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The Role of Prosodic Sensitivity in Children's Reading Development.

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Abstract

While the critical importance of phonological awareness (segmental phonology) to reading ability is well established, the potential role of prosody (suprasegmental phonology) in reading development has only recently been explored. This study examined the relationship between children's prosodic skills and reading ability. Hierarchical multiple regression analyses examined the unique contribution of word-level and phrase-level prosodic skills to the prediction of three concurrent measures of reading ability in 81 fourth-grade children (mean age 9;3 years). After controlling for phonological awareness and general rhythmic sensitivity, children's prosodic skills predicted unique variation in word-reading accuracy and in reading comprehension. Phrase-level prosodic skills, assessed by means of an reiterative speech task, predicted unique variance in reading comprehension, after controlling for word reading accuracy, phonological awareness, and general rhythmic sensitivity. These results add to the growing body of evidence of the importance of prosodic skills in reading development.

A generation of research has established the critical importance of phonological skills to reading development (Bradley & Bryant, 1978; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001; Snowling, 2000). Phonological awareness, the ability to recognise and manipulate the sound segments in words, is one of the most important predictors of early reading development (Share, 1995), and poor phonological awareness is a defining feature of developmental reading disability (Lyon, Shaywitz, & Shaywitz, 2003). Despite compelling evidence for the importance of phonological awareness in reading, the nature and locus of the phonological representations supporting phonological awareness remain unclear, as does the extent to which other aspects of phonological skill impact on reading development. Ramus (2001) has argued that the vast body of knowledge on phonology, largely overlooked by reading researchers, can contribute to our understanding of the phonological skills required for reading development.

One aspect of phonology that has recently received more attention is prosody: the phonological subsystem that encompasses the tempo, rhythm and stress of language. Wood and Terrell (1998) found that young poor readers are relatively insensitive to the suprasegmental (prosodic) cues of rhythm and stress at the phrasal level. Evidence of the relationship between prosodic skills and decoding speed in children has been found (Schwanenflugel, Hamilton, Kuhn, Wisenbaker, & Stahl, 2004) as well as a relationship between prosodic skills and reading ability in adult readers (Kitzen, 2001). Goswami and colleagues (Goswami et al., 2002; Richardson, Thomson, Scott, & Goswami, 2004) found that poor readers are less sensitive to detecting amplitude envelope cues, representative of speech rhythm. They propose that this deficit may underlie the poor phonological representations and phonological awareness impairments characteristic of reading difficulties (Goswami et al., 2002). Here, we investigate the role of prosodic skills at the word and phrase level in reading development.

The role of prosody in language comprehension

Prosody is a universal linguistic subsystem that performs many functions in all languages. Prosody interacts with, and adds value to, other language subsystems, such as syntax and semantics, facilitating understanding and providing scaffolding to children when acquiring language. For example, prosodic cues help segment the speech stream into phrases, words and syllables, inform syntactic structure, and emphasise salient information to facilitate understanding. Language users perceive speech to be made up of discrete sentences, phrases, words and even phonemes, although utterances are produced in an almost continuous speech stream. In English, the prosodic stress pattern of alternating strong and weak syllables provides a reliable and useful tool to separate words in speech, because strong syllables generally are assumed to mark the beginning of lexical words (such as nouns and verbs). Approximately 85 percent of English lexical words begin with a strong syllable (Cutler & Carter, 1987). The retrieval of spoken words from the mental lexicon is facilitated by the word's prosodic structure, providing a template or means for accessing lexical representations (Lindfield, Wingfield, & Goodglass, 1999). Furthermore, at the word level, prosodic cues are also necessary to differentiate between phonemically identical word strings in compound nouns (such as 'blackbird') and noun phrases or adjective and noun couplets (such as 'black bird') (Kitzen, 2001).

According to Bolinger (1978), the first universal property of prosody is the interface between prosodic and syntactic breaks. Once the speech stream has been segmented into words, the listener must extract the accompanying syntactic structure. Prosodic boundaries reliably inform parsing decisions, particularly at the phrasal level, providing reliable cues for ‘chunking’ spoken language into comprehensible syntactic units such as phrases and sentences (Cutler, Dahan, & van Donselaar, 1997). Chunking by prosodic means also allows listeners to reduce their memory load by aiding the retention of an utterance until more abstract and complex syntactic and semantic processes occur (Speer, Crowder, & Thomas, 1993).

