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Modeling the Relationship Between Prosodic Sensitivity and Early Literacy

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ABSTRACT

A growing literature has demonstrated that prosodic sensitivity is related to early literacy development; however, the precise nature of this relationship remains unclear. It has been speculated in recent theoretical models that the observed relationship between prosodic sensitivity and early literacy might be partially mediated by children's vocabulary knowledge, phonological awareness, and morphological awareness, although such models have yet to be confirmed using advanced statistical techniques. The study reported here uses covariance structure modeling to provide the first direct test of the model proposed by Wood, Wade-Woolley, and Holliman. We also test a modified version of this model that was designed to overcome some of the limitations in the original. Seventy-five 5-7-year-old English-speaking children completed a new measure of prosodic sensitivity and were also assessed for their vocabulary knowledge, phonological awareness, morphological awareness, word reading, and spelling. The results showed that Wood et al.'s model did not provide an adequate fit to our sample data; however, the new model, which permitted causal connections between the so-called mediator variables, provided an excellent fit. We argue that prosodic sensitivity should be afforded greater importance in models of literacy development, and offer a new theoretical model of the prosody-literacy relationship for future attempts at replication.

It is widely accepted that awareness of segmental phonology—that is, the separable sound segments of speech—is associated with successful reading acquisition (Bradley & Bryant, 1983; Cain, 2010). Children with reading difficulties often have accompanying phonological processing deficits (Vellutino & Fletcher, 2005), which has most commonly been attributed to fuzzy, underspecified phonological representations of words (Snowling, 2000). The link between segmental phonology and literacy is well established; however, a new and emerging area of phonological development that has recently begun to receive a great deal of research attention in relation to literacy development is that of prosodic sensitivity (suprasegmental phonology).

Prosodic sensitivity relates to overarching patterns of the speech stream encompassing intonation, rhythm, tempo, volume, and pauses, and these interact with syntax, lexical meaning, and segmental phonology in spoken language (Wennerstrom, 2001). Sensitivity to speech prosody develops in early infancy as part of a progressive attunement to one's first language (Jusczyk, 1999), as such sensitivity appears to be implicated in spoken word recognition. It also appears to play an important role in children's reading development: Not only is it linked to

Reading Research Quarterly, xx(x)
pp. 1–14 | doi:10.1002/rrq.82

successful reading comprehension (e.g., Whalley & Hansen, 2006), but more recent work suggests that it may also be linked to decoding text (see Wood, Wade-Woolley, & Holliman, 2009). The past 16 years in particular have seen the development of a literature showing that prosodic sensitivity is implicated in successful reading acquisition (e.g., Goswami et al., 2002; Goswami, Gerson, & Astruc, 2010; Holliman, Wood, & Sheehy, 2008, 2010a, 2010b, 2012; Leong, Hämäläinen, Soltész, & Goswami, 2011; Schwanenflugel, Hamilton, Kuhn, Wisenbaker, & Stahl, 2004; Whalley & Hansen, 2006) and in ways that are independent of segmental phonological awareness (e.g., Holliman et al., 2008, 2010a, 2010b, 2012; Whalley & Hansen, 2006; Wood, 2006). However, current models of reading acquisition do not incorporate the importance of prosodic sensitivity within early mechanisms of literacy (Wood et al., 2009; Zhang & McBride-Chang, 2010), perhaps because of the lack of clarity regarding how exactly it contributes to reading and spelling representations. The present study intends to address this gap in our theoretical understanding and reconceptualize the underpinnings of early literacy.

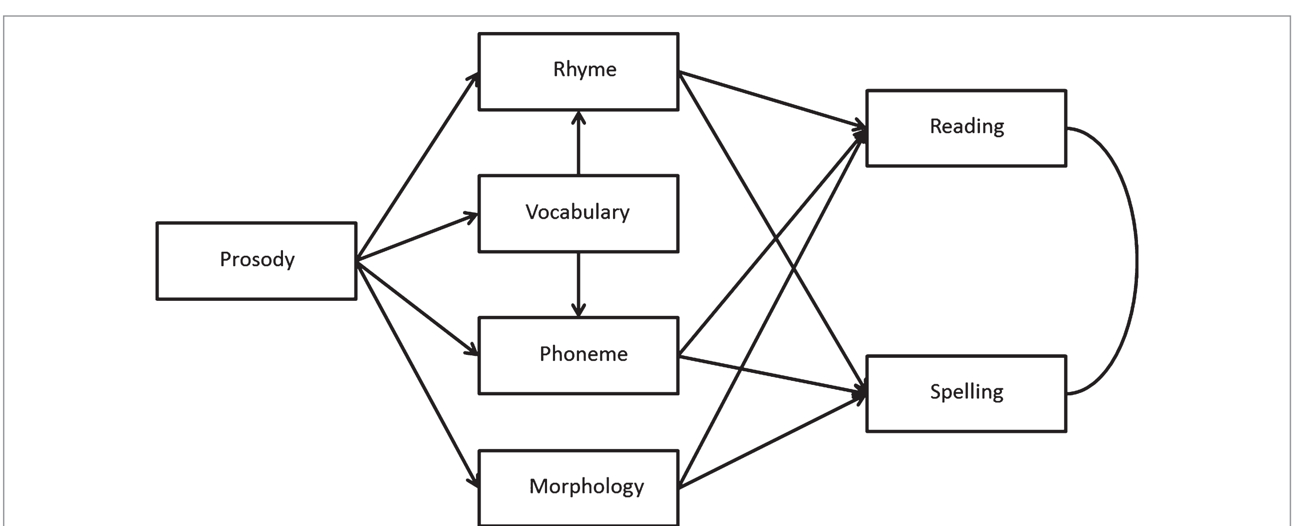
Greater understanding of the relationship between prosodic sensitivity and literacy may also have important implications for pedagogy and the design of interventions for children with written language difficulties. Currently, it is known that segmentally based phonics instructions benefit most children who are learning to read, but there are a proportion who still struggle despite them (Torgesen, 2000). Therefore, suprasegmentally based interventions may prove a viable alternative given the support that prosodic sensitivity provides in the development of high-quality phonological representations (see Goswami et al., 2013) and other reading skills. However, to inform these, more research is required to examine the mechanisms by which prosodic sensitivity may support the development of early reading and spelling; this is less well understood, although theoretical models have begun to enter the literature.

Modeling the Prosody–Literacy Relationship

Wood et al. (2009) reviewed the available evidence and proposed a model that aims to explain the nature of the relationship between prosodic sensitivity and early literacy development via four possible contributory pathways (see Figure 1). In the first pathway, it was suggested that children are born with a periodicity bias (Cutler & Mehler, 1993), which allows them to tune in to the rhythmic properties of speech in their environment. This allows children to bootstrap their way into spoken word recognition and facilitates the development of vocabulary, which in turn supports the development of phonological awareness (Walley, 1993), a skill that has been extensively linked to early reading and spelling attainment (e.g., Bus & van IJzendoorn, 1999; Cain, 2010; Snowling, 2000).

In a second, direct pathway to phonological awareness, it was argued in accordance with Chiat (1983) and Kitzen (2001) that sensitivity to speech prosody (and stress in particular) may facilitate the identification of phonemes in words (which are easier in stressed rather than unstressed syllables) and, in a third, direct pathway, may also promote the identification of onset-rime boundaries (rhyme) given that the peak of loudness in a syllable corresponds to vowel location (Scott, 1998); this

FIGURE 1
Conceptual Path Diagram for Model 1



may support decoding skill via analogical reasoning (Goswami, 2003; Goswami et al., 2002). Both segmental phonological skills reported here—phoneme and rhyme awareness—are widely recognized as being highly correlated and important for learning to read and spell (e.g., Anthony & Lonigan, 2004).

In a fourth pathway, it was argued that the relationship between prosodic sensitivity and literacy may be explained via its link with another key predictor of reading and spelling—morphological awareness (see Green, 2009, for a review)—while decoding multisyllabic words; although this proposed pathway has been suggested in the recent literature (e.g., Holliman et al., 2008, 2010a, 2010b, 2012; Jarmulowicz & Taran, 2013), few studies have assessed this dimension, which requires further consideration.

