Prosodic awareness and children's multisyllabic word reading

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Abstract

Prosody awareness (the rhythmic patterning of speech) accounts for unique variance in reading development. However, studies have thus far focused on early-readers and utilised literacy measures which fail to distinguish between monosyllabic and multisyllabic words. The current study investigated the factors that are specifically associated with multisyllabic word reading in a sample of fifty children aged between 7- and 8-years. Prosodic awareness was the strongest predictor of multisyllabic word reading accuracy, after controlling for phoneme awareness, morphological awareness, vocabulary, and short-term memory. Children also made surprisingly few phonemic errors while, in contrast, errors of stress assignment were commonplace. Prosodic awareness was also the strongest predictor of stress placement errors, although this finding was not significant. Prosodic skills may play an increasingly important role in literacy performance as children encounter more complex reading materials. Once phoneme-level skills are mastered, prosodic awareness is arguably the strongest predictor of single word reading.

Keywords: *Prosody; Suprasegmental phonology; Stress; Multisyllabic; Reading*

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As children progress through the first years of school they are expected to read increasingly longer, multisyllabic words; these words can be challenging even for those who can accurately decode monosyllabic words (Just & Carpenter, 1987). They also typically take longer to read (see Samuels, LaBerge, & Bremer, 1978) and thus may impact upon reading comprehension.

Until recently, theoretical accounts and models of word reading had been primarily constructed to capture the processes involved in reading one-syllable words, regardless of whether these accounts were rule-based (e.g., Rastle & Coltheart, 2000) or connectionist (e.g., Seidenberg & McClelland, 1989). Lately, researchers have begun to develop models of multisyllabic word reading, but these studies have been mostly confined to adult performance (e.g., Chateau & Jared, 2003; Chen & Viad, 2007; Yap & Balota, 2009) with only a few notable exceptions (e.g., Arciuli, Monaghan, & Seva, 2010). Furthermore, the few studies that explicitly investigate multisyllabic word reading, such as the ones mentioned above, focus primarily on lexical characteristics, such as number of syllables, word length, consistency of the onset or rime, and number of phonological or orthographic neighbours. There is even less research that investigates multisyllabic word reading from the perspective of reader characteristics i.e. by examining one's metalinguistic skills. The cognitive and linguistic processes inherent in the ability to read long words are likely to be similar to those involved in reading monosyllables, but long words pose particular challenges that are lacking in single-syllable items.

Key differences between mono- and multisyllabic word reading

Perhaps the most significant difference between monosyllabic and multisyllabic word reading is the issue of lexical stress. Function words aside (Weber, 2006), all monosyllabic words are stressed. In contrast, English multisyllabic words are likely to contain a mixture of stressed syllables, which are louder, articulated more forcefully, higher in pitch, and longer in duration (Graddol, Cheshire, & Swann, 1987) and unstressed syllables. Some languages have fixed stress, where word stress is reliably located on a particular syllable, but this is not the case for English (along with languages like Italian and Dutch). For these languages, lexical stress is free and it may be difficult to predict the syllable upon which stress should fall. As well, the metrical structure of English paces stressed syllables evenly in a word; when unstressed syllables intervene between stressed syllables, they must be shortened as needed to preserve the rhythmic pattern. For example, in the word *COMbinaTORial*, the unstressed syllables *bi* and *na* are shortened and their vowels are reduced (Fear, Cutler, & Butterfield, 1995). Free stress and the semi-obligatory nature of vowel reduction can be particularly challenging for readers of English, since there is no diacritic to mark stress (as is the case in Greek and Spanish), and because the reduced vowel schwa /ə/ can be represented by any vowel letter. In other words, there is no explicit orthographic notation indicating to the reader which syllable of the word should be stressed, or which vowel letters should receive reduced pronunciations. Strategies like 'sounding out' or 'seeking a small word within the big word' are likely to be ineffective for decoding multisyllabic words because they do not provide readers with cues for correctly assigning stress. In extreme cases, assigning stress to a letter string incorrectly can produce an entirely different word (e.g., *REcord* vs *reCORD*).

Strategies for successfully decoding multisyllabic words

There are some cues in written words that act as sources of information for stress assignment. First of all, the language itself codes distributional probabilities that bias the reader in the correct direction. For example, although English has an overall bias towards trochaic (first-syllable) stress in disyllabic words, this breaks down when considering grammatical category. Kelly and Bock (1988) reported that of nearly 4000 disyllabic English words, over 90 percent of words with trochaic stress were nouns, while 85 percent of words with iambic (final-syllable) stress were verbs. Experimental studies have shown that speakers are sensitive to the relationship between lexical stress and grammatical category, taking longer to make judgments when items have atypical stress (Arciuli & Cupples, 2003, 2004) and preferring to classify nonwords as noun-like or verb-like contingent on stress placement (Guion, Clark, Harada, & Wayland, 2003). Therefore, when coming across unfamiliar words in connected text, readers can exploit syntactic context to assign stress and have a better chance of matching the printed word to a word in their lexicon. However, not all disyllabic words are consistent with these phonotactic probabilities, and readers may not come across unfamiliar words in contexts that readily supply syntactic clues for stress assignment. Even when such context is available, it is not always reliable for stress assignment (Kelly & Bock, 1988).

