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Becoming a Fluent Reader: Reading Skill and Prosodic Features in the Oral Reading of Young Readers

Paula J. Schwanenflugel,
Department of Educational Psychology, University of Georgia

Anne Marie Hamilton,
Linguistics Program, University of Georgia

Joseph M. Wisenbaker,
Department of Educational Psychology, University of Georgia

Melanie R. Kuhn, and
Department of Teaching and Learning, Rutgers University

Steven A. Stahl
Department of Curriculum and Instruction, University of Illinois at Urbana–Champaign

Abstract

Prosodic reading, or reading with expression, is considered one of the hallmarks of fluent reading. The major purpose of the study was to learn how reading prosody is related to decoding and reading comprehension skills. Suprasegmental features of oral reading were measured in 2nd- and 3rd-grade children (N = 123) and 24 adults. Reading comprehension and word decoding skills were assessed. Children with faster decoding speed made shorter and less variable intersentential pauses, shorter intrasentential pauses, larger sentence-final fundamental frequency (F_0) declinations, and better matched the adult prosodic F_0 profile. Two structural equation models found evidence of a relationship between decoding speed and reading prosody as well as decoding speed and comprehension. There was only minimal evidence that prosodic reading was an important mediator of reading comprehension skill.

Prosodic reading, or reading with expression, is widely considered to be one of the hallmarks of the achievement of reading fluency. When a child is reading prosodically, oral reading sounds much like speech with appropriate phrasing, pause structures, stress, rise and fall patterns, and general expressiveness. However, exactly where does the development of prosodic reading or “making it sound like language” (Stahl & Kuhn, 2002, p. 582) fit in our conceptions of developing reading skill? The purpose of the current study was to determine how individual differences in developing reading skill are related to prosodic reading in order to better place prosodic reading in the process of learning to read fluently.

Gough and Tumner's (1986) “simple view of reading” proposed that reading comprehension could be described in terms of two factors—language comprehension and word decoding. In this model, both language comprehension and decoding are seen as limiting factors in reading comprehension. If the child's decoding is less than fully automatic, his or her comprehension will suffer. As decoding moves toward full automaticity, reading comprehension skill should equal comprehension of oral language (Carver, 1993, 2000; Hoover & Gough, 1990). Others

Correspondence concerning this article should be addressed to Paula J. Schwanenflugel, Department of Educational Psychology, University of Georgia, 323E Aderhold Hall, Athens, GA 30602. E-mail: pschwane@coe.uga.edu.

(e.g., Kuhn & Stahl, 2003; National Reading Panel, 2000) suggested that more than automaticity of individual word decoding is necessary for comprehension to be enhanced. Instead, they suggested that fluency, defined as not only accuracy and automaticity of individual word reading, but also prosodic rendering of the text, is needed for children to adequately comprehend.

What Is Reading Prosody?

Despite its presumed status as the hallmark of fluent reading, we currently know little about the nature of reading prosody per se. To read prosodically, children must be able to do more than decode the text and translate punctuation into speech. They must also incorporate the ordinary rise and fall of pitch in ordinary conversation. This would include a series of speech features that jointly would be perceived by the listener as an expressive rendering of a text (Allington, 1983; Dowhower, 1987; Schreiber, 1980, 1987, 1991).

To study reading prosody, one must transform speech sound waves of oral reading into a visual representation called a spectrogram where the waves can be analyzed more or less directly. Among the features potentially important to reading prosody are (a) perceived changes in pitch (indicated spectrographically as fundamental frequency or F_0; Lieberman, 1996), (b) stress or loudness (indicated spectrographically as signal amplitude), and (c) duration and pausing (usually measured in milliseconds). Pauses both within sentences (intrasentential) and between sentences (intersentential) can be identified objectively by demarking and measuring points of silence on the spectrograph not accounted for phonetically. One can measure directly the drop in F_0 at the ends of sentences (sentence-final F_0 declination) between the final pitch peak in the sentence and the lowest pitch at the end of the sentence (sentence-final F_0). Moreover, changes in F_0 can be measured at any point in the sentence. Additionally, prosodic reading may include appropriately chunking groups of words into phrases or meaningful units in accordance with the syntactic structure of the text. Taken together, these speech features are classified as suprasegmental because they extend over more than one speech sound and contribute to meaning.

Chafe (1988) suggested that, to read a sentence with intonation, one must assign syntactic roles to the words in the sentence. The assignment of syntactic roles is a key component of microprocessing, or the mental parsing of a text into hierarchically ordered propositions (Kintsch, 1998). Schreiber (1987) also suggested that the explicit presence of prosodic cues might be one crucial difference between speech and reading, and one of the reasons that speech is easier to understand. However, Schreiber reported that the evidence supporting a link between prosody and microprocessing is weak, with some studies finding links between the use of prosodic features and syntactic comprehension and others failing to find such an effect. Recently, Koriat, Greenberg, and Kreiner (2002) found that Hebrew-speaking adults' use of prosodic features reflected their processing of syntactic information, but not semantic information. They found that disruptions to syntax affected the quality of their participants' reading, but that participants were able to give a good prosodic rendering of well-structured, but nonsensical, sentences.

One point to consider regarding reading prosody is that the understanding of prosodic features in spoken language itself may be under development to some extent at the age when most children are learning to read prosodically. Children as old as 8 years of age process prosodic stress patterns in comprehension poorly. For example, they may not understand the communicative difference between sentences such as *Beth is already* ***at*** *the party* and *Beth is* ***already*** *at the party*. Even 9- and 10-year-olds are not quite at adult levels in understanding the function of some contextual prosodic features (Cruttenden, 1984, 1985; but see Cutler &

Swinney, 1987). Consequently, it is possible that prosody is an irrelevant feature of fluent reading fundamentally unrelated to reading skill at this age.

Prosodic features are not well dictated by text punctuation (Chafe, 1988). For example, commas may dictate pause structures for sentences like *Lesley came, she saw, and she conquered*, but not for sentences such as *Lesley wanted the one with the red, white, and blue sprinkles*. A question mark may dictate a pitch rise for the end of yes–no questions (e.g., *Did Robin go?*), but not usually for *Wh*- questions (e.g., *Where did Robin go?*). Moreover, oral speech usually contains more pauses than would be dictated by written punctuation, particularly for lengthy sentences that tax short-term memory. Consequently, oral readers must abstract prosodic features to a great extent while reading aloud. So, one of the tasks children have in learning how to read aloud is to learn the limitations of punctuation as a cue to the underlying prosodic structure of the text.