Until recently, popular models of reading development (e.g., Ehri, 1997; Frith, 1985; Ziegler & Goswami, 2005) have focused predominantly on how children come to separate the sound segments of spoken language (segmental phonological awareness). However, none of these theories sufficiently address how children come to read multisyllabic words, which require the additional skill of stress assignment (e.g., knowing to pronounce the word *together* as *toGEther* rather than *TOgether*). Indeed, Protopapas, Gerakaki, and Alexandri (2006) have argued that "reading models must be extended to account for multisyllabic word reading including, in particular, stress assignment" (p. 418) and that "if stress assignment is an important and necessary step in reading aloud, then cognitive models of reading must be extended to include it" (pp. 428–429).

In more recent models of literacy development (e.g., Nunes & Bryant, 2009), there has been increased emphasis on morphological awareness, which is also important when decoding multisyllabic words; this is a form of metalinguistic knowledge that is concerned with root words, affixes, and suffixes (e.g., knowledge that the word *unacceptable* is made up of three morphemes: *un-* [the prefix], *accept* [the root, which may or may not be a word itself in other terms], and *-able* [the suffix]). Morphological awareness is bound up with suprasegmental phonology; when we are decoding multisyllabic words, stress rules become very important, and the location of stress can change depending on the suffix of that word.

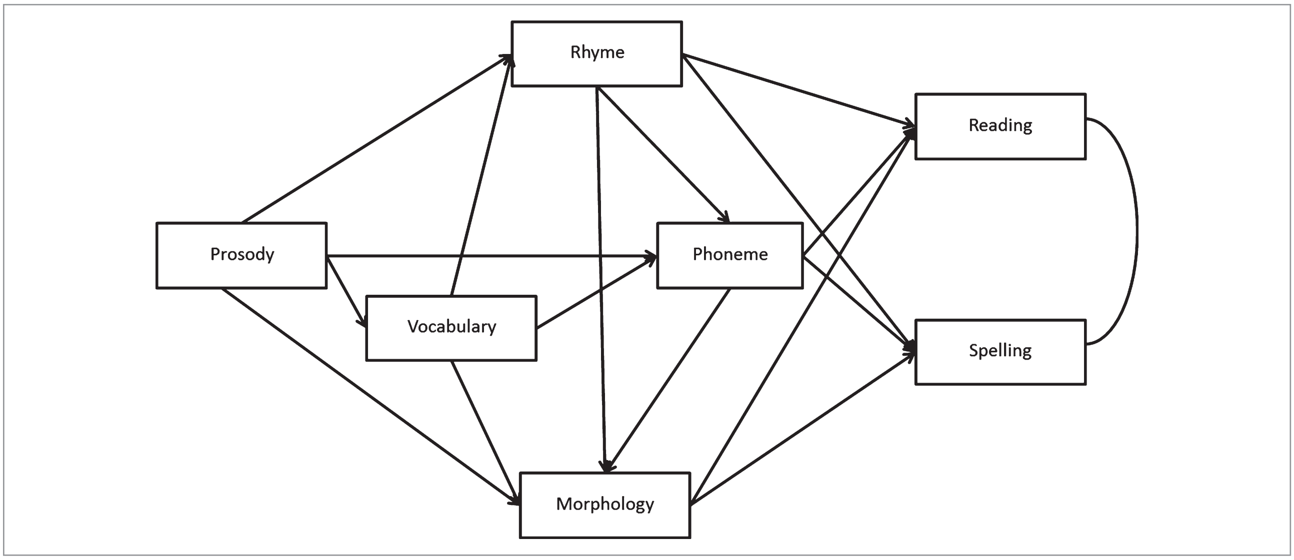
For example, Carlisle (1988, 2000) showed that for words ending in *-ity* or *-tion*, there is a stress shift (compared with the root word) to the syllable immediately before that suffix (e.g., in the word *electric*, the stress is on the *lec* syllable, but in the word *electricity*, there is a stress shift and the stress moves immediately before the suffix onto *tri*). The same principle applies to the suffix *-tion* (e.g., *OPerate*/*opeRAtion*). However, some suffixes (e.g., *-ness*) do not result in a stress shift. Researchers such as Clin, Wade-Woolley, and Heggie (2009) have argued that poor readers may be less sensitive to stress in oral language and less aware of morphological rules when decoding multisyllabic words. To pronounce words correctly, lexical stress placement is paramount. Therefore, the inclusion of prosodic sensitivity in models of reading acquisition may enable us to explain how children move from reading monosyllabic words to multisyllabic words during the intermediate phase of reading development.

Modifications to the Wood et al. (2009) Model

Although the predictions made by the Wood et al. (2009) model suggesting that the relationship between prosodic sensitivity and both reading and spelling would be mediated by vocabulary, phoneme, rhyme, and morphology were plausible, it could be argued that the hypothesized pathways between these contributory variables were somewhat simplistic. What the model did not fully consider were the possible interrelationships among vocabulary, phoneme, rhyme, and morphology. For example, it was not considered how the pathways from prosodic sensitivity to vocabulary and then on to reading and spelling might also, in turn, be mediated by morphology. Also, the Wood et al. model did not fully consider the role of morphology in the process as a potential mediator for both vocabulary and segmental phonology (phoneme and rhyme) in the pathways to both reading and spelling.

Therefore, following a review of the literature, a modified version of the Wood et al. (2009) model was proposed to address some of these limitations (see Figure 2) and consider the enhanced role that morphological processes might play in the development of reading and spelling skills as a mediator within the model. The challenge in developing this modified model was deciding the direction of the pathways, as it became apparent that many of the associations are bidirectional depending on the exact point of development, and therefore studies varied in the exact directions of influence they uncovered. Therefore, what was posited in this modified model seemed most appropriate for the ages of the children in this study (5–7 years) and/or had the most support in the literature but may need alterations for older age groups. It should be noted, however, that this review of the literature does not purport to be comprehensive, although efforts have been made to select studies in which the ages of the children studied falls within the 5–7 year range focused on here. These newly hypothesized pathways will now be addressed in turn.

FIGURE 2
Conceptual Path Diagram for Model 2



Note. Model 2 differed from model 1 by the inclusion of four additional paths: rhyme to phoneme and rhyme, vocabulary, and phoneme to morphology.

Vocabulary–Morphology

The Wood et al. (2009) model argues that prosodic sensitivity may facilitate the development of vocabulary and, in turn, phonological awareness (Walley, 1993). Indeed, the link between vocabulary and both phoneme (e.g., McBride-Chang, Cho, et al., 2005; McBride-Chang, Wagner, Muse, Chow, & Shu, 2005) and rhyme (e.g., Avons, Wragg, Cupples, & Lovegrove, 1998; Metsala, 1999)—two aspects of phonological awareness (Kirby, Desrochers, Roth, & Lai, 2008)—has been demonstrated in a variety of studies. However, it could also be posited that vocabulary may also make a contributory influence to morphology and then, in turn, to reading and spelling, although the exact direction of this connection is somewhat harder to specify.

A converging literature has demonstrated a strong association between vocabulary and morphology (e.g., Kieffer & Lesaux, 2012; McBride-Chang, Cho, et al., 2005; McBride-Chang, Wagner, et al., 2005), but there is marked complexity in specifying a relationship that is likely to be bidirectional (McBride-Chang, Wagner, et al., 2005). Some studies suggest that morphology is the predictor of vocabulary due to the syntactic bootstrapping hypothesis, where children use their implicit knowledge of grammatical categories to narrow down the meaning of unfamiliar words (e.g., Gleitman, 1990; Gleitman & Gleitman, 1992), although Nagy (2007) provides some alternative explanations of why morphology may influence vocabulary and the nature of that relationship. Nunes and Bryant (2009) support syntactic bootstrapping by explaining that children will use their morphological knowledge to remember the sounds in a new word when it has a morphological structure that they recognize alongside their phonological knowledge. This is validated by a wealth of studies over more than 50 years, from Brown (1957), who inspired the syntactic bootstrapping hypothesis, to the more recent work documented in several reviews (e.g., Anglin, 1993; Graves, 1986; Naigles, 1990; White, Power, & White, 1989).

