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A Longitudinal Study of the Development of Reading Prosody as a Dimension of Oral Reading Fluency in Early Elementary School Children

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Abstract

The purpose of this study was to examine the development of reading prosody and its impact on later reading skills. Suprasegmental features of oral reading were measured for 92 children at the end of grades 1 and 2 and oral reading fluency and reading comprehension assessments at the end of the third-grade school year. Tests were carried out to determine (a) the manner in which the key features of oral reading prosody unfold with development and (b) the extent to which the development of reading prosody is predictive of later oral reading fluency and comprehension outcomes beyond word reading skills alone. Path model tests found a relationship between the presence of fewer pausal intrusions during oral reading in first grade and subsequent development of an adult-like intonation contour in second grade. Outcome model tests indicated that the intonation contour was a significant predictor of later fluency once word reading skills were taken into account. Decreases in the number of pausal intrusions between the first and second grades and early acquisition of an adult-like intonation contour predicted better comprehension later. Thus, prosodic oral reading might signal that children have achieved fluency and are more capable of understanding what they read. Results of this study support the inclusion of prosody in formal definitions of oral reading fluency.

Since the publication of the National Reading Panel report (National Institute of Child Health and Human Development [NICHD], 2000), and more recently of the National Assessment of Educational Progress Special Study of Oral Reading (Daane, Campbell, Grigg, Goodman, & Oranje, 2005), the importance of the achievement of oral reading fluency in the development of reading skill has gained a renewed interest. The increased attention is derived largely from the recognition that there is a correlation between reading fluency and comprehension skill (Daane et al., 2005; Donahue, Voelkl, Campbell, & Mazzeo, 1999; Pinnell, Pikulski, Wixson, Campbell, Gough, & Beatty, 1995), and overall educational achievement as well. In fact, research has suggested that children who do not develop fluency early on in the schooling process are likely to experience difficulty learning and comprehending important material from texts introduced in later grades (Chall, Jacobs, & Baldwin, 1990; Lyon, 1997; Rasinski et al., 2005).

Despite near universal agreement that there are important educational outcomes associated with the ability to read fluently, the construct of fluency has been criticized for lacking clear

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theoretical and definitional consensus. Kame'enui and Simmons (2001), for example, characterized fluency as “a term so broad and unsatisfactory in meaning that little insight and understanding are gained beyond mere use of the term” (p. 204). Furthermore, they have contended that, at present, the exact cognitive mechanisms and processes that index oral reading fluency, and the manner in which they do so, remain theoretically unsettled and experimentally uncertain (Kame'enui & Simmons, 2001; NICHD, 2000; Stanovich, 2000).

Automaticity views of reading assert that children who have developed automatic word recognition skills are able to devote greater attention resources to reading for meaning (Gough, 1996; LaBerge & Samuels, 1974; Nicholson, 1999; Perfetti & Hogaboam, 1975; Schwanenflugel et al., 2006). Whereas some researchers support simple definitions of fluency that focus on rate and accuracy in oral reading as core features (Logan, 1997; Shinn, Good, Knutson, Tilly, & Collins, 1992), others, such as Wolf and Katzir-Cohen (2001), have contended that this singular emphasis “ignores the multi-dimensionality of fluency” (p. 218). More recent definitions have expanded this definition to include the additional element of prosodic or “expressive” oral reading. The National Reading Panel (NICHD, 2000), for example, defined fluency as the ability to “read text with speed, accuracy and proper expression” (p. 1) and further included specific recognition that “fluency requires the rapid use of punctuation and the determination of where to place emphasis or where to pause to make sense of a text” (p. 6). Alternatively, Pikulski and Chard (2005) proposed a synthesis of the National Reading Panel's and *The Literacy Dictionary*'s (Harris & Hodges, 1995) definitions that reads as follows: “Reading fluency refers to efficient, effective word recognition skills that permit a reader to construct the meaning of text. Fluency is manifested in accurate, rapid, expressive oral reading and is applied during, and makes possible, silent reading comprehension” (p. 510). Such definitions explicitly relate word recognition skill to prosodic reading and to subsequent comprehension. The current study focuses on reading prosody and its role in learning to read.

Syntactic Structure and Prosody in Speech and Reading

According to models of prosodic structure (Ferreira, 1993; Nespor & Vogel, 1986; Selkirk, 1986), the syntactic structure of a sentence ultimately influences the sentence's organization into prosodic segments. A syntactic phrase boundary is said to virtually force a phonological phrase boundary in speech, which is the reason that these boundaries are often the focus of various prosodic features, including pitch fluctuation, pausing, and phrase-final lengthening. Pragmatic concerns can also influence prosody, such as in the modulation of prosody to signal relevance for the upcoming discourse (Collins, 2006) and to direct upcoming turn-taking (Couper-Kuhlen, 2001).

Whereas the majority of research and theory on prosody has focused on speech rather than on reading, Koriat, Greenberg, and Kreiner (2002) proposed that prosody applied during text reading reflects the structural framework established for phrases and sentences as well. In fact, reading prosody may be more closely aligned with grammatical structure than speech prosody is (Goldman-Eisler, 1972). Goldman-Eisler found that breath pauses almost always occur at syntactic boundaries during oral reading but not necessarily during speech. In oral readings typical in early elementary school classrooms, pragmatic roles for prosody are likely to be limited. Moreover, Koriat et al. speculated that prosody may serve an important representative function of early structural analysis crucial for retaining information in working memory so that it may then be processed.

Prosodic Structures in Young Children's Understanding and Use of Language

Sensitivity to the use of prosodic features in speech is especially evident in young children (Dowhower, 1991; Schreiber, 1987; Schreiber & Read, 1980). Research suggests that infants not only use prosody as a primary cue to the syntactic structure of their language but also that their babbling mimics the prosodic characteristics inherent in their primary language (Kuhn & Stahl, 2003). Furthermore, Schreiber (1987; Read & Schreiber, 1982) found that children appear to be more reliant on prosodic elements in oral language for determining meaning than are adults.

Hirsh-Pasek et al. (1987) suggested that young infants perceive intonational phrase boundaries. Specifically, they observed that infants listened longer to stimulus sets when pauses were inserted at intonational phrase boundaries as opposed to when inserted at other, nonboundary points. Furthermore, numerous studies have demonstrated that infants are sensitive to prosodic cues and syntactic boundaries that correspond with phonological phrase boundaries (Christophe, Dupoux, Bertoncini, & Mehler, 1994; Christophe, Mehler, & Sebastian-Galles, 2001; Gerken, Jusczyk, & Mandel, 1994; Jusczyk et al., 1992). Gout, Christophe, and Morgan (2004) conducted a series of studies, the results of which indicated that infants as young as 10 months old may use cues to phonological phrase boundaries to segment connected speech as well.