The second universal property of prosody is the highlighting of prominent information (Bolinger, 1978). Prosody provides access to different meanings by focusing the listener’s attention on new or contrastive information and deaccentuating older or less relevant information (Warren, 1996). Prosody can also denote whether the same string of words is a question, a statement, a sarcastic comment or an exclamation (Speer et al., 1993). The application of a different prosodic structure to a sentence, such as ‘John was here’, can change its message from a statement to a question.

Prosodic cues are one of the first aspects of the speech stream to be utilised by newborns, infants, and children, to ‘bootstrap’ their acquisition of language. The prosodic bootstrapping hypothesis posits that, as they develop, newborns and infants become perceptually attuned to analyse and utilise the regularity and perceptual salience of prosodic patterns contained in the speech stream, such as rhythm, stress at the word and syllabic level, and pauses at phonological boundaries (Wanner & Gleitman, 1982). This allows them to segment the speech stream into comprehensible units, such as clauses, phrases and words, thus enabling further analysis by highlighting other important syntactic and semantic features necessary for learning language (Morgan & Demuth, 1996). Prosodic sensitivity explains the preference for infant-directed speech with its exaggerated prosodic features, segmenting the speech stream into words, emphasising content words, marking syntactic boundaries (such as phrases), and thus facilitating access to language (Werker, Pegg, & McLeod, 1994).

Prosodic skills development in middle childhood

Although children of 3 or 4 years of age are relatively competent in their native language (Berko Gleason, 2005), full perceptual understanding and productive control of prosodic intonation is not mastered until 12 or 13 years of age (Wells & Peppe, 2003). However, prosodic development in middle childhood (5 to 13 years of age), is much less studied. In one of the few studies to systematically investigate aspects of prosodic development in middle childhood, Atkinson-King (1973) found a developmental progression in the acquisition of prosodic skills, ranging from an early ability at approximately 4 years of age to produce emphatic or contrastive stress (such as “I want the green book, not the red book”) to the independent production by 11 year olds of the correct stress for compound words shown in pictures without linguistic context (such as ‘hot dog’ vs. ‘hotdog’). Adults were able to do all these tasks without error.

More recently, Wells, Peppe and Goulandris (2004) reported an in-depth study of 5 to 13 year-old children’s comprehension and production of intonation (a subset of prosodic skills). Among other tasks, Wells et al. tested the children’s ability to produce and distinguish between compound nouns (such as “chocolate biscuits”) and noun strings (such as “chocolate, biscuits”), as well as their ability to understand and to indicate the focus, or most important item, in an utterance by the use of stress (such as “chocolate and honey”). They found that while five year old children have acquired many functional intonational skills, there are further significant developments occurring through the primary school years, as well as considerable variation in children of the same age. Wells et al. found a strong correlation between children’s performance on the comprehension of intonation tasks and measures of receptive and expressive language development.

Read and Schreiber (1982) found that children were more likely than adults to rely on misleading prosodic cues than on conflicting, but correct syntactic cues, in listening tasks. In light of this evidence, Schreiber (1987) argued that adults use more abstract and symbolic processing strategies, relying on semantic, syntactic, social and general knowledge cues to comprehend spoken language, whereas children rely on the simpler prosodic cues to 'bootstrap' their acquisition of the more complex aspects of language. As language mastery is achieved, prosody assumes more of a supporting role to other linguistic processes. When learning a second language, adults will also use strategies to segment speech that are based on the rhythmic or prosodic features of their native language, even if such cues are irrelevant (Cutler & Butterfield, 1990, 1992). Prosody thus is critical to acquiring language.

Prosodic skills and reading

The discussion, thus far, has focussed on the role of prosody in spoken language. Are the prosodic skills required for reading the same as those for listening? Literacy skills are based upon the foundations built by spoken language and consequently oral and written language are intimately connected. Considerable research supports the simple view of reading, namely that reading comprehension is the product of two key skills: oral comprehension and the ability to decode individual written words in text (Gough, Hoover, & Peterson, 1996). While decoding is a process unique to reading, Hoover and Gough (1990) maintain that the comprehension processes are common to both spoken language and reading. Prosody plays an important role in listening comprehension and thus is important also in reading comprehension, particularly for children, who appear to rely on prosodic cues more than adults (Schreiber, 1987). Moreover, due to the paucity of prosodic information provided in written language contexts in comparison to spoken language, written language comprehension may place demands on prosodic sensitivity beyond those required for spoken language.

Prosody may also play a significant role in the development of word-level reading skills. As already noted, the retrieval of spoken words from the mental lexicon is facilitated by the word's prosodic structure, providing a template or means for accessing lexical representations (Cutler & Swinney, 1987). In addition, prosodic sensitivity may contribute to word-level reading skills by supporting the development of accurate phonological representations and phonological awareness (Goswami et al., 2002).

