophisticated syntax (e.g., increased use of passive voice as in *to be characterized* and nominalized agents as in *characterization*; Fang & Schleppegrell, 2006). Given evidence that bilingual readers with higher levels of metalinguistic ability are more successful with second-language reading comprehension (e.g., Jiménez, García, & Pearson, 1996; Nagy, García, Durgunoğlu, & Hancin-Bhatt, 1993), there is reason to believe that Nagy's *metalinguistic hypothesis* may be particularly relevant for understanding the English reading comprehension performance of LM learners.

Researchers studying this topic have typically sought to isolate the unique contribution of MA by controlling for known reading-related skills in multiple regression models. In light of the theoretical and empirical evidence for viewing MA as related to other aspects of oral language development (Kuo & Anderson, 2006), such an approach is reasonable. In particular, MA's contributions need to be isolated from the confounding contributions of phonologically based decoding skills, given the powerful role of the latter in reading development (e.g., Deacon & Kirby, 2004; Nagy et al., 2006). However, researchers have also often controlled for

intermediate reading skills, such as reading vocabulary and reading fluency, which may be better characterized as proximal outcomes for MA that partially mediate its contribution to the distal outcome of reading comprehension. By including main effects of vocabulary and fluency as controls in multiple regression models, researchers inadvertently partial out indirect effects of MA that occur via these intermediate skills, and thus may underestimate MA's importance. In the current study, we employ an alternate approach, multivariate path analysis, to model partially mediating relationships explicitly and account for the possibility that MA makes indirect contributions to reading comprehension via reading vocabulary and reading fluency.

CURRENT STUDY

The current study was designed to investigate the direct and indirect contributions of English derivational MA to English reading comprehension in Spanish-speaking LM learners in sixth, seventh, and eighth grade. Consistent with prior research, we first evaluated the unique contributions of MA to reading comprehension, after controlling for the known relationships with other reading skills and reading-related language skills. Next, we extended prior approaches by using multivariate path analysis to evaluate the simultaneous indirect contributions of MA to reading comprehension via reading vocabulary, sight word reading fluency, and passage reading fluency, as well as its direct contribution controlling for these indirect effects. This study was guided by the following research questions:

1. Does MA make a unique contribution to reading comprehension, controlling for phonemic decoding, sight word reading, passage reading fluency, reading vocabulary, and listening comprehension, among Spanish-speaking LM learners in sixth, seventh, and eighth grade?
2. Does MA make indirect contributions to reading comprehension via reading vocabulary, sight word reading fluency, and/or passage fluency, controlling for listening comprehension, and phonemic decoding, among Spanish-speaking LM learners in sixth, seventh, and eighth grade? Does the direct contribution of MA to reading comprehension remain after accounting for these indirect contributions?

METHOD

Sample

Participating students were recruited from English-language arts classes in an urban kindergarten to Grade 8 school in Massachusetts. The school was one of several Strategic Education Research Partnership (SERP) sites participating in a study of early adolescent students' strengths and weaknesses in literacy. SERP develops long-term partnerships between researchers and districts, with the overarching goals of solving urgent problems of practice while at the same time contributing to useable research knowledge. At the time of data collection, the school was participating solely in assessment of its students and their literacy

https://doi.org/10.1017/S0142716411000920 Published online by Cambridge University Press

strengths and weaknesses, but not in any SERP instructional interventions. The school serves a student population that is 91% Latino and 79% LM, with 46% designated as limited English proficient (LEP). Ninety-one percent of the student population came from low-income backgrounds, as indicated by receiving free or reduced lunch. According to school officials, the percent of students designated as LEP was much smaller in the middle grades, and thus no self-contained or pull-out English as a second language classes were offered for LEP students in Grades 6, 7, or 8. The six participating classes thus represented the entire regular education student population at these grades. Consistent with educational policy throughout Massachusetts, reading instruction at the school was delivered only in English throughout the elementary and middle school grades.

The sample consisted of 101 students who self-reported a home language of Spanish on a researcher-administered survey. Participants included 41 students in Grade 6, 35 students in Grade 7, and 25 students in Grade 8. The sample was 55.4% female. Median ages were 11 years for sixth graders, 12 years for seventh graders, and 13 years for eighth graders. Fifty percent of students reported feeling equally comfortable speaking in Spanish and in English, 7% declined to respond to this question, and the remaining students were evenly split between those who felt more comfortable in Spanish and those who were more comfortable in English. This variation in self-reported language use is typical of populations that are considered "language minority," a term that includes English-dominant students from Spanish-speaking homes as well as their Spanish-dominant counterparts (August & Shanahan, 2006). Nonetheless, to investigate the possibility that there are actually multiple populations in the sample for whom differing relationships exist, additional subgroup analyses were conducted, separating the Spanish-dominant subgroup from those reporting equal or greater comfort in English (see below).

Measures

Reading comprehension. Students' reading comprehension was assessed using the Group Reading Assessment and Diagnostic Evaluation (GRADE; Williams, 2001), an untimed, norm-referenced multiple-choice reading test. The GRADE reading comprehension section includes sentence comprehension and passage comprehension items, which together form a reading comprehension composite score. Sentence comprehension items measure students' comprehension of a sentence as a whole thought or unit. Students silently read short sentences in which one of the words is missing and then select the appropriate word to complete the sentence from a list of four to five choices. Passage comprehension items measure students' comprehension skills with an extended grade-level passage. After silently reading a passage with one or more paragraphs, students answer three to five multiple-choice questions about the passage. Students completed Form A of the test appropriate for their grade level (i.e., Level 6 for students in Grade 6 and Level M for students in Grades 7 and 8). The publisher reports evidence of good reliability across grade levels for both the passage comprehension (Cronbach $\alpha =$ 0.86–0.92) and sentence comprehension items (Cronbach $\alpha = 0.84$–0.87) as well as evidence of concurrent validity (Williams, 2001).

MA. Students' MA was assessed using a derivational decomposition task, created based on a paradigm originally designed by Carlisle (2000), which has been used in several studies conducted with LM learners (Carlo et al., 2004; Kieffer & Lesaux, 2008; Lesaux, Kieffer, Faller, & Kelley, 2010). The version of this task used in the current study was a 30-item untimed task, in which test administrators provide students with a word with a derivational suffix (e.g., *complexity*) and ask the children to extract the base word (e.g., *complex*) to complete a sentence (e.g., *The problem is* _____). Test administrators read the word and sentence aloud, while students read along, and students responded with a written answer. The first author scored written answers to the task dichotomously using a detailed scoring guide that included a rubric along with sample correct and incorrect responses. Responses were scored as correct if they provided the correctly spelled form of the base word or a phonetically justifiable version of the base word form, such as *posess* for *possess* or *durible* for *durable*. Responses were scored as incorrect if they were morphologically unrelated words such as *have* for *possess* or *hard* for *durable*, when they were incorrectly decomposed responses such as *poss* or *dur*, or when they were ambiguous responses such as *possese* and *durabil*.[1] The estimated internal consistency reliability in the current sample was adequate (Cronbach $\alpha = 0.81$). Interrater agreement between the first author and a trained research assistant was very high, when estimated based on duplicate coding of 100 tasks from sixth-grade LM learners in a separate sample (agreement = 98%; Cohen $\kappa = 0.96$). Several prior studies attest to the validity of tasks using this paradigm for this population, including evidence of convergent and divergent validity in LM populations (Carlo et al., 2004; Kieffer & Lesaux, 2008) and evidence of construct validity based on the fitting of confirmatory factor analytic models (Kieffer & Lesaux, in press-c).

Reading vocabulary. Students' reading vocabulary was assessed using the GRADE reading vocabulary subtest, an untimed, multiple-choice measure of students' breadth of vocabulary knowledge. Students silently read a short sentence in which a target word is printed in bold type and they select an appropriate synonym for the word from a list of four to five choices. The publisher reports good reliability across grades (Cronbach $\alpha = 0.80$–0.89) as well as evidence of concurrent validity (Williams, 2001).