Given the evidence demonstrating that children's understanding of oral language is to some extent dependent upon the use of prosodic features, one could reasonably assume that prosody is an important determining factor in children's ability to derive appropriate meaning from text as well (Allington, 1983; Dowhower, 1991; Kuhn & Stahl, 2003; Schreiber, 1991). In fact, appropriate phrasing, intonation, and stress are all considered to be indicators of fluent reading (Chomsky, 1978; Rasinski, 1990b; Samuels, Schermer, & Reinking, 1992) and are further thought to reflect the otherwise invisible process of comprehension (Kuhn & Stahl, 2003). Specifically, Kuhn and Stahl asserted that the ability to group text into syntactically appropriate phrases signifies that a reader has an understanding of what is being read.

Punctuation as a Cue to Prosodic Interpretation

Punctuation serves as a main visual cue to syntax-related prosody. Recently, Steinhauer (2003) found that commas in silent reading elicited covert brain responses similar to those shown for speech boundaries, suggesting a similar underlying mechanism for both. Others, such as Chafe (1988) and Miller and Schwanenflugel (2006), have argued for a distinct contrast between reading prosody and punctuation. For example, Miller and Schwanenflugel observed that adults marked phrase-final commas, like "As they waited, they could hear…," and quotatives, such as "'Let's find out,' said Toad," but did not mark commas for adjectives presented in a series, such as "pretty, colorful, tidy garden." Further, adults reserved sentence-final pitch rises for yes–no questions (e.g., "Did Melanie go?"), but not "wh-" questions (e.g., "Where did Melanie go?"). In fact, strict reliance on punctuation to signal reading prosody seemed to be more characteristic of children's oral reading than of adults'. Thus, one of the tasks children have in learning to read is to learn the limits of punctuation as a cue to the underlying prosodic structure of the text (see Schreiber, 1980).

The Development of Reading Prosody

Early studies of the growth of reading prosody focused on changes derived as a function of repeated reading. For example, Herman (1985) found that the number of spectrographic speech pauses not dictated by punctuation dropped considerably in remedial readers following repeated reading. Similarly, Dowhower (1987) found that repeated reading promoted significant improvements in prosodic reading in second-grade children in terms of decreased inappropriate intrasentential pausing, increased sentence-final vowel lengthening, and a greater pitch (F_0) declination occurring at the last syllable of a declarative sentence.

Other studies have taken an individual difference approach to characterize the development of reading prosody. Schwanenflugel, Hamilton, Kuhn, Wisenbaker, and Stahl (2004) found that skilled second- and third-grade readers took shorter pauses both within and between sentences compared with less skilled readers. Further, skilled readers ended declarative sentences with discernable and relatively large pitch declinations, and they better matched adults in their overall intonation contours. Miller and Schwanenflugel (2006) noted that skilled third graders resembled adults in that they did not mark commas with pauses unnecessarily, and they marked only yes–no questions with pitch rises. Rasinski (2004) has developed a multidimensional rating system to characterize reading prosody and has suggested that fluent and less fluent readers in a given grade can be distinguished on the basis of their oral reading expression, phrasing, smoothness, and pace. Still, studies of skill differences among children of a similar age do not substitute for examinations of longitudinal changes if we are interested in understanding the role that development of reading prosody might play in the development of reading skill.

Contribution of Prosody in Reading Comprehension

Although prosodic reading is widely considered a hallmark of the achievement of reading fluency (Dowhower, 1991; Kuhn & Stahl, 2003; Schwanenflugel et al., 2004), the link between the development of reading prosody and the development of other aspects of the reading process is poorly understood. Although automaticity theory can account for the accurate and effortless decoding that is characteristic of fluent reading (Schwanenflugel et al., 2004) and the concomitant increase in comprehension skill (Schwanenflugel et al., 2006), it does not explicitly address the role of prosody in the reading process. According to Kuhn and Stahl (see also NICHD, 2000), prosodic text reading is necessary beyond automatic individual word decoding for adequate comprehension to occur because prosodic reading is indicative of the ability to segment text according to major syntactic/semantic elements. In fact, some evidence, although mixed, suggests that comprehension may be related to skill in syntactic phrasing in young readers (Gottardo, Stanovich, & Siegel, 1996; Leikin & Assayag Bouskila, 2004; Muter, Hulme, Snowling, & Stevenson, 2004; Young & Greig Bowers, 1995).

Evidence that reading prosody is related to reading comprehension indicates that it may depend on the aspect of prosody measured. According to studies by Schwanenflugel and colleagues (Miller & Schwanenflugel, 2006; Schwanenflugel et al., 2004), as well as a recent study by Ravid and Mashraki (2007), children who showed more adult-like intonation contours and who marked various sentence-type appropriate changes in pitch were more likely to have good reading comprehension skills. Miller and Schwanenflugel found that, once word and text reading rate were accounted for, these pitch changes accounted for additional variance in reading comprehension skills. Pause structures, however, made no independent contribution to reading comprehension. Ravid and Mashraki found that children's pausing was less correlated with reading comprehension than intonation scores were. Consequently, prosody may serve comprehension processes by bracketing major syntactic and semantic boundaries but mainly through changes in pitch. However, we note pauses made by struggling readers can be the result of decoding difficulties or on the misreading of sentence syntax.

It is possible that different aspects of prosody may be linked to different aspects of the reading process. For example, long pauses may signal decoding difficulties, as children pause while they mentally attempt to identify an upcoming word. Pitch changes, by contrast, may be more relevant to reading comprehension skill. Alternatively, it may be that pitch and pause structures become more consolidated once decoding skills have been automatized. Longitudinal studies are needed to discern the ways in which prosody comes to influence reading comprehension skill.

