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A Longitudinal Investigation of Prosodic Sensitivity and Emergent Literacy

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Abstract

Prosodic sensitivity – the rhythmic patterning of speech – is theorized to influence reading and spelling via vocabulary knowledge, phonological, and morphological awareness. Previously this conceptual model has been evidenced with children who can already read, however as orthographic knowledge can be used to complete phonological awareness tasks it cannot be said definitively that it is prosodic sensitivity influencing reading and spelling and not the reverse. Therefore, the present study sought to test the model in a longitudinal study conducted at the outset of reading development. A sample of 4- to 5-year-old English-speaking children (*N* = 101) were assessed for their prosodic sensitivity, vocabulary knowledge, phonological and morphological awareness, and one year later (*N* = 93) for their word reading and spelling. A path analysis revealed that the conceptual model provides an adequate fit to our sample data: prosodic sensitivity in pre-reading children predicts reading and spelling indirectly through other emergent literacy skills. The implications of these findings are discussed in relation to models of literacy development and literacy instruction.

Keywords: literacy, phonology, prosody, prosodic sensitivity, rhythm

Introduction

Research over the past few decades has shown that phonological awareness – that is, the ability to identify and manipulate the sounds in words at the level of the syllable, rhyme, and phoneme – is strongly associated with reading development (see Melby-Lervag, Lyster, & Hulme, 2012). The vast majority of this research evidence emerges from studies assessing children's awareness of phonological 'segments' such as phonemes (segmental phonological awareness). However recent research has demonstrated that 'suprasegmental' phonological awareness or 'prosodic' sensitivity can make independent contributions to children's reading even when segmental phonological awareness has been controlled for (see Wade-Woolley & Heggie, 2016, for review). Furthermore, initial modelling studies have shown that variables such as vocabulary, segmental phonological awareness and morphological awareness might mediate the relationship between prosodic sensitivity and children's reading and spelling abilities (e.g., Holliman, Critten, et al., 2014).

What is unknown however is how prosodic sensitivity abilities in pre-readers may influence the later development of reading and spelling. In the present study, we employ a longitudinal design to test the conceptual model of Holliman, Critten et al. (2014) to measure the prosodic sensitivity abilities of 4- to -5-year-old pre-readers and then examine its relation with reading and spelling one year later. Given that this skill – prosodic sensitivity – develops prior to formal reading instruction (Rago, Honbolygo, Rona, Beke, & Csepe, 2014) this research may have important educational implications regarding how best to support the development of emergent literacy skills in young children.

Prosody, which is bound up with suprasegmental phonology, refers to the acoustic pattern of the speech stream i.e., intonation, volume, tempo, and rhythm

(Wennerstrom, 2001); these features carry information across segmental units such as phonemes, words, and phrases to convey information about the structure and meaning of an utterance.

Recent research has shown that sensitivity to speech prosody is implicated in successful literacy acquisition in different languages (e.g., Goswami, Gerson, & Astruc, 2010; Holliman, Critten, et al., 2014; Holliman, Gutiérrez Palma, et al., 2017; Holliman, Mundy, et al., 2017; Holliman, Williams, et al., 2014; Jiménez-Fernandez, Gutierrez-Palma, & Defior, 2015; Leong & Goswami, 2014; Lin, Wang, Newman, & Li, 2018; Lundetræ, K., & Thomson, 2018; see also Calat, Gutiérrez Palma, Defior, & Jiménez-Fernández, 2019; Goswami, Mead, Fosker, Huss, Barnes, & Leong, 2013 for children with dyslexia). Indeed, some of these studies have gone further and shown that prosodic sensitivity can make an independent contribution to reading (see Wade-Woolley & Heggie, 2016, for review). In the most comprehensive study of this nature Holliman, Gutiérrez Palma, et al. (2017) found an independent contribution of prosodic sensitivity to reading after individual differences in vocabulary, segmental phonological awareness and morphological awareness had been controlled.

Alongside this work has been a parallel focus on disentangling the mediating role that vocabulary, segmental phonological awareness and morphological awareness play in the relationship between prosodic sensitivity and literacy (e.g., Calet, Gutierrez-Palma, Simpson, Gonzalez-Trujillo, & Defior, 2015; Holliman, Critten, et al., 2014; Kim & Petscher, 2016). Taken together it can be concluded that prosodic sensitivity influences reading and/or spelling development both directly and via other associated oral language abilities.

Evidence is accumulating to suggest that prosodic sensitivity plays an important role in literacy development. However, the aforementioned studies have mostly tested typically developing children who are already literate, i.e., can read and spell or are at least starting to read a few rudimentary words. This makes understanding the prosody-literacy relation more complex as children can use their orthographic knowledge to complete phonological awareness tasks (Castles & Coltheart, 2004). Therefore, it cannot be said definitively that prosodic sensitivity abilities are influencing literacy, it may be that literacy abilities are enabling children to complete the prosodic sensitivity tasks. Indeed, when reading we are sensitive to the orthographic correlates of lexical stress (e.g., Arciuli & Cupples, 2006; Kelly, Morris & Verrekia, 1998). For example, words that show consistency between how they are spelled and their stress structure are processed more easily in naming and lexical decision tasks (Kelly et al. 1998). Thus, showing that the processing of orthographic markers when reading could feedback and support prosodic sensitivity.