The role of prosody in reading development has recently received more attention (Kuhn & Stahl, 2003; Schwanenflugel et al., 2004). In a reading level study**,** Wood and Terrell (1998) used a rhythmic matching task designed to assess children's sensitivity to the metrical or rhythmic characteristics of spoken language. Children were required to match a spoken phrase to one of two low-pass filtered phrases, in which only the rhythm and stress pattern of the original phrase was retained. Poor readers performed significantly worse than age-matched controls on the rhythmic matching task, and at the same level as younger children matched on reading ability. This pattern of results suggests a potential maturational lag in poor readers' sensitivity to these prosodic cues.

Goswami et al. (2002) used a beat detection task, in which they varied slow amplitude modulation of the speech waveform, representative of speech rhythm. In a reading level study, they found that poor readers were worse at detecting amplitude modulated "beats" than children matched on chronological age. Reading-level matched children demonstrated intermediate thresholds on this task. Goswami et al. (2002) also found that young early readers, who had begun to learn to read without instruction, were superior to control children at the beat detection task. In a later study, Richardson et al. (2004) also found that poorer readers were less sensitive to amplitude envelope cues, representative of speech rhythm, than chronological-age matched controls, with reading-level matched children displaying intermediate thresholds on the tasks. Goswami et al. (2002) have argued that sensitivity to the rhythmic properties of speech may contribute to word-level reading skills by supporting the development of accurate phonological representations underlying phonological awareness.

Kitzen (2001) found a strong positive relationship between reading ability and prosodic sensitivity for college students with and without a history of reading disability and reading remediation. A reiterative speech task, the 'DEEdee' task, was used to assess phrasal prosody. In this task, a phrase's prosodic pattern is retained by replacing phonemic or segmental information with a single meaningless syllable, such as 'dee' (Nakatani & Schaffer, 1978). Word level prosody was assessed using the Blumstein Goodglass (BG) task. This task measured whether individuals could differentiate between phonemically identical word strings of compound nouns and noun phrases (such as '*lighthouse*' and '*light house*') solely by relying on prosodic cues (Blumstein & Goodglass, 1972, as cited in Kitzen, 2001). The DEEdee task was a significant predictor of word decoding skills and text reading accuracy, after controlling for other reading predictors (including phonological awareness). Both the DEEdee and BG tasks were correlated significantly with reading comprehension. Thus, Kitzen's study demonstrated a strong, and partially unique, relationship between prosodic skills and reading ability in adult poor readers.

The Present Study

Reading comprehension deficits have been linked to subtle language processing deficits (Nation, 2001; Stothard & Hulme, 1992, 1995) and it has been demonstrated that prosody plays a crucial role in language processing, especially for children. Moreover, prosodic skills may be particularly important for reading comprehension, given the paucity of prosodic information provided in written language contexts in comparison to spoken language. Prosody may also be important to word-level reading skills, by contributing to underlying phonological representations that support phonological awareness (Goswami et al, 2002) and by facilitating the retrieval of words from the mental lexicon (Lindfield et al., 1999).

The present study further investigated the role of prosodic sensitivity in children's reading ability. Using a correlational design, the possible relationships between prosodic skills, reading ability, and other phonological skills were investigated, to determine whether prosodic sensitivity makes a unique contribution to predicting reading ability over and above the well-established role of segmental phonological skills (phonological awareness). Children of eight and nine years of age completed tests of word-level reading skills, reading comprehension, prosodic sensitivity and phonological awareness, as well as a non-speech rhythm (control) task. Prosodic skills were assessed at the word level by administering a compound nouns task, adapted and extended from the prosody tasks used by Kitzen (2001), and at the phrase level by administering a 'DEEdee' task (Kitzen, 2001), adapted for use with children. Phonological awareness was assessed by means of a phonological oddity task. A non-speech rhythmic task was incorporated in the study. Its inclusion served to control for possible individual differences in discerning non-linguistic stimuli, which may be linked to reading ability (Anvari, Trainor, Woodside, & Levy, 2002; Espy, Molfese, Molfese, & Modglin, 2004).

While the correlational design of this study cannot support causal inferences, it does allow examination of differential relationships between prosodic skills at the word and phrasal level and different aspects of reading ability, and of whether prosodic skills predict unique variation in different aspects of reading ability.