Sight word reading fluency. Students' fluency at reading frequent sight words was assessed individually using the sight word efficiency subtest of the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999). In this test, students read aloud a list of sight words of increasing complexity in 45 s, with their score representing the number of words read correctly. The publisher reports reliability estimates above 0.90 as well as substantial evidence of validity.

Passage reading fluency. Students' fluency with connected text was assessed individually using passages from the oral reading fluency subtest of the Dynamic Indicators of Basic Early Literacy Skills (Good & Kaminski, 2002). In this task, students read a passage aloud in 1 min, while a test administrator notes words read correctly and errors. Each student read four passages drawn from the materials

available for fifth and sixth grade (one narrative and one expository passage from each grade level). The totals for words read correctly on the four passages were averaged to form a simple composite.[2] In the current sample, this composite had very high internal consistency reliability (0.98). As evidence of concurrent validity, this measure also demonstrated strong correlations with the other reading measures and a much lower correlation with the listening comprehension measure in the current sample (see Table 1). The publishers report reliability and validity evidence for this subtest through third grade, although not for the grade levels used in the current study (Good, Wallin, Simmons, Kame'enui, & Kaminski, 2002).

Listening comprehension. Students' comprehension of oral language was assessed using the GRADE listening comprehension subtest, a multiple-choice measure of students' ability to comprehend complex statements without printed cues. Students listen to a sentence or pair of sentences that are read aloud by the test administrator, and they select one of four pictures that best matches the sentence or pair of sentences. The publisher reports internal consistency reliability estimates across grades that are moderate (0.66–0.81), although consistent with other measures of this construct.[3]

Phonemic decoding efficiency. Students' efficiency of phonemic decoding was assessed individually using the phonemic decoding efficiency subtest of the TOWRE (Torgesen et al., 1999). In this test, students read aloud a list of phonetically regular nonwords of increasing complexity in 45 s, with their score representing the number of nonwords read correctly. The publisher reports reliability estimates above 0.90 as well as substantial evidence of validity.

Data analyses

Multivariate path analysis was used to investigate multiple simultaneous relationships among the variables of interest, while estimating both direct and indirect (partially mediating) effects of MA on reading comprehension. Path analysis can be thought of as a subtype of structural equation modeling in which all constructs in the structural model are represented by variables that have a single, observed indicator (e.g., Bollen, 1989; Bozionelos, 2003). Path analysis has several advantages over the ordinary least squares (OLS) multiple regression approaches that have been used almost exclusively in prior research in this area, three of which are particularly relevant to this study. First, whereas OLS regression models only allow independent predictors for a single dependent outcome, path analysis allows researchers to specify that one or more variables are simultaneously dependent variables in one relationship and independent variables in another (i.e., that they are serving as a mediating variable to a full or partial extent). In the current study, the most linguistically basic variables (i.e., MA, listening comprehension, and phonemic decoding efficiency) were specified as independent variables, whereas intermediate reading skills hypothesized to act as mediators (i.e., reading vocabulary, sight word fluency, passage reading fluency) were specified as proximal outcomes for the independent variables as well as predictors of the distal outcome of reading comprehension. Second, unlike OLS regression, path analysis allows

Table 1. *Correlations, means, and standard deviations for language and literacy measures, estimated using full-information maximum likelihood (n = 101)*

	1	2	3	4	5	6	7
1. Reading comprehension (standard score)	—						
2. Reading vocabulary (standard score)	.64***	—					
3. Listening comprehension (stanine)	.39***	.44***	—				
4. Sight word reading efficiency (standard score)	.32***	.29**	−.02	—			
5. Phonemic decoding efficiency (standard score)	.38***	.36***	.11	.78***	—		
6. Passage reading fluency (average words correct per minute)	.47***	.42***	.09	.67***	.68***	—	
7. Morphological awareness (raw score out of 30)	.46***	.44***	−.02	.47***	.46***	.47***	—
Mean	95.53	98.34	3.71	97.70	102.39	145.09	24.57
Standard deviation	9.51	10.24	1.15	9.29	12.97	31.81	3.98

**$p < .01$. ***$p < .001$.

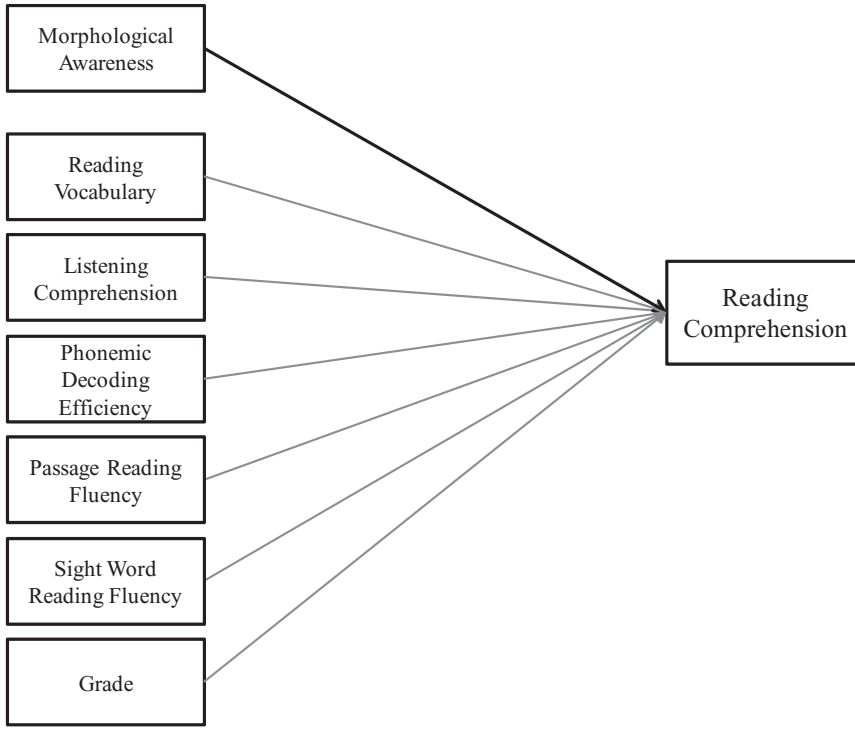

Figure 1. A path diagram representing the hypothesized path analysis model to address the first research question, with observed variables represented as rectangles, the effect of interest represented as a black arrow, and effects of controls represented as gray arrows.

researchers to estimate the magnitude and test the significance of indirect effects. Third, path analysis can utilize full-information maximum likelihood estimation to account for missing data appropriately; in the present study, this prevented the exclusion of 10 cases with missing data on one or two measures.

The first research question was addressed by fitting the hypothesized path model displayed in the path diagram in Figure 1. Variables are represented with labeled rectangles while hypothesized regression paths are represented as single-headed arrows, with the central path of interest in black and control effects in gray. The second research question was addressed by fitting the hypothesized model displayed in Figure 2. As shown, MA and the control variables of phonemic decoding efficiency and listening comprehension each predicted the mediating variables of reading vocabulary, sight word fluency, and passage reading fluency, each of which in turn predicted the distal outcome of reading comprehension. The direct effect of MA on reading comprehension is depicted as a black single-line arrow, whereas the partially mediated paths of interest are depicted as black double-line arrows. The statistical significance of each of these paths of interest was evaluated, using the corresponding z statistic (which is analogous to a

https://doi.org/10.1017/S0142716411000920 Published online by Cambridge University Press