A bi-directional relation between segmental phonological awareness and reading has previously been evidenced (e.g., Nation & Hulme, 2012) and it is plausible that a similar bi-directional relation occurs between prosodic sensitivity and reading. This is not problematic in itself; however, the nature of this relationship requires further elucidation if implications for the role of prosodic sensitivity in models of literacy development and literacy instruction are to be given credence. Furthermore, given the clear longitudinal evidence to suggest a relationship between segmental phonological awareness and reading and spelling in pre-readers (for review see Castles & Coltheart, 2004) an intuitive next step is to test the prosodic sensitivity abilities of pre-readers and follow up their reading and spelling abilities. This is particularly relevant as prosodic sensitivity develops prior to formal reading instruction (Rago et al. 2014).

As we explore these relations in pre-readers, we also consider just how prosodic sensitivity might influence word reading and spelling. The most prominent theoretical framework comes from Wood, Wade-Woolley and Holliman (2009). Based on an extensive review of the literature at the time, Wood et al. theorized the relation between prosodic sensitivity and children's word reading and spelling abilities as two possible, co-occurring routes. First as a direct route and second, an in-direct route mediated by each of vocabulary, phonological awareness (rhyme and phoneme) and morphological awareness. The latter route is the focus of this paper.

According to the model prosodic sensitivity predicts vocabulary as sensitivity to syllabic stress facilitates spoken word segmentation and recognition given that 85% of lexical words in English begin with a strong syllable (Cutler & Carter, 1987). In turn vocabulary supports the development of phonological awareness (Walley, 1993), which, in turn, supports written word recognition (e.g., Bus & van Ijzendoorn, 1999; Cain, 2010; Snowling, 2000).

Wood et al. (2009) also suggested that prosodic sensitivity might support phonological awareness directly. Sensitivity to stress might facilitate phoneme awareness given that phonemes and phoneme boundaries appear to be easier to perceive in stressed rather than unstressed syllables (e.g., Chiat, 1983; Kitzen, 2001). It might also support rhyme awareness (awareness of onset-rime boundaries) given that the peak of loudness in a syllable corresponds to vowel location (e.g., Scott, 1998) and may support decoding skill via analogical reasoning (see Goswami et al., 2002). As mentioned previously, segmental phonological awareness is widely implemented in successful reading and spelling development and both skills linked to prosody – phoneme and rhyme awareness – are highly correlated and implicated in the development of literacy (e.g., Anthony & Lonigan, 2004).

Finally, Wood et al. (2009) suggested that prosodic sensitivity may also predict morphological awareness. Sensitivity to stress might be combined with knowledge of morphological rules to decode multisyllabic words. For example, stress patterning in a multisyllabic word can depend in part on its suffix (see Carlisle, 2000). Suffixes such as “ity” and “ion”) result in a stress placement shift, so *eLECtric* becomes *elecTRICity*, while others (e.g., “ness”) do not. The recognition of the role of morphological awareness in literacy development is growing (e.g., Nunes & Bryant, 2009) and studies have demonstrated an independent contribution beyond phonological awareness to both reading (e.g., Kirby, Desrochers, Roth, & Lai, 2008) and spelling (e.g., Deacon, Kirby, & Casselman-Bell, 2009).

To our knowledge there has only been one empirical test of the Wood et al. (2009) model to date. Holliman, Critten et al. (2014) tested 75 five to seven-year-old children on measures of prosodic sensitivity, single-word reading and spelling and the four suggested mediating variables; vocabulary, segmental phonological awareness (rhyme and phoneme) and morphological awareness. Path Analysis modelling showed that this model was not a good fit leading the authors to re-conceptualise the Wood et al. theoretical framework.

They posited that the difficulty with the framework is that it did not take into account the possible inter-relationships between the mediating variables themselves. Therefore, major modifications were made to the model in the form of three new pathways. A link between vocabulary and morphological awareness was included, based on findings of these relations (e.g., Sparks & Deacon, 2015). A link between rhyme and phoneme level awareness was added acknowledging the likely developmental order of the acquisition of these aspects of segmental phonology (Kirby et al., 2008). Finally, segmental phonological awareness (rhyme and phoneme) was suggested to be connected to morphological awareness. Both theoretical models and a wealth of empirical studies has shown that segmental phonological awareness is the predominant force in initial reading and spelling while children tend to implement their knowledge of morphology later on (e.g., Critten, Pine & Steffler, 2007; Ehri, 1998, 1999, 2000; Frith, 1985; Nunes, Bryant, & Bindman, 1997). For a thorough theoretical justification of these model modifications please see Holliman, Critten et al. (2014).

This modified model provided an excellent fit to the sample data; please see Figure 1 for the path analysis results. The major findings were as follows: 1. Prosodic sensitivity predicted rhyme, both directly and indirectly via vocabulary and in turn rhyme predicted reading and spelling; 2. Vocabulary directly and rhyme (via phoneme awareness) predicted morphological awareness, which in turn predicted reading and spelling. These results confirmed the important mediating role of vocabulary and segmental phonological awareness (rhyme) in the relationship between prosodic sensitivity and literacy. The role of morphological awareness was also highlighted, which was more unexpected given the relative neglect of this variable in the literature previously. However, the fact that there was no direct link from prosodic sensitivity to phoneme or from phoneme to reading and spelling was extremely surprising as acknowledged by the authors who also expressed concerns about the relatively low internal reliability for the prosodic sensitivity measure used.