Method

Participants

Participants were 84 children in 4th Grade (46 girls and 38 boys) attending two State Primary Schools in a low- to middle-income socioeconomic area of Brisbane, Australia. All children for whom parental permission was obtained were included in the study. The children's ages ranged from 8;8 to 10;5 years with a mean age of 9;3 years (*SD* = 4.58 months).

Apparatus

The prosodic sensitivity and non-speech rhythm tasks were pre-recorded, with spoken stimuli recorded by a professional female speaker. The stimuli were recorded on a Fostek X15 four-track tape recorder, then digitally edited and mastered using Cakewalk Sonar 1.0.1 digital editing software (Twelve Tone Systems Inc.). The final stimuli were saved to compact disc and played to the children using a Philips AZ1146 compact disc player.

Measures

Reading ability. The Word Identification and Word Attack subtests of the Woodcock Reading Mastery Tests – Revised (Woodcock, 1987) were used to assess word and nonword reading accuracy, respectively. Raw scores on the Woodcock tests were converted to W scores (a common metric derived from a Rasch-calibrated interval score) for analysis. Reading comprehension was assessed with the Neale Analysis of Reading Ability – Revised (Neale, 1988), which provides norms applicable for Australian use. Children read a series of graded passages and then answered questions about each passage. Reading errors and the time taken to read the passage were recorded. The Neale yields scores for reading comprehension, reading accuracy and reading rate in context.

Phonological awareness. Phonological awareness was assessed by means of a Phonological Oddity, or ‘odd-one-out’ task. The child heard a series of three monosyllabic spoken words, two of which contained a sound sequence not present in the third word. The child’s task was to identify the ‘odd word out’ in each trial. The oddity task comprised two subtests, where the odd word out differed from the other words by rhyme (for example, ‘rob’, ‘nod’, ‘sob’) or final phoneme (for example, ‘log’, ‘red’, ‘pad’). Each subtest comprised 2 practice trials and 10 test trials. Scores on the two subtests were combined to provide a phonological awareness score, with a maximum possible score of 20.

Stimuli were based on the phonological oddity task devised by Bowey, Cain, and Ryan (1992). They were modified to increase item difficulty, in order to avoid ceiling effects noted in previous studies with children in this age range (Hansen & Bowey, 1994). For the rhyme oddity subtest, five trials were modified so that words contained irregular spelling patterns (such as ‘cot’ and ‘yacht’) to limit support from spelling information when making rhyme judgments. To increase the difficulty level in the final phoneme awareness task, five trials used final phonemes that differed only in place of articulation such as /*p*/ versus /*b*/ and /*g*/ versus /*k*/ ((Snowling, Hulme, Smith, & Thomas, 1994).

Prosodic sensitivity. The DEEdee task assessed prosodic sensitivity at the phrasal level. This task is based on a reiterative speech technique, in which each syllable in a phrase is replaced by the same reiterative syllable ‘dee’ to eliminate phonemic information, but spoken so as to retain the same stress, rhythm and intonational pattern of the original phrase (Kitzen, 2001). Both target and foil phrases were titles of popular children’s books, movies or television programs, and hence were familiar to the children and were phonotactically legal phrases. The phrases varied in length from two to five syllables. Target and foil DEEdee phrases in each trial were matched in syllable length. Stimuli for the DEEdee task are provided in Appendix A.

In each trial, the child heard the original phrase (a movie or book title) followed at one second intervals by two DEEdee phrases, one of which matched the stress, rhythm and intonation of the original phrase. All three phrases were then repeated, in the same order, after an interval of three seconds. The child had to choose whether the first or second DEEdee phrase corresponded to the original phrase. Children indicated by marking the appropriate box on the answer sheet (which showed a graphic of the target phrase) whether the first or second DEEdee stimulus matched the target phrase. There were two practice trials with corrective feedback, followed by eighteen test trials over which the length of the target and foil phrases increased from two to five syllables. The order of target and foil DEEdee phrases was counterbalanced across trials.

Prosodic sensitivity at word level was assessed by means of a Compound Nouns task, comprising two subtests. These subtests assessed whether the children could distinguish between compound nouns (such as ‘ice-cream’) and noun phrases (such as ‘ice, cream’) that differ only by prosodic features such as intonation, stress and pause (Wells, & Peppe, 2003). The first Compound Nouns subtest was drawn from the Profiling Elements of Prosodic Systems – Children test (Wells & Peppe, 2003). Children heard a single phrase which could represent either two or three items, depending on the prosodic cues used (such as ‘chocolate-cake and honey’ or ‘chocolate, cake and honey’). The children were provided with an answer sheet, with line drawings depicting the two possible spoken phrases for each trial, and they were required to choose the graphic that best depicted the spoken phrase. The second subtest followed the same format, except that the stimuli comprised compound nouns (such as ‘highchair’) and noun phrases (such as ‘high chair’) and were presented in sentences which provided no contextual cues to the correct answer. Scores for the 32 test trials (20 for the first subtest, and 12 for the second subtest) were combined to provide a measure of word-level prosodic sensitivity. Appendix B contains the stimuli used in the Compound Nouns tasks.