Purpose of the Present Study

According to Chall's (1996) *Stages of Reading Development*, the development of prosodic text reading occurs in the second of six proposed stages called confirmation and fluency, or "ungluing from print" (p. 18). During this stage, readers "confirm" what is already known to develop their fluency and, having established accurate decoding skills in the previous stage, must now develop automaticity with text (Chall, 1996; Kuhn & Stahl, 2003). According to Chall and Kuhn and Stahl, children are expected to develop automaticity and ultimately prosodic text reading skills during the confirmation and fluency stage, which typically spans from the end of first grade through third grade. To do this requires use of prosodic features that include appropriate phrasing, pause structures, stress, rise and fall patterns, and general expressiveness. In a sense, then, this model suggests that the development of accurate decoding and automatic word recognition in connected text creates the conditions necessary for full prosodic reading to occur. Although research suggests that skilled readers are more likely to read prosodically (Clay & Imlach, 1971; Dowhower, 1987; Herman, 1985; Miller & Schwanenflugel, 2006; Schwanenflugel et al., 2004), at present there are no systematic longitudinal studies examining the development of prosodic reading. A longitudinal analysis is necessary to determine how prosodic reading proceeds during the process of skilled reading acquisition.

The current study examined the development of prosodic text reading from grades 1 to 2 and the relationship between reading prosody and general reading fluency and comprehension outcomes in grade 3. Children were administered assessments that included measures of word reading efficiency, oral reading fluency, and reading comprehension (in addition to prosodic measurements). We focused on a set of target prosody features that prior research had indicated might be implicated in the development of reading prosody. We carried out preliminary analyses to identify reading prosody features most indicative of prosodic development. Our goals were then to determine (a) the relationships between specific prosody features during the development of reading prosody and (b) the relative contribution of changes in reading prosody and decoding skills between grades 1 and 2 on fluent reading and comprehension outcomes in grade 3. This analysis was designed to situate the role of reading prosody in the development of skilled reading.

Method

Participants

Participants were 92 first-grade students (40% boys, 60% girls; *M* age = 7 years, 2 months; *SD* = 4 months; range = 6 years, 4 months–8 years, 1 month) who were part of a larger study on the development of reading fluency. The students were enrolled in one of five schools in northeast Georgia (two high-poverty public schools, two rural public schools, and one private parochial school). Only children who were not currently receiving special services for English-language learners were included in the study. Six additional subjects were excluded a priori because they were unable to read the target passage at a level from which meaningful prosodic measurements could be obtained. An additional 8 subjects were removed because their recordings were of insufficient quality to carry out prosodic analysis. Approximately 63% of the children were African American, 20% European American, 13% Hispanic American, and 4% of unknown ethnicity. Of these, 66% were African American Vernacular English speakers possessing at least one of the four most common phonological African American Vernacular

English features found in Craig, Thompson, Washington, and Potter (2003), and 26.7% did not speak Southern dialect according to vowel pronunciation. Children enrolled in the public education system came from schools in which approximately 72% of the students qualified for free- or reduced-lunch programs.

In addition, oral reading recordings from the 34 adults from Schwanenflugel et al. (2004) served as the adult baseline. This sample consisted of balanced numbers of middle- and working-class men and women, of whom, 38% did not speak Southern dialect, and 29% were African-American participants who possessed at least one feature of African American Vernacular English.

General Reading Assessments and Procedures

Assessments included formal measures of word reading efficiency, oral reading fluency, and reading comprehension. Assessments were counterbalanced, such that half the subjects received the word reading efficiency and oral reading fluency measures in the first half of the battery and half received the reading comprehension assessment first. Testers were trained on administration and scoring procedures to the standard of 100% agreement with a trained Ed.S.-level school psychologist on all assessments immediately prior to collection at each data collection wave.

Word reading skill assessment—To obtain an independent estimate of word reading skill, children were administered the Test of Word Reading Efficiency (TOWRE), Sight Word Efficiency subtest (Torgesen, Wagner, & Rashotte, 1999). The Sight Word Efficiency subtest assesses the number of real words correctly read from a list within 45 seconds. Children were assessed during the spring of first and second grades with the TOWRE–Form A and with TOWRE–Form B during the spring of third grade. Concurrent validity estimates reported in the test manual have a median of 0.91 in grades 1 through 3. Test–retest reliability calculated from the current sample produced a coefficient of 0.97. Raw scores from the Sight Word Efficiency subtest were used as an indicator of word reading skills.

Oral reading fluency assessment—The purpose of administering the assessment of oral reading fluency in grades 1 and 2 was to obtain a recording from each child on a designated passage from the Gray Oral Reading Test (GORT). Form A of the GORT (3rd ed.; GORT-3; Wiederholt & Bryant, 1992) was administered during the initial spring of first-grade assessment. Form A of the GORT (4th ed.; GORT-4; Wiederholt & Bryant, 2001) was administered at the end of second grade. The target passage appeared in both editions of the test. Form B of the GORT-4 was administered at the end of third grade as the outcome assessment. The GORT presents children with a series of increasingly difficult passages to read aloud, and children were scored on the rate and accuracy of their reading. On the outcome assessment, rate and accuracy scores were combined to yield a standard fluency score for each passage read as directed by the test manual. The sum of the individual passage fluency scores was used as an indicator of connected text reading ability. The test manual reports validity estimates compared with other tests of reading skills of between 0.39 and 0.89 and an internal consistency reliability of 0.91 for children in this age range for fluency scores.

Reading comprehension assessment—The Reading Comprehension subtest of the Wechsler Individual Achievement Test (The Psychological Corporation, 1992) served as the outcome assessment for reading comprehension skill. This subtest consists of a series of printed passages, each of which increases in complexity, followed by an orally presented question to which children respond orally. The subtest contains both literal and inferential comprehension question types. The test is discontinued once a child misses four consecutive items as directed by the test manual. The test measures reading comprehension as children's ability to answer questions about the text, a skill that many teachers consider a key indicator of reading comprehension (Richardson, Anders, Tidwell, & Lloyd, 1991). The test manual reports validity estimates of between 0.74 and 0.78 with other reading comprehension tests and a split half reliability estimate of 0.91 in this age range (The Psychological Corporation, 1992). The raw score, determined by the number of individual questions answered correctly, served as an indicator of reading comprehension skill.

Reading Prosody Assessment and Procedures

Prosodic measurements were carried out on the selected target passage from the GORT in grades 1 and 2. This passage was the first from Form A of the GORT-3 and the third in the updated GORT-4, Form A. This passage was selected because it was highly decodable and allowed for the assessment of prosodic reading in the absence of numerous decoding errors. The technical manual reported that this passage was appropriate entry-level material for children in the first and second grades. Our own readability analyses using the Flesch–Kincaid Grade-Level Formula (Flesch, 1948) and the Spache Readability Index (Spache, 1953) concurred with this and yielded an averaged estimated grade level of 1.97. The passage was 52 words long and consisted of seven sentences: three simple declaratives, a salutation quotative, a yes–no question quotative, and then two declarative quotatives. Examiners provided students with general directions to read the passage as quickly and as well as they could. In addition, the passage was introduced with the following instructions: “This story is about two people in a family. Read the story to find out what happens to them.” The passage was presented as formatted in the student booklet.