However, other studies suggest that vocabulary may actually predict morphology, as evidenced by children's spellings. Findings consistently show that children are more likely to spell morphemes correctly in real words than pseudowords (e.g., Chliounaki & Bryant, 2007; Kemp & Bryant, 2003), indicating that when children use letter sequences frequently enough, it may lead to learning the underlying morphological rule (Nunes, Bryant, & Bindman, 1997). So, in these instances, children's vocabulary or word-specific knowledge precedes and predicts explicit knowledge of morphemes, although there is a close, continuous relationship over time (Chliounaki & Bryant, 2007). Furthermore, McBride-Chang et al. (2008) also reported evidence that vocabulary can predict morphology.

Therefore, in positing the pathway for the modified model, it was decided that vocabulary would predict morphology according to the findings from the spelling literature, as overall the focus is on predictors of reading and spelling. This represents the first significant modification to the Wood et al. (2009) model.

Rhyme–Phoneme

It seems plausible that segmental phonology might mediate the relationship between vocabulary and both reading and spelling, but what might the relationship between the two components of rhyme and phoneme be? This pathway was not included in the Wood et al. (2009) model. The literature would suggest that rhyming skill emerges first and therefore could predict phoneme skills such as identification, segmentation, and deletion.

Ellis (1997) explains that rhyme detection is an implicit ability that young children acquire before development of the alphabetic principle has fully occurred while phoneme-based tasks are more explicit and may require some form of instruction before they can be successfully completed. This is confirmed by Kirby et al. (2008) who explain that rhyme-based tasks are much easier than phoneme-based tasks for young children. Theoretically there is also support that rhyme may predict phoneme as phonological grain size theory (Ziegler & Goswami, 2005) suggests that children naturally develop awareness of larger grain sizes such as syllables and onset-rime (which would include rhyming skill) prior to smaller grain sizes such as phonemes again suggesting that the latter requires instruction to acquire. This additional pathway, from rhyme to phoneme, represents the second significant modification to the Wood et al. (2009) model.

Segmental Phonology (Rhyme and Phoneme)–Morphology

It has already been discussed how morphology may mediate between vocabulary and both reading and spelling, but it may also have a role to play as a mediator between segmental phonology and both reading and spelling. Again, strong associations between phonological and morphological awareness have been documented many times in the literature (e.g., Carlisle, 1995; Egan & Pring, 2004; Fowler & Liberman, 1995; Mann, 2000), although there are inherent complexities when studying these two components. Although Nunes and Bryant (2009) confirmed that they are separate skills and that morphology is not just an extension of phonology, they can be difficult to distinguish in English at an empirical level. As McBride-Chang, Wagner, et al. (2005) explained, morphemes are strongly associated with phonological units, such as syllables and phonemes. Despite this, associations between morphology and both aspects of phonological awareness can be confirmed, with Deacon and Kirby (2004) reporting relationships with a rhyme-based task and McBride-Chang, Cho, et al. (2005), McBride-Chang, Wagner, et al. (2005), and Singson, Mahoney, and Mann (2000) reporting relationships with phoneme-based tasks.

In terms of predicting the direction of the relationships, the wealth of literature would support that both rhyme and phoneme would predict morphology as posited in the modified model. It has been frequently suggested in classic models of literacy over the past 30 years (e.g., Ehri, 1998, 1999, 2000; Frith, 1985) that children tend to implement their knowledge of phonology when reading and spelling prior to morphology, although the relationship is likely to be more closely related in development than might be suggested by stage and phaselike models (Beech, 2005; Ellis, 1997). Furthermore, studies of spelling development (e.g., Critten, Pine, & Steffler, 2007; Nunes et al., 1997) have demonstrated that when learning to spell morphemes, children often tend to employ phoneme–grapheme correspondences first, producing some errors (e.g., *filld* instead of *filled*) before realizing that morphemes are units of the word that have a regularity across the orthography and are not always spelled as they sound, leading to the correct spelling of inflectional morphemes like *-ed*.

Once phonology and morphology are more fully integrated, successful reading and spelling are much more likely, hence why morphology may be an important mediating factor for segmental phonology and both reading and spelling in the modified model, which represents the third significant modification to the Wood et al. (2009) model.

Summary and Rationale

A growing literature has demonstrated that prosodic sensitivity is related to early literacy development; however, the precise nature of this relationship remains unclear. It has been speculated in recent theoretical models (e.g., Wood et al., 2009) that the observed relationship between prosodic sensitivity and early literacy might be partially mediated by children's vocabulary knowledge, phonological awareness, and morphological awareness, although such models have yet to be confirmed using advanced statistical techniques. Moreover, several limitations seem inherent in the Wood et al. (2009) model in that important pathways (mainly between the so-called mediator variables) were not included/permitted.

The study reported here uses covariance structure modeling to provide the first direct test of the model proposed by Wood et al. (2009). We also test a modified version of this model that was designed to overcome some of the limitations in the original. A new holistic assessment of prosodic sensitivity was developed, and its relationship with measures of vocabulary, segmental phonology, morphology, word reading, and spelling was explored.

Method

Participants

All participating children in this study ($N = 75$) were recruited from a single infant school in the United Kingdom. According to the Ofsted inspection report (www.education.gov.uk/schools/performance) for this school, relative to similar schools in the United Kingdom, this school is larger and has a lower proportion of pupils who speak English as an additional language, an average proportion of disabled pupils, an above-average proportion of pupils who have special educational needs, and a below-average proportion of pupils who are known to be eligible for free school meals (an indicator of socioeconomic status).

The participating children were between 5 years 2 months of age and 7 years 0 months (mean = 6 years 2 months) and were in either year 1 ($n = 37$) or year 2 ($n = 38$) classes. All of the males ($n = 39$) and females ($n = 36$) who took part spoke English as their first language, and none of the children had been identified as having a special educational need. The mean vocabulary raw score of the sample according to the British Picture Vocabulary Scales II (Dunn, Dunn, Whetton, & Burley, 1997) was 68 (standard deviation = 11.2), which equates to a standardized vocabulary score of 106 and falls in the high-average score range. The mean word reading raw score, according to the British Ability Scales II word reading subtest (Elliot, Smith, & McUlloch, 1996) was 32.15 (standard deviation = 20.4), which equates to an ability score of 90 and a reading age equivalent of 7 years 10 months.

Measures

Vocabulary

The British Picture Vocabulary Scales II (Dunn et al., 1997) provided a measure of children's receptive vocabulary. They heard a word spoken aloud by the administrator and were required to point to the picture that best fitted what they had heard from a choice of four pictures that were available. Children received 1 point for each correct answer. Dunn et al. report internal reliability (Cronbach's α) of .93–.94.

Rhyme Detection

The rhyme detection subtest of the Phonological Assessment Battery (Frederickson, Frith, & Reason, 1997) provided a measure of children's phonological awareness. They heard three words spoken aloud by the administrator (e.g., *dog*, *man*, *fog*) and were required to verbally identify the two rhyming words. Children received 1 point for each correct answer and obtained a total score out of 21. Frederickson et al. report internal reliability (Cronbach's α) of .92.

Phoneme Deletion

The phoneme deletion task (Wood, 1999) provided another measure of children's phonological awareness. They heard a word spoken aloud by the administrator and were required to verbally repeat it back to the administrator without either the first phoneme (e.g., *igloo* → *glue*) or the last phoneme (e.g., *party* → *part*). Children received 1 point for each correct answer and obtained a total score out of 24. The Cronbach's α reliability coefficient was .85.

Morphological Awareness

The morphology task (Duncan, Casalis, & Cole, 2009) provided a measure of children's morphological awareness. They heard a partial sentence from the administrator and were required to finish it with a similar, appropriate word in accordance with the morphological rules of the English language. For example, if the administrator said, "When there is *dust*, it is—," a correct response from the child would be, "Dusty." Children received 1 point for each correct answer and obtained a total score out of 18. The Cronbach's α reliability coefficient was .9.

Word Reading

The British Ability Scales II word reading subtest (Elliot et al., 1996) provided a measure of children's word identification. They were required to read as many words aloud as possible from a printed list of up to 90 words with increasing difficulty; the test was terminated if eight or more failures were made in a block of 10 words. Children received 1 point for each correct answer and obtained a total score out of 90. Elliot et al. report internal reliability (Cronbach's α) of .88–.98.