Non-speech rhythm. The Non-speech Rhythm task assessed the children's ability to discern stress and rhythm in a non-speech context. Two patterns of drumbeats were presented and the children were required to indicate on an answer sheet if the drumbeats were the same or different. There were 19 trials, with matching sets of three to five beats in each trial.

Procedure

The children were tested in a quiet location at their school, in three sessions each lasting approximately 20 minutes. The reading and phonological awareness tests were administered in two individual testing sessions. The prosodic and rhythmic sensitivity tasks were administered to small groups of three to six children.

Results

Of the 84 children who participated in the study, data for 81 children were included in the analyses. Data were excluded for one child with a developmental disorder and one with extreme shyness, both of whom were unable to complete all experimental tasks successfully, as well as one child who was absent for one testing session. A fourth child was identified as an outlier, scoring poorly on reading comprehension. His data was retained because similar patterns of results were found with or without his inclusion.

Descriptive statistics for all measures are reported in Table 1. The Non-speech Rhythm task was negatively skewed due to ceiling effects. This variable was transformed using a 'reflect and square root' transformation. However, as this transformation did not significantly alter its relationships with the other variables, analyses based on the original scores are reported. Scores on all other measures were normally distributed.

Insert Table 1 about here

Intercorrelations among Reading Ability, Phonological Awareness, and Prosodic and Rhythmic Sensitivity Measures

Zero-order correlations among the experimental measures can be seen in Table 2. Only correlations with significance at the $p < .01$ level have been interpreted as reliable. There was a strong correlation ($r = .85$) between the two measures of word-reading accuracy; the Woodcock Word Identification test, assessing word decoding in isolation, and Neale Accuracy, assessing decoding accuracy in context. Woodcock Word Identification was used as the measure of word decoding skills in subsequent analyses. Phonological Oddity and Non-speech Rhythm scores were positively correlated with measures of reading accuracy (Woodcock Word Identification and Word Attack skills, and Neale Accuracy), but not with Neale Comprehension. Both prosodic sensitivity tasks (the Compound Nouns and DEEdee tasks) were significantly correlated with Woodcock Word Identification and Neale Accuracy. There was a significant correlation between scores on the Compound Nouns tasks and Woodcock Word Attack skills, whereas performance on the DEEdee task was significantly correlated with Neale Comprehension.

Insert Table 2 about here

Neale Reading Rate was correlated with word-level reading skills and phonological awareness, but not with Neale Comprehension or prosodic skills. This pattern of relationships is consistent with the procedure used to calculate Neale Reading Rate, wherein reading time is not corrected for reading errors or self-corrections. Thus Neale Reading Rate is influenced by word-reading accuracy, and is not a pure measure of reading fluency. A similar pattern of results was reported by Oakhill, Cain, and Bryant (2003)

Contribution of Prosodic Sensitivity Measures to Reading Ability.

In order to determine whether prosodic sensitivity explained unique variation in reading achievement, parallel hierarchical multiple regression analyses were carried out, with each of three reading measures used as dependent variables: Neale Comprehension, Woodcock Word Identification, and Woodcock Word Attack scores. The predictor variables were Phonological Oddity, Non-speech Rhythm, and word-level and phrase-level prosodic sensitivity (Compound Nouns and DEEdee tasks, respectively). Results of each of these analyses can be seen in Table 3.

Insert Table 3 about here

In each analysis, the Phonological Oddity and Non-speech Rhythm scores were entered at steps 1 and 2, to control for variation in reading ability attributable to individual differences in phonological awareness and general rhythmic sensitivity. Phonological Oddity, entered at step 1, was a strong predictor of word-level reading skills and a lesser predictor of reading comprehension, accounting for between 28.5% and 40.8% of the variability in word-level skills, and 4.8% of the variability in reading comprehension. At step 2, Non-speech Rhythm scores accounted for an additional 6.5% of the variation in Word Identification scores, but did not contribute significant incremental variance to the prediction of the other reading measures (see Table 3). To examine the unique contribution of prosodic sensitivity to reading ability, the prosodic sensitivity measures were entered, in alternate order of entry, at steps 3 and 4. Both prosodic sensitivity tasks, entered at step 3, accounted for a small but significant proportion of additional variability in Word Identification scores. The Compound Noun task accounted for significant unique variability at step 4, after controlling for the other prosody measure. The DEEdee task predicted unique variability in Neale Comprehension after all other measures were statistically controlled, accounting for 9.3% additional variability when entered at step 3, and 7.7% unique variability when entered at step 4, after taking the Compound Noun task into account. Thus, the Compound Noun task, measuring word-level prosody, was most strongly related to Word Identification, whereas the DEEdee task, representing phrase-level prosody, was most strongly related to Neale Comprehension.