Orthography also appears to provide information relevant to stress assignment. It is common knowledge that English spelling represents sound units in multiple ways, but it is perhaps less obvious that some of these alternatives are associated with different stress patterns. Kelly, Morris, and Verrekia (1998) showed through corpus analysis that phonologically identical word-final orthographic rimes (e.g., *–el* and *–elle*) were probabilistically associated with trochaic or iambic stress. For example, 86 percent of words ending in *–el* had first syllable stress (e.g., *gravel*), while 0 percent of words ending in *–elle* had first syllable stress (e.g., *gazelle*). Kelly et al. make two points: that the orthographic cues to word stress are located at the end of the word (compare *discus* and *discuss*), and that iambic stress is marked by more letters relative to trochaic stress (*rivet* vs *roulette*). Although skilled readers are probably not able to consciously access knowledge of these orthographic regularities, they are nevertheless more likely to make naming errors and be slower at making lexical decisions on words where the pronunciation is not consistent with the orthographic cues to stress (e.g., *cadet* and *palette*). In their discussion, Kelly et al. point out that, due to the strong tendency of English to associate vowel reduction with weak, unstressed syllables, the orthographic cues to primary stress are also communicating information about the phonemic character of the unstressed syllable. Therefore, the reader who is sensitive to stress signals encoded in orthography is getting two pieces of information for the price of one. Orthographic position effects have been found by other researchers, as well; Arciuli and Cupples report that certain letters at the beginning (Arciuli & Cupples, 2007) and ends of disyllabic words (Arciuli & Cupples, 2006) are associated with first or second syllable stress, with the latter having a stronger impact, even in children (Arciuli, Monaghan, & Seva, 2010). Because these effects are found in monomorphemic words, they are not artefacts of derivational morphology, which can have an impact on lexical stress.

Of course, orthography interacts with phonology, and the phonotactics of English yield information that reinforces the probabilistic relationship between stress and orthography. In English, a general descriptive account of word stress includes consideration of syllable structure, namely vowel length and number of consonants in the syllable coda. Syllables with long vowels and full codas are generally considered heavy, and heavy syllables attract stress (Blevins, 1995). English orthography often codes long vowels with multiple letters, thereby providing another access point for stress assignment when reading unfamiliar words.

Morphology is yet another source of information about stress assignment in multisyllabic words. The majority of multisyllabic words in English are multimorphemic (Baayen, Piepenbrock, & Van Rijn, 1993), composed of stems and affixes. Inflectional affixes, which change case, number or tense, are stress neutral, but derivational affixes, which change grammatical category or meaning, have predictable impact on lexical stress. One class of derivational affixes (e.g., *–ness*, *–ment*) is stress neutral; when these are applied to a stem, the position of lexical stress is not changed. A second class of derivational affixes (e.g., *–ic*, *–ity*, *–tion*) drives stress to the syllable immediately before the suffix, regardless of its place in the stem. Therefore, stress in the word *happiness* is in the same location as in the word *happy*, but stress has moved from the first syllable in *simple* to the second syllable in *simplicity*. The key point is that certain suffixes can provide strong information about the location of word stress. At least one computational study has shown positive effects for including derivational morphology in reading multisyllabic words (Rastle & Coltheart, 2000). Although other researchers have argued that these effects can be derived without explicitly coding for morphology in the computational models (e.g., Arciuli et al., 2010), the link to meaning that morphemes provide might make them particularly useful for instructional purposes.

Thus far we have discussed various sources of information that can be utilised to successfully read multisyllabic words. The significant variability among readers, however, indicates that there are also reader-level factors that are involved. Reliable information in the signal may not be picked up on or attended to, in the absence of some necessary abilities on the part of the reader. As previously mentioned, some children have significant difficulty reading multisyllabic words, even when they can manage one-syllable words (Just & Carpenter, 1987). Poor readers often find it difficult to use effective strategies for decoding long words (Archer, Gleason, &

Vachon, 2003; Roberts, Torgeson, Boardman, & Scammacca, 2008). There are at least three metalinguistic skills that are likely to be implicated in multisyllabic word reading: phonological awareness, prosodic awareness, and morphological awareness.

Metalinguistic skills associated with multisyllabic word reading

Phonological awareness is undoubtedly the precursor to reading that has received the strongest research attention over the last two decades. It is now beyond doubt that children's abilities to reflect on and manipulate sublexical units of speech is a strong predictor of later reading outcomes (Adams, 1990; Goswami & Bryant, 1990; National Reading Panel, 2000; Snow, Burns, & Griffin, 1998). Analysis of the spoken word into individual phonemes or onsets and rimes is a necessary first step before decoding skill can be acquired. There is every reason to expect that phonological awareness should be related to reading multisyllabic words in the current study, since phonological awareness allows children access to the alphabetic principle by which consonants and vowels in oral language are mapped onto consonant and vowel letters, and these correspondences are used in monosyllabic and multisyllabic words alike. However, within traditional phonological awareness tasks such as segmentation, deletion, and blending, the unit of manipulation or comparison is the phoneme, onset or rhyme, and crucially therefore, these tasks are nearly without exception situated in one-syllable words. This is important because one-syllable words are, by definition, stressed, while multisyllabic words, as we have seen, are somewhat predictable combination of stressed and unstressed syllables. Phonological awareness, as we have traditionally defined it, has nothing to say about how readers may achieve the feat of stress assignment (Wade-Woolley & Heggie, in press).