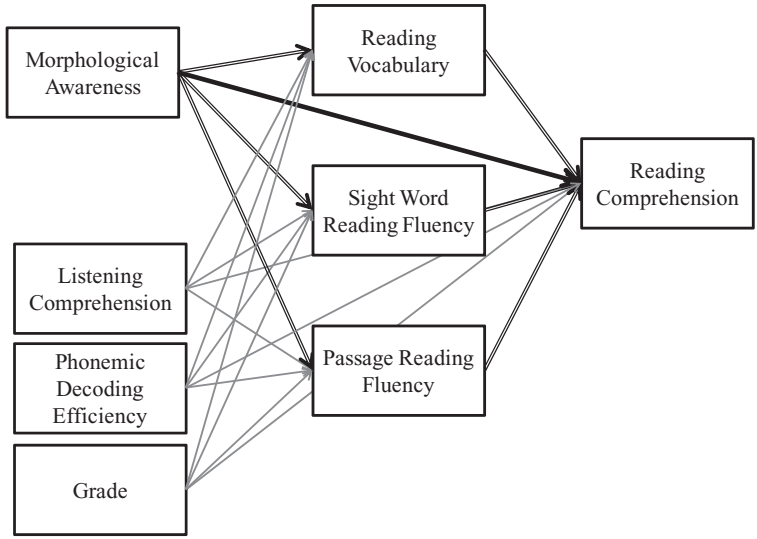

Figure 2. A path diagram representing the hypothesized path analysis model to address the second research question, with observed variables represented as rectangles, direct effect of interest represented as a black single-line arrow, moderated effects of interest represented as black double-line arrows, and effects of controls represented as gray arrows.

t statistic in OLS regression) for each direct effect and using 95% confidence intervals (CIs) based on bootstrapped standard errors for each indirect effect. To determine whether a partially mediated model was appropriate, the overall goodness of fit for the hypothesized model represented in Figure 2 was compared to that of the model represented in Figure 1 (i.e., a direct effects-only model) and to a model in which only indirect effects were included (i.e., a fully mediated model). In addition, multiple-group path analysis models, in which group was specified by students' grade level, were estimated to investigate whether the relationships of interest differed by grade level. Multiple-group models were also fitted to investigate whether students who were Spanish dominant demonstrated different relationships from those LM learners who spoke English and Spanish equally comfortably or spoke English more comfortably. Finally, to investigate whether findings were sensitive to the effects of the hierarchical nesting of students within classrooms, additional models that included fixed effects of classes were fitted.

RESULTS

Descriptive statistics

Table 1 presents descriptive statistics for the sample, including means, standard deviations, and correlations for the English language and literacy measures used. The students were performing in the average range based on national norms (i.e.,

https://doi.org/10.1017/S0142716411000920 Published online by Cambridge University Press

within five standard score points of the mean of 100) for reading comprehension, reading vocabulary, sight word fluency, and phonemic decoding efficiency, but in the low-average range for listening comprehension (i.e., 1.3 stanines or approximately two-thirds of a standard deviation below the national average of 5). Although this weakness is specific to a single measure, there is some reason to believe that it indicates a meaningful limitation in these LM learners' oral English development. A prior study we conducted (Mancilla-Martinez, Kieffer, Biancarosa, Christodoulou, & Snow, 2011) found that this measure did predict the elevation of students' growth trajectories in reading comprehension between fifth and seventh grade, correlations in the current sample support the convergent and divergent validity of this measures, and a content analysis of this measure found that it draws on semantic and syntactic knowledge that are likely to be important for reading with understanding (Mancilla-Martinez & Spencer, 2007). At the same time, it is worth noting that this may be due to the moderate reliability of the listening comprehension measures, which is consistent with other measures of this construct (see above).

The correlations indicated that MA was moderately related to reading comprehension as well as moderately related to each of the other reading measures. There was no evidence of a correlation between MA and listening comprehension. In addition, the moderate to strong correlations between reading comprehension and all of the other language and literacy measures suggest the importance of controlling for these variables to identify the unique contribution of MA.

Unique contribution of MA

To address the first research question, reading comprehension was regressed on MA as well as phonemic decoding efficiency, sight word reading, passage reading fluency, reading vocabulary, listening comprehension, and the main effects of grade level (see Figure 1). Results indicated that MA had a statistically significant relationship to reading comprehension, after controlling for the main effects of the other variables (standardized $\hat{\beta} = 0.24$; z statistic $= 3.01$; $p = .0026$), and that a model including the path between MA and reading comprehension had a much better fit than a model without this path ($\Delta\chi^2 = 56.33$). The second and third column in Table 2 display this fitted model for the direct contributions of MA and the control variables on reading comprehension. To be consistent with prior studies, the same model was fitted using OLS regression to the data from the 90% of cases with complete data, as shown in the fourth and fifth column in Table 2. Results were essentially the same, with MA making a statistically significant unique contribution to reading comprehension, after controlling for the other main effects (standardized $\hat{\beta} = 0.251$; $t = 2.92$; $p = .0046$; $\Delta R^2 = .04$). These results were robust to the inclusion of fixed effects to account for the hierarchical nesting of students within classes.

Multiple-group path analyses indicated that the unique contribution of MA did not differ significantly by grade. This finding was the same in a more parsimonious model in which the effects of all other variables were fixed to be the same across grades (for the effect of MA: $\Delta\chi^2 = 4.16$; $\Delta df = 2$; $p = .1252$) and in a more

https://doi.org/10.1017/S0142716411000920 Published online by Cambridge University Press

Table 2. *Direct effects of morphological awareness and control variables on reading comprehension, based on path analysis and multiple regression models*

	Path Analysis ($n = 101$)		Multiple Regression ($n = 91$)	
Variable	Stand. $\hat{\beta}$	z	Stand. $\hat{\beta}$	t
Morphological awareness	0.24	3.01**	0.25	2.92**
Reading vocabulary	0.35	3.81***	0.32	3.36**
Listening comprehension	0.14	1.77	0.17	1.99*
Sight word reading fluency	0.01	0.09	0.04	0.97
Phonemic decoding efficiency	−0.21	−1.81	−0.20	−1.59
Passage reading fluency	0.47	4.03***	0.45	3.66***
Grade 7	−0.37	−4.81***	−0.38	−4.39***
Grade 8	−0.30	−3.55***	−0.28	−2.98**

*$p < .05$. **$p < .01$. ***$p < .001$.

conservative model in which the effects of all other variables were allowed to vary by grade (for the effect of MA: $\Delta\chi^2 = 3.58$; $\Delta df = 2$; $p = .1672$). Although the differences by grade were not statistically significant in the multiple-group models, the point estimates for the standardized regression coefficients suggested a trend in which effects for the sixth graders (0.35–0.36, varying by model) were larger than those of the seventh graders (0.19–0.22), which in turn were larger than those for the eighth graders (0.03–0.15). These results were further confirmed by OLS regression; interactions between grade level and MA did not significantly predict reading comprehension, when accounting for the main effects of grade level and MA. These regression results were also robust to the inclusion of fixed effects for classes.

Indirect contributions of MA

To address the second research question, we fitted a multivariate path analysis model (see Figure 2) to evaluate the indirect contributions of MA via reading vocabulary, sight word fluency, and passage reading fluency, as shown in Table 3. Because z statistics for indirect effects can be biased by deviations from distributional assumptions, bootstrapped standard errors were estimated for these parameters and used to construct 95% CIs to determine whether they were statistically significant, as displayed in the fifth column in Table 3.