Reading comprehension involves additional skills over effective decoding or word identification skills. To analyse whether the phrasal prosodic measure could account for unique variance in reading comprehension, after taking into account word-level decoding, a further hierarchical multiple regression analysis was conducted. The results of this analysis are shown in Table 4. Word Identification, Phonological Oddity and the Non-speech Rhythm control task were entered at step 1. To further account for processes occurring at the word level, the Compound Nouns task, which predicted unique variation in Word Identification scores in the earlier analysis, was entered at step 2. The phrase-level prosodic measure (the DEEdee task) was then entered at step 3. The DEEdee task accounted for a further significant 5% of variance in Neale Comprehension, after taking into account all the other measures.

Insert Table 4 about here

Discussion

In exploring the role of prosodic sensitivity in children's reading ability, this study provided evidence that prosodic skills are important for successful reading. The two measures of prosodic sensitivity, the compound noun and DEEdee tasks, exhibited a differential pattern of relationships with word-level reading ability and reading comprehension proficiency. Regression analyses revealed that the compound nouns task, which relies on prosodic features of intonation, stress, and pause to distinguish among phonemically identical compound nouns and noun phrases, predicted unique variance in word identification accuracy. The DEEdee task, designed to assess prosodic skills at the phrasal level, predicted unique variance in reading comprehension.

Although phonological awareness emerged, as expected, as the strongest predictor of word-level reading skills, performance on the compound nouns task predicted unique variance in word identification, after accounting for phonological awareness and non-speech rhythmic skills. Goswami et al. (2002) have suggested that prosody may support word-level reading skills by contributing to underlying phonological representations that support phonological awareness, and thus the development of word attack skills and reading proficiency (Rayner et al., 2001). However, the present results suggest that prosodic sensitivity may also contribute to word identification skills beyond a role in the development of phonological awareness. As (Lindfield et al., 1999) have suggested, prosodic information may support word identification by facilitating the retrieval of words from the mental lexicon. This interpretation is consistent with the present finding that performance on the compound noun task predicted unique variance in word identification skills (which entail lexical access) but not in word attack skills (a measure of phonological recoding).

The phrasal prosodic measure (the DEEdee task) emerged as a unique predictor of reading comprehension. Children's performance on the DEEdee task accounted for significant additional variance in reading comprehension, after word level reading processes were accounted for by removing variance associated with word identification skill, phonological awareness, and performance on the compound nouns task. The DEEdee task thus appears to capture prosodic skills relevant to reading comprehension. Children may use their prosodic skills to help discern syntactic structure, and to identify salient information to facilitate understanding (Cutler et al., 1997).

The pattern of results in the present study is largely consistent with, and extends, the results of previous studies. In line with Wood and Terrell (1998), but using different measures of prosodic sensitivity, our findings further confirmed a positive relationship between children's prosodic sensitivity and their reading skills. The unique relationship between prosodic sensitivity and reading ability found in adult readers (Kitzen, 2001) was also found for children in this study, using similar tasks. However, Kitzen found a different pattern of relationships between the compound noun and DEEdee tasks and reading skills than was found in the present study. In Kitzen's adult sample, performance on the compound nouns task was more strongly related to reading comprehension than was performance on the DEEdee task.   Thus, the results of the present study require replication before strong inferences can be drawn about a differential contribution of prosodic skills at word and phrase levels to successful decoding and reading comprehension.