Oral reading recordings were obtained for the passage with the goal of acquiring high quality recordings suitable for prosodic analysis. These recordings were obtained using either a Sony TCD-D100 digital audiotape cassette recorder or Sound Devices USBPre 1.5 microphone computer interface, both via a Sony ECM-717 Stereo Unidirectional Microphone. USBPre 1.5 is a complete, portable hardware interface for computer-based digital recording. All of these means of recording have been used in previous studies examining reading prosody (see Miller & Schwanenflugel, 2006; Schwanenflugel et al., 2004). A shareware version of GoldWave Digital Audio Editor (GoldWave, Inc., 2004) was used to create individual .wav files. Noise-reduction procedures were used to filter background interference. Prosodic analysis of these recordings was conducted using Praat v.4.3.07. Praat is a comprehensive speech software package designed to analyze, synthesize, and manipulate digital speech data (Boersma & Weenink, 2004).

Procedures for Selecting Developmentally Relevant Prosodic Features

Our goal was to select key features of reading prosody most indicative of fundamental change from a larger set of prosodic features. These key features would be targeted in the larger study. To this end, a preliminary exploratory longitudinal analysis was conducted with a subsample of children and an assortment of prosodic features implicated in previous research as markers of reading skill. Selection decisions were based on the extent to which the particular feature displayed reliable change between first and second grades across children (see Clay & Imlach, 1971; Dowhower, 1987; Miller & Schwanenflugel, 2006; Schwanenflugel et al., 2004). We selected the prosodic features that were the best indicators of prosodic change based on effect sizes in these analyses.

A total of 30 children (a third of the total sample) with complete oral reading data were randomly sampled from the larger set of children participating in this study. Selected participants demonstrated a sufficient range of reading ability (25th–99th percentiles) as evidenced by their performance on the TOWRE (Torgesen, Wagner, & Rashotte, 1999) in the first-grade assessment. Furthermore, an independent-samples *t*-test confirmed that there were no statistically significant differences between the 30 participants selected for the preliminary analyses and the remainder of the sample based on performance on the TOWRE, $t(90) = 1.113$, $p = .270$.

The following linguistic features were targeted for spectrographic measurement based on the findings of Chafe (1988) and Cooper and Paccia-Cooper (1980), for their relevance in measuring prosody in adults, and the findings of Miller and Schwanenflugel (2006) and Schwanenflugel et al. (2004) on young readers: (a) intersentential pause duration; (b) phrase-final comma pause duration; (c) pausal intrusion duration; (d) number of pausal intrusions; (e) sentence-final pitch, or fundamental frequency (F_0), declination; and (f) intonation contour.

Intersentential pause duration, or the mean length of pauses between sentences, was measured similarly to pauses within sentences. Intersentential pause lengths were determined by visually demarking the spectrograph at the limits of sentence-final pauses, noting durations (in milliseconds), and averaging across all sentences in the passage. Only measurements exceeding 100 milliseconds were included because they could be reliably measured. Pause measurements were restricted to a maximum duration of 3,000 milliseconds, as required by the GORT protocol.

Phrase-final comma pause duration measurements were determined by slicing the spectrograph at the appropriate phrase boundaries and recording the pause length occurring between the ending of the word preceding a comma and the start of the word following it. Measurements were made for each of three phrase-final commas included in the passage and averaged across observations. Duration constraints were identical to those of intrasentential and intersentential pauses.

Pausal intrusion duration (in milliseconds) was measured as an indicator of the presence of inappropriate pauses within words or syntactical units. Pause lengths were determined by visually creating a spectral slice at the limits of the pause interval and noting its duration in milliseconds. Again, only pause durations between 100 milliseconds and 3,000 milliseconds were included. Pausal intrusion duration measurements were taken from the first three sentences of the passage because the sentences were of the same type (declarative) and lacked commas or quotatives, indicating that pausing was neither required nor implied. Mean pause durations were obtained by averaging across sentences. The actual number of pausal intrusions was counted as well to provide an alternative, simpler measure of pausal intrusions.

The sentence-final pitch (F_0) declination was determined by isolating the target area on the spectrograph and measuring the pitch change, in Hertz (Hz), from the final pitch peak to the end of the sentence. Magnitude of F_0 declination was determined by subtracting the final from the peak fundamental frequency. Measurements were taken on the three basic declarative sentences in the text and the mean difference in F_0 was used as an indicator of sentence-final F_0 declination.

Intonation contour was determined by isolating each word in the target sentence and measuring the F_0 at the vocalic nucleus (the voiced portion of the word that produces F_0) of that word. The term *intonation contour* generally refers to the pattern of pitch changes in the voice; however, local intonation contours are those fall–rise patterns that occur specifically at syntactic phrase boundaries within the sentence and at the terminal marker (Dowhower, 1987). According to Snow and Coots (1981), intonation contours are regarded “as prominent prosodic markers of the natural units of language” (p. 26). These measurements allowed for the creation of a prosodic profile that provided information about pitch changes over an entire sentence. Measurements of the F_0 at the vocalic nucleus were made for each word of the first three sentences in the passage. The resulting prosodic profile of each child was correlated with the mean prosodic profile obtained from the adult sample, and the resulting correlation was taken as the measure of an adult-like intonation contour, or F_0 match, for that child.

Selection Decisions Based on Preliminary Analysis of Prosodic Features

Prosodic change between first and second grade was determined for each prosodic feature by means of a repeated-measures analysis of variance. Means, standard deviations, and ranges for each prosodic variable at each timepoint can be found for this subsample of children in Table 1. Analysis of pause features is presented first, followed by analysis of pitch features.

An examination of the descriptive statistics for intersentential pause durations found that, by second grade, children made pauses between sentences that were on average 127 milliseconds shorter than the pauses were in first grade. This change was statistically significant, $F(1, 29) = 4.42$, $p = .044$, partial $\eta^2 = .132$. This is similar to the observation of Schwanenflugel et al. (2004) that high skilled readers pause less at the ends of sentences than low skilled readers do.

Phrase-final comma pause durations diminished by 253 milliseconds between first and second grades. This change too was statistically reliable, $F(1, 29) = 7.49$, $p = .011$, partial $\eta^2 = .205$. The observed decrease in pause duration over time might indicate that children may no longer feel driven to mark every comma with long pauses as their reading skills develop.