Results indicated that, in addition to a significant direct contribution, MA made significant indirect contributions to reading comprehension via reading vocabulary ($\hat{\beta} = 0.32$; 95% CI = 0.13–0.63; standardized $\hat{\beta} = 0.13$) and via passage reading fluency ($\hat{\beta} = 0.19$; 95% CI = 0.04–0.48; standardized $\hat{\beta} = .08$). However, MA did not make a significant indirect contribution via sight word reading fluency ($\hat{\beta} = 0.003$; 95% CI = −0.07–0.13; standardized $\hat{\beta} = .001$). Multiple-group path analyses indicated that none of these indirect contributions differed by grade,

https://doi.org/10.1017/S0142716411000920 Published online by Cambridge University Press

Table 3. *Direct and indirect effects of morphological awareness on reading comprehension*

Path	$\hat{\beta}$	Stand. $\hat{\beta}$	z	CI $\hat{\beta}^a$
Direct Effects on Reading Comprehension				
Morphological awareness	0.58	0.24	2.77**	
Reading vocabulary	0.32	0.35	3.71***	
Listening comprehension	1.18	0.14	1.45	
Sight word reading fluency	0.01	0.01	0.07	
Phonemic decoding efficiency	−0.16	−0.21	−1.55	
Passage reading fluency	0.14	0.47	3.27**	
Grade 7	−7.44	−0.37	−4.69***	
Grade 8	−6.54	−0.30	−3.16**	
Indirect Effects on Reading Comprehension				
Morphological awareness via reading vocabulary	0.32	.13	2.54*	0.13 to 0.63
Morphological awareness via sight word reading fluency	0.003	.001	0.05	−0.07 to 0.13
Morphological awareness via passage fluency	0.19	.08	1.78	0.04 to 0.48
Direct Effects on Moderators				
Morphological awareness → reading vocabulary	0.98	0.38	3.68***	
Listening comprehension → reading vocabulary	3.86	0.43	4.67***	
Phonemic decoding efficiency → reading vocabulary	0.11	0.14	1.52	
Grade 7 → reading vocabulary	1.31	0.06	0.65	
Grade 8 → reading vocabulary	−0.05	−0.002	1.81	
Morphological awareness → sight word reading fluency	0.25	0.11	1.34	
Phonemic decoding efficiency → sight word reading fluency	0.52	0.73	11.15***	
Listening comprehension → sight word reading fluency	−0.65	−0.08	−1.14	
Grade 7 → sight word reading	2.44	0.13	1.95	
Grade 8 → sight word reading	−0.08	−0.004	−0.04	
Morphological awareness → passage fluency	1.37	0.17	1.85	
Listening comprehension → passage fluency	2.65	0.09	1.27	
Phonemic decoding efficiency → passage fluency	1.56	0.61	8.05***	
Grade 7 → passage reading fluency	16.87	0.24	3.71***	
Grade 8 → passage reading fluency	28.57	0.38	4.46***	

Note: From the path analysis model in Figure 2 ($n = 101$).
[a] Bootstrappcd 95% confidence interval (CI).
*$p < .05$. **$p < .01$. ***$p < .001$.

https://doi.org/10.1017/S0142716411000920 Published online by Cambridge University Press

including the indirect effect via reading vocabulary ($\Delta\chi^2 = 0.53$; $\Delta df = 4$; $p = .9701$), the indirect effect via passage reading fluency ($\Delta\chi^2 = 5.64$; $\Delta df = 4$; $p = .2281$), and the indirect effect via sight word fluency ($\chi^2 = 7.37$; $\Delta df = 4$; $p = .1176$). Similar to the results for the direct effect of MA, the point estimate for the indirect effect via passage reading fluency was notably larger for the sixth graders, compared to the seventh and eighth graders. The point estimates for the other two indirect effects had similar magnitudes across the three grades.

Robustness checks

Findings were robust to a variety of different specifications and superior to several theoretically grounded alternative hypotheses. In particular, the findings of significant indirect contributions via reading vocabulary and via passage reading fluency, but nonsignificant indirect contributions via sight word reading fluency were consistent across a variety of alternative model specifications. For instance, we considered the possibility that including both sight word reading fluency and passage reading fluency as mediators may have induced multicollinearity, and thus fitted two additional, separate models: one that excluded sight word reading fluency and one that excluded passage reading fluency as mediators. Results were entirely consistent with the more complicated model including both mediators simultaneously. Results also remained the same regardless of whether we accounted for marginal covariances among the independent variables and among the error variances for the dependent variables. Similarly, each of the results reported above were robust to the inclusion of fixed effects of classes on reading comprehension.[4]

To investigate whether the indirect effects fully mediated rather than partially mediated the effect of MA, we compared the model in Figure 2 to a model that included all three indirect effects but no direct effect of MA on reading comprehension. The direct and indirect effects model had significantly better goodness of fit than an indirect effects only model ($\Delta\chi^2 = 8.68$; $\Delta df = 1$; $p = .0032$), indicating that MA is partially mediated by other skills, and confirming that the direct effect of MA is significant after accounting for indirect effects. In addition, to shed light on whether the three mediated paths collectively improved model fit, we compared the overall goodness of fit of the mediated model represented in Figure 2 with that of the direct effects-only model represented in Figure 1, and found that the mediated model had superior fit ($\Delta\chi^2 = 18.59$; $\Delta df = 3$; $p = .0003$). As with the findings above, these results were robust to a variety of alternate model specifications.

Finally, to investigate the possibility that the sample actually represented two distinct populations, one that included Spanish-dominant LM learners and one that included students who were dominant or equally fluent in English, additional multiple-group analyses were conducted. A dichotomous language dominance group variable represented whether students were Spanish dominant (i.e., those who reported speaking Spanish better than English) or balanced/English dominant (i.e., those who reported speaking both languages equally comfortably or who reported being more comfortable in English). This variable was not significantly correlated with any of the measures (all ps $> .10$). In addition, models for research question 1 (i.e., Figure 1) and research question 2 (i.e., Figure 2) were refitted

https://doi.org/10.1017/S0142716411000920 Published online by Cambridge University Press

in multiple-group path models with group specified by this language dominance variable. Given the relatively small subgroup sample sizes, the effects of grade level were not included in these additional models. Neither model indicated two populations with differing relationships. The fitted relationships did not differ significantly by language dominance group for the model with only direct effects ($\Delta\chi^2 = 11.14$; $\Delta df = 6$; $p = .0842$) nor for the mediated model displayed in Figure 2 ($\Delta\chi^2 = 18.78$; $\Delta df = 15$; $p = .2534$. Overall, the findings reported above are robust for LM learners from Spanish-speaking home regardless of variation in the language in which they report being most comfortable speaking. Further details on each of these robustness checks are available from the first author.

DISCUSSION

This study builds on and extends prior research establishing a relationship between MA and reading comprehension by providing explicit tests of direct and indirect pathways that explain this relationship for Spanish-speaking LM learners in Grades 6, 7, and 8. A model that included direct and partially mediated effects of MA on reading comprehension yielded superior fit to the data, compared to a fully mediated model and to a model with only direct effects. This conclusion was consistent for Spanish-dominant LM learners as well as balanced bilingual and English-dominant LM learners and was found to be robust across grades and model specifications.

The findings from this study have three main implications for understanding the reading development of LM learners. First, our results converge with prior studies in highlighting the important role of MA in the reading development of Spanish-speaking LM learners (Kieffer & Lesaux, 2008; Ramirez et al., 2010), while demonstrating that the unique contribution of MA to reading comprehension remains significant after controlling for language and reading skills that have not been taken into account previously (i.e., listening comprehension and passage reading fluency). Second, our results converge with prior research conducted with native English speakers in identifying reading vocabulary as a powerful mediator of the relationship between MA and reading comprehension (Nagy et al., 2006) and extend this finding to the population of Spanish-speaking LM learners. Both of these findings are also consistent with those from a recent study conducted by Kieffer and Lesaux (in press-b), which used similar measures and analyses with a large linguistically diverse sample of sixth graders. Third, our results suggest that the effects of MA may also be mediated by reading fluency at the passage level, a rarely examined indirect path. Together, these findings contribute to a more complete view of the multiple direct and indirect roles that MA may play in English reading comprehension for LM learners.