Furthermore there was also some concern about the direction of the pathway from Vocabulary → Morphology as while this was supported by the findings of the Holliman, Critten et al. model and the aforementioned studies of spelling development there is also notable evidence for a pathway in the opposite direction. The syntactic boot-strapping hypothesis (e.g., Gleitman, 1990; Gleitman & Gleitman, 1992) suggests that children use their implicit knowledge of grammatical categories to narrow down the meaning of unfamiliar words, as demonstrated originally by Brown (1957; see also e.g., Anglin, 1993; Graves, 1986; Naigles, 1990; White, Power, & White, 1989). The model in the present study will therefore include a bi-directional pathway between vocabulary and morphology.

Holliman, Critten et al. (2014) made a notable start in trying to understand exactly how prosodic sensitivity may influence reading and spelling abilities. The aim of the present study was to apply their modified version of the Wood et al. (2009) theoretical model (with the newly introduced bi-directional pathway between vocabulary and morphology) and assess whether the prosodic sensitivity abilities of 4- to 5-year-old pre-reading children in Reception Year (the UK equivalent of Kindergarten in the US) predicts reading and spelling one year later. This design will go some way in controlling for the potential bi-directional relationship between prosodic sensitivity and reading and confirm the importance of prosodic sensitivity for both models of literacy development and literacy instruction. Finally, it can also be seen whether the relative null findings with phoneme in the Holliman, Critten, et al. study will be replicated in this younger age group.

Method

Participants

Participants in this study (N = 101, 64 males) were recruited from three primary schools in the West Midlands, UK. The level of Social Economic Status of participating schools were similar to reported averages of other English mainstream schools in terms of pupils eligible for free school meals (a strong indicator of SES in the UK). The three schools were comparable in terms of locality, proportion of males to females, and percentage of pupils with additional education requirements, although one school had a lower percentage of pupils receiving free school meals, a higher percentage of pupils achieving government set standards in English and Mathematics, and a higher Ofsted Inspection outcome (http://www.education.gov.uk/schools/performance/). Children were aged between 4 years 3 months and 5 years 2 months (mean age 4 years 8 months; standard deviation = 0 years and 3 months) in Reception Year; the UK equivalent of Kindergarten in the US. All children spoke English as their first language and were classified as 'pre-readers' in the emergent phase of reading development (pre-literacy) on the basis that they likely had some knowledge of print and sound, but were unable to read a single word on the British Ability Scales III Word Reading subtest (Elliott & Smith, 2011). At follow-up one-year later, participating children (N = 93, 59 males, attrition rate = 8%) were aged between 5 years 3 months and 6 years 5 months (mean age 5 years 9 months; standard deviation = 0 years and 4 months) in Year 1; the UK equivalent of Grade 1 in the US. There were no significant differences between children who did and did not participate at follow-up on any of the measures taken in Reception Year one year earlier.

Measures

All criterion measures in this study were chosen on the basis that they are commonly used in the education and literacy field and have been standardized on UK and/or other English-speaking populations.

Vocabulary. Receptive vocabulary was measured using the British Picture Vocabulary Scales III (Dunn, Dunn, Styles, & Sewell, 2009). During this task, the administrator read a word orally and the child was required to point to the picture that best corresponded to the word from a choice of four pictures that were available.

Children received one point for each correct answer. Dunn et al. report that reliability is built into the confidence bands.

Rhyme awareness. Rhyme awareness was measured using the Rhyme Awareness subtest of the Preschool and Primary Inventory of Phonological Awareness (Dodd, Crosbie, McIntosh, Teitzel, & Ozanne, 2000). During this task, the administrator read four words orally that were also supported by four corresponding pictures and the child was required to identify the non-rhyming word (e.g., wall…fall…ball…cat). Children received one point for each correct answer. Dodd et al. report internal reliability (Cronbach's α) of .83.

Phoneme isolation. Phoneme isolation was measured using the Phoneme Isolation subtest of the Primary Inventory of Phonological Awareness (Dodd et al., 2000). During this task, the administrator read a word orally that was also supported by a corresponding picture and the child was required to orally produce the first sound (e.g., 'dog' would be /d/). Children received one point for each correct answer. Dodd et al. report internal reliability (Cronbach's α) of .92.

Morphological awareness. Morphological Awareness was measured using the Morphology Completion subtest of the Test of Oral Language Development: Primary – Fourth Edition (Newcomer & Hammill, 2008). During this task, the administrator read a sentence orally with the last word missing and the child was required to orally complete the sentence using the most appropriate morphological form. For example, if the administrator said 'Here's a cat. Over there are four more…' a correct response from the child would be 'cats'. Children received one point for each correct answer. Newcomer and Hammill report internal reliability (Cronbach's α) of between .91 and .94.

Word reading. Single word reading was measured using the Word Reading subtest of the British Ability Scales III (Elliott & Smith, 2011). During this task, children were required to read as many words orally as possible from a list of up to 90 words of increasing difficulty. Children received one point for each correct answer. Elliott and Smith report internal reliability (Cronbach's α) of .99.

Spelling. Single word spelling was measured using the Spelling subtest of the British Ability Scales III (Elliott & Smith, 2011). Children were required to write up to 75 single words that were orally presented by the administrator. Each word was presented three times: in isolation, in a sentence, then finally in isolation. Children received one point for each correct answer. Elliott and Smith report internal reliability (Cronbach's α) of .96.