Investigation of pausal intrusions consisted of two separate (though related) measurements: average pausal intrusion duration in milliseconds and total number of pausal intrusions made during oral reading. Our reasons for doing this were due in large part to a general uncertainty as to which might be the best indicator of irrelevant pausing during reading. A brief example is included for clarification purposes. Suppose Child A's reading consisted of seven extraneous pauses with durations of 172, 312, 236, 1293, 482, 647, and 125 milliseconds, the average of which would be 467 milliseconds. Alternatively, Child B recorded only one extraneous pause of 500 milliseconds in duration. Given this information, most would argue that the latter was more fluent than the former was; yet, it would appear that the two readers performed similarly when the mean duration value is presented alone. For pausal-intrusion duration, the length of these pauses shrunk by 77 milliseconds between first and second grades, but this change was not statistically reliable across participants, $F(1, 29) = 1.79$, $p = .191$, partial $\eta^2 = .058$. By contrast, the number of pausal intrusions proved a highly reliable indicator of prosodic change with a large effect size, $F(1, 29) = 25.54$, $p < .001$, partial $\eta^2 = .468$, and children made 3.20 fewer pauses within the first three sentences of the passage between second and first grades. Consequently, in light of this finding, the number of pausal intrusions was retained as the key indicator of pausal intrusions.

With regards to changes in pitch features, previous research suggested that skilled readers end declarative sentences with marked declinations in pitch (Clay & Imlach, 1971; Dowhower, 1987; Miller & Schwanenflugel, 2006; Schwanenflugel et al., 2004). Unfortunately, in this subsample of children, the 11 Hz change in pitch at the ends of declarative sentences between grades 1 and 2 just missed standard levels of significance, $F(1, 32)=4.059$, $p=.052$, partial $\eta^2=.113$, and so was eliminated from further consideration.

Finally, analysis of the mean values for the intonation-contour match between children and adults (F_0 match, or the correlation between children's F_0 values and adult values at the vocalic nucleus over each word in the sentence) revealed a clear pattern of change in which the overall intonation contour of children's oral reading increasingly approximated that of adults' between first and second grades. The initial correlation between child and adult prosodic contours was moderate (.527) and increased to .69 between first and second grades, a statistically significant change between first and second grade, $F(1, 29) = 11.66$, $p = .002$, partial $\eta^2 = .287$.

In sum, this preliminary analysis allowed us to identify those prosodic features that were most relevant in a developmental study of prosodic reading. Between first and second grades, significant changes in reading prosody were observed for intersentential pausing, phrase-final comma pauses, number of pausal intrusions, and adult–child intonation contour or F_0 match. In terms of effect size, however, the largest effects were shown for number of pausal intrusions and F_0 match and, thus, these could be considered to be the best indicators of prosodic change between first and second grades. This is fortuitous because number of pausal intrusions and F_0 match are fairly global indicators of pause and pitch. F_0 match represents the overall prosodic profile and incorporates sentence-final declination within its measurement (results of Schwanenflugel et al. [2004] demonstrated F_0 match to be a significant predictor of comprehension skill as well), whereas the number of pausal intrusions accounts for all irrelevant pauses unconnected to punctuation. Thus, these two prosodic features were targeted for further examination in the oral readings of all 92 children participating in the longitudinal study.

For the larger longitudinal analysis on the full sample of children, then, the number of pausal intrusions and F_0 match served as indicators of reading prosody. The TOWRE Sight Word Efficiency subtest raw score in the first and second grades served as the indicator of word reading skills. Indicators of reading-skill outcomes were children's third-grade performance on the GORT-4 for reading fluency and the Reading Comprehension subtest of the Wechsler Individual Achievement Test for reading comprehension.

Results

Analyses (using an *N* of 92) were centered on two main research objectives. The first objective focused on the development of reading prosody itself. Specifically, we aimed to determine the relationship of specific prosody features to one another in the development of reading prosody. The second objective focused on contextualizing the role of reading prosody in the development of skilled reading per se. Specifically, we wished to determine how changes in reading prosody and word reading skills relate to the development of later reading fluency and reading comprehension skills.

Screening for Outliers and Treatment of Missing Data

Prior to conducting any analyses, we screened for outliers on all variables. Kline (2005) presented a common "rule of thumb" for identifying univariate outliers in which scores that are more than three standard deviations from the mean are considered extreme. We found only one outlier, which was truncated to three standard deviations from the mean. Furthermore, analysis of the skewness and kurtosis values indicated that all variables showed univariate normality (with values < |2|). DeCarlo's (1997) macro was used within LISREL 8.8 for Windows (Joreskog & Sorbom, 2006) to screen for possible multivariate outliers. Based on the five observations with the largest Mahalanobis distances, a measure of how far an observation's values on the variables are from the multivariate mean of all variables, there were no single multivariate outliers in the data set. Further, the relative multivariate kurtosis statistic obtained was 1.26, which was considerably less than the general recommended upward bound of 2.0, suggesting considerable multivariate normality. Means, standard deviations, and skewness and kurtosis values for all variables included in the model tests are presented in Table 2. In addition, correlations between all variables are presented in Table 3.

Treatment of missing data (approximately 18% of the entire data set) was addressed using the expectation-maximization algorithm (Dempster, Laird, & Rubin, 1977), a general iterative algorithm for computing maximum likelihood (ML) estimates from incomplete data. The expectation-maximization algorithm is used to obtain estimates of population means and covariances, which LISREL then uses to obtain starting values for the ML procedure. Although

ML is the default method of estimation in LISREL, it is the most widely researched estimator, and it works well under a variety of conditions (e.g. small sample size). Furthermore, characteristics of the data, such as approximate multivariate normality (described previously), suggest that ML is the appropriate estimation procedure.

Fit Criteria

Based on the combination of recommendations proposed by Hoyle and Panter (1995) and Hu and Bentler (1999), the following fit indexes were chosen to evaluate model fit: minimum fit function chi-square, goodness- of-fit index (GFI), nonnormed fit index (NNFI), comparative fit index (CFI), and root-mean-square error of approximation (RMSEA). The LISREL GFI is a measure of the proportion of the observed covariation that is accounted for by the model. Hoyle and Panter have recommended including this index to complement presentation of the chi-square statistic as measures of overall fit. A GFI value exceeding 0.95 is considered an indication of model fit. In addition to indexes of overall fit, Hoyle and Panter recommended inclusion of incremental fit indexes (specifically Type 2 and Type 3 indexes) to assess model fit with reference to some type of baseline model (something that the chi-square value does not indicate). Type 2 indexes represent the proportion of increased fit the hypothesized model shows over the null model and incorporate the expected values of the chi-square under the central chi-square distribution. The NNFI was selected as a Type 2 index, with a cut-off value of at least 0.95. Type 3 indexes represent the proportion of increased fit the hypothesized model shows over the null model and incorporate the expected values of the chi-square under the noncentral chi-square distribution. The CFI, selected as a Type 3 index, compares the noncentrality parameters of the target and baseline models. The ML-based estimate of the CFI is especially preferred when sample size is small as well. Again, Hu and Bentler recommend a CFI value of 0.95 or above. Finally, the RMSEA is a highly recommended fit index that provides a standardized measure of the lack of fit of the population data to the model. Desired values of this index are low and Hu and Bentler recommend a cut-off close to 0.06.