Although prosodic skills were found to contribute to successful reading comprehension in the present study, the exact nature of this relationship requires further investigation. Prosodic skills may contribute indirectly to reading comprehension through the importance of prosody in oral language comprehension. This indirect contribution is in line with the simple view of reading, which posits that the language skills used in reading comprehension are the same as those used in listening comprehension (Hoover & Gough, 1990). Prosody is critically interwoven with other aspects of spoken language, such as semantics and syntax, and thus is necessary for oral language comprehension. It is posited that normally developing children use their sensitivity to prosody to acquire and master spoken language and, in turn, use this linguistic skill to indirectly aid the comprehension of written text. Researchers such as Nation (2001) and Stothard and Hulme (1992; 1995) argue that children with poor reading comprehension have normal phonological awareness and decoding skills but have subtle language processing deficits, in semantics and syntax, which become evident when considering reading ability. It is conceivable that these linguistic deficits also are intimately connected with problems in prosodic processing. Moreover, if children rely more heavily on prosodic information to discern syntactic structure than adults do (Schreiber, 1987), prosody may play a more integral role for children when learning to read, than for adults who have mastered both oral and written language.

We have further suggested that reading comprehension may place demands on prosodic sensitivity, different from those made when processing spoken language. In contrast to the rich prosodic cues embedded in spoken language, prosody in text is minimally conveyed by punctation (such as commas and full stops) for pause, italics for stress and capitalisation for beginning new sentences. Thus the reader must supply the prosody intended by the writer, which is only sparsely captured by punctuation, to fully understand the context of the passage and its intended message. As listening comprehension was not controlled in the present study, the proposal that reading comprehension places demands on prosodic skills over and above those required for listening comprehension remains untested. Future studies incorporating a measure of listening comprehension would clarify whether prosodic skills play a direct role in reading comprehension, over and above the indirect role expected through their contribution to language comprehension. Similarly, the inclusion of a measure of general intelligence in future studies would provide a stronger test of the unique relationship between prosodic skills and reading.

The present study examined prosodic skill in the context of the English language, whose prosodic or rhythmic properties classify it as a stress-timed language (Nazzi, Bertoncini, & Mehler, 1998). Cross-linguistic differences in prosodic, phonological and orthographic structures preclude generalisation of the present results to other languages. Studies of bilingual speakers and second-language learners would provide a fruitful avenue for examining linguistic differences in the relationship between prosodic skills and reading.

There is mounting evidence for a significant role for prosodic skills in reading development and this study provides further evidence of the importance of prosodic skills in children’s reading. However, a great deal more research is required to elucidate the contribution of prosodic skills to reading development. Further research is needed to explore the relative importance of prosodic skills in the comprehension of spoken versus written language, and to determine the extent to which different aspects of prosodic skill contribute differentially to different aspects of reading. Longitudinal and reading level comparison studies, such as have been carried out for phonological awareness and reading (Manis, Custodio, & Szeszulski, 1993; Torgesen, Wagner, & Rashotte, 1994), would provide stronger evidence of potential causal links between prosodic skills and reading development.

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Table 1

Means and Standard Deviations of Age, Reading Ability, Phonological Skills and Prosodic and Rhythmic Sensitivity Measures

	Mean	SD	Maximum
Age (months)	111	4.58	
Reading age (months)			
Neale Comprehension	108	17	
Neale Accuracy	113	17	
Neale Reading Rate	132	20	
Woodcock Reading Mastery Test (W scores)			
Word Identification	491.12	21.35	
Word Attack	504.31	15.5	
Phonological Oddity	13.95	3.13	20
Prosody: DEEdee	11.42	2.61	18
Prosody: Compound Nouns	25.26	4.92	32
Non-speech Rhythm	16.02	3.28	19

Table 2

Intercorrelations among Measures of Reading Ability, Phonological Awareness, and Prosodic and Rhythmic Sensitivity (N=81)

	1 Age	2 NC	3 NA	4 NR	5 WI	6 WA	7 PO	8 CN	9 DD
2. Neale Comprehension	-.109								
3. Neale Accuracy	-.073	.619**							
4. Neale Reading Rate	.141	.233	.484**						
5. Word Identification	-.074	.464**	.850**	.444**					
6. Word Attack	.003	.292**	.567**	.343**	.706**				
7. Phonological Oddity	-.004	.219	.573**	.399**	.639**	.534**			
8. Compound Nouns	-.168	.249	.405**	.072	.455**	.318**	.325**		
9. DEEdee	-.190	.383**	.346**	.070	.368**	.255	.264	.353**	
10. Non-speech Rhythm	-.113	.268	.360**	.126	.441**	.323**	.312**	.244	.326**

** p <.01.

Table 3

Hierarchical Multiple Regression Analyses Predicting Three Aspects of Reading Ability from Phonological and Prosodic Skills.