Spelling

The Single Word Spelling Test (Sacre & Masterson, 2000) provided a measure of children's spelling ability. They heard 30 words spoken aloud by the administrator, each of which was presented three times: in isolation, in a sentence, then finally in isolation (e.g., "*It*, please put it on the shelf, *it*"). Children received 1 point for every word that was correctly spelled (permitting *b*/*d* and *p*/*q* reversals and incorrect punctuation) and obtained a total score out of 30. Sacre and Masterson report internal reliability (Kuder–Richardson's α) of .94.

Prosodic Sensitivity

The Dina the Diver task (Holliman et al., 2014) provided a holistic measure of children's prosodic sensitivity. All aspects of this task involved Dina the Diver, who invariably said prerecorded words, phrases, and sentences either outside the water (resulting in clearly and correctly sounded utterances) or underwater (resulting in low-pass filtered utterances, omitting any phonemic information, but preserving the rhythmic aspects of those utterances). Sound Forge Audio Studio 9.0 was used to achieve this low-pass filtered effect. The audio files were accompanied by an image of Dina the Diver entering or exiting the water as well as a set of character cards, which included recognizable images and scenes from children's storybooks, cartoons, and other television shows. The task format was slightly different depending on which aspect of prosodic sensitivity was being measured.

For stress, children had to decide which correctly spoken utterance (e.g., Aladdin = weak-strong-weak, Tinkerbell = strong-weak-weak) matched the low-pass filtered (underwater) utterance based on the stress pattern. For intonation, children had to decide whether they heard a question implied by a rise in intonation at the end of the utterance (e.g., /Godzilla) or a statement implied by a fall in intonation at the end of the utterance (e.g., \Godzilla). For timing, children had to decide whether two low-pass filtered (underwater) utterances were the same in terms of duration (e.g., Spiderman/Spiderman) or different (e.g., Spiderman/Spiiiiiderman). The duration of utterance was manipulated using Praat 4.0.7. Children received 1 point for each correct answer and obtained a total score out of 45. The Cronbach's α reliability coefficient was .63.

Procedure

Once informed consent had been gained from the head teacher at the participating school, information sheets and opt-out consent forms were sent to the parents of eligible children via the school. Any children whose parents expressed an unwillingness to take part were withdrawn from the study. Data were collected between November 2010 and February 2011. The test battery, which included seven assessments in total, was individually administered in a quasi-randomized order over two sessions to minimize the length of the testing period. Batch 1 always consisted of the Dina the Diver task, rhyme detection, and word reading, and Batch 2 always consisted of the vocabulary measure, phoneme deletion, morphological awareness, and spelling. The order of these batches was randomized, and the order of the presentation of tasks within each batch was also randomized. These assessments were chosen on the basis that they have been standardized for the U.K. population and/or have been used in the prosody–literacy literature.

Results

Table 1 shows the mean and standard deviation scores on all the assessments in this study. Because the prosodic sensitivity measure involved a forced-choice procedure, it was important to demonstrate that performance on this task was significantly above that expected by chance. It can be seen from Table 1 that performance was significantly above chance for all three components of the prosodic sensitivity measure: for stress, mean (M) = 8.37, $\chi^2(1, N = 75) = 9.720$, $p = .002$; for intonation, $M = 9.15$, $\chi^2(1, N = 75) = 12.813$, $p < .001$; and for timing, $M = 9.44$, $\chi^2(1, N = 75) = 40.333$, $p < .001$. The collective performance on the assessment of prosodic sensitivity was also significantly above that expected by chance: $M = 26.96$, $\chi^2(1, N = 75) = 22.413$, $p < .001$. It can also be seen from Table 1 that participants generally scored in the middle to upper middle range on all other assessments in this study.

TABLE 1
Summary Statistics for Children on All Assessments in This Study

Task	Mean	Standard deviation
Prosody: Stress (max = 15)	8.37	2.20
Prosody: Intonation (max = 15)	9.15	3.33
Prosody: Timing (max = 15)	9.44	2.06
Prosody total (max = 45)	26.96	5.09
Vocabulary (max = 168)	68.00	11.15
Rhyme detection (max = 21)	12.95	3.76
Phoneme deletion (max = 24)	17.20	4.84
Morphological awareness (max = 18)	9.51	5.03
Word reading (max = 90)	32.15	20.40
Spelling (max = 60)	18.43	10.03

Note. The mean scores presented are raw scores.

Correlation Analyses

Bivariate correlations between the measures of prosodic sensitivity (overall composite), vocabulary, rhyme awareness, phoneme awareness, morphological awareness, word reading, and spelling are presented in Table 2. Prosodic sensitivity was significantly correlated with all other measures in this study. However, it was important to demonstrate that this relationship persists after controlling for age (given the broad age range of the sample in this study), and therefore partial correlations controlling for age were also calculated. After controlling for age, participants' overall level of prosodic sensitivity was still significantly correlated with vocabulary ($pr = .34$, $p = .003$), rhyme awareness ($pr = .48$, $p < .001$), phoneme awareness ($pr = .31$, $p = .008$), morphological awareness ($pr = .33$, $p = .005$), word reading ($pr = .4$, $p < .001$), and spelling ($pr = .41$, $p < .001$). Generally speaking, the same pattern of results was observed even after age had been partialed out.

TABLE 2
Correlation Matrix Between Prosodic Sensitivity, Vocabulary, Rhyme Awareness, Phoneme Awareness, Morphological Awareness, Word Reading, and Spelling

Variable	1	2	3	4	5	6	7
1. Prosodic sensitivity	—	.34**	.48***	.31**	.33**	.40***	.41***
2. Vocabulary	.52***	—	.44***	.27*	.50***	.27*	.29*
3. Rhyme awareness	.59***	.56***	—	.44***	.41***	.50***	.46***
4. Phoneme awareness	.39***	.37**	.49***	—	.51***	.42***	.45***
5. Morphological awareness	.47***	.62***	.52***	.56***	—	.52***	.56***
6. Word reading	.55***	.48***	.60***	.49***	.63***	—	.82***
7. Spelling	.57***	.50***	.57***	.51***	.66***	.87***	—

Note. Bivariate correlations (Pearson) are presented below the diagonal, and partial correlations after controlling for age are presented above the diagonal.
*p < .05. **p < .01. ***p < .001.

TABLE 3
Univariate Descriptive Statistics for Modeled Variables (N = 75)

Variable	Mean	Skewness	Kurtosis	Standard deviation
Prosody	26.96	0.097	−0.471	5.092
Word reading	32.15	0.665	−0.914	20.403
Spelling	18.43	1.261	1.019	10.027
Vocabulary	68.00	0.154	−0.558	11.150
Rhyme	12.95	0.120	−0.706	3.756
Phoneme	17.20	−0.989	0.641	4.841
Morphology	9.51	0.072	−1.137	5.028
Multivariate normality indicators				
Mardia's coefficient	2.188			
Bonett–Woodward–Randall test	No excess kurtosis reported			

Path Analysis

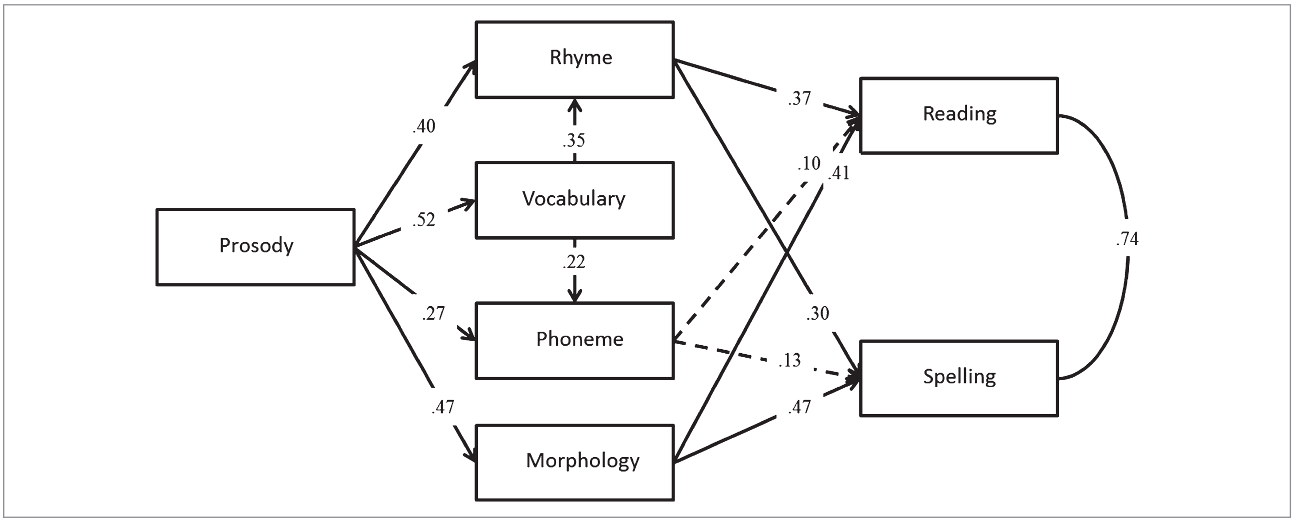
All preliminary and main analyses reported herein were conducted using M*plus* 7.0. All variables were examined for univariate normality and for evidence that might warrant caution over the assumption of multivariate normality. There was evidence of very slight deviations from normality (see Table 3). Accordingly, all models were estimated using robust maximum likelihood estimation, which is robust under conditions of nonnormality.