Analysis of Development of Reading Prosody Between First and Second Grades

Our first objective was to determine the nature of the development of reading prosody between first and second grades. In this section, we examine the relationship between number of pausal intrusions and F_0 match between first and second grade. Our primary interest was in determining whether decreases in the presence of pausal intrusions between first and second grades were related to the development of more adult-like intonation contours (F_0 match), or whether these prosodic features grow more or less in unison and interdependently. We considered three types of relationships, which can be seen in the path diagrams presented in Figures 1 (a), (b), and (c).

The first model tested, called the independence model, was essentially a null model that assumed that pausal intrusions decreased independently of changes in the ability of children to match the adult intonation contour, that is, that no cross-lagged effect would be found between the number of pausal intrusions present during oral reading in first grade and the development of F_0 match in second grade. The independence model was the baseline analysis used to evaluate ensuing model tests. The outcome of this analysis can be seen in the path diagram presented in Figure 1a. As expected, each path included in this model was significant at the $p < .01$ level. This finding suggested that the number of pausal intrusions made during the spring of first grade was significantly related to the number of pausal intrusions observed during the spring of the second-grade school year. Similarly, the child–adult F_0 contour match measured during the spring of first grade was significantly related to the F_0 contour match during the spring of second grade. Overall model fit to the observed data, however, was marginal, $\chi^2(3, N = 92) = 8.25$, $p = .041$, GFI = 0.96, NNFI = 0.90, CFI = 0.95, RMSEA = 0.14, suggesting that this model was not a good representation of the development of reading prosody. Path weights, standard errors, and *t* values for the independence model are summarized in Table 4.

According to Chall (1996), as reading becomes increasingly less halting, perhaps because children no longer have to pause to recognize upcoming words, children develop the ability to represent what is read in conversational tones. In our second model, labeled the skill-development model, we hypothesized that the presence of a substantial number of pauses during text reading reflects a basic level of disfluency that precludes true prosodic interpretation as evidenced by the development of an adult-like intonation contour. Thus, changes in the number of pausal intrusions would serve as a precursor to the development of a more appropriate intonation contour during oral reading. To represent this idea, we tested an additional path between pausal intrusions in grade 1 and subsequent F_0 match in grade 2. The outcome of this model test can be found in the path diagram in Figure 1b. Results supported this skill-development hypothesis, and the overall fit of the model to the observed data was excellent, $\chi^2(2, N = 92) = 1.27$, $p = .53$, GFI = 0.99, NNFI = 1.02, CFI = 1.00, RMSEA = 0.0. Grade 1 pausal intrusions and F_0 match continued to demonstrate significant influences on grade 2 levels ($p < .01$), but also, the additional path between pausal intrusion at grade 1 and F_0 match at grade 2 was significant at the $p < .01$ level. A summary of the path weights, standard errors, and *t* values for the skill-development model is presented in Table 4. The chi-square difference test (χ^2_{diff}) comparing the fit of the independence model and the skill-development model indicated a statistically better fit of the skill- development model, χ^2_{diff} $(1, N = 92) = 6.98$, $p < .01$. Thus, children who had fewer pauses in first grade had a more adult-like contour in second grade.

We considered a third model, labeled the cross-lagged effect model, which tested the possibility that reading prosody emerges as a whole, and its component features are intertwined in their development. In statistical terms, a cross-lagged relationship may exist between the number of pausal intrusions and F_0 match. A cross-lagged relationship would be evident if pausal intrusions in grade 1 impacted F_0 match in grade 2, *and* F_0 match had a significant impact on pausal intrusions in grade 2, as well. The outcome of this analysis can be found in the path diagram in Figure 1c. Results demonstrated that the paths of the nested skill-development model were significant at the $p < .01$ level; however, the additional path between F_0 contour at grade 1 and pause at grade 2 (representing the cross-lagged effect) was not significant. A summary of the path weights, standard errors, and *t* values for the cross-lagged effect model are summarized in Table 4. Although a review of the fit indices suggests exceptional model fit to the observed data, $\chi^2(1, N = 92) = 0.18$, $p = .67$, GFI = 1.00, NNFI = 1.04, CFI = 1.00, RMSEA = 0.0, the lack of significance for the cross-lagged path between grade 1 F_0 match and pausal intrusions in grade 2 indicates a lack of support for the complete cross-lagged effect promised by the model. Comparison between the cross-lagged effect and skill-development models, however, revealed no statistically significant difference between models either, χ^2_{diff} $(1, N = 92) = 1.09$, $p = .30$.

Taking into account comparisons between models, the skill-development model provides the best representation of the development of reading prosody between first and second grades. This model of reading prosody was embedded in subsequent model tests designed to assess the role of reading prosody in later reading-skill outcomes in third grade.

Analysis of the Role of Reading Prosody in the Development of Reading Skill

The model tests for our second objective examined the contribution of the development of prosodic text reading and word reading abilities to later oral reading fluency and reading comprehension. Specifically, we wanted to address the extent to which the development of reading prosody adds to our ability to account for reading fluency and comprehension outcomes above and beyond children’s word reading skills. To accomplish this, we added the TOWRE

Sight Word Efficiency raw scores from first and second grades to the prosody model selected above to serve as the indicator of word reading skill. Essentially, if the prosodic features included in these models are important to later outcomes, we expected that prosody would have an effect on later reading skills beyond that detectable for early word reading skills. We planned to test these models without including paths between prosody variables and word reading skill. However, doing so resulted in generally poor model fit for both fluency and comprehension skill outcomes, and the modification indices produced by LISREL suggested the inclusion of paths between pausal intrusions and word reading skill. This confirmed our previous conjecture that there is an integral relationship between pausal intrusions and word reading skills. Consequently, we added contemporaneous and cross-lagged paths in each model that examined the relationship between the number of pausal intrusions and the development of word reading skills.