Prosodic sensitivity. Prosodic sensitivity was measured using a newly developed task called Brenda's Animal Park (Holliman, Gutiérrez Palma, et al., 2017). This task was administered on a laptop using a Microsoft PowerPoint Presentation with audio files. During the task, children are asked to support the main character, Brenda, to solve four different kinds of 'problems' on the animal park – these 'problems' can be thought of as four subtests inspired by prior work (see Holliman, Gutiérrez Palma, et al., 2017) that collectively capture the full range of prosodic components.

Children were asked to decide: 1) whether they heard a single item compound noun (e.g., "butterfly") or a two-item noun phrase (e.g., "butter", "fly"); 2) whether or not a word was articulated correctly based on the stress pattern (e.g., "CROcodile" verses "croCOdile"); 3) whether they were being *asked* something, implied by a rise in intonation (e.g., '/the farmer gets up early'), or *told* something, implied by a fall in intonation (e.g., '\the farmer gets up early'); 4) which of two utterances matched a

"Ba-Ba" utterance based on the stress pattern; for example, BA ba BA (strong-weak-strong) would correspond with "apple pie" (strong-weak-strong) rather than "tomatoes" (weak-strong-weak). In line with prior work in this area (e.g., Holliman, Gutiérrez Palma, et al., 2017) performance in each subtest was pooled into a global measure of prosodic sensitivity. This task was also administered on two separate occasions in Reception Year (one month apart) to a small subsample of participants so that test-retest reliability could be calculated; this was found to be acceptable (r = .79). Internal reliability (Cronbach's α) was .91.

Procedure

Information sheets and opt-out 'assent' forms were sent to the parents of participating children via the school. In Reception Year, data were collected over a five month period from October to January by two experienced research assistants who were employed specifically for this purpose. The Reception Year assessments were administered in a fixed order (as far as this was feasible) over three sessions. In the first session, the BAS III Word Reading subtest was administered (as a screening tool in Reception Year to identify 'pre-literate' children) along with the new measure of prosodic sensitivity (Brenda's Animal Park). In the second session, the tasks from the Primary Inventory of Phonological Awareness (Rhyme Awareness and Phoneme Isolation) were presented in this fixed order. In the final session, participants completed the British Picture Vocabulary Scales III and the Morphology Completion subtest of the Test of Language Development: Primary – Fourth Edition in a randomized order. Participating children then completed the BAS III Word Reading and Spelling subtests one year later in Year 1 making every attempt to leave 12 months between testing periods.

Results

Table 1 shows the means and standard deviations for all of the assessments in this study. As 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. A chi-square analysis indicated that a significant number of participants were performing above chance on the measure of prosodic sensitivity, $x^2(1, N = 101) = 12.129, p < .001$. There was also substantial variability in performance on this measure. Further, it can be seen from Table 1 that sample performance on all standardized measures was in the expected normal range for the age of the children as confirmed by consulting the test manuals.

Modeling the Relations between Prosodic Sensitivity and Word Reading and Spelling

We first report on bivariate correlations (see Table 2). Prosodic sensitivity in Reception Year (Time 1) was found to correlate significantly with vocabulary, rhyme awareness, phoneme isolation, and morphological awareness measured concurrently and with word reading and spelling measured one year later (Time 2).

We then evaluated relations between prosodic sensitivity and word reading and spelling with path analyses. All modelled variables were examined for univariate normality (skewness and kurtosis). There were deviations from normality on several of the measures (see Table 1). Prosody and phoneme had a mild negative skew while morphology and reading had a mild positive skew. Accordingly, models were estimated using MLR which is robust under conditions of non-normality (Muthen & Muthen, 2010).

Models were assessed using a number of fit statistics in-line with accepted criteria (e.g., Hu & Bentler, 1998, 1999). For the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI), models were considered to adequately fit the data at values ≥.90 (Bentler & Bonett, 1980) with values >.95 preferred (Hu & Bentler, 1998, 1999). For the Standardised Root Mean Square Residual (SRMR) (Spence, 1997) and Root Mean Square Error of Approximation (RMSEA) (Browne & Cudeck, 1993), models were considered to adequately fit the data at values of ≤.08, with values ≤.05 preferred (Hu & Bentler, 1998, 1999).

The direct test of the conceptual model presented in Figure 2 included variables measured at Time 1 (Prosody, Vocabulary, Rhyme, Phoneme, and Morphology) and Time 2 (Reading and Spelling). The model provided an adequate fit to the data (x^2 = 2.403, *df* = 4, *p* = .662, CFI = 1, TLI = 1.037, RMSEA = 0, SRMR = .029) and accounted for 25.4% of the variance in Word Reading scores and 22.5% of the variance in Spelling scores. The model with standardized parameter estimates is presented in Figure 3. In total, there were eight non-significant paths, most of which involved Rhyme and Morphology. No modification indices were suggested.

Discussion

Previous research has shown that prosodic sensitivity is likely to influence reading and spelling abilities via mediating variables of vocabulary, segmental phonological awareness and morphological awareness. However, this research was conducted with children who were already literate and therefore the direction of influence between prosodic sensitivity and reading/spelling could be questioned. The aim of this study was to test empirically a recent conceptual model of the prosody-literacy relation (Holliman, Critten, et al., 2014) in pre-readers.