When assessing model fit, four of the more accurate and reliable fit indexes (Hu & Bentler, 1998, 1999) were consulted, namely, the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker–Lewis Index (TLI), and the standardized root mean square residual (SRMR). Models were considered to adequately fit the data at values of ≤0.08 for the SRMR (Spence, 1997) and the RMSEA (Browne & Cudeck, 1993), with values <0.05 preferred (Hu & Bentler, 1998, 1999), as well as values ≥0.90 for the CFI and TLI (Bentler & Bonett, 1980), with values >0.95 preferred (Hu & Bentler, 1998, 1999).

Path Analysis of Model 1

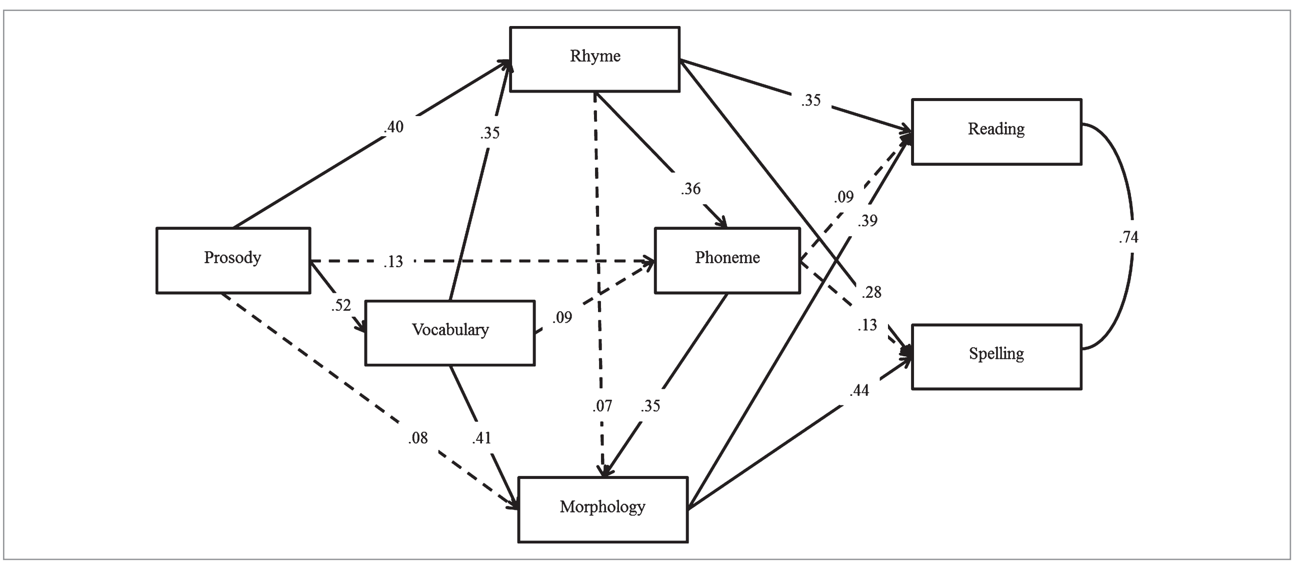
Model 1 (Wood et al., 2009; see Figure 1) failed to fit the data as indicated by all fit indexes: χ^2 = 47.974, df = 8, p = .001, CFI = 0.850, TLI = 0.606, RMSEA = 0.258, SRMR = 0.132. Results revealed that all but two of the specified paths (phoneme → word reading and phoneme → spelling) were significant, whereas the model modification indexes suggested that two additional paths, between vocabulary and morphology (modification index = 17.477) and phoneme and morphology (modification index = 10.164), would improve model fit. Both of the recommended additional paths were proposed a priori in the development of model 2

FIGURE 3
Path Analysis Results for Model 1



Note. Nonsignificant paths are represented by dashed lines.

FIGURE 4
Path Analysis Results for Model 2



Note. Nonsignificant paths are represented by dashed lines.

(see Figure 2). Model 1 with standardized parameter estimates is displayed in Figure 3.

Path Analysis of Model 2

Model 2 differed from model 1 by the inclusion of four additional paths: rhyme to phoneme and rhyme, vocabulary, and phoneme to morphology. Model 2 provided an excellent fit to the data (χ^2 = 6.319, *df* = 4, *p* = .176, CFI = 0.991, TLI = 0.954, RMSEA = 0.088, SRMR = 0.033) and accounted for 50% of the variance in word reading scores and 51.8% of the variance in spelling scores. The model is presented with standardized parameter estimates in Figure 4. In total, there were six nonsignificant paths (represented by dashed lines in Figure 4), four of which involved phoneme. Three of the newly proposed parameters were supported (with the exception of rhyme to morphology). No modification indexes were suggested.

Discussion

The study set out to elucidate the relationship between prosodic sensitivity and literacy development by first testing the model proposed by Wood et al. (2009) and then testing a modified version of this model that was designed to overcome some of the limitations in the original and focus on the mediating role of morphological processes. These will be addressed and discussed in turn.

The path analysis testing of model 1 very clearly demonstrated that the proposed pathways involving links between prosody and both word reading and spelling via vocabulary, rhyme, phoneme, and morphology were far too simplistic and therefore not a good fit for the data. It therefore became apparent that the modifications to this original model proposed in model 2 were going to prove vital in understanding this complex relationship, and indeed this was the case, as the path analysis testing confirmed an excellent fit.

So, when examining model 2, the interrelating pathways provide strong insight into the nature of the effect that prosody has on literacy—at this age range, certainly. As expected (from both models), vocabulary is a key mediator in the influence that prosody has; prosody acts through it to further influence both rhyme and morphology, which directly link to both word reading and spelling. This pathway from prosody to vocabulary supports notions of the periodicity bias (Cutler & Mehler, 1993), where children are sensitive to the rhythmic properties of speech, thus leading to spoken word recognition and vocabulary development.

The pathway from prosody to vocabulary and then to phonological awareness (in the form of rhyme and phoneme) was supported by Walley (1993) and was also proposed by both models. The link to rhyme was found in model 2, supporting previous findings (Avons et al., 1998; Metsala, 1999) and suggesting that prosody (via vocabulary) has a key role to play in very early or implicit phonological awareness. However, surprisingly, a link between vocabulary and phoneme was not found, contradicting previous findings (McBride-Chang, Cho, et al., 2005; McBride-Chang, Wagner, et al., 2005) and perhaps suggesting that prosody does not act via vocabulary to influence explicit phonological awareness (phoneme). Indeed, model 2 suggests that prosody may instead link to phoneme via rhyme, which will be discussed in more depth. Furthermore, in reference to predictions made by both models, a pathway from prosody to rhyme was also confirmed, again suggesting that important influence on implicit phonological awareness. Finally, rhyme, in turn, then directly predicts both word reading and spelling, supporting previous research (e.g., Anthony & Lonigan, 2004).