Currently, there is a fair amount of research activity around the relationship between prosodic awareness (loosely defined here as children's knowledge of the rhythmic patterning of speech, Holliman, Williams, et al., 2014) and reading (see Wood, Wade-Woolley, & Holliman, 2009, for a summary). Prosodic awareness captures the same notion about the ability to reflect on and manipulate elements of spoken language that underlies phonological awareness, but the scope of prosodic awareness is the suprasegmental rather than the segmental domain. Although stress is only one aspect of suprasegmental phonology, it is the most important for English (for example, vowel harmony and tone are relevant for other languages). There is still much work to be done in the area of measurement of prosodic awareness, and awareness of syllabic stress in particular. In some studies, pairs of real words or phrases have been transformed or manipulated, for example, by low-pass filtering or replacing the original syllables with reiterative speech (such as presenting 'The Jungle Book' as 'dee DEEdee DEE'), thereby requiring participants to make judgments on the gross intonation contour or stress patterns of the items (Clin, Wade-Woolley, & Heggie, 2009; Goswami, Gerson, & Astruc, 2010; Holliman, Critten, et al., 2014; Holliman, Gutiérrez Palma, et al., 2016; Holliman, Williams, et al., 2014; Whalley & Hansen, 2006; Wood & Terrell, 1998). Other studies have exploited differences in stress patterns in phrases and compound nouns (Whalley & Hansen, 2006) or asked participants to produce or make judgments on items that contain stress-shifting suffixes (Clin et al., 2009; Jarmulowicz, Hay, Taran, & Ethington, 2008; Jarmulowicz, Taran, & Hay, 2007; Wade-Woolley & Heggie, 2014). Yet others attempt to decompose various aspects of stress (Holliman, Wood, & Sheehy, 2008, 2010a, 2010b, 2012). Regardless of the measurement approach, research has reliably found that prosodic awareness is predictive of word reading and reading comprehension. In most cases where statistical information has been provided, studies that use both phonological awareness and prosodic awareness as predictors in regression analyses show that the latter makes a unique contribution to reading when the former is controlled (Wade-Woolley & Heggie, in press). In addition to research conducted with large samples of typically developing children, it has also been found that children (Goswami et al., 2010) and adults (Mundy & Carroll, 2012) with dyslexia show lower levels of prosodic awareness than age/ability-matched controls.

Despite the coherent theoretical picture that has begun to emerge from this field of research, studies have often utilised standardised reading measures that do not generate separate scores for monosyllabic and multisyllabic items or distinguish between segmental and suprasegmental decoding errors. One recent study has suggested that phonemic and prosodic skills may in fact be independently related to different types of reading error. In an error analysis of 10- to 13-year-old children's readings of two- to six-syllable words, Heggie, Wade-Woolley, and Briand (2010) found that phonological awareness was correlated with the number of phoneme-level decoding errors (wrong phoneme, omission, or insertion of phoneme), but not with errors involving the placement of stress on the wrong syllable. Conversely, prosodic awareness was correlated with stress placement errors, but not with phoneme decoding errors. It seems likely that both segmental and suprasegmental phonology are recruited to accurately decode multisyllabic words. However, more research is required in order to determine the precise nature of these relationships.

The third metalinguistic ability that is likely to be involved in multisyllabic word reading is morphological awareness. Morphological awareness is the individual's consciousness of the morphemic structure of words, specifically how the sublexical morphemes combine to create and change meaning (Carlisle, 1995; Deacon & Kirby, 2004; Kuo & Anderson, 2006; Tyler & Nagy, 1989). Morphological awareness is assessed by a variety of tasks that require the participant to make judgments that rely on morphological knowledge (e.g., are fun/funny or turn/turnip related?), derive morphologically related words to fit a sentence context (e.g., Accident. The fire was started ______) or complete analogies (e.g., Walk-walked, Run-______). Ample evidence is beginning to accumulate across studies that performance on these morphological awareness tasks is related to both word reading and reading comprehension (Apel, Wilson-Fowler, Brimo, & Perrin, 2012; Carlisle, 2000; Nagy, Berninger, & Abbott, 2006), even after considering the contribution made by phonological awareness (Carlisle & Nomanbhoy, 1993; Deacon, 2012; Deacon & Kirby, 2004; Shankweiler et al., 1995).

Morphological understanding may be particularly useful for reading multisyllabic words; although not all multisyllabic words are multimorphemic, the vast majority of derived words are multisyllabic. Since morpheme boundaries generally coincide with syllable boundaries, morphological awareness can provide useful information about word pronunciation. At least one reading intervention uses this redundancy to assist poor readers in successfully decoding complex words (Lovett, Lacarenza, & Borden, 2000; Lovett, Lacerenza, Borden, Frijters, Steinbach, & De Palma, 2000). A slightly different aspect of morphological awareness was measured by Jarmulowicz (2006) who asked children aged 7–9-years to add derivational suffixes to stems (e.g., “Put *–ity* on the end of *active*”). This ability, which Jarmulowicz called morphophonological knowledge, was easier for children when the suffix was stress neutral, but more challenging when the suffix required a stress shift. Later work by Jarmulowicz and colleagues showed that morphophonological knowledge explained variance in decoding after accounting for phoneme blending and elision and traditional morphological awareness (Jarmulowicz et al., 2007) and, in a path analysis, morphophonological knowledge was a direct predictor of decoding, as was phonological awareness, while traditional morphological awareness was not (Jarmulowicz et al., 2008).

Summary and Rationale

Most theoretical accounts and models of reading development have focused primarily on how children come to read one-syllable words and less is known about the cognitive and linguistic processes involved in multisyllabic word reading. In recent years, a converging literature has demonstrated that prosodic awareness is implicated in successful reading acquisition and it has been argued here, and by others (e.g., Protopapas, Gerakaki, & Alexandri, 2006), that knowledge of linguistic stress may play an important role in decoding multisyllabic words. However, research examining the contribution of prosodic awareness to multisyllabic word reading is sparse. The majority of published studies exploring the relationship between prosodic awareness and literacy have utilised standardized reading measures as outcomes, most of which do not differentiate between monosyllabic and multisyllabic words. Furthermore, few studies have employed a measure of multisyllabic word reading that permits an analysis of the decoding errors that are made. Such an analysis is of importance because not only would we expect prosodic awareness to contribute strongly to accurate multisyllabic word reading, we might also expect an association between prosodic awareness and certain, specific types of reading error, such as stress placement errors.