The path analysis results revealed that the conceptual model proposed by Holliman, Critten, et al. (2014) provides an adequate fit to our sample data, demonstrating that prosodic sensitivity in pre-reading children predicts word reading and spelling via its inter-relations with other emergent literacy skills. Specifically, prosody acts through vocabulary, rhyme, and morphology to further influence phoneme which directly predicts both word reading and spelling one year later. The present study validated this model in a younger age group with longitudinal data. However, it is important to draw attention to the fact that the routes by which prosody influenced word reading and spelling (while sharing some similarities) do indicate important differences to the Holliman, Critten, et al. (2014) findings (see Figure 1) and these will be explored below.

There are some pathways that have been maintained. Prosody still shows direct links to vocabulary and rhyme. Regarding vocabulary, this model has again supported the notion of the periodicity bias (Cutler & Mehler, 1993) showing that sensitivity to the rhythmic properties of speech may facilitate spoken word recognition and vocabulary development. Furthermore, the link with rhyme again confirms the role that prosody plays in the development of early segmental phonological awareness that is likely to be implicit in nature (Ellis, 1997; Ziegler & Goswami, 2005). Indeed, it has been suggested that prosody may promote the identification of onset-rime boundaries given that the peak of loudness in a syllable corresponds to vowel location (Scott, 1998) and may support decoding skill via analogical reasoning (e.g., Goswami, 2003; Goswami et al., 2002).

Regarding inter-relationships between rhyme, vocabulary, phoneme and morphology, rhyme still links to phoneme and the vocabulary and morphology pathway is also maintained albeit in the newly specified bi-directional relationship. The direction from rhyme to phoneme again supports the notion that within segmental phonological awareness, the implicit awareness of rhyme emerges first before influencing the development of the more explicit phoneme awareness that children acquire only following direct instruction programmes in school (Kirby et al., 2008).

Perhaps a more complex prospect is attempting to understand the vocabulary-morphology relationship as there are two plausible areas of research that would specify different directions for this pathway. The Holliman, Critten, et al. (2014) model found a link from vocabulary to morphology supporting findings from children's spelling development showing that children are first likely to spell morphologically complex words based on specific word knowledge rather than explicit awareness of the regularity and meaning of morphemes across the orthography (e.g., Chliounaki & Bryant, 2007; Kemp & Bryant, 2003; McBride-Chang, Tardif et al., 2008; Nunes et al., 1997). However the syntactic boot-strapping hypothesis (e.g., Gleitman, 1990; Gleitman & Gleitman, 1992) would suggest that morphology may actually predict vocabulary as children use their implicit knowledge of grammatical categories to narrow down the meaning of unfamiliar words (e.g., Anglin, 1993; Brown; 1957; Graves, 1986; Naigles, 1990; White, Power, & White, 1989). The modification to the Holliman, Critten, et al. model to introduce a bi-directional pathway has been supported accordingly in the present study.

However, there are also some key differences in the routes by which prosody influences word reading and spelling. First there is a newly established pathway from prosody to morphology that was not significant in the Holliman, Critten, et al. (2014) study. The authors had originally predicted this would be a significant pathway citing the importance of both prosodic sensitivity (especially stress assignment) and morphological awareness when reading multisyllabic words (e.g., Clin et al., 2009; Nunes & Bryant, 2009; Wade-Woolley & Heggie, 2015). Indeed, the two abilities are clearly linked as when decoding multisyllabic words, stress rules are very important and the location of stress can change depending on the suffix of the word. For example, Carlisle (1988, 2000) showed that for words ending in –ity there is a stress shift (compared with the root word) to the syllable immediately before that suffix (e.g., in the root word electric, the stress is on the ‘lec’ syllable, however in the derived form, electricity there is a stress shift and the stress moves immediately before the suffix onto ‘tri’). The same principle applies to the suffix –tion but not to others such as –ness.

The confirmation of this newly established pathway added to the fact that the vocabulary-morpheme relationship was specified as bi-directional in the present study, suggests that not only does prosody directly predict vocabulary but also indirectly via morphology. The former was theorised in the Wood et al. (2009) model and empirically confirmed by both Holliman, Critten, et al. (2014) and the present study. However, the latter is a newly confirmed empirical finding and could suggest that when prosodic sensitivity assists the understanding of stress assignment and morphological awareness in multisyllabic words, this in turn enhances the complexity of our vocabulary knowledge of longer, multimorphemic words.

Second there is a newly established pathway from vocabulary to phoneme. Originally the Holliman, Critten, et al. (2014) model had predicted that both aspects of segmental phonological awareness would be predicted by vocabulary; only the link to rhyme proved significant. This finding has been reversed in the present study and is supported by the same notion of the periodicity bias already mentioned that forms the basis for the relationship between prosody and vocabulary. Once sensitivity to the rhythmic properties of speech has created a pathway to word recognition, this in turn facilitates phonological awareness (Walley, 1993) and the identification of phonemes in words which are easier in stressed rather than unstressed syllables (e.g., Chiat, 1983; Kitzen, 2001).