Now the focus turns specifically to the success of modifications proposed in model 2. The first modification suggested a pathway from vocabulary to morphology, and this was found, supporting previous literature on children's spelling and suggesting that children's vocabulary or word-specific knowledge can precede and predict explicit knowledge of morphemes (e.g., Chliounaki & Bryant, 2007; Kemp & Bryant, 2003; McBride-Chang et al., 2008; Nunes et al., 1997). However, as acknowledged earlier, there is such a strong relationship between vocabulary and morphology that, in fact, it is likely to be bidirectional (McBride-Chang, Wagner, et al., 2005), and therefore the direction of the relationship may shift developmentally over time. Furthermore, although the direction found in model 2 might contradict findings that morphology predicts vocabulary (e.g., Anglin, 1993; Graves, 1986; Naigles, 1990; White et al., 1989) via syntactic bootstrapping (Brown, 1957), again it would not be surprising if this was the case when testing children of an older age group when morphological awareness starts to have more of an obvious impact on the sophistication of both oral and written language.

The second major modification included in model 2 was a pathway from rhyme to phoneme, and again this was supported by the path analysis testing. Rhyme is considered to be an implicit form of phonological awareness and therefore likely to develop before phoneme, considered to be an explicit form of phonological awareness (Ellis, 1997; Ziegler & Goswami, 2005), which is dependent on formalized instruction in school for development and therefore a more difficult task for young children to do (Kirby et al., 2008). Another reason why support for this particular pathway is so important is that only two pathways involving phoneme were actually found to be significant contributors to model 2: this link from rhyme to phoneme and the link from phoneme to morphology, which will be discussed in more depth. Therefore, as hinted at earlier, this pathway from rhyme to phoneme is vital for understanding how prosody acts on phonological awareness; the major influence is on the implicit form (rhyme), which directly predicts word reading and spelling and also lays the foundations for development of the explicit form (phoneme) once formal instruction is introduced to children.

Following directly on from this point is the third modification proposed in model 2, suggesting that both aspects of segmental phonology (rhyme and phoneme) would have pathways to morphology. The path analysis testing supported this prediction in part because although no direct link from rhyme to morphology was found, there is a significant pathway from phoneme to morphology. Therefore, although phoneme did not directly predict word reading and spelling (a surprising result, although not an artifact of the task according to the distributions), it predicts morphology, which in turn is predictive of literacy. Therefore, morphology, like rhyme, is emerging as a strong mediator between prosody and both word reading and spelling via vocabulary and phoneme.

Previous findings widely suggested that phoneme would predict morphology, including classic models of literacy (e.g., Ehri, 1998, 1999, 2000; Frith, 1985) and studies of spelling development (Critten et al., 2007; Nunes et al., 1997), because children implement knowledge of phonology first in reading (grapheme–phoneme correspondences) and spelling (phoneme–grapheme correspondences) before gaining explicit awareness and understanding of the regularity of morphemes across the orthography and the contribution they make to meaning, such as inflectional marking of tense and plurality and derivational marking of changes to word class. However, it should be noted from the correlational findings that phoneme still significantly related to both word reading and spelling. Therefore, the relationship that previous research found still occurred in this study, but its predictive influence on word reading and spelling may be occurring via the morphological mediator. Furthermore, morphology predicted word reading and spelling as expected from previous research (see Green, 2009, for a review).

Overall, it can be seen that model 2 was very successful in explaining the relationship between prosodic sensitivity and literacy via a complex pattern of interrelationships between vocabulary, rhyme, phoneme, and morphology. Indeed, although the challenge in developing this model was deciding the direction of the pathways due to the bidirectional associations of many of these factors, it certainly seems a suitable way of understanding the influence of prosodic sensitivity for the age of the children in this study (5–7 years). It could be argued that given the amount of development that occurs between the ages of 5 and 7, the age range considered within this model is too broad. However, it should be acknowledged that all of the significant correlations between the variables in this study remained so after controlling for age. Furthermore, although examinations of different age groups may uncover different pathways, a clear implication of this study is the strong mediating influence that morphology exerts in the relationship between prosodic sensitivity and both word reading and spelling. This relationship has not received the amount of attention that, say, vocabulary has merited as a mediator between prosodic sensitivity and phonological awareness.

Limitations and Future Directions

There are several limitations in the research reported here that will now be acknowledged. First, it was regrettable that the internal reliability for the measure of prosodic sensitivity was only moderate (Cronbach's $\alpha = .63$); however, it should also be noted that there are few (if any) highly reliable measures of prosodic sensitivity for children of this age. Furthermore, in testing the predictions made by the original model, we needed to use a measure that captured all aspects of prosodic sensitivity: stress, intonation, and timing. There was no existing measure that satisfied this remit, and thus the present measure was developed for the study. Therefore, although we acknowledge that moderate reliability may be potentially problematic in path analyses where a single measure is used for each construct (as is done here) because measurement error cannot be accounted for, we have certainly made progress in capturing and testing this type of prosodic sensitivity compared with previous studies. To validate our findings, future research will require more reliable and valid composite assessments of prosodic sensitivity and also include multiple measures for each construct.

This leads directly into further consideration of what multiple measures for each construct might comprise. For instance, the spelling measure chosen for this study simply offered a standardized view of spelling accuracy, which was adequate for our purposes. However, this measure did not discriminate between phonological errors (e.g., spelling *cat* as *kt*) and nonphonetic errors (e.g., spelling *cat* as *mb*); both types of errors would be marked as incorrect, yet the phonological and orthographic knowledge demonstrated would appear quite different. Therefore, multiple measures for a spelling construct could also incorporate the sophistication or approximation of children's spelling errors alongside single-word accuracy measures. Similarly, a reading construct could involve both word reading and passage reading measures.

Caution is also offered with respect to the direction of the pathways posited in the modified model. As noted previously, deciding the direction of the pathways was difficult given that many of the associations between variables are likely to be bidirectional depending on the exact point of development. We made efforts to conceptualize a model that was appropriate for the age of the children in this particular study based on the available literature; however, it remains plausible that the complex causal directions between variables may not have been fully captured in this model. Furthermore, because the design of this study was correlational, using concurrent data only, it is also inadequate for establishing cause–effect relationships.

Further research using longitudinal studies with autoregressive techniques and cross-lagged analyses would allow us to test our hypotheses about the likely cause–effect relationships between prosodic sensitivity, vocabulary, phonological, and morphological awareness variables and children's literacy and whether these patterns shift at different points in development. Another design possibility is to consider cause–effect relationships from the perspective of the impact of interventions. The pedagogic potential of future research is subsequently considered more fully, but another advantage of interventions comprising prosodic sensitivity is the opportunity to analyze whether gains in prosodic sensitivity predict gains in reading and spelling via the relationships with vocabulary, phonological awareness, and morphological awareness suggested by the model. Alternatively, it may also be true that improving reading and spelling by the use of more standard phonologically based approaches actually then produces comparable gains in prosodic sensitivity. Many questions, therefore, remain for future research about cause–effect relationships.

Finally, and as stated previously, the analyses reported here combined children between the ages of 5 and 7 years old, and this age range might be considered too broad, particularly at this stage of development. Although we provided some justification for doing this, future attempts at replication might analyze each year of age/grade separately; regrettably, we were unable to do this in the present study due to a limited sample size.

Conclusions

The most important implication of the study is that given the influence of prosodic sensitivity on both word reading and spelling, this predictive factor should be afforded greater importance in models of literacy development. The focus is often strongly on segmental phonological awareness, and what our model shows is the sheer depth and breadth of complexity in the relationship between oral and written language in that phonological awareness only exerts such an influence because of its connections with prosody (suprasegmental phonology), vocabulary, and morphology, and this complexity should be acknowledged.

From a pedagogical perspective, there are three areas where this greater understanding of prosodic sensitivity and literacy may be of benefit:

1. Using measures of prosodic sensitivity to identify young children who may be at risk of later reading difficulties, given that it develops (and is measurable) earlier on in child development than most other skills (e.g., segmental phonological awareness)
2. Incorporating awareness of prosodic sensitivity (alongside segmental instruction) into early reading instruction methods to help support developing phonological representations (Goswami et al., 2013)
3. Developing interventions for struggling readers and spellers based around prosodic sensitivity because this may help those who have not benefited from segmental approaches (Torgesen, 2000)

Members of our research team (e.g., Harrison, Wood, Holliman, & Vousden, 2014) are currently making progress regarding this final point, demonstrating that prosodic sensitivity interventions can be just as effective as segmentally based approaches for improving reading.

Furthermore, because this model is ripe for further replication, we hope that discussion of the roles of prosodic sensitivity and morphology in reading and spelling will be stimulated as a result.