MA as a robust unique predictor of reading comprehension

Our results indicated that the unique contribution of English MA to English reading comprehension remained significant, not only after accounting for the effects of commonly used controls such as phonological decoding and vocabulary

https://doi.org/10.1017/S0142716411000920 Published online by Cambridge University Press

knowledge, but also after controlling for listening comprehension and reading fluency at both the word and passage level. Further, we found that the unique, direct effect of MA remains significant after accounting for three of the most likely indirect pathways. In other words, MA is an important predictor of reading comprehension, even after we account for its role in predicting other components of skilled reading including vocabulary, word recognition, and oral reading fluency. This finding adds to a small, but growing body of research that has identified MA as a robust predictor of reading outcomes for not only monolingual speakers of various languages (Kuo & Anderson, 2006), but also students from varying backgrounds learning English as a second language (Kieffer & Lesaux, 2008; Ramirez et al., 2010; Schiff & Calif, 2007; Wang et al., 2006; Wang, Ko, & Choi, 2009; Zhang et al., 2010). In particular, we extend previous findings on the importance of derivational MA to reading comprehension during the elementary grades (e.g., Carlisle, 2000; Kieffer & Lesaux, 2008) by finding that the predictive power of derivational MA continues into the middle school grades for LM learners.

There are multiple interpretations for this finding. One possibility is that MA, particularly as assessed on a sentence completion measure, may draw on syntactic skills that are in turn involved in sentence and text comprehension. Despite the numerous controls and mediators investigated in the current study, syntactic awareness was not among them, raising an important question for future research. A second possibility is that MA may provide insights into semantic information at the word and sentence level during real-time reading comprehension, regardless of any effects on long-term vocabulary acquisition (Nagy, 2007). When students with well-developed MA encounter novel morphologically complex words while reading, they may not always succeed in acquiring these words into their vocabularies, but may nonetheless gain meaning that is helpful to getting the gist of a sentence or passage.

This finding also supports Nagy's (2007) *metalinguistic hypothesis*, which theorizes that MA, as one aspect of metalinguistic awareness, contributes to the reading comprehension process beyond its role in vocabulary acquisition. Specifically, the current finding supports the notion that LM learners who do better with English reading comprehension do not merely know more words, but they also know more *about* words, including how words are structured, how they relate semantically to other words, and how their constituent parts contribute to their syntactic features. Conversely, LM learners who struggle with comprehension may have underdeveloped metalinguistic awareness that is not readily apparent from their vocabulary and listening comprehension. This latter hypothesis contrasts with the frequently considered idea that metalinguistic abilities are an area of strength for bilingual readers (e.g., Cummins, 1978, 1993; Jiménez et al., 1995) that they can use to compensate for limited linguistic knowledge (e.g., knowledge of specific word meanings in the second language). Although some LM learners certainly demonstrate sophisticated metalinguistic skills in English, our findings suggest that other LM learners have underdeveloped metalinguistic skills that are insufficient for comprehending sophisticated English text. Future research is needed to investigate these hypotheses, by directly comparing native English speakers and LM learners on these dimensions, and exploring the extent to which LM learners' development of these metalinguistic abilities is related to their levels

of bilingualism (e.g., Bialystok, 1988) as well as opportunities to develop these abilities in school.

Supporting a partially mediating role for vocabulary

Findings from the current study converge with previous empirical findings (e.g., Nagy et al., 2006) as well as a common theoretical argument (e.g., Kuo & Anderson, 2006; Stahl & Nagy, 2006) in suggesting that an important role for MA involves the broadening of students' reading vocabulary, which in turn yields a broader repertoire of word meanings for extracting meaning from text. The indirect contribution of MA to comprehension via reading vocabulary was found to be statistically significant and larger in magnitude than any of the other indirect paths. This path was significant after controlling for English listening comprehension, suggesting differences in overall English language development do not explain this effect.

For the large numbers of LM learners in the middle grades who demonstrate relatively limited levels of English vocabulary and consequently low reading comprehension (e.g., August et al., 2005; Lesaux & Kieffer, 2010; Mancilla-Martinez & Lesaux, 2010), this finding suggests that MA may be a promising point of leverage for intervention. A growing body of experimental and quasiexperimental research suggests that instruction in morphology may be able to improve vocabulary and reading comprehension outcomes in monolingual students (for a review, see Bowers, Kirby, & Deacon, 2010), and a few studies conducted with LM learners have suggested similar results (Carlo et al., 2004; Lesaux et al., 2010). Recent research syntheses have also provided some guidelines for what such instruction should entail (e.g., Bowers et al., 2010; Kieffer & Lesaux, 2007, 2010; Stahl & Nagy, 2006). The nonexperimental, observational design of the current study prevents us from making any claims about the utility of instruction in MA for students with limited English vocabulary knowledge. Nonetheless, our findings, combined with those of others, suggest that this may be a valuable area for intervention studies to pursue.

The intriguing partially mediating role of passage reading fluency

Perhaps the most surprising findings from the current study was that reading fluency at the passage level, but not the word level, was a significant mediator of MA. Although MA, along with more implicit morphological processing, has often been implicated in accurate and efficient word reading (Carlisle & Stone, 2005; Deacon & Kirby, 2004; Deacon et al., 2006; Mahony et al., 2000; Nagy et al., 1989, 2006), it has rarely been investigated as a predictor of passage reading fluency. There are multiple possible explanations for this finding, each of which raises important questions for future research.

One explanation is that this effect is not specific to passage reading fluency, per se, but is rather due to the accumulation of effects on word reading. That is, perhaps morphological processing simply speeds up students' reading of individual words, consistent with prior findings (e.g., Berninger et al., 2001; Deacon et al., 2010), enough so that it thereby increases the speed with which a whole passage is read.

Although this explanation is compelling, the indirect effect of MA on reading comprehension via passage reading fluency remained significant in a model that controlled for partial mediation via sight word reading fluency, suggesting that this pathway may be independent of any cumulative effect on individual word reading fluency.

A second explanation of this finding relates to features of the sight word fluency and/or passage reading fluency measures used. Although the TOWRE sight word efficiency (Torgesen et al., 1999) and Dynamic Indicators of Basic Early Literacy Skills oral reading fluency (Good & Kaminski, 2002) measures are both widely used in practice and research, they have been used less frequently in studies investigating MA, in part because they were not specifically designed to be sensitive to the effects of MA. It is possible that using a word reading fluency measure that targeted morphologically complex words, similar to the timed word reading measure used by Berninger et al. (2001), in place of the TOWRE would have led to a larger and significant moderating effect for word reading; if so, the moderating effect of word reading fluency might have lessened the moderation by passage reading fluency. Then again, because studies that have incorporated word reading measures that target morphological complex words have not also incorporated passage reading fluency, this remains an open question.

A more interesting explanation for the finding is that MA truly plays a role in facilitating passage-level fluency and thereby facilitating reading comprehension. LM learners with more developed awareness of derivational morphology may be better equipped not only to read individual words rapidly, but indeed to parse the syntactic structures of connected text rapidly, yielding more efficient oral reading of phrases, clauses, and sentences. This finding thus suggests that morphology should be integrated into multidimensional models of reading fluency.

Although reading research and theory have historically treated morphology with "benign neglect" (Durgunoğlu, 2006, p. 438; see also Goswami & Ziegler, 2006), recent theoretical models of reading fluency have recognized the contributions of multiple language systems, including morphology. For instance, Berninger and colleagues (2001) proposed a systems model for learning to read single words in which a morphological layer is interconnected with the well-established orthographic and phonological layers of word learning, each of which are thought to be managed by a lexical and sublexical processor. Berninger and colleagues (2001) provided empirical support for the importance of this morphological layer to single-word reading fluency by reporting data that demonstrated that MA predicts single-word reading rate, after controlling for phonological decoding, in second and fourth graders who are at risk for reading difficulties. More interesting in light of our findings, the authors proposed that this morphological layer is also interconnected with a syntactic layer, which in turn connects individual words with the discourse processor for larger units of text. Combined with their reminder that fluency at the word, sentence, and text levels may operate differently (and that readers who are dysfluent at each level may have different underlying processing difficulties), this systems model suggests that fluent reading of connected text may draw on MA in ways that are distinct from those involved in fluent reading of individual words (see also Wolf & Katzir-Cohen, 2001).