The present study investigated the contribution of prosodic awareness to multisyllabic word reading in a sample of 7- and 8-year-old children and examined the extent to which this is mediated by other well-documented predictors such as morphological awareness. As mentioned earlier, a number of paradigms have been developed to assess children’s awareness of syllabic stress patterns within words and phrases, but these can often be criticised for placing heavy demands on verbal short-term memory and for yielding poor levels of internal reliability. The DEEdee task (Whalley & Hansen, 2006) was chosen for inclusion in the current study because it has been most widely used by other researchers, albeit with slightly older children than those in current sample (9- to 10-year-olds), and also because it focuses predominantly on an awareness of stress assignment (rather than intonation or timing, for example), which is the prosodic feature of most importance for multisyllabic word reading. We control for short-term memory capacity in the present study; however, it remains unknown whether this measure will yield acceptable levels of internal reliability using a sample of slightly younger children. It is also difficult to speculate on this given that other studies adopting this or similar tasks do not report internal reliability (e.g., Goswami et al., 2010; Whalley & Hansen, 2006). We will examine the internal consistency of the DEEdee task and in order to obtain a single reliable estimate of prosodic sensitivity items may be removed that lack internal consistency with the other items. In the UK (the location of this study), children of this age (7- to 8-year-olds) would have received approximately three- or four-years phonics instruction and would be expected to comfortably decode most monosyllabic words; however, they would now be faced with the challenge of decoding multisyllabic words; thus making them an appropriate sample for the purposes of this study.

Three key questions were explored:

1. Does prosodic awareness make a significant direct contribution to multisyllabic word reading accuracy?
2. What are the most frequent types of decoding errors made during multisyllabic word reading?

3. Is prosodic awareness significantly related specifically to the number of stress placement errors made during multisyllabic word reading?

Method

Participants

All of the children who took part in this study (*N* = 50, 24 males) were recruited via convenience sampling from a single primary school in Warwickshire, UK. According to the Ofsted Inspection Report for this school at the point of data collection (http://www.education.gov.uk/schools/performance/), relative to other similar schools in the UK, this school is larger; has an above-average proportion of pupils who are known to be eligible for free school meals (an indicator of socio-economic status); a higher proportion of pupils receiving some form of special education need; and a higher percentage of pupils achieving expected levels in reading, writing, and maths. Participating children were in Year-3 and aged between 7-years 5-months and 8-years 9-months (mean age 8-years 0-months). All of the children spoke English as their first language. None of the children had been diagnosed with a statement of special educational needs.

Measures

Prosodic Awareness.

The DEEdee task (Whalley & Hansen, 2006) was used to assess awareness of speech prosody (e.g., Goswami et al., 2010; Holliman et al., 2012). Children heard a naturally spoken pre-recorded target phrase through laptop speakers, which took the form of a children’s book or cartoon title (e.g., “Lady and the Tramp”) and then heard two DEEdee phrases, one of which retained the prosodic structure of the original phrase (e.g., DEE-dee-dee-dee-DEE) and one of which did not (e.g., DEE-dee-DEE-DEE-dee). Using a forced choice procedure children had to indicate which of the two

DEEdee phrases shared a stress pattern with the target. Children indicated their response verbally by saying “the first one” or “the last one”. Following two practice items with corrective feedback, there were 18 test items and children received one point for each correct answer. This task can be seen as more valid that many others in the literature given that the DEEdee phrases include no identifiable phoneme content, but preserve the prosodic contour. It was also considered most suitable for this particular study given that it focuses predominantly on an awareness of stress assignment, which is the prosodic feature of most relevance to multisyllabic word reading (although note that variation in stress cannot be completely delineated from variations in other prosodic features, such as syllabic timing). Further, in a reliability analysis, the internal consistency (Cronbach’s α) was found to be unacceptably low (α = .46); therefore, in accordance with the standard procedure for internal reliability analysis, seven test items were removed to improve the internal consistency of the task resulting in an 11-item measure of prosodic awareness. There was no obvious pattern that would explain why these items lacked internal consistency with the other items. The internal reliability (Cronbach’s α) was .66.

Short-Term Memory.

The digit span (forwards) subtest from the British Ability Scales II (Elliot, Smith, & McUlloch, 1996) provided a measure of children’s short-term memory capacity. Children heard a series of digits spoken aloud by the administrator and were required to repeat the digits back to the administrator in the correct order. Digit strings varied in length from 2 to 9 digits. Children received one point for each correct sequence and obtained a total score out of 36. Elliot et al. report internal reliability (Cronbach’s α) of between .87 and .96.

Vocabulary.

The British Picture Vocabulary Scales II (Dunn, Dunn, Whetton, & Burley, 1997) provided a measure of children's receptive vocabulary. Children heard a word spoken aloud by the administrator and were required to identify the best-fitting illustration from a choice of four that were available. Children received one point for each correct answer and obtained a total score out of 168. Dunn et al. report internal reliability (Cronbach's α) of .93.

Phonological Awareness.

The Spoonerisms subtest of the Phonological Assessment Battery (Frederickson, Frith, & Reason, 1997) provided a measure of children's phonological awareness. In the first part of this test, children heard a word spoken aloud by the administrator (e.g., "might") and were then asked to replace the first sound with a different sound (e.g., with an "f" to become "fight"). In the second part of this test, children heard two words spoken aloud by the administrator (e.g., "lazy dog") and were then asked to swap the first sounds of the two words (e.g., "dazy log"). Children received one point for each correct answer on both parts of the test and obtained a total score out of 30. Frederickson et al. report internal reliability (Cronbach's α) of .93.

Morphological Awareness.

The morphology task (Duncan, Casalis, & Cole 2009) provided a measure of children's morphological awareness. Children heard a partially spoken sentence from the administrator (e.g., "If you clean, you are a ______") and were required to finish the sentence using a similar, appropriate derivation of the word using the morphological rules of the English language (e.g., "cleaner"). Children received one point for each correct answer and obtained a total score out of 18. The internal reliability (Cronbach's α) was .83.

Multisyllabic Word Reading.