Measuring Prosody

One reason for the lack of information about the role of prosody in reading is the technical difficulty of measuring prosodic renderings historically. For practical reasons, fluency rating scales have often been used in lieu of direct measurements of prosody. These scales often incorporate oblique references to prosody as a way of distinguishing fluent from less fluent reading. For example, the National Assessment of Educational Progress (2000) used a 4-point fluency scale that distinguished reading that was *primarily word-by-word, with occasional 2-word or 3-word phrases that did not preserve meaningful syntax* (1) from reading that was conducted *primarily in larger, meaningful phrase groups, with regressions, repetitions, and deviations that did not detract from the overall structure of the story, that preserved the author's syntax, and where most of the story was read with expressive interpretation* (4). Similarly, Allington (1983) used a 6-point scale that distinguished *word-by-word reading* (1) from reading that occurred with *phrases coinciding with punctuation, appropriate semantic and syntactic emphasis, and expression that approximated normal speech* (6). Zutell and Rasinski (1991) recommended breaking fluency up into three 4-point rating scales that distinguished smoothness (ranging from 1 [*frequent extended pauses, hesitations, false starts, sound-outs, repetitions, and/or multiple attempts*] to 4 [*generally smooth reading with some breaks, but word and structure difficulties are resolved quickly, usually through self-corrections*]), phrasing (ranging from 1 [*monotonic with little sense of phrase boundaries, frequent word-by-word reading*] to 4 [*generally well-phrased, mostly in clause and sentence units, with adequate attention to expression*]), and pace (ranging from 1 [*slow and laborious*] to 4 [*consistently conversational*]). These scales, however useful as they may be practically, are not direct measurements of the prosodic aspects of reading and may not enable us to disentangle the relative contributions of decoding speed and accuracy from prosodic aspects of fluent reading.

Research examining oral reading prosody directly is surprisingly sparse. The landmark study of reading prosody by Clay and Imlach (1971) used a rater to assess specific prosodic variables. Clay and Imlach analyzed pausing, pitch, and stress for a large sample of audiotaped oral reading behavior of 7-year-old children, rating each of these variables separately. They found that children who made few pauses and short pauses were the best readers according to objective assessments of skill, and the best readers completed declarative sentences with a fall in pitch.

There were a number of issues that limit the utility of the Clay and Imlach (1971) study for establishing basic findings regarding the development of reading prosody in the transition to fluent reading. First, because the technology to analyze prosody was not yet widely available, Clay and Imlach did not directly measure sound features and, instead, relied on the impressions of a single rater. These days, one can map prosodic features more or less directly using spectrographic analyses that allow one to visually represent and analyze sound waves for their pause structures, pitch peaks, and valleys, among other features. A second problem was that neither reliability nor statistical analyses were conducted on the ratings of prosody that were performed. Consequently, it is unclear whether the changes they noted were general across children and whether other issues, such as decoding problems, influenced them. Indeed, Bear (1992) found little reliability between experienced reading clinicians in their ratings of sentence-final F_0 declination and word stress. Finally, a large percentage of the children Clay and Imlach studied had decoding error rates exceeding 30% and reading rates below 25 correct words per minute, so many of the children in the sample might not even be characterized as transitioning to fluency. It is hard to know whether it is possible to reliably distinguish decoding issues from prosodic ones.

Prosody has been examined directly in several studies. Herman (1985) electronically counted the presence of pauses exceeding 166 ms in eight remedial fourth- to sixth-grade children reading passages at a moderate level of difficulty. She found that the number of pauses not dictated by punctuation dropped considerably after the children repeatedly read the story until they reached a rate of 85 correct words per minute. However, several problems exist with this study as well. First, punctuation is only a very rough indicator of where pauses are appropriate. Second, the number of participants was quite small. Nevertheless, this study does suggest that children's appropriate pausing improves with greater reading fluency.

Perhaps the best study of the development of prosodic features in children's oral reading to date is one by Dowhower (1987). Using audiotaped samples of students' reading, Dowhower studied the effect of repeated reading on oral reading prosody in second-grade children who showed adequate word decoding, but who read in a slow, word-by-word way. The mean number of inappropriate pauses, the mean phrase length, and sentence-final fall in pitch (defined as a decrease of more than 15 Hz from the peak to the final pitch) were determined. She found that, after repeated practice, the children made fewer pauses not dictated by sentence structure and showed greater sentence-final vowel lengthening (another prosodic feature demarking the ends of major syntactic units; Cooper & Paccia-Cooper, 1980) and a larger F_0 declination for the final syllables of declarative sentences.

Prosody and Reading Comprehension

What these studies of reading prosody have in common is that they link improvements in reading skills to improvements in expressive oral reading. However, exactly where prosody fits in our understanding of the development of various aspects of reading skills is unclear. Nearly all would agree that the development of reading prosody is a phenomenon that occurs once decoding skills are fluent. Both Perfetti's (1985) verbal efficiency theory and, in particular, LaBerge and Samuels's (1974) automaticity theory would suggest that once words are processed fluently and automatically, resources become available for children to engage in the additional processing required for prosodic oral reading. However, the link between prosody and other aspects of the reading process is unclear.

One possibility is that reading prosody is an epiphenomenon unrelated to other important aspects of reading such as reading comprehension. For example, Karlin (1985) rated pitch, stress, and pauses in college students and found no relationship between prosody and comprehension skill. Another possibility, which we term the *reading prosody as partial mediator model*, is that prosody may actually assist reading comprehension. In this model, children who show rapid, accurate decoding skills should have resources available to enable prosodic reading. Thus, prosody may serve to mediate between decoding skills and comprehension to enhance comprehension. Kuhn and Stahl (2003) suggested that the development of reading prosody may assist comprehension because prosodic reading indicates that the child has segmented text according to major syntactic–semantic elements. Providing information regarding syntactic and semantic boundaries has been shown to improve comprehension in elementary school children (Cromer, 1970; O'Shea & Sindelar, 1983), and syntactic phrasing ability is somewhat related to superior comprehension in older children (Young & Bowers, 1995). Moreover, fluency ratings, which capture some elements of syntactic–semantic phrasing, seem to be related to reading comprehension skills at some level. For example, Young and Bowers (1995) found that children with higher fluency ratings tended to demonstrate at least average comprehension, decoding, and parsing skills compared with those with lower ratings. This suggests that it is important to examine the role of prosody further to determine how it fits into our conceptions of skilled reading. Consequently, this model predicts that (a) prosodic reading emerges once children have efficient decoding skills and (b) this prosody enhances reading comprehension.

A second way that comprehension might be related to reading prosody is by serving as a reflection that the message has been comprehended. We call this model the *reading comprehension as predictor of reading prosody model*. That is, instead of prosodic reading serving as feedback to enable enhanced comprehension, enhanced comprehension might enable the child to read prosodically. Prosody, in this case, might be an indicator that the child understands what is being read. Thus, a child who can read quickly, accurately, and prosodically might be one who comprehends well. This model predicts, then, that (a) efficient decoding skills contribute to prosodic features in oral reading and (b) reading comprehension skills make an independent contribution to the prediction of prosodic features.