REFERENCES

Anglin, J.M. (1993). Vocabulary development: A morphological analysis. *Monographs of the Society for Research in Child Development*, *58*(10).

Anthony, J.L., & Lonigan, C.J. (2004). The nature of phonological awareness: Converging evidence from four studies of preschool and early grade school children. *Journal of Educational Psychology*, *96*(1), 43–55. doi:10.1037/0022-0663.96.1.43

Avons, S.E., Wragg, C.A., Cupples, L., & Lovegrove, W.J. (1998). Measures of phonological short-term memory and their relationship to vocabulary development. *Applied Psycholinguistics*, *19*(4), 583–601. doi:10.1017/S0142716400010377

Beech, J.R. (2005). Ehri's model of phases of learning to read: A brief critique. *Journal of Research in Reading*, *28*(1), 50–58.

Bentler, P.M., & Bonett, D.G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, *88*(3), 588–606. doi:10.1037/0033-2909.88.3.588

Bradley, L., & Bryant, P.E. (1983). Categorizing sounds and learning to read: A causal connection. *Nature*, *301*, 419–421. doi:10.1038/301419a0

Brown, R.W. (1957). Linguistic determinism and the part of speech. *The Journal of Abnormal and Social Psychology*, *55*(1), 1–5. doi:10.1037/h0041199

Browne, M.W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K.A. Bollen & J.S. Long (Eds.), *Testing structural equation models* (pp. 136–162). Beverly Hills, CA: Sage.

Bus, A.G., & van IJzendoorn, M.H. (1999). Phonological awareness and early reading: A meta-analysis of experimental training studies. *Journal of Educational Psychology*, *91*(3), 403–414. doi:10.1037/0022-0663.91.3.403

Cain, K. (2010). *Reading development and difficulties*. Oxford, UK: BPS Blackwell.

Carlisle, J.F. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics*, *9*(3), 247–266. doi:10.1017/S0142716400007839

Carlisle, J.F. (1995). Morphological awareness and early reading achievement. In L.B. 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*(3), 169–190. doi:10.1023/A:1008131926604

Chiat, S. (1983). Why Mikey's right and my key's wrong: The significance of stress and word boundaries in a child's output system. *Cognition*, *14*(3), 275–300. doi:10.1016/0010-0277(83)90007-0

Chliounaki, K., & Bryant, P. (2007). How children learn about morphological spelling rules. *Child Development*, *78*(4), 1360–1373. doi:10.1111/j.1467-8624.2007.01070.x

Clin, E., Wade-Woolley, L., & Heggie, L. (2009). Prosodic sensitivity and morphological awareness in children's reading. *Journal of Experimental Child Psychology*, *104*(2), 197–213. doi:10.1016/j.jecp.2009.05.005

Critten, S., Pine, K.J., & Steffler, D. (2007). Spelling development in young children: A case of representational redescription? *Journal of Educational Psychology*, *99*(1), 207–220. doi:10.1037/0022-0663.99.1.207

Cutler, A., & Mehler, J. (1993). The periodicity bias. *Journal of Phonetics*, *21*, 103–108.

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*(2), 223–238. doi:10.1017/S0142716404001110
Duncan, L.G., Casalis, S., & Cole, P. (2009). Early metalinguistic awareness of derivational morphology: Observations from a comparison of English and French. *Applied Psycholinguistics*, *30*(3), 405–440. doi:10.1017/S0142716409090213
Dunn, L.M., Dunn, L.M., Whetton, C., & Burley, J. (1997). *British Picture Vocabulary Scales II*. Windsor, UK: NFER-Nelson.
Egan, J., & Pring, L. (2004). The processing of inflectional morphology: A comparison of children with and without dyslexia. *Reading and Writing*, *17*(6), 567–591. doi:10.1023/B:READ.0000044433.30864.23
Ehri, L.C. (1997). Sight word learning in normal readers and dyslexics. In B. Blachman (Ed.), *Foundations of reading acquisition and dyslexia: Implications for early intervention* (pp. 163–190). Mahwah, NJ: Erlbaum.
Ehri, L.C. (1998). Word reading by sight and by analogy in beginning readers. In C. Hulme & M. Joshi (Eds.), *Reading and spelling: Development and disorders* (pp. 87–112). Mahwah, NJ: Erlbaum.
Ehri, L.C. (1999). Phases of development in learning to read words. In J. Oakhill & R. Beard (Eds.), *Reading development and the teaching of reading: A psychological perspective* (pp. 79–108). Oxford, UK: Blackwell.
Ehri, L.C. (2000). Learning to read and learning to spell: Two sides of a coin. *Topics in Language Disorders*, *20*(3), 19–36. doi:10.1097/00011363-200020030-00005
Elliot, C.D., Smith, P., & McUlloch, K. (1996). *British Ability Scales II*. Windsor, UK: NFER-Nelson.
Ellis, N. (1997). Interactions in the development of reading and spelling: Stages, strategies and exchange of knowledge. In L. Rieben, C.A. Perfetti, & M. Fayol (Eds.), *Learning to spell: Research, theory and practice across languages* (pp. 271–294). Mahwah, NJ: Erlbaum.
Fowler, A.E., & Liberman, I.Y. (1995). The role of phonology and orthography in morphological awareness. In L.B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 157–188). Mahwah, NJ: Erlbaum.
Frederickson, N., Frith, U., & Reason, R. (1997). *Phonological Assessment Battery*. Windsor, UK: NFER-Nelson.
Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. Patterson, M. Coltheart, & J. Marshall (Eds.), *Surface dyslexia: Neuropsychological and cognitive studies of phonological reading* (pp. 301–330). Hillsdale, NJ: Erlbaum.
Gleitman, L.R. (1990). The structural sources of verb meaning. *Language Acquisition*, *1*(1), 3–55. doi:10.1207/s15327817la0101_2
Gleitman, L.R., & Gleitman, H. (1992). A picture is worth a thousand words, but that's the problem: The role of syntax in vocabulary acquisition. *Current Directions in Psychological Science*, *1*(1), 31–35. doi:10.1111/1467 8721.ep10767853
Goswami, U. (2003). How to beat dyslexia. *The Psychologist*, 16(9), 462–465.
Goswami, U., Gerson, D., & Astruc, L. (2010). Amplitude envelope perception, phonology and prosodic sensitivity in children with developmental dyslexia. *Reading and Writing*, *23*(8), 995–1019. doi:10.1007/s11145-009-9186-6
Goswami, U., Mead, N., Fosker, T., Huss, M., Barnes, L., & Leong, V. (2013). Impaired perception of syllable stress in children with dyslexia: A longitudinal study. *Journal of Memory and Language*, *69*(1), 1–17. doi:10.1016/j.jml.2013.03.001
Goswami, U., Thomson, J., Richardson, U., Stainthorp, R., Hughes, D., Rosen, S., & Scott, S.K. (2002). Amplitude envelope onsets and developmental dyslexia: A new hypothesis. *Proceedings of the National Academy of Sciences of the United States of America*, *99*(16), 10911–10916. doi:10.1073/pnas.122368599
Graves, M.F. (1986). Vocabulary learning and instruction. In E.Z. Rothkopf (Ed.), *Review of research in education* (Vol. 13, pp. 49–89). Washington, DC: American Educational Research Association.
Green, L. (2009). Morphology and literacy: Getting our heads in the game. *Language, Speech, and Hearing Services in Schools*, *40*, 283–285. doi:10.1044/0161-1461(2009/08-0091
Harrison, E., Wood, C., Holliman, A., & Vousden, J. (2014). *The immediate and longer term effectiveness of a speech rhythm-based reading intervention in beginning readers*. Manuscript submitted for publication.
Holliman, A.J., Williams, G.J., Mundy, I.R., Wood, C., Hart, L., & Waldron, S. (2014). Beginning to disentangle the prosody–literacy relationship: A multi-component measure of prosodic sensitivity. *Reading and Writing*, *27*(2), 255–266. doi:10.1007/s11145-013-9443-6
Holliman, A.J., Wood, C., & Sheehy, K. (2008). Sensitivity to speech rhythm explains individual differences in reading ability independently of phonological awareness. *British Journal of Developmental Psychology*, *26*(3), 357–367. doi:10.1348/026151007X241623
Holliman, A.J., Wood, C., & Sheehy, K. (2010a). Does speech rhythm sensitivity predict children's reading ability 1 year later? *Journal of Educational Psychology*, *102*(2), 356–366. doi:10.1037/a0018049
Holliman, A.J., Wood, C., & Sheehy, K. (2010b). The contribution of sensitivity to speech rhythm and non-speech rhythm to early reading development. *Educational Psychology*, *30*(3), 247–267. doi:10.1080/01443410903560922
Holliman, A.J., Wood, C., & Sheehy, K. (2012). A cross-sectional study of prosodic sensitivity and reading difficulties. *Journal of Research in Reading*, *35*(1), 32–48. doi:10.1111/j.1467-9817.2010.01459.x
Hu, L.T., & Bentler, P.M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods*, *3*(4), 424–453. doi:10.1037/1082-989X.3.4.424
Hu, L.T., & Bentler, P.M. (1999). Cut-off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1–55. doi:10.1080/10705519909540118
Jarmulowicz, L., & Taran, V.L. (2013). Lexical morphology: Structure, process, and development. *Topics in Language Disorders*, *33*(1), 57–72. doi:10.1097/TLD.0b013e318280f5c0
Jusczyk, P.W. (1999). How infants begin to extract words from speech. *Trends in Cognitive Sciences*, *3*(9), 323–328. doi:10.1016/S1364-6613(99)01363-7
Kemp, N., & Bryant, P. (2003). Do beez buzz? Rule-based and frequency-based knowledge in learning to spell plural -s. *Child Development*, *74*(1), 63–74. doi:10.1111/1467-8624.00521
Kieffer, M.J., & Lesaux, N.K. (2012). Knowledge of words, knowledge about words: Dimensions of vocabulary in first and second language learners in sixth grade. *Reading and Writing*, *25*(2), 347–373. doi:10.1007/s11145-010-9272-9
Kirby, J.R., Desrochers, A., Roth, L., & Lai, S.S.V. (2008). Longitudinal predictors of word reading development. *Canadian Psychology*, *49*(2), 103–110. doi:10.1037/0708-5591.49.2.103
Kitzen, K.R. (2001). *Prosodic sensitivity, morphological ability, and reading ability in young adults with and without childhood histories of reading difficulty* (Unpublished doctoral dissertation). New York, NY: Columbia University.
Leong, V., Hämäläinen, J., Soltész, F., & Goswami, U. (2011). Rise time perception and detection of syllable stress in adults with developmental dyslexia. *Journal of Memory and Language*, *64*(1), 59–73. doi:10.1016/j.jml.2010.09.003
Mann, V.A. (2000). Introduction to special issue on morphology and the acquisition of alphabetic writing systems. *Reading and Writing*, *12*(3), 143–147. doi:10.1023/A:1008190908857