Fluency as Outcome—Results of the fluency-outcome model (see Figure 2) indicated that the general structure of the skill-development hypothesis between prosodic variables remained valid, with all paths significant at the $p < .01$ level. As expected, performance on word reading skill in grade 1 significantly impacted performance at grade 2 ($p < .01$). The cross-lagged relationship between the number of pausal intrusions in grade 1 and word reading skill in grade 2 was not significant; however, the contemporaneous relationship between the number of pausal intrusions and word reading skill in grade 2 was significant ($p < .01$). Examination of the outcome relationships revealed several additional findings of definite theoretical importance. First, both the direct relationship between children's initial word reading skill and later oral reading fluency, and the effect of children's second grade word reading skill on oral reading fluency, were found to be significant ($p < .01$). However, the effects of neither grade 1 nor grade 2 pausal intrusions on later fluency were significant. Intonation contour (F_0 match), in contrast, emerged as a significant additional predictor of oral reading fluency in grade 3. Specifically, both grades 1 and 2 F_0 match demonstrated significant relationships with the fluency-achievement outcome measure ($p < .05$ for each).

In our previous analyses examining the development of reading prosody between the first and second grades, we suggested that decreases in pausal intrusions may initiate the development of pitch aspects of prosody, and results of this model test suggest that this supposition is correct. However, this model suggests that pauses may be linked to decoding issues in grade 2, but it is word reading skills that are the largest contributor to fluency, with respect to later fluency observed in grade 3. Change in children's ability to approximate the adult intonation contour is another significant predictor of later fluency. Path weights, standard errors, and *t* values for the fluency as predicted outcome model (TOWRE included) are presented in Table 5. The overall fit of the model to the data was considered marginal to good, $\chi^2(6, N = 92) = 11.59$, $p = .072$, GFI = 0.97, NNFI = 0.97, CFI = 0.99, RMSEA = 0.098, depending on the index of fit.

Comprehension as Outcome—The findings for the comprehension outcome model (see Figure 3) shared some similarities with those of the fluency model; however, important distinctions were evident. Again, the skill-development relationships between prosodic variables remained significant ($p < .01$), and performance on the TOWRE in grade 1 significantly impacted performance on the TOWRE in grade 2 ($p<.01$). Though the grade 1 TOWRE measurement was not a significant predictor of comprehension in grade 3, the total effect of the development of word reading skills over time significantly predicted comprehension skill at the end of the third-grade school year ($p < .05$). However, unlike for the long-term prediction of reading fluency, this time there were significant effects of decreases in pausal intrusions between grades 1 and 2 on later comprehension skill ($p < .05$). Further, whereas the direct relationship between the initial intonation contour measurement and comprehension skill in grade 3 was found to be significant at the $p < .01$ level, the effect of the development of appropriate intonation contour by grade 2 did not predict later comprehension skill. Overall, the data were well fit to the model, $\chi^2(6, N = 92) = 9.75$, $p = .14$, GFI = 0.97, NNFI = 0.97, CFI = 0.99, RMSEA = 0.079. A summary of the path weights, standard errors, and *t* values for the comprehension-outcome (TOWRE included) model can be found in Table 6.

General Discussion

Our objectives for this longitudinal investigation were as follows: (a) to determine the relationship between specific reading prosody features and the development of reading prosody—specifically, we investigated whether having fewer pausal intrusions was related to the development of a more adult-like intonation contour; and (b) to determine the extent to which the development of reading prosody in grades 1 and 2 assists in predicting later reading fluency and comprehension-skill outcomes in grade 3, beyond word reading skills alone.

Results of a preliminary analysis on a subset of children in the study illustrated that various pause and pitch features of oral reading prosody develop throughout the early years of reading acquisition. Specifically, we found decreases in the number of pausal intrusions present in children's oral reading between first and second grade, along with diminished durations in both intersentential and phrase-final comma pauses, all of which became increasingly consistent with "target" readings. Furthermore, intonation contours became increasingly adult-like by the end of the second grade. For this subset of children, pausal intrusions were not statistically significantly shorter, and sentence-final pitch change was not larger, as children moved from first to second grade, but the mean change was in the general direction anticipated. We found the number of pausal intrusions and match to an adult-like intonation contour to be the most robust indicators of change between first and second grades.

Prior research had shown that individual differences in pausing and intonation among children of a similar age were related to various reading-skill indices, such as word reading and reading comprehension (see Clay & Imlach, 1971; Miller & Schwanenflugel, 2006; Ravid & Mashraki, 2007; Schwanenflugel et al., 2004). Further, other studies had shown decreased irrelevant pausing and more pronounced pitch changes with repeated passage practice (Dowhower, 1987; Herman, 1985). However, because we examined change longitudinally, this study could show that these changes emerge as children accrue reading skill between first and second grades. Further, we showed that children who made few pausal intrusions in first grade would later demonstrate a more adult-like intonation contour in second grade.

We explored the impact of the development of reading prosody on later reading skills by focusing on the interrelationships among features most directly implicated in this change. According to Chall (1996b) and Kuhn and Stahl (2003), true prosodic text reading might emerge after children have solidified automatic decoding and word reading capabilities. Inherent in this theory is a skill-development approach to understanding prosodic reading, which suggests that as children's reading skills become more fluent, they develop the ability to represent what is read in ways that imitate the tonal and rhythmic aspects of conversational speech. The findings of this study support this view regarding how fluent reading might unfold. Pausing was integrally and contemporaneously connected to children's word reading skills. Further, the number of pausal intrusions in early readings was predictive of children's later development of an adult-like intonation contour.

Once the skill-development relationship was identified, we explored the issue of what the development of reading prosody implies for the later course of reading skills in general. We proceeded with additional tests that examined the extent to which the development of reading prosody between first and second grades predicted fluent reading and comprehension skills in third grade. Model tests incorporated word reading skills as an additional predictor of fluency

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and comprehension outcomes to determine the extent to which the development of reading prosody added to our ability to account for reading-achievement outcomes beyond the development of word reading skills. We also theorized that decreases in the number of pausal intrusions between first and second grades were closely related to the development of automatic word reading skills.