Despite this theoretical support for a role for MA in fluent reading of connected text, the empirical studies to date have focused almost exclusively on the role of morphological processes in fluency at the sublexical and lexical levels. Subject to replication with other populations, measures, and research designs, our findings suggest that this emphasis may neglect important processes: students' extraction of morphosyntactic information (i.e., syntactic information from affixes) from individual words may facilitate more efficient reading at the phrase, clause, and/or sentence level. This morphosyntactic role may be particularly important for LM learners who are likely to have less developed understanding of syntax in their second language, which may constrain the efficiency with which they can read connected text, even in the presence of accurate and fast word recognition. This latter hypothesis would be consistent with findings that second-language oral proficiency more broadly plays a unique role in word and passage reading fluency for second-language learners (e.g., Geva & Zadeh, 2006) and is worthy of future research comparing these relationships in LM learners with those of native English speakers.

It is also possible that MA's effects on passage reading fluency are the result, rather than the cause, of MA's effects on reading comprehension. Although fluency is often treated as the prerequisite for successful higher order comprehension processing, researchers have also acknowledged that successful comprehension processing facilitates more rapid reading of connected texts (e.g., Dowhower, 1987; Kuhn & Stahl, 2003; Slocum, Street, & Gilberts, 1995). For instance, if MA allows readers to utilize semantic and syntactic information to draw more successful inferences that yield a more robust representation of the text base from the first few sentences of a passage, this may then support more rapid and efficient reading of subsequent sentences. Although the current data did not allow us to investigate this explanation, future experimental studies that carefully manipulate morphological features of sentences or passages may shed some light on the directionality of these relationships.

This finding also raises the practical question of whether instruction in morphology could particularly benefit those LM learners who struggle with passage fluency when reading in English, whether or not they also demonstrate limited English vocabulary knowledge. Some evidence suggests that substantial numbers of LM learners with reading comprehension difficulties also demonstrate slow passage reading; for instance, Lesaux and Kieffer (2010) found that approximately 60% of LM learners in sixth grade who struggled with reading comprehension demonstrated slow, but accurate reading, albeit combined with limited English vocabulary knowledge. Although morphology is more often taught in the context of vocabulary interventions, a few interventions have involved integrating morphology into spelling and reading instruction for struggling decoders (e.g., Abbott & Berninger, 1999; Kirk & Gillon, 2009), and at least one multicomponent intervention that incorporates morphology has targeted slow, but accurate readers (Wolf, Miller, & Donnelly, 2000). Despite the promise of these approaches, the unique effects of morphology instruction, isolated from other instructional components, remains unclear. Thus, there is limited evidence for its effectiveness, especially for LM learners who struggle with fluency, again highlighting the need for greater attention to these hypotheses by researchers. Ultimately, experimental manipulation of MA

through instruction will allow us to determine which of the explanations for the current findings is best.

Limitations

This study has three limitations to be noted in the design of future studies. First, although path analysis provides a valuable tool for simultaneously investigating multiple direct and indirect relationships, it cannot establish causal relations from observational data. Similarly, path analysis of cross-sectional data did not allow us to model the bidirectional longitudinal relationships that may exist among MA, vocabulary, and reading (e.g., Kieffer & Lesaux, in press-a; Kuo & Anderson, 2006; McBride-Chang et al., 2008). Future research utilizing experimental and longitudinal data is needed to investigate such reciprocal or recursive developmental processes.

Second, the findings from the current study may not generalize to other language and reading measures. In particular, the published measures of sight word reading efficiency, reading vocabulary, and passage reading fluency used may not be the most sensitive to the roles of MA, as noted earlier. Our findings thus speak to the relationships of MA to these broad domains (i.e., the universes of grade-level vocabulary, of frequent sight words, and of commonly used reading passages), but cannot shed light on the presumably stronger relationships with the reading of morphologically complex words and passages in which such words predominate. In addition, the morphological decomposition task was selected because of its frequent use in studies conducted with LM learners, but it may draw on syntactic aspects of MA to a different extent than do analogy measures (e.g., Deacon & Kirby, 2004). As a written task, it might also have yielded different results than would an oral version of the measure. Future studies should consider using multiple written and oral formats for measuring MA, as well as measures in LM learners' first languages, given recent evidence for cross-linguistic relationships in MA (Deacon et al., 2007; Ramirez et al., 2010). Finally, the present study used measures of listening and reading comprehension that came from the same battery; an independent measure of English language proficiency may have provided additional insight into the nature of the sample.

Third, our null finding concerning the indirect effect of MA on reading comprehension via sight word reading fluency should be interpreted with caution, because the moderate size of the current sample yields relatively limited statistical power to detect small effects.[5] Similarly, larger sample sizes within each grade would have provided greater power to detect differences related to grade level, and larger sample sizes within each language dominance group would have provided greater power to determine whether the relations of interest differed by the language use of students within the heterogeneous population of LM learners.

CONCLUSION

This study sheds light on the predictors of English reading comprehension for Spanish-speaking LM learners in middle school by investigating the direct and moderated roles of English MA. Findings contribute to the small but growing body

https://doi.org/10.1017/S0142716411000920 Published online by Cambridge University Press

of evidence supporting the importance of MA in reading development across diverse language backgrounds, while also suggesting that the relationship between MA and reading comprehension is moderated by reading vocabulary and passage reading fluency in this population. Rather than seeking to partial out these moderating effects, researchers should consider the multiple important roles that MA may play in the reading comprehension process for LM learners.

ACKNOWLEDGMENTS

Collection of data was supported by SERP, which receives support from the Spencer Foundation, the Carnegie Corporation of New York, and the William and Flora Hewlett Foundation. We thank Catherine E. Snow, who originated and supervised the larger research project in the context of which these data were collected. We also thank the participating administrators, teachers, and students who made this work possible.

NOTES

1. The dichotomous scoring scheme for this task was designed to improve upon the multiple-category, partial-credit scoring scheme used by Carlo et al. (2004); in particular, dichotomous scores of these responses are likely to be less influenced by base-word spelling skills than the partial-credit scheme used previously (Nagy, personal communication). In this way, we protected in part against the confounding of variation in students' ability to spell the base word with true variation in MA. That said, it is worth noting that individually administering an oral version of the task (as done by Carlisle, 2000) would have been ideal, but was not feasible in the present study due to the size of the sample and concerns about the disruption to instructional time.
2. Recent research indicates that averaging oral reading fluency rates is essentially as accurate and reliable as using a median rate to predict reading comprehension (Petscher & Kim, 2011).
3. The moderate reliability on this subtest may be due to the difficulty of measuring this construct with early adolescents, as opposed to younger children. Test publishers guidelines for reliability appear to be more liberal for listening comprehension tests, with alpha estimates often dipping well below 0.80. For instance, while the Woodcock Language Proficiency Battery—Revised (Woodcock, 1995) listening comprehension subtest has a median α of 0.81, the α is 0.66 for 13-year-olds. Even an assessment like the Clinical Evaluation of Language Fundamentals (Semel, Wiig, & Secord, 2003), which is focused specifically on oral language development, can have only moderate internal consistency. The Clinical Evaluation of Language Fundamentals subtests most similar to the GRADE listening comprehension subtest show similar levels of internal consistency; the α ranges from 0.64 to 0.76 for the sentence structure subtest and from 0.54 to 0.81 for the understanding spoken paragraphs subtest.
4. The models that incorporated fixed effects of classes on reading comprehension also differ from the model presented in Figure 2 in that they do not include effects of grade on the moderating variables.
5. It is worth noting that the current sample size is somewhat smaller than suggested by some "rules of thumb" for minimum sample sizes in structural equation modeling.

However, as demonstrated by the reviews of research in quantitative methods conducted by MacCallum, Widaman, Zhang, and Hong (1999) and by Velicer and Fava (1998), such simple rules of thumb are invalid, because they do not account for the fact that adequate sample size will always depend on the characteristics of the variables and the study design. A moderate sample size does not, necessarily, lead to less trustworthy findings when path analysis is used, as opposed than any other statistical technique. Nonetheless, as with results from OLS regression, null results from path analyses using relatively smaller samples should be interpreted with more caution than null results from analyses with larger samples.