The multisyllabic word reading task (Heggie et al., 2010) was used to assess multisyllabic word reading accuracy and the frequency of different types of decoding errors. Children were asked to read aloud 50 low-frequency multisyllabic words (five lists of 10 words varying from two- to six-syllables in length) as best as they could in their own time and this was audio recorded. These words were chosen to include a variety of affixes (prefixes, suffixes) and stress patterns (i.e., location of primary stress); low-frequency words were selected in order to increase the likelihood of eliciting errors for analysis. These words were also matched for frequency (mean frequency in each list of 10 words) with Standard Frequency Indices ranging from 33.9 – 35.9 (Carroll, Davies, & Richman, 1971). The audio recordings were later scored by a member of the research team using the accompanying scoring scale (Table 1) to indicate whether each reading was accurate, had a decoding (phonological) error, stress placement error, spondee error (where the pronunciation was so haltingly or slowly read that it was impossible to treat the spoken syllables as a single word, making it too difficult to assign primary stress), syllable error (either too many or too few syllables), or whether no attempt to decode the word was made. The frequency of each type of reading across the 50 multisyllabic words was totaled. The audio recordings were scored blindly without any accompanying information about participants' performance on other assessments. A sample of the audio recordings was also scored by a second, independent researcher. The correlation between the researchers' ratings was statistically significant ($r = .90$, $p < .001$), indicating consistent, accurate scoring. The internal reliability (Cronbach's α) was .935. The stimuli for this task are presented in the Appendix.

<<<Table 1 about here>>>

Procedure

Once informed consent had been gained from the head teacher at the participating school, eligible parents/guardians were sent information sheets and ‘opt out’ consent forms via the school. The children themselves also had to verbally consent to taking part prior to participation. Data were collected in January and February 2012. All six assessments in this study were administered in a randomised order on a single occasion lasting approximately 40 minutes. Standardised tests were administered in accordance with the instructions in the test manuals.

Results

Preliminary analyses

Table 2 shows the mean and standard deviation scores along with skewness and kurtosis (z-scores) on all assessments in this study. Sample means for all standardised measures were in the normal range. The mean number of multisyllabic words read correctly with both accurate stress and decoding was quite low, indicating that many decoding errors were made. A chi-square analysis, $\chi^2(1, N = 50) = 3.920$, $p = .048$, indicated that sample performance on the measure of prosodic awareness was significantly above chance, although not all children achieved this level of performance. Inferential analyses conducted on the sample as a whole were therefore repeated with a smaller sample ($N = 32$) containing only those children who had scored above chance on the prosodic awareness task. Importantly, normal distributions were observed on all assessments and measures of dispersion indicated that there was variability in performance within the sample.

<<<Table 2 about here>>>

Correlation analyses

Bivariate correlations between age, phonological awareness, morphological awareness, vocabulary, short-term memory, prosodic awareness, and multisyllabic word reading accuracy are presented in Table 3.

<<<Table 3 about here>>>

It can be seen that prosodic awareness, vocabulary, and morphological awareness, were all significantly correlated with multisyllabic word reading accuracy, as expected. Surprisingly, although phonological awareness correlated significantly with morphological awareness, it was not significantly correlated with prosodic awareness and its relationship with multisyllabic word reading accuracy was marginally non-significant (r = .276, p = .053).

1. Does prosodic awareness make a significant direct contribution to multisyllabic word reading accuracy?

The first research question was addressed with a standard multiple regression analysis (Table 4). Using the enter method it was found that phonological awareness, morphological awareness, vocabulary, short-term memory, and prosodic awareness explain a significant amount of the variance in multisyllabic word reading accuracy, $F(5, 44) = 11.779$, $p < .001$, $R^2 = .572$, $R^2_{Adjusted} = .524$). The analysis also showed that while phonological awareness (*Beta* = -.011, $t(44) = -.093$, *ns*), vocabulary (*Beta* = .181, $t(44) = 1.768$, *ns*), and short-term memory (*Beta* = .202, $t(44) = 1.783$, *ns*) were not found to significantly predict multisyllabic word reading accuracy, both morphological awareness (*Beta* = .290, $t(44) = 2.496$, $p = .016$) and to a greater extent prosodic awareness (*Beta* = .454, $t(44) = 4.298$, $p < .001$), were found to make a significant independent contribution.

A further analysis conducted with a smaller sample (N = 32) containing only those children who had scored above chance on the prosodic awareness task revealed a similar pattern of results. In predicting multisyllabic word reading accuracy, only prosodic awareness (*Beta* = .406, $t(26) = 3.223$, $p = .003$) and morphological awareness (*Beta* = .422, $t(26) = 3.063$, $p = .005$) were able to make a significant, unique contribution.

<<<Table 4 about here>>>

2. What are the most frequent types of decoding errors made during multisyllabic word reading?

Table 5 shows the mean and standard deviation scores for the different types of decoding errors that were made on the multisyllabic word reading measure.

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It can be seen that although the most common type of decoding was a 'correct pronunciation', the most frequent type of error was a 'stress placement error' (mean = 9.78, SD = 4.33). This was followed closely by 'syllabic errors' (mean = 8.14, SD = 6.58), 'spondee errors' (mean = 6.98, SD = 7.18), and 'no attempts' (mean = 4.18, SD = 7.72). Very few 'decoding (phonological) errors' were observed during multisyllabic word reading in this study.

3. Is prosodic awareness significantly related specifically to the number of stress placement errors made during multisyllabic word reading?

A multiple regression analysis was conducted to investigate whether prosodic awareness made a significant contribution to the number of 'stress placement errors' made during multisyllabic word reading beyond its association with phonological awareness, morphological awareness, vocabulary, and short-term memory (see Table 6). Using the enter method it was found that phonological awareness, morphological awareness, vocabulary, short-term memory, and prosodic awareness did not explain a significant amount of the variance in stress placement errors made during multisyllabic word reading, $F(5, 44) = .672$, $p = .647$, $R^2 = .071$, $R^2_{Adjusted} = -.035$). It was also found that none of the variables were able to significantly predict the number of stress placement errors made during multisyllabic word reading; although the best predictor of this was prosodic awareness, *Beta* = -.191, $t(44) = -1.227$, $p = .226$. Note also that none of the variables (including prosodic awareness) were able to make a significant independent contribution to the other types of decoding errors made during multisyllabic word reading.