The third and perhaps most notable difference is that the Holliman, Critten, et al. (2014) study found that prosody (mediated by vocabulary) acted through rhyme and morphology to directly predict word reading and spelling. In the present study, prosody acted through rhyme, vocabulary and morphology (via vocabulary) to link to phoneme and it was phoneme alone that directly predicted word reading and spelling. There is already extensive literature supporting this relation (e.g., Melby-Lervag et al., 2012). However, it does beg the question why the findings are so different from Holliman, Critten et al. given that rhyme (e.g., Anthony & Lonigan, 2004) and morphology (e.g., Green et al., 2009) have also been previously shown to predict word reading and spelling?

One possibility is that the diminished role of phoneme in the Holliman, Critten, et al. (2014) study was due to the use of a non-standardised measurement. This was highlighted as a limitation by the authors and corrected in the present study. However, it is unlikely that such a substantial change is due to the measure as the one used by Holliman, Critten, et al. was normally distributed and did behave as expected in the manner it correlated with all other measures. Therefore, perhaps a more over-arching explanation should be sought.

More pertinent might be the fact that younger children from a narrower age range were used in the present study and thus any differences found may simply be a reflection of natural developmental differences that would be expected when modeling the prosody-literacy relation with pre-readers versus more experienced readers and spellers aged 5-7 years. Phoneme awareness may be the main direct link to word reading and spelling for the other variables as this is the focus of early literacy instruction. However, as children pass through the first two years of schooling, other literacy instruction techniques are also used including morphology

(DfE, 2013) hence why this factor was so prominent in the Holliman, Critten, et al. (2014) model.

Connected to this is that the present study was a longitudinal exploration over the course of a year whereas the Holliman, Critten, et al. (2014) used concurrent data. This perspective may greatly alter the inter-relations between the variables as it is a more valid way of measuring cause-effect. Unfortunately, although the only other study measuring a longitudinal effect of prosody on literacy in this age group (Calet et al., 2015) also found this clear predictive effect of phoneme they did not measure rhyme or morphology and therefore a direct comparison cannot be made and should be addressed by future research.

In summary, we provide an empirical test validating Holliman, Critten, et al.'s (2014) model in pre-reading children. We think that important next steps lie in exploring whether the differing routes by which prosody influences word reading and spelling are simply due to developmental changes in the inter-relations that could be expected given the differences in the ages of the samples or whether they are due to differences in measurement of phoneme and/or whether data is longitudinal or concurrent. Moreover, the findings of this study were drawn from a sample of pre-readers and therefore controlled (to some degree) for the effects of reading experience on the predictor variables (i.e., prosodic sensitivity, vocabulary knowledge, phonological and morphological awareness). This indicates that these precursor skills in pre-readers may systematically affect reading acquisition and that this becomes apparent once instruction commences.

Limitations and Future Directions

The present study made several notable improvements on previous studies (e.g., Holliman, Critten, et al., 2014) and similarly there is great scope for future research based on the present findings. First, it is important to note that the literacy constructs in this study were assessed using a single measure only: this is problematic in path analyses because it prohibits a calculation of measurement error and we therefore encourage future research to include multiple measures for each construct. Moreover, path analysis results are only valid and unbiased if the predicted relations (pathways) accurately represent the real causal processes. In the present study, ordering decisions were based on the available research evidence and theory, and on previous conceptual models (e.g., Holliman, Critten, et al., 2014; Wood et al., 2009) that formed the basis for the model included in this research. However, as we have alluded to, the relation between some of the constructs is likely to be bi-directional and/or take a slightly different form depending on the age of participating children. While this was controlled for, to some degree, by focusing on a sample of pre-readers, the causal relations (directions) between the predictor variables must be treated with caution. Furthermore, other control variables such as IQ could be entered into future tests of such models.

Another aspect to note is the way we have defined pre-readers as children aged 4-5 years who were unable to read a single word on a standardised measure of reading. While this technique seems intuitive, if ultimately, we're concerned with trying to establish a causal link between prosodic awareness and reading and spelling then future research could test children with no reading and spelling skills at all (Castles & Coltheart, 2004), i.e., no letter-sound knowledge. However, given children receive formal instruction in segmental phonological awareness and letter-sound correspondences from 3-4 years old (in the UK at least) it is debateable whether children with no literacy skills at all would have the cognitive capacity to complete the prosodic sensitivity task. This would be a challenge for future research to tackle.

Implications

The present study has some important implications for models of literacy development and literacy instruction. Classic theories of literacy development (e.g., Ehri, 1998, 1999, 2000; Frith, 1985) gave prominence to segmental phonological awareness and this has been strongly evidenced over the last few decades (e.g., Melby-Lervag et al. 2012). The present findings taken in conjunction with recent research (e.g., Holliman, Critten, et al 2014; Holliman, Gutierrez-Palma et al. 2017; Wade-Woolley & Heggie, 2016) suggest that suprasegmental phonology should also be given due consideration in the way grain size theory has done previously (Ziegler & Goswami, 2005). However, the latter model has been criticised for not giving proper consideration to morphology, a fact acknowledged by the authors themselves (Goswami & Ziegler, 2006). In contrast the conceptual model of Holliman, Critten et al. (2014) is arguably more comprehensive as alongside both segmental and suprasegmental phonology, vocabulary and morphology are also included.