REFERENCES

Abbott, S. P., & Berninger, V. W. (1999). It's never too late to remediate: Teaching word recognition to students with reading disabilities in Grades 4–7. *Annals of Dyslexia, 49*, 223–250.

Anderson, R. C., & Freebody, P. (1981). Vocabulary knowledge. In J. Guthrie (Ed.), *Comprehension and teaching: Research reviews* (pp. 77–117). Newark, DE: International Reading Association.

Anglin, J. M. (1993). Vocabulary development: A morphological analysis. *Monographs of the Society for Research in Child Development, 58*(Serial No. 238).

August, D., Carlo, M., Dressler, C., & Snow, C. E. (2005). The critical role of vocabulary development for English language learners. *Learning Disabilities Research & Practice, 20*, 50–57.

August, D., & Shanahan, T. (Eds.). (2006). *Developing literacy in second-language learners: Report of the National Literacy Panel on Language-Minority Children and Youth*. Mahwah, NJ: Erlbaum.

Barth, A. E., Catts, H. W., & Anthony, J. L. (2009). The component skills underlying reading fluency in adolescent readers: A latent variable analysis. *Reading and Writing, 22*, 567–590.

Berninger, V. W., Abbott, R. D., Billingsley, F., & Nagy, W. (2001). Processes underlying timing and fluency of reading: Efficiency, automaticity, coordination, and morphological awareness. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain*. (pp. 383–415). Baltimore, MD: York Press.

Berninger, V. W., Abbott, R. D., Trivedi, P., Olseon, E., Gould, L., Hiramatsu, S., et al. (2010). Applying the multiple dimensions of reading fluency to assessment and instruction. *Journal of Psychoeducational Assessment, 28*, 3–18.

Bialystok, E. (1988). Levels of bilingualism and levels of linguistic awareness. *Developmental Psychology, 24*, 560–567.

Bollen, K. A. (1989). *Strutural equations with latent variables.* New York: Wiley.

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

Bozionelos, N. (2003). Causal path modeling: What it does and does not tell us. *Career Development Instruction, 8*, 5–11.

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

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

Carlisle, J. F., & Stone, C. A. (2005). Exploring the role of morphemes in word reading. *Reading Research Quarterly, 40*, 428–449.

Carlo, M. S., August, D., McLaughlin, B., Snow, C. E., Dressler, C., Lippman, D. N., et al. (2004). Closing the gap: Addressing the vocabulary needs of English-language learners in bilingual and mainstream classrooms. *Reading Research Quarterly, 39*, 188–215.

Carnegie Council on Advancing Adolescent Literacy. (2010). *Time to act: An agenda for advancing adolescent literacy for college and career success*. New York: Carnegie Corporation of New York. Retrieved May 15, 2010, from http://carnegie.org/fileadmin/Media/Publications/PDF/tta_Main.pdf

Chafe, W., & Danielewicz, J. (1987). Properties of spoken and written language. In R. Horowitz & S. J. Samuels (Eds.), *Comprehending oral and written language* (pp. 83–113). San Diego, CA: Academic Press.

Cohen-Mimran, R. (2009). The contribution of language skills to reading fluency: A comparison of two orthographics for Hebrew. *Journal of Child Language, 36*, 657–672.

Cummins, J. (1978). Bilingualism and the development of metalinguistic awareness. *Journal of Cross-Cultural Psychology, 9*, 131–149.

Cummins, J. (1993). Bilingualism and second language learning. *Annual Review of Applied Linguistics, 13*, 51–70.

Deacon, S. H., Campbell, E., Tamminga, M., & Kirby, J. (2010). Seeing the harm in harmed and harmful: Morphological processing in Grades 4, 6, and 8. *Applied Psycholinguistics, 31*, 759–775.

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

Deacon, H., Parrila, R., & Kirby, J. R. (2006). Processing of derived forms in high-functioning dyslexics. *Annals of Dyslexia, 56*, 103–128.

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

Dowhower, S. (1987). Effects of repeated reading on second-grade transitional readers' fluency and comprehension. *Reading Research Quarterly, 22*, 389–406.

Durgunoğlu, A. (2006). Learning to read in Turkish. *Developmental Science, 9*, 437–439.

Fang, Z., & Schleppelgrell, M. J. (2008). *Reading in the secondary content areas: A language-based pedagogy*. Ann Arbor, MI: University of Michigan Press.

Fuchs, L. S., Fuchs, D., Hosp, M. K., & Jenkins, J. R. (2001). Oral reading fluency as an indicator of reading competence: A theoretical, empirical, and historical analysis. *Scientific Studies of Reading, 5*, 239–256.

Geva, E., & Zadeh, Z. Y. (2006). Reading efficiency in native English-speaking and English-as-a-second-language children: The role of oral proficiency and underlying cognitive-linguistic processes. *Scientific Studies of Reading, 10*, 31–57.

Goulden, R., Nation, P., & Read, J. (1990). How large can a receptive vocabulary be? *Applied Linguistics, 11*, 341–363.

Good, R. H., & Kaminski, R. A. (2002). *Dynamic indicators of basic early literacy skills* (6th ed.). Eugene, OR: Institute for the Development of Educational Achievement.

Good, R. H., Wallin, J., Simmons, D. C., Kame'enui, E. J., & Kaminski, R. A. (2002). *System-wide percentile ranks for DIBELS benchmark assessment* (Technical report 9). Eugene, OR: University of Oregon.

Goswami, U., & Ziegler, J. (2006). Fluency, phonology, and morphology: A response to the commentaries on becoming literate in different languages. *Developmental Science, 9*, 451–453.

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

Jiménez, R. T., García, G. E., & Pearson, P. D. (1995). Three children, two languages, and strategic reading: Case studies in bilingual/monolingual reading. *American Educational Research Journal, 32*, 67–97.

Katzir, T., Kim, Y., Wolf, M., O'Brien, B., Kennedy, B., Lovett, M., et al. (2006). Reading fluency: The whole is more than the parts. *Annals of Dyslexia, 56*, 51–82.

Kieffer, M. J., & Lesaux, N. K. (2007). Breaking words down to build meaning: Morphology, vocabulary, and reading comprehension in the urban classroom. *Reading Teacher, 61*, 134–144.

Kieffer, M. J., & Lesaux, N. K. (2008). The role of derivational morphological awareness in the reading comprehension of Spanish-speaking English language learners. *Reading and Writing, 21*, 783–804.

Kieffer, M. J., & Lesaux, N. K. (2010). Morphing into adolescents: Active word learning for English language learners and their classmates in middle school. *Journal of Adolescent & Adult Literacy, 54*, 47–56.

Kieffer, M. J., & Lesaux, N. K. (in press-a). Development of morphological awareness and vocabulary knowledge for Spanish-speaking language minority learners: A parallel process latent growth model. *Applied Psycholinguistics.* Advance online publication. doi:10.1017/S0142716411000099.

Kieffer, M. J., & Lesaux, N. K. (in press-b). Direct and indirect roles of morphological awareness in the English reading comprehension of native Spanish, Filipino, Vietnamese, and English speakers. *Language Learning*.

Kieffer, M. J., & Lesaux, N. K. (in press-c). Knowledge of words, knowledge about words: Dimensions of vocabulary in first and second language learners in sixth grade. *Reading and Writing.* Advance online publication. doi:10.1007/s11145-010-9272-9.

Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. New York: Cambridge University Press.

Kintsch, W. (2004). The construction-integration model of text comprehension and its implications for instruction. In R. B. Ruddell & N. J. Unrau (Eds.), *Theoretical models and processes of reading* (5th ed., pp. 1270–1328). Newark, DE: International Reading Association.

Kintsch, W., & van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological Review, 85*, 363–394.

Kirk, C., & Gillon, T. G. (2009). Integrated morphological awareness intervention as a tool for improving literacy. *Language, Speech, and Hearing Services in Schools, 40*, 341–351.