A further analysis conducted with a smaller sample ($N = 32$) containing only those children who had scored above chance on the prosodic awareness task revealed a similar pattern of results. Prosodic awareness was still the best predictor of the number of stress placement errors, but was now able to make a significant, unique contribution (*Beta* = -.413, $t(26) = -2.119$, $p = .044$).

<<<Table 6 about here>>>

Discussion

The current study investigated the contribution of prosodic awareness to multisyllabic word reading in a sample of 7- and 8-year-old children. The aim of the study was to determine whether prosodic awareness makes an independent contribution to multisyllabic word reading, after controlling for other known predictors. Furthermore, the study aimed to investigate the types of reading error that were most common within the sample and the extent to which prosodic awareness may be specifically associated with certain types of error, namely, stress placement errors.

As anticipated, the findings indicate that prosodic awareness is able to account for a very substantial amount of unique variance in multisyllabic word reading, even after controlling for the contributions of phonological (phoneme) awareness, morphological awareness, vocabulary, and verbal short-term memory. In addition, stress placement errors were the most commonly observed type of reading error, occurring nearly five times more frequently than phonemic decoding errors, and the strongest predictor of this type of error was prosodic awareness.

These results are consistent with previous studies investigating the role of prosodic awareness in reading development. Measures of prosodic awareness have consistently been found to be positively associated with reading ability in samples of typically developing children, both concurrently and longitudinally, and children with dyslexia have been found to show lower levels of prosodic awareness than age/ability-matched controls. However, the results of the current study also diverge from this literature as the magnitude of the association between prosodic awareness and decoding appears far stronger than has been previously observed. Earlier research has demonstrated that prosodic awareness is able to account for unique variance in reading ability after controlling for the role of segmental phonological awareness. However, the amount of variance attributed to prosodic awareness in these studies has typically been quite small (e.g., Holliman et al., 2008, 2010a, 2010b). In the current study, prosodic awareness was comfortably the strongest predictor of children's multisyllabic word reading accuracy, even after controlling for several other well-known predictors, all of which were significantly correlated with the reading measure; although recall that the sample size associated with this analysis relative to the number of predictor variables was somewhat limited.

The ages of the children in the sample, and the nature of the reading materials used in the study, appear to be the most likely explanations for this discrepancy. Earlier studies of the prosody-literacy relationship have typically focused on beginning readers and/or utilised standardised measures to assess reading outcomes.

The fact that such measures fail to distinguish between monosyllabic and multisyllabic words, and that younger children are likely to have relatively little experience of reading longer words, suggest that these studies may have underestimated the potential contribution that prosodic awareness has to make over the full course of reading development. By recruiting a sample of children with approximately three- or four-years phonics instruction already behind them, and presenting them with the challenge of accurately decoding multisyllabic words, the current study has indicated that prosodic awareness may have a more substantial role to play in reading development as children age and begin to encounter more difficult texts. This impression is reinforced by the other novel element of the study: the analysis of different types of reading error. The children in this sample made very few decoding errors, despite the complexity of the stimuli. In contrast, syllable and spondee errors occurred quite frequently and approximately two words in every ten were read with misplaced stress. This indicates that, while children of this age clearly possess a degree of segmental phonological awareness sufficient to allow the decoding of letter strings, the processes of syllable segmentation and awareness of prosodic features of speech (linguistic stress in particular) continue to cause difficulty. This observation is consistent with prior findings indicating that some children have significant difficulty reading multisyllabic words, even though they can accurately decode monosyllables (Just & Carpenter, 1987).

There are a number of reader characteristics that could potentially influence the degree of success that children have in reading multisyllabic words. The current study focused on three types of metalinguistic awareness: phonological awareness, prosodic awareness, and morphological awareness. Morphological awareness was found to be a significant predictor of multisyllabic word reading accuracy, as was vocabulary, and verbal short-term memory. There was only a marginally significant association between multisyllabic word reading and phonological awareness; however, this may have been due, in part, to the high number of phonological irregularities in the multisyllabic word reading task. In contrast, prosodic awareness was very strongly associated with children's performance on the reading measure and was clearly the strongest unique predictor of multisyllabic word reading accuracy after controlling for other variables in the model. Morphological awareness was also able to make a significant unique (albeit lesser) contribution and this was consistent with other research in this area (e.g., Carlisle & Nomanbhoy, 1993; Deacon, 2012; Deacon & Kirby, 2004; Shankweiler et al., 1995). Furthermore, prosodic awareness was also the best predictor of the frequently observed stress placement errors, although this was not significant perhaps due in part to the lack of statistical power in the present study. This was an intuitive finding; however, as the results did not reach significance they have to be interpreted with substantial caution.

Taken together with the results of the error analyses, it can be suggested that the primary barrier to literacy progress in children of this age is no longer phoneme-level skills, but an understanding of how to segment polysyllables and recognise prosodic features of speech. Furthermore, the results of the current study strongly suggest that the most effective way of supporting the development of these skills may be via training in prosodic awareness. It has previously been demonstrated that English orthography contains abundant cues to aid stress assignment and that children make use of this information when assigning stress to nonwords. Models proposed by Ariculi et al. (2010) and Perry, Ziegler, & Zorzi (2010) conceptualise this process as an extension of the spelling-sound conversion that occurs at the segmental level during decoding and argue that readers learn correspondences between orthographic structures – particularly the spelling of word endings – and specific patterns of lexical stress assignment. Just as phonological awareness has been seen as the key driver of this process at the segmental level, prosodic awareness can be considered as a fundamental skill for learning to read multisyllabic words. The findings of this study strongly suggest that children with higher levels of morphological awareness, phonological awareness, but most of all, prosodic awareness, are better able to map spelling to sound at the suprasegmental level, and thus will have greater success when challenged to read long, complex words.