McBride-Chang, C., Cho, J.-R., Liu, H., Wagner, R.K., Shu, H., Zhou, A., … Muse, A. (2005). Changing models across cultures: Associations of phonological awareness and morphological structure awareness with vocabulary and word recognition in second graders from Beijing, Hong Kong, Korea, and the United States. *Journal of Experimental Child Psychology*, *92*(2), 140–160. doi:10.1016/j.jecp.2005.03.009

McBride-Chang, C., Tardif, T., Cho, J.-R., Shu, H., Fletcher, P., Stokes, S.F., … Leung, K. (2008). What's in a word? Morphological awareness and vocabulary knowledge in three languages. *Applied Psycholinguistics*, *29*(3), 437–462. doi:10.1017/S014271640808020X

McBride-Chang, C., Wagner, R.K., Muse, A., Chow, B.W.-Y., & Shu, H. (2005). The role of morphological awareness in children's vocabulary acquisition in English. *Applied Psycholinguistics*, *26*(3), 415–435. doi:10.1017/S014271640505023X

Metsala, J.L. (1999). Young children's phonological awareness and nonword repetition as a function of vocabulary development. *Journal of Educational Psychology*, *91*(1), 3–19. doi:10.1037/0022-0663.91.1.3

Nagy, W. (2007). Metalinguistic awareness and the vocabulary–comprehension connection. In R.K. Wagner, A.E. Muse, & K.R. Tennenbaum (Eds.), *Vocabulary acquisition: Implications for reading comprehension* (pp. 52–77). New York, NY: Guilford.

Naigles, L. (1990). Children use syntax to learn verb meanings. *Journal of Child Language*, *17*(2), 357–374. doi:10.1017/S0305000900013817

Nunes, T., & Bryant, P. (2009). *Children's reading and spelling: Beyond the first steps*. Oxford, UK: Wiley-Blackwell.

Nunes, T., Bryant, P., & Bindman, M. (1997). Morphological spelling strategies: Developmental stages and processes. *Developmental Psychology*, *33*(4), 637–649. doi:10.1037/0012-1649.33.4.637

Protopapas, A., Gerakaki, S., & Alexandri, S. (2006). Lexical and default stress assignment in reading Greek. *Journal of Research in Reading*, *29*(4), 418–432. doi:10.1111/j.1467-9817.2006.00316.x

Sacre, L., & Masterson, J. (2000). *Single Word Spelling Test*. London, UK: NFER-Nelson.

Schwanenflugel, P.J., Hamilton, A.M., Kuhn, M.R., Wisenbaker, J.M., & Stahl, S.A. (2004). Becoming a fluent reader: Reading skill and prosodic features in the oral reading of young readers. *Journal of Educational Psychology*, *96*(1), 119–129. doi:10.1037/0022-0663.96.1.119

Scott, S.K. (1998). The point of P-centres. *Psychological Research*, *61*(1), 4–11. doi:10.1007/PL00008162

Singson, M., Mahoney, D., & Mann, V. (2000). The relation between reading ability and morphological skill: Evidence from derivational suffixes. *Reading and Writing*, *12*(3), 219–252. doi:10.1023/A:1008196330239

Snowling, M.J. (2000). *Dyslexia* (2nd ed.). Malden, MA: Blackwell.

Spence, S.H. (1997). Structure of anxiety symptoms among children: A confirmatory factor-analytic study. *Journal of Abnormal Psychology*, *106*(2), 280–297. doi:10.1037/0021-843X.106.2.280

Torgesen, J.K. (2000). Individual differences in response to early interventions in reading: The lingering problem of treatment resisters. *Learning Disabilities Research & Practice*, *15*(1), 55–64. doi:10.1207/SLDRP1501_6

Vellutino, F.R., & Fletcher, J.M. (2005). Developmental dyslexia. In M.J. Snowling & C. Hume (Eds.), *The science of reading: A handbook* (pp. 362–378). Oxford, UK: Blackwell. doi:10.1002/9780470757642.ch19

Walley, A.C. (1993). The role of vocabulary development in children's spoken word recognition and segmentation ability. *Developmental Review*, *13*(3), 286–350. doi:10.1006/drev.1993.1015

Wennerstrom, A.K. (2001). *Music of everyday speech: Prosody and discourse analysis*. New York, NY: Oxford University Press.

Whalley, K., & Hansen, J. (2006). The role of prosodic sensitivity in children's reading development. *Journal of Research in Reading*, *29*(3), 288–303. doi:10.1111/j.1467-9817.2006.00309.x

White, T.G., Power, M.A., & White, S. (1989). Morphological analysis: Implications for teaching and understanding vocabulary growth. *Reading Research Quarterly*, *24*(3), 283–304. doi:10.2307/747771

Wood, C. (1999). The contribution of analogical problem solving and phonemic awareness to children's ability to make orthographic analogies when reading. *Educational Psychology*, *19*(3), 277–286. doi:10.1080/0144341990190303

Wood, C. (2006). Metrical stress sensitivity in young children and its relationship to phonological awareness and reading. *Journal of Research in Reading*, *29*(3), 270–287. doi:10.1111/j.1467-9817.2006.00308.x

Wood, C., Wade-Woolley, L., & Holliman, A.J. (2009). Phonological awareness: Beyond phonemes. In C. Wood & V. Connelly (Eds.), *Contemporary perspectives on reading and spelling* (pp. 7–23). London, UK: Routledge.

Zhang, J., & McBride-Chang, C. (2010). Auditory sensitivity, speech perception, and reading development and impairment. *Educational Psychology Review*, *22*(3), 323–338. doi:10.1007/s10648-010-9137-4

Ziegler, J., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin*, *131*(1), 3–29.

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