From a more educational perspective and given that prosodic sensitivity is measurable prior to most other literacy skills and to reading instruction itself (Rago et al., 2014), as shown in this study, assessment of prosodic sensitivity might allow earlier identification of young children at risk of later reading difficulties. Furthermore, interventions designed to enhance prosodic sensitivity might be incorporated into early reading instruction methods to support the development of other emergent literacy skills (e.g., vocabulary knowledge, phonological, and morphological awareness).

Indeed, some very recent work has made important headway in this direction by suggesting that prosodic sensitivity interventions are at least as successful as more traditional segmental phonological awareness approaches in improving reading abilities of early readers (Harrison, Wood, Holliman, & Vousden, 2018). This suggests that prosodic sensitivity interventions could be a valuable addition to the intervention tool kit for children struggling with reading and spelling. This could be particularly pertinent in instances where segmental phonological approaches have proved ineffective with a child and a viable alternative is sought.

Conclusion

In the present study we found support for the model proposed by Holliman, Critten, et al. (2014), in a pre-reading sample. Our findings indicated that prosodic sensitivity supports the development of emergent literacy skills (e.g., vocabulary knowledge, phonological awareness, and morphological awareness) which in turn support the development of word reading and spelling one year later. This finding has important educational implications for how literacy abilities are theorised, assessed and the nature of interventions delivered to children who are struggling with written language.

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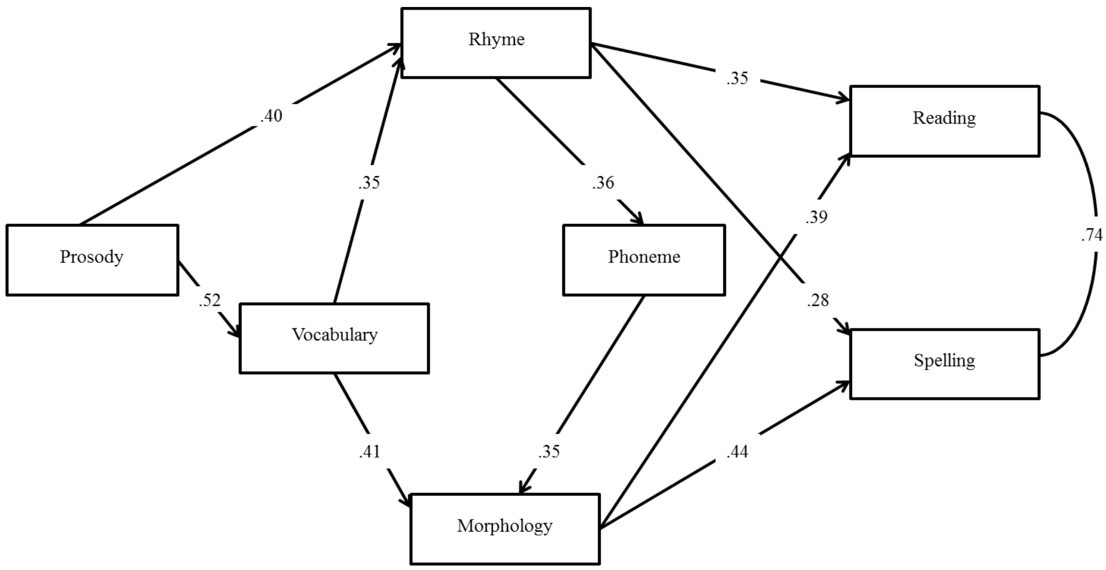

Figure 1. Path analysis results for the conceptual model reported in Holliman, Critten, et al. (2014). Non-significant paths are not presented.

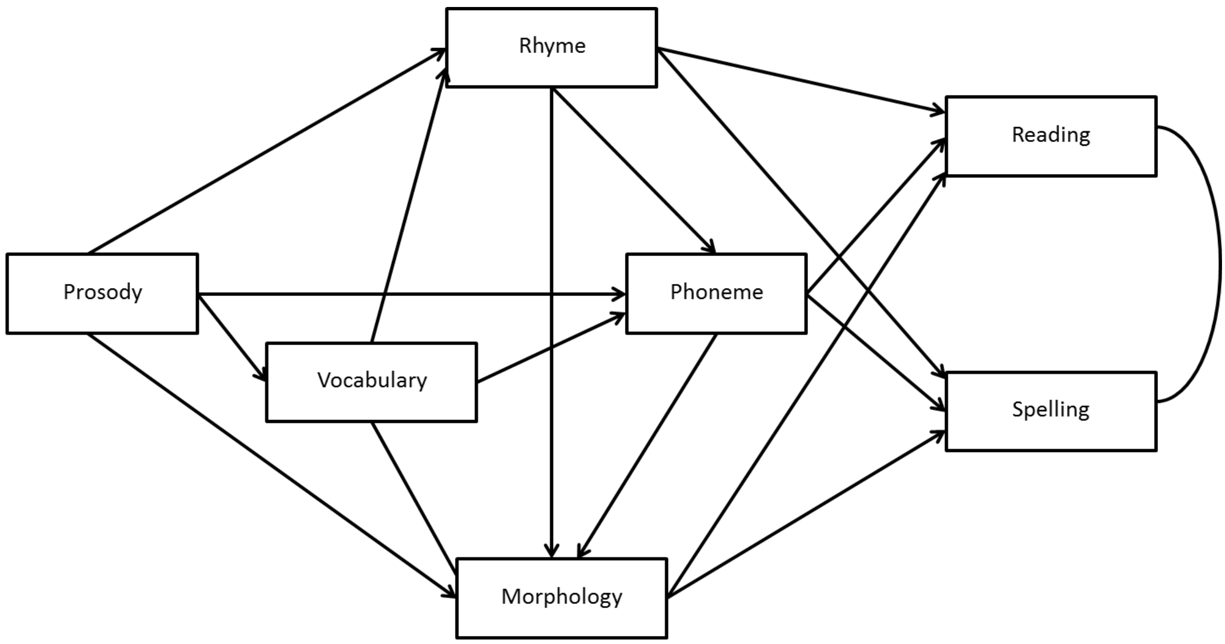

Figure 2. Path diagram for the conceptual model. This differs from Holliman, Critten, et al. (2014) by including a bi-directional rather than directional path between Vocabulary and Morphology.