The current study examined the role of reading prosody with respect to decoding and comprehension skills. There were two goals of the present research: First, we wanted to characterize the development of prosodic reading as a function of reading skill based on direct measurements of reading prosody. To this end, we recorded a large number of second- and third-grade readers reading an easy-to-decode passage that had a variety of syntactic forms. Because pause structures have been central in prior research on reading prosody, we measured inter- and intrasentential pauses and variability. Sentence-final declination in pitch and general prosodic contour when matched up against adult reading were measured. Second, we wanted to test the predictions of the reading prosody as a partial mediator model and the comprehension as predictor of reading prosody model. Thus, we assessed children's decoding and reading comprehension skills using standardized assessments. We conducted several analyses that tested the potential role of reading prosody as a mediator of reading comprehension skill.

Method

Participants

Participants were 120 second- and third-grade children (mean age = 8 years 6 months; *SD* = 7 months; range = 7 years 4 months to 10 years 4 months) attending five public schools located in communities in urban northeast Georgia (61) or suburban central New Jersey (59). The children were part of a larger unpublished study of the development of reading fluency. Only children whose native language was English and who were able to decode most of the words (> 90%) in the targeted oral reading passage were included in the study. An additional 7 children were excluded a priori because they did not read the passage at a 90% accuracy level. Approximately 47% of the children were African American, 17% were European American, 16% were Hispanic American, and 5% were Asian American. Fifteen percent were some other ethnicity or did not report ethnicity. The children came from schools in which approximately 46% were eligible for free and reduced lunch.

In addition, 16 adults from New Jersey and 18 adults from Georgia from the children's communities were recorded to serve as a baseline with which child reading prosody could be compared. Adults were recruited from staff at schools, neighborhood restaurants, stores, and other public venues within “shopping range” of the children's schools. Balanced numbers of middle- and working-class, male and female adults were sampled from each region (10 were African American, 7 of these from Georgia). Class information was determined from self-reported occupation and education levels. All adults were recruited by asking them whether they felt comfortable reading a children's passage aloud. All felt that they could read such a passage accurately and fluently and, in fact, all were able to do so. They were paid $10 for their participation.

Reading Assessments and Procedures

The order of the reading prosody and decoding speed assessments was counterbalanced with the reading comprehension assessment, such that half of the children received the reading prosody and word decoding assessments in the first half of a larger reading assessment battery, and half received them in the second half of the battery.

Reading prosody assessment—Oral reading recordings were obtained using a Sony digital audiotape recorder or a Radio Shack CTR-119 analog cassette recorder and clip-on microphone. Recordings were taken in a quiet place in the children's school. Prior to recording the passage, children were asked a series of questions to elicit natural speech to adjust the sound levels. They were asked to read the first passage of the Gray Oral Reading Test, Third Edition (GORT; Weiderholt & Bryant, 1992) out loud as quickly and as well as they could. This passage was chosen because it was a highly decodable passage and we wanted to assess the development of reading prosody in the absence of a large number of decoding errors. Decoding errors make the determination of reading prosody almost impossible and represent a preprosodic stage of reading development. In addition, children were told, “This story is about two people in a family. Read the story to find out what happens to them.” Then, each child read the passage once.

The passage was presented as it was formatted in the GORT (one line per sentence). The passage contained seven sentences; five were declarative sentences requiring a fall in pitch at the end of the sentence when read aloud, and these declarative sentences were particularly targeted for measuring final-sentence declination. Further, because they were not embedded in a quote, the first three sentences allowed for the measurement of the full F_0 contour typical of declarative sentences during reading. This passage also provided for measurement of four intersentential pauses.

We chose to measure five prosodic structures in oral reading: (a) intersentential pause length means, (b) intersentential pause length variances, (c) intrasentential pause length means, (d) child–adult F_0 sentence profile match (henceforth, child–adult F_0 match), and (e) the sentence-final declination of F_0. Each of these prosodic features has been implicated in the development of oral reading and/or speech prosody.

The recordings of the oral reading passage from both the analog and digital tape recorders were converted to a digital .wav file using a shareware version of Cool Edit 96 (1996) and GoldWave (GoldWave Digital Audio Editor, 2001). Background static, hums, and repetitive sounds that occurred during recording were reduced electronically using the current spectrum function of GoldWave. The TF-32 demonstration version of CSpeech was used to analyze the prosodic characteristics of the speech files (Milenkovic, 2000). This program has functions that easily allow one to measure time, F_0 change, F_0 mean, and pause lengths in milliseconds, among other features.

The intersentential pause length, or mean length of pauses, between sentences was measured in milliseconds. Intersentential pause lengths were determined by visually demarking the spectrograph at the limits of the sentence-final pauses, noting durations, and averaging across sentences. Intersentential pause variability was calculated in a similar manner. Only nonoptional pauses were included in the calculation of intersentential pause length and variability for each child.

Intrasentential pauses were caused by mistakes in reading the passage and ranged in length from 150 ms to over 1,000 ms. Only pauses in the first three sentences of the passage were analyzed because these sentences were all of the same type (declarative), and this kind of analysis is particularly time consuming. As in the case of intersentential pauses, pause lengths were determined by visually demarcating the spectrograph at the limits of the pause interval and noting the duration in milliseconds. Mean intrasentential pause lengths were obtained by averaging across sentences.

The child–adult F_0 sentence profile match (henceforth, child–adult F_0 match) was obtained by measuring the average F_0 in Hertz for each word in each of the first three sentences of the passage. We determined the child–adult F_0 match by visually demarking the spectrograph at the limits of the nucleus of each spoken word (the voiced portion of the word that produces F_0) for the first three sentences and noting the average F_0 for each word. This was done so that the general profile of the sentence could be compared from each child with the adults without regard to speech rate differences. The speech rate of children at this age is generally slower than that of adults (Chermak & Schneiderman, 1985; Smith, 1992), so it was important to control for F_0 across time when fitting children's prosodic profiles to adults. That is, we averaged F_0 from the beginning to the end of each word (one mean for *the*, *man*, *got*, etc.), conducting a word-by-word correlation rather than conducting a time-point-by-time-point correlation of the complete F_0 plot, which would have produced strange correlations that compared, say, an adult's reading of *The man got out of the car* in the same time span it took a child to read *The man got out*…. The prosodic profile of each child was correlated with the prosodic profile of the adults,[1] and the resulting correlation was taken as the child–adult F_0 match for that individual.