This interpretation of the current study converges with research conducted with samples of Spanish-speaking children. Gutierrez-Palma, Raya-García, and Palma-Reyes (2009) have reported that individual differences in children's ability to learn the rules governing stress assignment are best predicted by performance in a stress awareness task. In this study, higher levels of stress awareness were associated with greater ability to apply stress correctly to unfamiliar, nonword targets as well as higher levels of literacy ability overall. Furthermore, researchers have recently begun to observe an interesting dissociation in the pattern of correlations between literacy outcome measures, phonological awareness, and prosodic awareness. Specifically, performance on prosodic awareness tasks appear to be more strongly related to stress errors than to decoding errors, while performance on phoneme-level phonological awareness tasks is more strongly related to decoding errors than to stress errors (Heggie et al., 2010). This once again reinforces the related but independent contributions that segmental and suprasegmental phonological skills can make to reading development and the need to provide children with instruction, and where necessary remediation, in both of these areas. A small number of studies have recently begun to demonstrate that interventions targeting poor readers' prosodic language skills can complement more traditional interventions and potentially lead to improved gains in phonological and literacy skills (Harrison, Wood, Holliman, & Vousden, submitted; Thomson, Leong, & Goswami, 2013).

Limitations and Future Directions

There are some limitations in the research reported here that will now be acknowledged. First, a clear caveat in interpreting the results of the current study is the chosen measure of prosodic awareness. A number of paradigms have been developed to assess prosodic awareness and the DEEdee task was chosen for inclusion in the current study because it has been used widely by other researchers, albeit with slightly older children, and because it assesses awareness of stress assignment, which is the prosodic feature most closely associated with multisyllabic word reading. However, the paradigm can also been criticised on the grounds that it places a large load on verbal short-term memory and has on occasions yielded poor (or unreported) levels of internal reliability. While the former could be controlled in the statistical analyses, Cronbach's alpha indicated that this version of the DEEdee task showed acceptable reliability within the current sample, but only after seven of the test items were removed. It could, however, be argued that this (reduced alpha) actually strengthens the findings in the present study – the true relations with prosodic awareness might be even stronger than reported here given that a reduced alpha attenuates the correlations. Moreover, although sample performance on the measure of prosodic awareness was significantly above chance level, not all children achieved this level of performance. However, additional analyses excluding those who performed at or below chance level revealed a similar pattern of results. In spite of a reduced sample size and diminished statistical power, prosodic sensitivity was found to make a significant, unique contribution to children's multisyllabic word reading accuracy and to the number of stress placement errors made, supporting our main arguments in this paper. Additionally, as alluded to earlier, it is also important to note that ‘speech prosody’ (and awareness of this) comprises multiple features such as stress, intonation and timing (see Miller & Schwanenflugel, 2008) and can also be assessed at different linguistic levels such as syllabic, word, phrasal and sentence (see Holliman, Williams, et al., 2014). Although it is difficult to fully delineate such features (see Holliman, 2016) this study (the DEEdee task) focused mostly on word- and phrase-level stress assignment (for reasons noted previously); but in doing so, the relative importance of other prosodic components (e.g., intonation and timing) at different linguistic levels (e.g., sentence) remain unknown. There is clearly a good deal of work still to be done in developing effective and reliable measures of prosodic awareness.

Another potential limitation concerns the measure of multisyllabic word reading. As noted earlier, low-frequency words were intentionally selected in order to increase the likelihood of eliciting errors for analysis (one of the novel features of this study). However, in doing so, the words were often unfamiliar to children; therefore, this may have resembled a non-word reading task. The findings suggest, then, that prosodic sensitivity may play an important role in both the reading of words and nonwords. This is supported by previous research (e.g., Arciuli & Cupples, 2006, 2007; Arciuli, Monaghan, & Seva, 2010) that demonstrates orthographic cues to stress assignment. Future research might further consider the factors that determine how stress is assigned to unfamiliar words (or nonwords) in order to enhance current understandings of how children might gain this awareness and to also consider, comparatively, the relative contribution of different cues to the multisyllabic word reading accuracy.

Additionally, in relation to the above, it would have been interesting to examine the extent to which children's item-specific vocabulary predicted multisyllabic word reading accuracy – this would seem sensible given that recent findings have shown that children's ability to provide definitions for word items (semantic knowledge) predicted their ability to read them (Ricketts et al., 2016). However, it should be noted that vocabulary (albeit not item-specific vocabulary) was controlled for in the present study, and also that, in an unreported analysis, a similar pattern of results was found for words of 2, 3, 4, 5 and 6 syllables, i.e. the pattern of results that emerged overall was evident even when analyses were restricted to the easiest/shortest words. Notwithstanding this, future research of this kind might benefit from the inclusion of a measure of item-specific vocabulary to help further tease out the independent contribution of prosodic sensitivity to children's multisyllabic word reading accuracy.

We also acknowledge here that, since the design of this study was correlational, utilising concurrent data only, it is inadequate for establishing cause-effect relationships. Thus, it remains possible that that multisyllabic word reading may actually support the development of prosodic awareness, for example, or at least that this association might be bi-directional. Therefore, a degree of caution is offered with respect to the direction of the relationships that have been presented. The literature is in much need of longitudinal studies with autoregressive techniques and intervention studies to inform us more about the likely cause-effect relationships between prosodic awareness and multisyllabic word reading.