Klauda, S. L., & Guthrie, J. T. (2008). Relationships of three components of reading fluency to reading comprehension. *Journal of Educational Psychology, 100*, 310–321.

Kuhn, M. R., & Stahl, S. A. (2003). Fluency: A review of developmental and remedial practices. *Journal of Educational Psychology, 95*, 3–21.

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

Lesaux, N. K., & Kieffer, M. J. (2010). Exploring sources of reading comprehension difficulties among language minority learners and their classmates in early adolescence. *American Educational Research Journal, 47*, 596–632.

Lesaux, N. K., Kieffer, M. J., Faller, E., & Kelley, J. (2010). The effectiveness and ease of implementation of an academic vocabulary intervention for linguistically diverse students in urban middle schools. *Reading Research Quarterly, 45*, 198–230.

Levasseur, V. M., Macaruso, P., Palumbo, L. C., & Shankweiler, D. (2006). Syntactically cued text facilitates oral reading fluency in developing readers. *Applied Psycholinguistics, 27*, 423–445.

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods, 4*, 84–99.

Mahony, D. (1994).Using sensitivity to word structure to explain variance in high school and college level reading ability. *Reading and Writing, 6*, 19–44.

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

Mancilla-Martinez, J., Kieffer, M. J., Biancarosa, G., Christodoulou, J., & Snow, C. E. (2011). Investigating English reading comprehension growth in adolescent language minority learners: Some insights from the simple view. *Reading and Writing, 24*, 339–354.

Mancilla-Martinez, J., & Lesaux, N. K. (2010) Predictors of reading comprehension for struggling readers: The case of Spanish-speaking language minority learners. *Journal of Educational Psychology, 102*, 701–711.

Mancilla-Martinez, J., & Spencer, K. (April, 2007). *Middle school language minority learners' listening comprehension performance: Much more than hearing.* Paper presented at the American Education Research Association Annual Meeting, Chicago.

McBride-Chang, C., Wagner, R. K., Muse, A., Chow, B., & Hua, S. (2005). The role of morphological awareness in children's vocabulary acquisition in English. *Applied Psycholinguistics, 26*, 415–435.

Mokhtari, K., & Thompson, H. B. (2006). How problems of reading fluency and comprehension are related to difficulties in syntactic awareness skills among fifth graders. *Reading Research and Instruction, 46*, 73–94.

Nagy, W. E. (2007). Metalinguistic awareness and the vocabulary-comprehension connection. In R. K. Wagner, A. E. Muse, & K. R. Tannenbaum (Eds.), *Vocabulary acquisition: Implications for reading comprehension*. New York: Guilford Press.

Nagy, W. E., & Anderson, R. C. (1984). The number of words in printed school English. *Reading Research Quarterly, 19*, 304–330.
Nagy, W. E., Anderson, R., Schommer, M., Scott, J., & Stallman, A. (1989). Morphological families in the internal lexicon. *Reading Research Quarterly, 24*, 262–282.
Nagy, W., Berninger, V., Abbott, R., Vaughan, K., & Vermeulen, K. (2003). Relationship of morphology and other language skills to literacy skills in at-risk second-grade readers and at-risk fourth-grade writers. *Journal of Educational Psychology, 95*, 730–742.
Nagy, W. E., Berninger, V. W., & Abbott, R. D. (2006) Contributions of morphology beyond phonology to literacy outcomes of upper elementary and middle-school students. *Journal of Educational Psychology, 98*, 134–147.
Nagy, W. E., Diakidoy, I. N., & Anderson, R. C. (1993). The acquisition of morphology: Learning the contributions of suffixes to the meanings of derivatives. *Journal of Literacy Research, 25*, 155–170.
Nagy, W. E., García, G. E., Durgunoğlu, A.Y., & Hancin-Bhatt, B. J. (1993). Spanish–English bilingual students' use of cognates in English reading. *Journal of Reading Behavior, 25*, 241–259.
Perfetti, C. A. (1985). *Reading ability*. New York: Oxford Press.
Perfetti, C. A. (1988). Verbal efficiency in reading ability. In M. Daneman, G. E. Mackinnon, & G. T. Waller (Eds.), *Reading research: Advances in theory and practice* (Vol. 6, pp. 109–143). San Diego, CA: Academic Press.
Petscher, Y., & Kim, Y. S. (2011). The utility and accuracy of oral reading fluency score types in predicting reading comprehension. *Journal of School Psychology, 49*, 107–129.
Ramirez, G., Chen, X., Geva, E., & Kiefer, H. (2010). Morphological awareness in Spanish-speaking English language learners: Within and cross-language effects on word reading. *Reading and Writing, 23*, 337–358.
RAND Reading Study Group. (2002). *Reading for understanding: Toward an R&D program in reading comprehension*. Santa Monica, CA: RAND.
Reynolds, R. (2000). Attentional resource emancipation: Toward understanding the interaction of word identification and comprehension processes in reading. *Scientific Studies of Reading, 4*, 169–195.
Saiegh-Hadadd, E., & Geva, E. (2008). Morphological awareness, phonological awareness, and reading in English–Arabic bilingual children. *Reading and Writing, 21*, 481–504.
Schiff, R., & Calif, S. (2007). Role of phonological and morphological awareness in L2 oral word reading. *Language Learning, 57*, 271–298.
Semel, E., Wiig, E. H., & Secord, W. A. (2003). *Clinical Evaluation of Language Fundamentals* (CELF-4; 4th ed.). Toronto: Psychological Corporation.
Slocum, T., Street, E., & Gilberts, G. (1995). A review of research and theory on the relation between oral reading rate and reading comprehension. *Journal of Behavioral Education, 5*, 377–398.
Stahl, S., & Nagy, W. (2006). *Teaching word meanings*. Mahwah, NJ: Erlbaum.
Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1999). *Test of Word Reading Efficiency (TOWRE)*. Austin, TX: Pro-Ed.
Umbel, V. M., Pearson, B. Z., Fernandez, M. C., & Oller, D. K. (1992). Measuring bilingual children's receptive vocabularies. *Child Development, 63*, 1012–1020.
Velicer, W. F., & Fava, J. L. (1998). Effects of variable and subject sampling on factor pattern recovery. *Psychological Methods, 3*, 231–251.
Wang, M., Cheng, C., & Chen, S. (2006). Contribution of morphological awareness to Chinese–English biliteracy acquisition. *Journal of Educational Psychology, 98*, 542–553.
Wang, M., Ko, I. Y., & Choi, J. (2009). The importance of morphological awareness in Korean–English biliteracy acquisition. *Contemporary Educational Psychology, 34*, 132–142.
Wang, M., Yang, C., & Cheng, C. (2009). The contributions of phonology, orthography, and morphology in Chinese–English biliteracy acquisition. *Applied Psycholinguistics, 30*, 291–313.
Williams, K. T. (2001). *Group Reading Assessment and Diagnostic Evaluation (GRADE). Technical manual: All levels*. Circle Pines, MN: AGS Publishing.
Wolf, M., & Katzir-Cohen, T. (2001). Reading fluency and its intervention. *Scientific Studies of Reading, 5*, 211–239.

Wolf, M., Miller, L., & Donnelly, K. (2000). Retrieval, automaticity, vocabulary elaboration, orthography (RAVE-O): A comprehensive, fluency-based reading intervention program. *Journal of Learning Disabilities, 33*, 375–387.

Wood, D. E. (2009). Modeling the relationships between cognitive and reading measures in third and fourth grade children. *Journal of Psychoeducational Assessment, 27*, 96–112.

Woodcock, R. W. (1995). *Woodcock Language Proficiency Battery—Revised* (WLPB-R). Itasca, IL: Riverside.

Zhang, J., Anderson, R. C., Li, H., Dong, Q., Xinchun, W., & Zhang, Y. (2010). Cross-language transfer of insight into the structure of compound words. *Reading and Writing, 23*, 311–336.