The sentence-final declination of F_0 was measured in Hertz from the final pitch peak to the end of the sentence. This was viewed as preferable to simply measuring the fall in pitch on just the final word in the sentence because that measure of declination often fails to describe the fall in pitch that we hear at the end of a sentence when the final word is only one syllable long (e.g., the sentence *The man got out of the car* illustrates this issue. The F_0 structure is rather flat for *car*, and the meaningful F_0 change is between *the* and *car*). We measured the declination from the final peak to the end of the five declarative sentences by demarking the peak F_0 and

[1]Prior to correlating the children's profiles with the averaged adult profile, we assessed that there was, indeed, an adult F_0 profile to which most adults adhered and that there were no regional, ethnic, class, or gender differences that needed to be taken into account. This was accomplished in three phases: First, we wanted to make sure that the adults we sampled were, in fact, able to read the passage well enough to be considered fluent. We calculated the correct words per minute and number of errors made by each adult in reading the passage (excluding repetitions). The adults all read the passage at a rate of at least 95 correct words per minute (M = 189.0, SD = 38.0) and with high accuracy (M = 99.3, SD = 1.3). Because the goal of collecting this data was to provide a general sense of the prosodic features of the oral reading that might be typical for the child's community, and not to study the reading skills of the adults themselves, this was deemed sufficient.

Second, separate average profiles for female and male, African American and European American, and working-class and middle-class adults from New Jersey and Georgia were calculated for each word in the three sentences and then correlated with each other. These correlations all exceeded .91, suggesting minimal variation as a function of gender, region, ethnicity, and class.

Third, an averaged profile across all adults was calculated, and the profile of each individual adult was correlated with this group profile. With the exception of 4 out of 34 adults, these correlations were large and highly significant, suggesting evidence of an adult prosodic profile to which most adults adhered. Of the 4 remaining adults, 2 were monotone, 1 had "Valley girl" prosody (where all sentences ended with a rising pitch), and 1 was idiosyncratic. Because they did not adhere to an idealized adult prosody, these 4 individuals were eliminated from the analysis.

In sum, there did seem to be a targeted reading prosody to which most adults adhered. Consequently, the remaining adults were averaged as a measure of the adult prosodic profile against which the children's prosody would be compared.

final F_0 of the sentence. The mean difference in F_0 was used as an index of sentence-final declination.[2]

Decoding speed assessment—To obtain an independent estimate of the children's word reading speed, we gave children the Test of Word Reading Efficiency (TOWRE) Sight Word Efficiency and Phonemic Decoding Efficiency subtests, Form A (Torgesen, Wagner, & Rashotte, 1999). The Sight Word Efficiency subtest asks children to name all of the words that they can from a list of words in 45 s. The Phonemic Decoding Efficiency subtest requires children to pronounce all of the phonetically regular nonwords in a list that they can in 45 s. Concurrent validity estimates reported in the test manual have a median of .91 in Grades 1–3. Alternate form reliabilities have a median of .97 in Grades 1–3. The numbers of words and nonwords read correctly were summed, and this figure was used as an index of decoding speed.

Reading comprehension assessment—To obtain an independent measure of the children's reading comprehension skill, we administered the Wechsler Individual Achievement Test (WIAT; 1992) Reading Comprehension subtest, which consists of a number of passages that increase in complexity. A comprehension question was asked when the child was finished reading a passage, and the child answered it aloud in his or her own words. The test was discontinued once the child missed four questions in a row. Validity estimates of this subtest reported in the test manual have a median of .74 and a reliability of .91 in Grades 1–3 (WIAT, 1992). The number of questions answered correctly was used as an index of reading comprehension skill.

Results

A Characterization of the Development of Reading Prosody as a Function of Decoding Skill

One goal of the present research was to characterize the development of reading prosody as a function of decoding skill. However, prior to further prosodic analysis, we created scatter plots on all prosodic variables. Scatter plots indicated that 3 children had unusually long and variable pauses (and they were outliers on at least one other measure of prosody). So that these children would not distort the relationships between reading skill and other variables, they were removed from the data set as outliers (2.4% of the child participants). We divided the remaining children into skill group quartiles based on the sum of the Sight Word and Phonemic Decoding Efficiency raw scores on the TOWRE. Raw scores were used because children were from two grade levels and because they better preserved the developmental nature of our variables. Means for the raw and standard scores on all reading skill assessments and means for the prosody measures can be found in Table 1.

Prior to analyzing our data as a function of decoding skill, we wanted to ensure that decoding skill did not interact with gender, region, or ethnicity for any of the prosodic variables. A 4 (skill group) × 2 (region: New Jersey and Georgia) × 2 (gender: male and female) analysis of variance (ANOVA) was conducted using each prosodic feature as the dependent variable. Further, a 4 (skill group) × 5 (ethnicity: Asian American, African American, Latino American, multiracial, European American) was conducted for children whose ethnicity was reported using each prosodic feature as the dependent variable.[3] Using Bonferroni-adjusted *p* values for the 55 potential interactions tested for, we found that no interactions approached statistical

[2]We wanted to ensure that there was no consistent measurement issue introduced by using recordings from different types of tape recorders. (Fifty-two children were recorded on digital and 68 were recorded on analog.) Analog machines have a tendency to build up noise, which might make it difficult to measure sentence-final F_0 declination accurately. We conducted a one-way ANOVA comparing tape recorder type (digital vs. analog), using sentence-final F_0 declination as the dependent variable. This analysis found no effect of tape recorder type, $F(1, 118) = 0.588$, $p = .445$.

[3]There was a large number of children for whom ethnicity was not reported, so we conducted Skill × Ethnicity ANOVAs for this factor separately.

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significance. With unadjusted *p* values, only one was statistically significant (1.8% of the interactions), intrasentential pause length Skill Group × Region, $F(3, 104) = 2.81$, $p = .043$. Low-skilled decoders from Georgia had longer intrasentential pauses than the low-skilled children from New Jersey. Overall, these analyses painted a picture of remarkable similarity across children at a given decoding skill level as to the prosodic nature of their reading. Because we were mainly interested in changes in reading prosody as a function of decoding skill, for the remaining analyses, regional, gender, and ethnicity variables were not considered further.

To characterize changes in pause structure as a function of decoding skill, we conducted separate one-way ANOVAs using skill group as an independent variable and intersentential pause length, intersentential pause variability, and intrasentential pause lengths as dependent variables. As can be seen in Table 1, children with higher decoding skill had shorter intersentential pauses than those with lower decoding skill, $F(3, 116) = 14.59$, $p < .001$, partial $\eta^2 = .274$. Follow-up Tukey tests (all of which used a .05 alpha level) indicated that the major change in intersentential pausing came between high-middle- and low-middle-skill decoders ($p < .05$). Intersentential pause variability was higher among low- than high-skill decoders, $F(3, 116) = 3.86$, $p = .011$, partial $\eta^2 = .091$, giving low-skill decoders' renderings a hesitant quality. Tukey tests indicated that the major decrease in this variability occurred between low- and high-middle-skill readers ($p < .05$). Finally, intrasentential pauses were longer for low-skill readers than for high-skill readers, $F(3, 116) = 8.76$, $p < .001$, partial $\eta^2 = .185$. Tukey tests indicated the major demarcation in this variability occurred between low- and high-middle-skill readers ($p < .05$). Throughout, high- and middle-high-skill decoders were very similar in their pause structures.