	Word Identification		Word Attack		Neale Comprehension	
Step	R^2_{change}	Final β	R^2_{change}	Final β	R^2_{change}	Final β
1. Phonological Oddity	.408***	.482***	.285***	.439***	.048*	.070
2. Non-speech Rhythm	.065**	.199*	.027	.134	.044	.149
3. Prosody: Compound Nouns	.042*	.190*	.013	.107	.020	.071
4. Prosody: DEEdee	.013	.126	.004	.069	.077**	.303*
3. Prosody: DEEdee	.027*		.008		.093**	
4. Prosody: Compound Nouns	.028*		.009		.004	
Total R^2	.528***		.330***		.189**	

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

Table 4

Hierarchical Multiple Regression Analysis Predicting Reading Comprehension from Prosodic Sensitivity, after Controlling for Other Variables

Step	Final ß	R^2 change
1. Word Identification	-.445*	.231***
Phonological Oddity	-.145	
Non-speech Rhythm	.061	
2. Prosody: Compound Nouns	-.014	.001
3. Prosody: DEEdee	.247*	.050*
Total R^2		.282***

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

Appendix A

Stimuli for the DEEdee Task

Practice Trials

1. Humpty Dumpty	DEEdee DEEdee	dee DEEdee DEE
	Humpty Dumpty	The Lion King
2. Bob the Builder	DEE dee DEEdee	deeDEEdeeDEE
	Bob the Builder	Pinocchio

Trials

1. Snow White	DEE DEE	DEEdee
	Snow White	Bambi
2. Aladdin	dee DEE DEE	deeDEEdee
	The Frog Prince	Aladdin
3. Pokemon	Dee DEE DEE	DEEdeeDEE
	The Snow Dogs	Pokemon
4. Old King Cole	DEE dee DEE	DEE DEE DEE
	Jack and Jill	Old King Cole
5. The Simpsons	DEEdee DEE	dee DEEdee
	Peter Pan	The Simpsons
6. Cinderella	DEEdeeDEEdee	DEEdee dee DEE
	Cinderella	Winnie the Pooh
7. Old Mother Goose	DEE DEEdee DEE	deeDEEdeeDEE
	Old Mother Goose	Pinocchio
8. Sesame Street	DEEdeedee DEE	DEE dee DEEdee
	Sesame Street	Bob the Builder
9. Thumbelina	deeDEEdeeDEE	DEEdeeDEEdee
	Pinocchio	Thumbelina

10. Sleeping Beauty	DEEdee DEEdee	dee DEEdee DEE
	Sleeping Beauty	The Saddle Club
11. The Jungle Book	dee DEEdee DEE	DEEdee DEEdee
	The Jungle Book	Mary Poppins
12. Pocahontas	dee DEEdee DEE	DEEdeeDEEdee
	The Lion King	Pocahontas
13. Stuart Little	DEEdee DEEdee	DEEdee DEE DEE
	Stuart Little	Little Boy Blue
14. The Gingerbread Man	dee DEEdeedee DEE	dee DEEdee DEEdee
	The Gingerbread Man	The Ugly Duckling
15. The Little Mermaid	dee DEEdee DEEdee	DEEdee deeDEEdee
	The Little Mermaid	Hairy McClary
16 Hansel and Gretel	dee deeDEEdeeDEE	DEEdee dee DEEdee
	The Aristocrats	Hansel and Gretel
17 The Fox and the Hound	dee DEE dee dee DEE	DEE DEEdee DEEdee
	The Fox and The Hound	Hey Diddle Diddle
18. Lady and the Tramp	DEEdee dee dee DEE	DEEdee DEE DEEdee
	Lady and the Tramp	Little Miss Muffet

Appendix B

Stimuli for the Compound Nouns Tasks

Task A

Stimuli

1. chocolate, cake and honey
2. twenty-one and six
3. foot, ball and socks
4. paperbag and string
5. bowtie and shoes
6. fruit, salad and milk
7. bean, bag and flowers
8. sunlight and tress
9. breadstick and eggs
10. paint, brush and water
11. fruit-salad and milk
12. paper, bag and string
13. beanbag and flowers
14. chocolate-cake and honey
15. bow, tie and shoes
16. football and socks
17. sun, light and trees
18. bread, stick and eggs
19. paintbrush and water
20. twenty, one and six

Task B

Stimuli

1. “The *highchair* is in the corner.”

2. “The *blackboard* is over there.”

3. “The *light house* is on the hill.”

4. “The *hot rod* is red.”

5. “The *greenhouse* is down there.”

6. “*My key* is there”

7. “Amy went to buy a *high chair*.”

8. “Jack went to the *black board*.”

9. “Look out for the *lighthouse*.”

10. “Matt gave his *hotrod* to Tina.”

11. “The women went into the *green house*.”

12. “Where is *Mikey*?”