In summary, this paper has attempted to extend the existing literature on the role of prosodic awareness in reading by utilising a reading measure that focuses on challenging multisyllabic words and permits an analysis of different types of reading error. The findings have demonstrated that prosodic awareness has a specific role in a particular aspect of literacy, that is, reading multisyllabic words, and in particular, the correct assignment of stress to multisyllabic items. Furthermore, in the current sample of 7- and 8-year-old children, prosodic awareness appeared to outstrip phonological awareness, morphological awareness, vocabulary, and short-term memory in the ability to account for individual differences in reading performance. For some time it has been argued that theoretical accounts of reading development and interventions for poor readers should seek to integrate this knowledge with our existing understanding. The results of the current study suggest that this may be most appropriate when considering ways in which non-beginners approach multisyllabic words and complex texts.

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Appendix

Table A1. Stimuli for the multisyllabic word reading task.

2-syllables	**3-syllables**	**4-syllables**	**5-syllables**	**6-syllables**
Urchin	Ensemble	Aviator	Aristocracy	Meteorology
Afresh	Enigma	Ukulele	Inoculation	Infallibility
Fissure	Heresy	Incessantly	Antagonism	Paleontology
Brocade	Demeanour	Imitators	Inexperience	Incomprehensible
Plaza	Cinema	Optimism	Juxtaposition	Autobiography
Microbe	Profusion	Mediocre	Equilateral	Infinitesimal
Deceit	Audio	Evacuate	Undergraduate	Internationally
Monsoon	Irony	Certificate	Veterinary	Capitalisation
Carnage	Aurora	Incandescent	Exasperation	Irregularity
Abode	Aperture	Salamander	Incredulity	Reconciliation

Table 1.

Scoring scale for the multisyllabic word reading task

Description	**Example**
Correct pronunciation, stress placement, and decoding	re-con-ci-li-A-tion
Correct stress, but incorrect decoding	re-con-ki-li-A-tion
Main stress placed on wrong syllable	re-con-ci-li-a-TION
Spondee, long syllables	re...con...ci...li...a...tion
Incorrect number of syllables	re-con-ci-li-tion
No attempt made	

Table 2

Summary statistics (raw scores) for children on measures of phonological awareness, morphological awareness, vocabulary, short-term memory, prosodic awareness, and multisyllabic word reading (MWR) accuracy

Task	**Mean**	**SD**	**Skewness**	**Kurtosis**
Phonological Awareness (Max = 30)	14.86	5.07	1.08	-.24
Morphological Awareness (Max = 18)	11.34	4.18	-2.25	-.38
Vocabulary (Max = 168)	70.48	13.02	-.77	-.49
Short-Term Memory (Max = 36)	17.2	4.09	-.25	1.01
Prosodic Awareness (Max = 11)	6.28	2.59	-.41	-.32
MWR Accuracy (Max = 50)	18.84	10.42	1.63	-1.21

Note: The mean standardised scores on all assessments in this study fell within the normal range. The values reported for skewness and kurtosis are z-scores.

Table 3

Correlation matrix between age, phonological awareness, morphological awareness, vocabulary, short-term memory, prosodic awareness, and multisyllabic word reading (MWR) accuracy

Variables	1	2	3	4	5	6
1. Age	-------					
2. Phonological Awareness	.02	-------				
3. Morphological Awareness	-.24	.45**	-------			
4. Vocabulary	-.07	-.1	.13	-------		
5. Short-Term Memory	.16	.42**	.31**	.08	-------	
6. Prosodic Awareness	-.17	.2	.27†	.17	.28*	-------
7. MWR Accuracy	-.13	.28†	.51***	.31*	.45**	.62***

Note: †*p=.05*, **p*<.05, ***p*<.01, ****p*<.001

Table 4

Multiple regression analysis predicting multisyllabic word reading accuracy from phonological awareness, morphological awareness, vocabulary, short-term memory, and prosodic awareness

	Multisyllabic word reading accuracy			
Variable	B	SE B	β	95% CI
Constant	-19.624**	7.192		[-34.119, -5.129]
Phonological Awareness	-.023	.234	-.011	[-.513, .468]
Morphological Awareness	.725*	.29	.29*	[.140, 1.31]
Vocabulary	.145	.082	.181	[-.020, .311]
Short-Term Memory	.515	.289	.202	[-.067, 1.098]
Prosodic Awareness	1.829***	.426	.454***	[.972, 2.687]
R^2	.572			
F	11.779***			
ΔR^2	.524			

Note: N = 50. CI = confidence interval.

*p<.05, **p<.01, ***p<.001

Table 5

Summary statistics for the different types of decoding errors made on the multisyllabic word reading measure

Task	**Mean**	**SD**	**Skewness**	**Kurtosis**
Correct: Pronunciation, Stress, Decoding	18.84	10.42	1.63	-1.21
Error: Decoding	2.08	1.69	2.36	-.12
Error: Stress Placement	9.78	4.33	.79	-.26
Error: Spondee	6.98	7.18	4.68	3.82
Error: Syllables	8.14	6.58	4.09	2.73
Error: No Attempt	4.18	7.72	6.5	6.65

Note: The mean standardised scores on all assessments in this study fell within the normal range. The values reported for skewness and kurtosis are z-scores.

Table 6

Multiple regression analysis predicting stress placement errors in multisyllabic word reading from phonological awareness, morphological awareness, vocabulary, short-term memory, and prosodic awareness

	Stress placement errors			
Variable	B	SE B	β	95% CI
Constant	15.397**	4.4		[6.529, 24.265]
Phonological Awareness	.02	.149	.023	[-.281, .32]
Morphological Awareness	-.046	.178	-.044	[-.404, .312]
Vocabulary	-.042	.05	-.127	[-.143, .059]
Short-Term Memory	-.024	.177	-.022	[-.38, .333]
Prosodic Awareness	-.32	.26	-.191	[-.844, .205]
R^2	.071			
F	.672			
ΔR^2	-.035			

Note: $N = 50$. CI = confidence interval.

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