We also found decoding skill differences in the way children handled the musical quality of oral reading, which is signified by changes in F_0. A one-way ANOVA indicated that decoding skill was related to sentence-final declination of F_0, $F(3, 116) = 4.75$, $p = .004$, partial $\eta^2 = .109$. Follow-up Tukey tests indicated that low- and low-middle-skill readers made less exaggerated pitch drops at the ends of sentences than high-skill readers did ($p < .05$). Further, the child–adult F_0 match varied as a function of decoding skill, $F(3, 117) = 3.66$, $p = .014$, partial $\eta^2 = .087$. Tukey tests indicated that low-skill readers displayed a poorer match than high-middle- and high-skill decoders to the adult prosodic F_0 profile, but the low-middle decoders did not differ significantly from any of the other skill groups. Again, in both cases, high- and high-middle-skill readers were very similar in their regulation of F_0 in their oral reading.

In sum, primary grade children with good to excellent decoding speed skills read with few, brief intrasentential pauses; they read briskly with clear demarcations at sentence boundaries that they indicated more by a falling pitch than with intersentential pauses. They mirrored the adult contour of the sentence. In contrast, children with poor to moderate decoding speed read slowly with many long, hesitant pauses, with pauses that occurred in the middles of sentences, and with a rather flat prosodic contour.

The Role of Oral Reading Prosody in the Reading Process

Structural equation modeling in LISREL was used to examine the relations between general decoding speed skills, prosody variables, and reading comprehension skills. We tested two versions of the potential way that general decoding speed, comprehension, and prosodic reading skills relate to each other. These are described below.

Prosody as partial mediator model—The first model we tested assumed that prosody serves as a partial mediator between decoding speed and reading comprehension. The view is that once a child has acquired rapid, accurate, and automatic word decoding skills, these skills permit cognitive resources to become available for allowing the child to read prosodically. This prosody serves to provide additional feedback to the child regarding the major semantic and syntactic units in the linguistic message, resulting in better reading skill than his or her decoding speed would account for alone.

Structural equation modeling with the LISREL 8.3 (Joreskög & Sorböm, 1999) program was used to examine relations between reading skill variables and prosody. We began by assuming that the TOWRE raw scores would provide a reasonable measure of the child's general decoding speed, and the two subtests from this test were combined to form a latent variable called *Decoding Speed*. This variable was used as a predictor of prosody variables and reading comprehension skill. We also assumed that the WIAT-Reading Comprehension raw scores would provide a general indicator of the child's reading comprehension skills, which is used as an outcome variable in this model.

We also conducted some general analyses designed to capture the major elements of the internal structure of prosody. The structure obtained from the analyses was translated into the LISREL model. First, simple correlations between prosodic variables were calculated (see Table 2). These analyses indicated a sizeable correlation between intersentential pause length and intersentential pause variability. Moreover, a single-factor principal-axis exploratory factor analysis was conducted, and this indicated that intersentential pause length and variability shared a great deal of extracted commonality (.48 and .50) compared with other prosodic variables (all < .22). Consequently, we assumed that intersentential pause structures could be combined as a latent variable to form one component of the skill. Second, the parameter linking child–adult F_0 match and sentence-final F_0 average was freed to capture the fact that these two variables are derived from F_0.

To capture the fact that word decoding speed should play a key role in reading comprehension, we created a direct path between Decoding Speed and WIAT-Reading Comprehension. We also reflected the fact that prosodic reading should be affected by fluent word decoding skills by inserting paths between Decoding Speed and each of the prosody variables (intersentential pause structure, intrasentential pause length, sentence-final F_0 average and child–adult F_0 match). However, this model also states that prosody variables should play a partial mediating role above and beyond simple decoding speed skills. Consequently, indirect paths were included from the prosody variables and WIAT-Reading Comprehension. The resulting model was well fitting and is pictured in Figure 1, $\chi^2(15, N = 120) = 13.71$, $p = .548$, root-mean-square error of approximation (RMSEA) < .01, goodness-of-fit index (GFI) = .97. Table 3 presents a table of path weights and their standard errors.

This model clearly shows that children with faster decoding speed are more likely to read prosodically than children who have slower decoding speed, even for this passage, which they could read with at least 90% accuracy. Children with faster decoding speed read sentences with shorter and less variable pauses, shorter intrasentential pauses, and larger sentence-final declination in F_0; they read with F_0 contours that more closely approximated adult readings. This supports the view that automatic decoding skills are associated with prosodic reading.

The model also suggests that there is only a very minor role for reading prosody in skilled reading comprehension. Only child–adult F_0 match showed a significant indirect path to WIAT-Reading Comprehension. Further, all of the prosodic variables taken together accounted for only .03 of the total variance accounted for by all of the variables on WIAT-Reading Comprehension (.76). Consequently, the message taken away from tests of this model is that decoding speed is the major factor involved in prosodic reading and improved reading comprehension.

Reading comprehension as predictor of reading prosody model—The minimal importance of reading prosody to improved reading comprehension shown in the above model was surprising. As noted earlier, Chafe (1988) and others suggested that prosody is a reflection of comprehension. That is, it is possible that children who read prosodically not only have better decoding speed but also understand what they are reading and are able to reflect this understanding by making it "sound like speech" (Stahl & Kuhn, 2002, p. 582). Thus, prosodic reading could be used diagnostically to identify children who can both decode and comprehend well.

To capture the fact that having quick decoding skills may be important to reading prosodically, we incorporated direct paths from Decoding Speed to each of the prosody variables, as in the previous model. To capture the idea that good comprehension skills might allow children to read prosodically, we incorporated direct paths from WIAT-Reading Comprehension to each of the prosody variables. Finally, the correlation between reading comprehension and word decoding speed skills was represented.

The data were well fit by the resulting model, $\chi^2(14, N = 120) = 12.92$, $p = .533$, RMSEA < .01, GFI = .97 (see Figure 2). However, this time, Decoding Speed accounted for only two prosody variables, intersentential pause structure and intrasentential pause length (see Table 4). By introducing both reading comprehension skill and decoding speed as explanatory variables, we degraded the ability of decoding to explain a unique relationship with prosody because of the shared common variance between Decoding Speed and WIAT-Reading Comprehension. This resulted in large standard errors of the weights, as is indicated by comparing the standard errors found in Table 3 with those found in Table 4, as well as a complete change in the directionality of effects in some cases. Consequently, we view this model to be a generally poorer reflection of where prosody "fits" in terms of our thinking of developing reading skill.