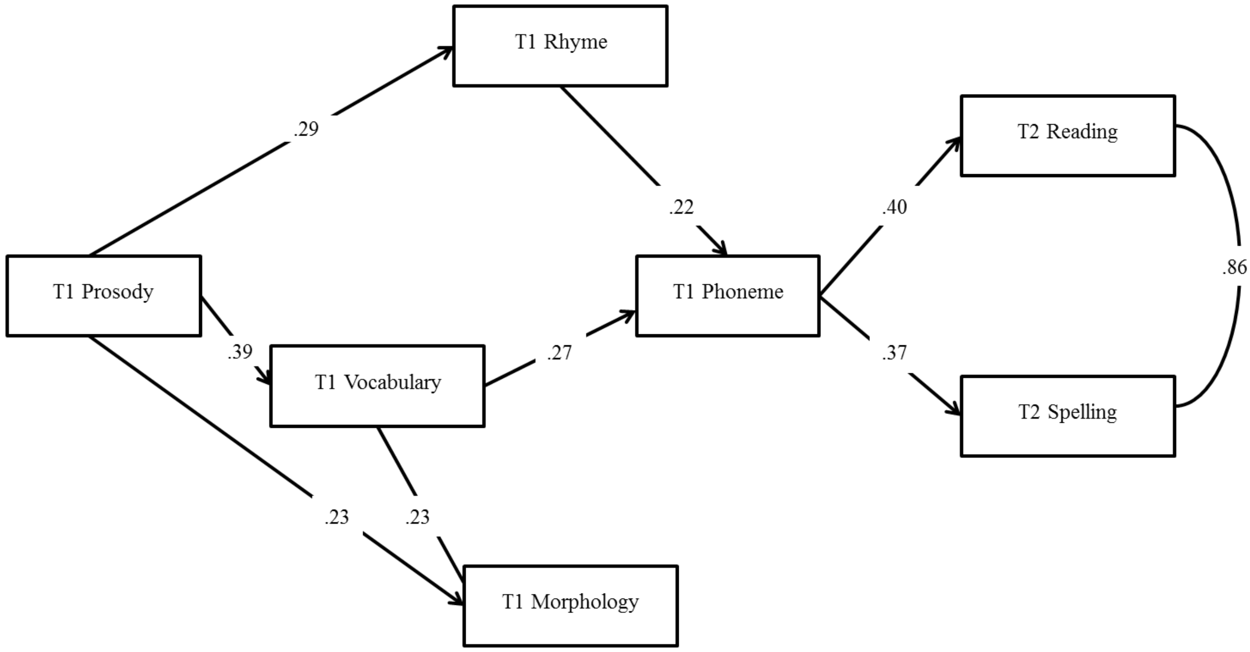

Figure 3. Path analysis results for the conceptual model including Prosody, Vocabulary, Rhyme, Phoneme, and Morphology at Time 1, and Reading and Spelling at Time 2. Non-significant paths are not presented.

Table 1:

Univariate Descriptive Statistics for Modelled Variables (N = 101; 91)

Variables	Mean	Skewness	Kurtosis	Std. Dev.
Time 1				
Prosody (Max = 56)	33.1	-4.06	0.07	11.34
Vocabulary (Max = 168)	52.06	-0.17	-1.76	9.11
Rhyme (Max = 12)	3.52	1.75	-1.72	2.72
Phoneme (Max = 12)	7.46	-2.92	-1.54	3.88
Morphology (Max = 38)	7.96	2.87	0.46	5.13
Time 2				
Word Reading	84.59	1.38	0.06	35.09
Spelling	88.91	-0.16	3.52	27.64

Note. The mean scores presented above are ‘raw scores’ with the exception of Word Reading and Spelling which are ‘ability’ scores. The values reported for skewness and kurtosis are z-scores. Sample performance on all measures was in the ‘normal range’.

Table 2

Correlation Matrix Between Prosodic Sensitivity (Overall Composite), Vocabulary, Rhyme Awareness, Phoneme Isolation, Morphological Awareness, Word Reading and Spelling

Variable	1	2	3	4	5	6
1: T1: Prosodic Sensitivity						
2: T1: Vocabulary	.38***					
3: T1: Rhyme Awareness	.30**	.09				
4: T1: Phoneme Isolation	.29**	.34**	.28**			
5: T1: Morphological Awareness	.31**	.35***	.21*	.30**		
6: T2: Word Reading	.26*	.29**	.26*	.47***	.28**	
7: T2: Spelling	.22*	.27*	.30**	.44***	.23*	.89***