General Discussion

The results of this study highlight the key role of word decoding speed in reading prosodically. Our characterization of reading prosody variables suggested that, as children became skilled word decoders, reading prosody took on a culturally normative character. Children read with short pauses between sentences. There was minimal variability in their pause structures so that there was a smoothness and evenness in the way that pauses occurred between sentences. The pauses made in the middles of sentences were kept short. Skilled decoders ended their declarative sentences with a decidedly falling pitch. The pitch contours of their sentences mirrored those of adults reading the same passage.

Young readers with emerging decoding speed, in contrast, read with lengthy, sporadic pauses between sentences that gave their rendering a hesitant, start–stop quality. They read with unnecessarily long pauses in the middles of sentences where none were needed. Their sentence pitch structure was quite unlike that of a skilled adult reader, and they ended each sentence with a rather flat tone.

To the extent that our look at prosody variables overlapped with other studies, our characterization of skilled, prosodic reading is similar. Similar to Clay and Imlach (1971), we found that good readers made short pauses. We found that these short pauses were the norm both within sentences and between them. Also similar to Clay and Imlach and to Dowhower (1987), we found that good oral readers ended declarative sentences with a discernable and relatively large fall in pitch. To these observations, we add the observation that skilled oral readers matched their overall prosodic sentence contours to be like those of adults, such that it was clear that there was a prosodic target toward which children were striving. Moreover, because we made our reading prosody observations directly and without having to disregard large numbers of decoding errors, and because we made them over large numbers of children, we feel our observations help establish the generality of these observations made by others and us.

The major goal of this study, however, was to learn exactly where prosody fits in our thinking about developing reading skill. We could think of several reasonable hypotheses for how prosody might fit into our current conceptions of reading skill. We conducted structural equation model tests that depicted two distinct ways in which prosody, word decoding, and reading comprehension might be related. One model, which we called the reading prosody as partial mediator model, treated prosody as a partial mediator between decoding speed and comprehension skill. This view states that, as a child acquires automatic word decoding skills, there are attention resources that are freed up so that they are available to be allocated to higher order functions of reading (LaBerge & Samuels, 1974; Perfetti, 1985). Assuming that these resources are at least somewhat allocated to the goal of reading prosodically in oral reading situations, the natural breaks and pitch falls associated with prosodic reading may serve to provide feedback to the child regarding the major syntactic and semantic units of the text, yielding improved comprehension.

The reading prosody as partial mediator model actually has two associated subhypotheses that can be considered separately. The first of these is that fluent word decoding skills permit freeing up of attention resources so that they are available for prosodic reading. As can be seen in Figure 1, evidence for this part of the model is strong. Fluent decoding skills were related to shorter, less variable intersentential pauses, shorter intrasentential pauses, steeper sentence-final pitch declines, and a more adult-like prosodic profile. The second subhypothesis is that prosody independently contributes to better reading comprehension above and beyond the contribution of word decoding speed by providing linguistic feedback to the child, which aids comprehension. This second hypothesis has less support from our data. Only one prosodic variable, child–adult F_0 match, had any significant indirect relationship to reading skill, and this effect was small. Thus, we conclude that the view of prosody as an additional scaffold for comprehension has minimal support. Consequently, on the basis of the model depicted in Figure 1, prosody appears to emerge mainly as an epiphenomenon of fluent word decoding skills. The additional cognitive benefits that making it sound like speech may provide are unclear from this model.

We tested a second model of the potential relationship between prosodic reading and reading comprehension skills, the reading comprehension as predictor of reading prosody model. This model assumed that prosodic reading is a reflection of good comprehension and decoding skills, such that children who are better able both to understand and to decode what they are reading are more likely to draw the appropriate syntactic and semantic emphases while they read aloud. In this model, the relationship between prosody and comprehension has been turned around so that now comprehension is viewed as a copredictor of prosodic reading with decoding speed. This model also failed to reveal much of an independent relation between enhanced comprehension and prosodic reading. Again, there was a strong relationship between Decoding Speed and WIAT-Reading Comprehension, a reduced relationship between Decoding Speed and prosody, but no significant relationships between WIAT-Reading Comprehension and any of the prosody variables.

There are, however, several important common themes that run through both modeling efforts that help us understand where prosody fits in our conceptions of developing reading skill. Like the prosody as partial mediator model, the reading comprehension as predictor of reading prosody model found evidence of a key relationship between decoding speed and reading comprehension skills. Both models suggest that automatic decoding skills are related to prosodic reading. Both models suggest that there is minimal relationship between prosodic reading and reading comprehension skills. Thus, prosodic reading would seem to serve mainly as evidence that children have automatic decoding skills.

Alternatively, it may be that reading prosody actually does carry benefits for comprehension, but that our measure of reading comprehension skill was not a particularly good one. Valid and reliable assessments of reading comprehension are quite difficult to come by for this stage of reading development. Although we felt the measure we chose had appropriate psychometric properties and generally captured what many mean when they say that a child comprehends a text (that a child can answer a question about what he or she has read), it was not a sophisticated treatment of the many facets of comprehension skill. It may be that prosodic reading is unrelated only to the type of reading comprehension measure chosen here.

The WIAT was chosen as a measure of the construct of comprehension. As such, it has adequate psychometric properties. It was not connected to the passage used to measure prosody and thus was not a measure of comprehension of that particular passage. The GORT does provide questions for each passage, but we felt that the validity and reliability of the questions were not sufficient to include in our battery. Perhaps the relations between prosody and comprehension might be stronger if measured on the same passage.

Also, Kuhn and Stahl (2003) suggested that the link between prosody and comprehension might be strongest in measures of microprocessing (Kintsch, 1998). The WIAT may have measured comprehension more globally. A measure such as a cloze measure or the number of propositions recalled might also show stronger relationships. This needs to be tested in future research.

Another possibility for why we failed to find much of a relationship between reading prosody and comprehension is that we used a passage so simple and straightforward that it limited our ability to find relationships between prosody and reading comprehension. That is, a passage with more challenging content, structure, and comprehension demands may have produced different results. We agree that this, indeed, may be theoretically so, but practically it is quite difficult to find passages that are both highly decodable (an essential ingredient for measuring prosody in the first place because calculating the prosody of a reading error makes little sense) and demanding and engaging for comprehension. Highly decodable passages tend to be less interesting and demanding on the whole. Ideally, future studies might try to find such passages and have participants answer comprehension questions about that passage itself to attempt to find a more direct relationship between prosody and comprehension.

However, we are not sure that these potential challenges to our conclusions regarding the relationship between comprehension and prosody have much merit. First, stating that our findings came about because our passage did not engage comprehension processes fully seems to assume that our participants were so bored or unchallenged by our passage that they did not read aloud in a way that was connected to meaning. Our descriptive data show otherwise. Students with mid-high and high decoding skill did indeed read prosodically at major meaning units, despite the inherent blandness of the passage. Moreover, the comprehension assessment, which was challenging, did not relate well to prosody once decoding skills were accounted for. What is important about our findings is that we found a much, much larger relationship between decoding and comprehension than prosody and comprehension. Given the relatively minuscule effect of prosody, we doubt that this basic pattern would have been dramatically altered if we had used a different passage.

We are concerned that our findings might be taken to imply that to encourage prosodic reading and reading comprehension, teachers should resort to classroom practices that solely emphasize isolated word skills. Studies that have tested this hypothesis have failed to show that teaching children to say words faster improves comprehension (Dahl, 1979; Fleisher, Jenkins, & Pany, 1979; Levy, Abello, & Lysynchuk, 1997; Spring, Blunden, & Gatheral, 1981). Although in all of these studies children's passage reading fluency improved, in none of these studies did their comprehension significantly differ from that of a control group. In these studies, children were taught to say a list of words that they could decode faster. In contrast, preteaching words that children did not know seems to improve comprehension (e.g., Tan & Nicholson, 1997). More important, assisted reading of connected text seems to have significant effects on children's comprehension (Kuhn & Stahl, 2003; National Reading Panel, 2000). This is consistent across a variety of studies in a variety of contexts. In the instructional literature, then, reading accuracy and practice in reading connected text seem to improve comprehension, but speeded isolated word decoding does not, at least in the three studies that tested its effect. Moreover, there are many reasons, cognitive, motivational, and otherwise, not to do this. Instead, our findings could be used productively with regard to classroom practice to suggest that, when children are reading prosodically, one can probably infer that they are well on their way to having automatic and fluent word decoding skills, and our instructional efforts can be placed elsewhere.

In sum, the current study has characterized some of the prosodic features that change as a child develops fluent word decoding skills. We have shown that as children become fluent decoders, they read with shorter pauses, steeper sentence-final declines, and with a more adult-like prosodic contour. We found little evidence that this prosodic reading was related to better comprehension.

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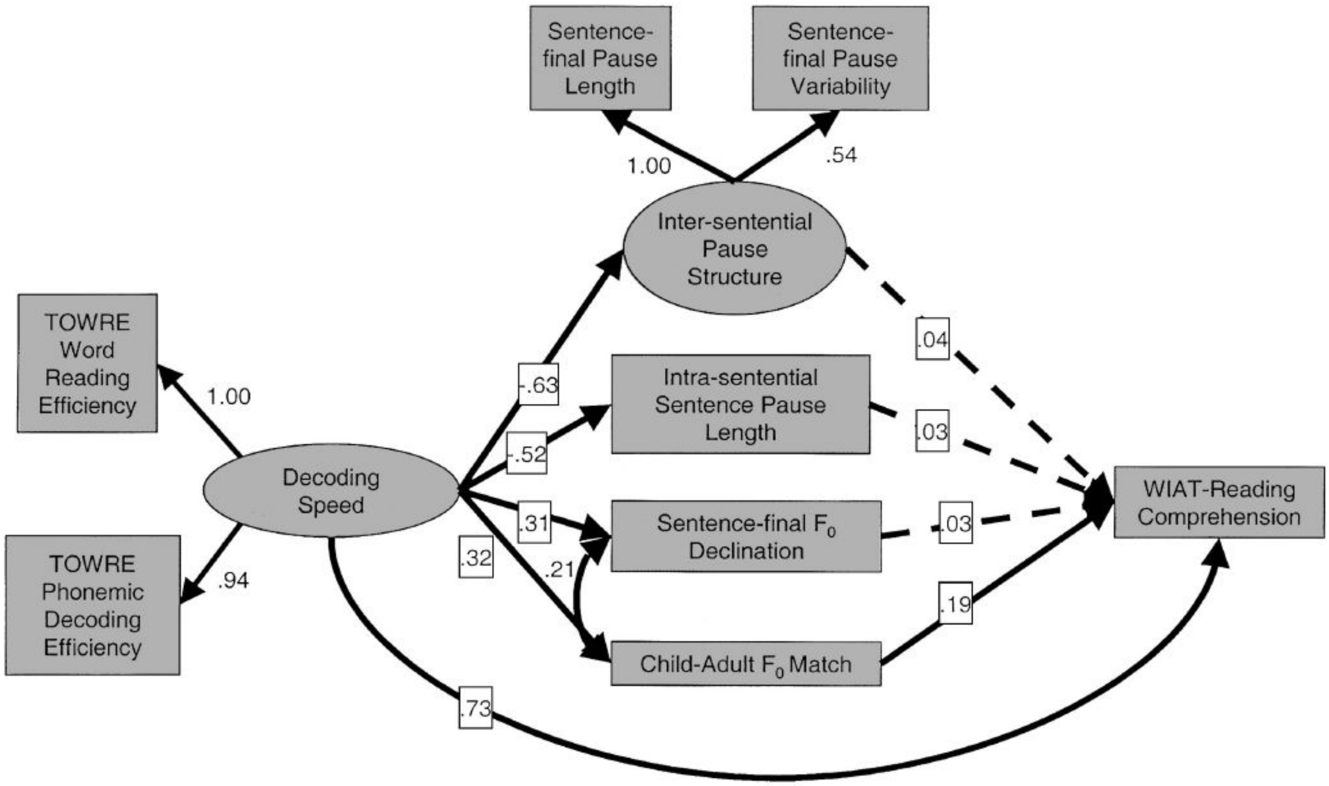

Figure 1.

Reading prosody as partial mediator model. Solid lines represent significant paths; dashed lines represent nonsignificant paths. TOWRE = Test of Word Reading Efficiency; F_0 = fundamental frequency; WIAT = Wechsler Individual Achievement Test.

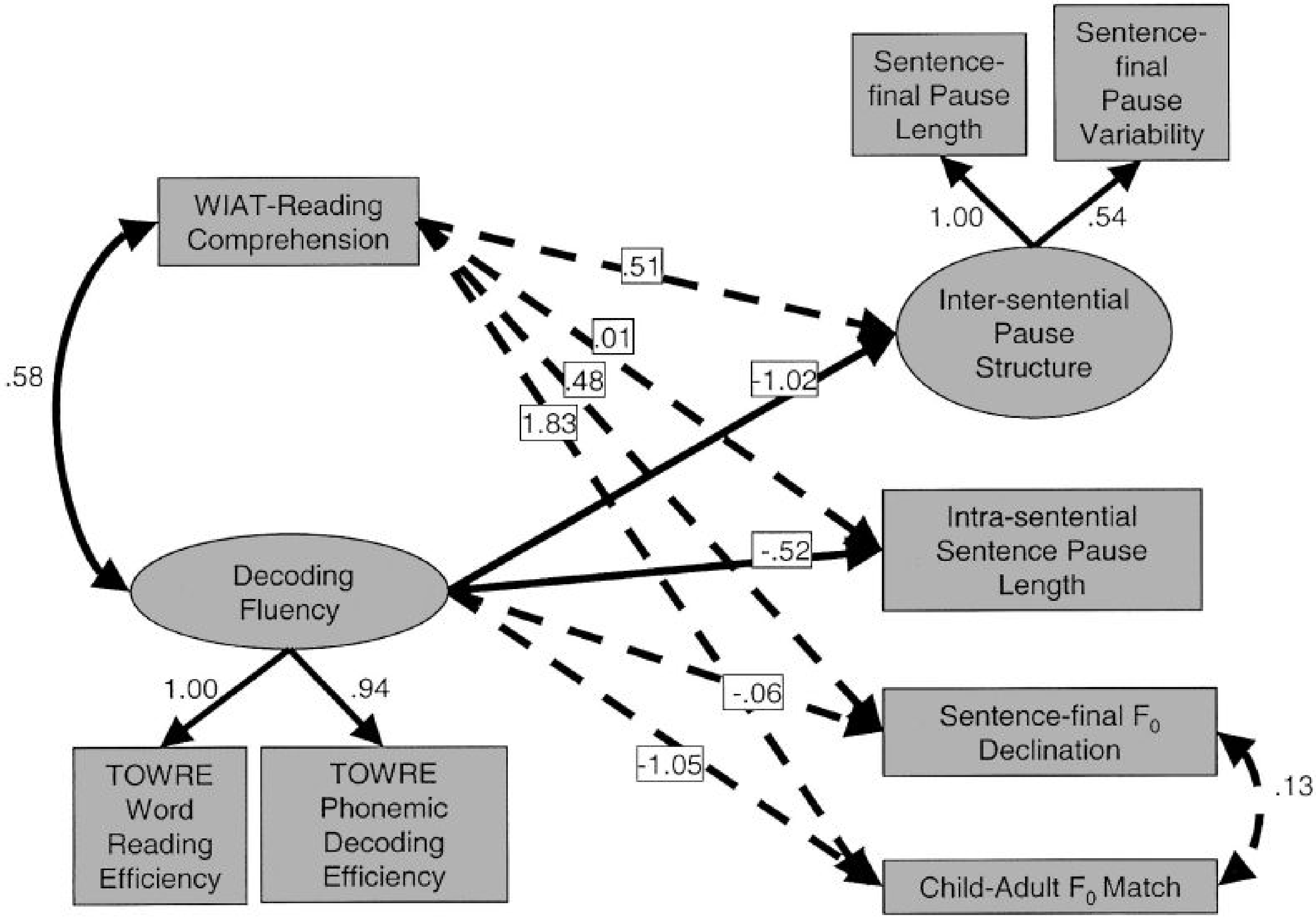

Figure 2.
Reading comprehension as predictor of reading prosody model. Solid lines represent significant paths; dashed lines represent nonsignificant paths. WIAT = Wechsler Individual Achievement Test; TOWRE = Test of Word Reading Efficiency F_0 = fundamental frequency.

Table 1

Means and Standard Deviations on Reading Skill and Prosody Variables

	Decoding skill group							
	Low		Low middle		High middle		High	
Variable	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
TOWRE								
Sight Word Efficiency								
Raw score	43.28	7.90	52.28	5.40	62.39	4.59	71.70	5.56
Standard score	92	8	101	8	109	7	121	8
Phonemic Decoding								
Raw score	14.90	5.95	23.30	4.38	31.61	5.93	43.10	7.49
Standard score	91	9	100	6	108	8	122	12
TOWRE raw score total	58.17	9.28	75.58	3.64	93.94	5.69	114.87	10.74
Range	35–69		71–82		84–101		102–145	
N	29		29		31		30	
Target passage reading								
Correct words per minute	92	29	119	32	154	26	176	31
Accuracy percentage	98	3	99	1	99	1	100	1
WIAT Reading Comprehension								
Raw score	14.79	3.34	16.10	3.49	20.06	4.25	22.30	4.75
Standard score	96	10	97	18	105	20	115	15
Intersentential pause								
Length in ms	661	231	604	234	411	149	369	195
Variability in ms	155,751	148,569	111,065	175,283	60,007	59,150	54,024	120,354
Intrasentential pause length in ms	688	450	518	243	313	236	365	267
Sentence-final declination of F_0 in Hz	39.67	21.66	38.68	20.82	51.72	25.13	56.22	19.61
Child–adult F_0 match *r*	.51	.20	.58	.12	.63	.13	.61	.16

Note. TOWRE = Test of Word Reading Efficiency; WIAT = Wechsler Individual Achievement Test; ms = milliseconds; F_0 = fundamental frequency.

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Table 2

Correlations Between Prosody Variables

Variable	1	2	3	4	5
1. Intersentential pause length	—				
2. Intersentential pause variability	.55*	—			
3. Intrasentential pause length	.36*	.26*	—		
4. Sentence-final F_0 declination	− .08	− .18	− .17	—	
5. Child–adult F_0 match	− .08	− .17	− .17	.29*	—

Note. F_0 = fundamental frequency.

* $p < .05$.

Table 3

Path Weights, Standard Errors, and t Values for the Prosody as Partial Mediator Model

Path	**Weight**	***SE***	t^a	***p***
Direct paths				
Decoding speed to:				
Intersentential pause structure	− .63	.11	6.00	.001
Intrasentential pause length	− .52	.11	4.81	.001
Sentence-final F_0 declination	.31	.11	2.78	.004
Child–adult F_0 match	.32	.11	2.84	.003
WIAT-Reading Comprehension	.73	.14	5.15	.001
Indirect paths				
Reading comprehension from:				
Intersentential pause structure	.04	.09	0.42	.170
Intrasentential pause length	.03	.08	0.36	.181
Sentence-final F_0 declination	.03	.08	0.34	.185
Child–adult F_0 match	.19	.07	2.57	.005

Note. F_0 = fundamental frequency; WIAT = Wechsler Individual Achievement Test.

[a] *df* = 15.

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Table 4

Path Weights, Standard Errors, and t Values for the Decoding Speed and Reading Comprehension Skill as Predictor of Reading Prosody Model

Path	Weight	*SE*	t^a	*p*
Direct paths from decoding speed				
Intersentential pause structure	− 1.02	0.41	2.47	.007
Intrasentential pause length	−0.52	0.35	1.49	.040
Sentence-final F_0 declination	−0.06	0.73	0.08	.234
Child–adult F_0 match	− 1.05	1.92	−0.55	.352
Direct paths from WIAT-Reading Comprehension				
Intersentential pause structure	0.51	0.51	1.01	.082
Intrasentential pause length	0.01	0.43	0.03	.224
Sentence-final F_0 declination	0.48	0.95	0.51	.155
Child–adult F_0 match	1.83	1.56	0.71	.122

Note. F_0 = fundamental frequency; WIAT = Wechsler Individual Achievement Test.

[a] *df* = 14.