Our first analysis focused on the role of reading prosody in the development of reading fluency, as indicated by fluency scores on the GORT-4. Word reading skills in grades 1 and 2 were found to be strong predictors of later reading fluency achievement. Furthermore, the development of an adult-like intonation contour emerged as an additional predictor of fluency outcomes beyond the development of word reading skills. Results indicated that neither grade 1 nor grade 2 pauses predicted fluency outcomes in grade 3. In fact, the influence of pausal intrusions on later fluency was fully mediated by its effect on word reading skill and children's intonation contour in grade 2. These findings are consistent with the conclusions of previous research on reading prosody, which suggested that pitch features may be the "true" indicators of fluent, prosodic text reading (Cowie, Douglas-Cowie, & Wichmann, 2002; Ravid & Mashraki, 2007). We conclude that the ability to produce appropriate pitch interpretations during oral reading predicts future performance in reading fluency and other reading-related skills as well (Clay & Imlach, 1971; Dowhower, 1987; Miller & Schwanenflugel, 2006; Schwanenflugel et al., 2004). We are struck by the growing consensus around the importance of intonation contour in the development of fluent reading.

The model for reading comprehension as outcome bore both similarities and differences to the fluency-outcome model. Like the fluency-outcome model, we found that children's possession of an adult-like intonation contour in first grade was related to skilled comprehension two years later. Moreover, there were direct effects of the development of word reading skill in first and second grades that accounted for significant variance in comprehension at the end of third grade. Unlike the fluency model, there was a greater relevance of the number of pausal intrusions on later comprehension skill.

These findings both support and contradict some conclusions put forth by prior research regarding the relationship between reading prosody and reading comprehension. Like in Miller and Schwanenflugel (2006) and Schwanenflugel et al. (2004), the current study finds support for the view that the development of appropriate pitch features in reading prosody is indicative of good comprehension. That is, children who showed early acquisition of an adult-like intonation contour were more likely to show good comprehension in third grade. Children who will be good comprehenders mark basic sentence structure through pitch pretty much from the outset. However, whereas some earlier studies failed to find an independent effect of pause structures on reading comprehension (Miller & Schwanenflugel, 2006; Schwanenflugel et al., 2004), other studies did find such a relationship (Ravid & Mashraki, 2007). In this study, we found that having fewer pausal intrusions over time was associated with good comprehension. It may be that some of these earlier studies did not find such an effect because they did not examine pausal intrusions developmentally and, thus, these results support the importance of using longitudinal studies for examining the changing relationships of distinct oral reading skills over time.

One goal of this research was to develop a better understanding of the role that reading prosody plays in the reading process. The differences in the models for fluency and comprehension as outcomes are illustrative in this regard. We found that prosodic features of reading were important from the outset (or at least as early as we were able to test it), regardless of outcome. For fluency, it appears that children develop a more adult-like intonation contour with growing fluency, and this adult-like intonation contour is associated with later fluency achievement. However, irrelevant pausing was more closely related to word reading difficulties than it was to later fluency development. Once word-decoding issues were accounted for, irrelevant pausing no longer seemed to play much of a role in predicting later fluency. However, with regards to comprehension, we did find some additional evidence for the role of pausal intrusions beyond what could be accounted for by word reading speed alone.

There are a number of possibilities as to why pausing not accounted for by word reading skills might be connected to reading comprehension in a way that it is not for fluency. It may be that children who pause despite having good decoding skills are pausing as a sort of check on their comprehension. The fact that intrasentential pauses are negatively associated with comprehension skills suggests that there are children who struggle to understand what they are reading despite having good decoding skills. Perhaps these children are, as some describe them, "word callers" (Hamilton & Shinn, 2003). Another possibility is that these pauses are caused by a difficulty with synchronizing all of the different underlying processes associated with reading for some children (Breznitz, 2006; Wolf & Katzir-Cohen, 2001). Perhaps children with this problem pause as a way to allow their cognitive processes time to catch up with one another. Although we recognize the many processes underlying basic word reading skills, at this point it is unclear to us why such pausing would be related to comprehension but not to later fluency. A third alternative is that comprehension-specific connection of pausal intrusions to later reading comprehension emerged because of unmeasured factors outside our model, such as vocabulary skills or syntax awareness, which have sometimes been shown to be related to later reading comprehension skills. Although we have no doubt that vocabulary is important for later comprehension (Storch & Whitehurst, 2002), we doubt its responsibility for the pause–comprehension connection here because the passage we used was very simple in its vocabulary. Syntax awareness would seem to be a better candidate for this pause connection, but syntax awareness as a variable has had uneven success as a predictor of later reading comprehension (Cain, 2007; Demont & Gombert, 1996; Siegel & Ryan, 1988), and it is unclear why pausal intrusions would not also be related to later reading fluency. At the moment, we favor the first of these ideas because it relates pausing not explained by decoding skills directly to comprehension.

The findings presented here may have educational implications for teachers who monitor their students' oral reading development. The results of this study are clear in demonstrating the importance of pausal intrusions and an adult-like intonation contour from grades 1 to 2 for later reading achievement. Furthermore, results also suggest that the early decreases in the number of pausal intrusions during oral reading appear to influence subsequent development of appropriate intonation contour. An understanding of the processes involved in the development of prosodic text reading alone holds considerable value for educators particularly because such information increases awareness about what changes may occur in their students' reading expression over time.

Limitations of the Present Study and Future Research

The current investigation of the development of reading prosody has several limitations. The sample size available for the present research was its greatest limitation. Because of the sample-size requirements of model tests, we were restricted to focusing models on a limited number of prosodic features. Future studies should include a more detailed focus on the range of reading-prosody features and their relationship to achievement outcomes over a larger period of time. Beyond the features we examined in our preliminary study, some studies have suggested that other prosodic features, such as sentence-final syllable lengthening and stress, might be fruitfully examined (Whalley & Hansen, 2006). Further, the oral reading of texts that draw on various sentence types (Miller & Schwanenflugel, 2006) and nondefault prosody, such as sarcasm, exclamation, and sentence ambiguity (Speer, Crowder, & Thomas, 1993), might be profitably examined. Continuing the measurement of reading prosody into third grade might allow for a more detailed portrayal of the development of prosodic text reading.

In conclusion, with regards to the goals of our study, we have three findings. We have found that decreases in the number of pausal intrusions are related to the development of a more adult-like intonation contour in the development of reading prosody. The number of pausal intrusions is intimately related to the development of word reading skills per se, but the development of appropriate intonation contours is most relevant to predicting later reading fluency. However, both aspects of reading prosody were relevant to predicting later reading comprehension skill beyond word reading skills alone.

Finally, our results have implications for the definition of reading fluency. We have learned that the development of reading prosody is an important element of reading fluency and should be considered a key aspect of any definition of it. In sum, we conclude that reading prosody plays an important role in the general development of reading skills.

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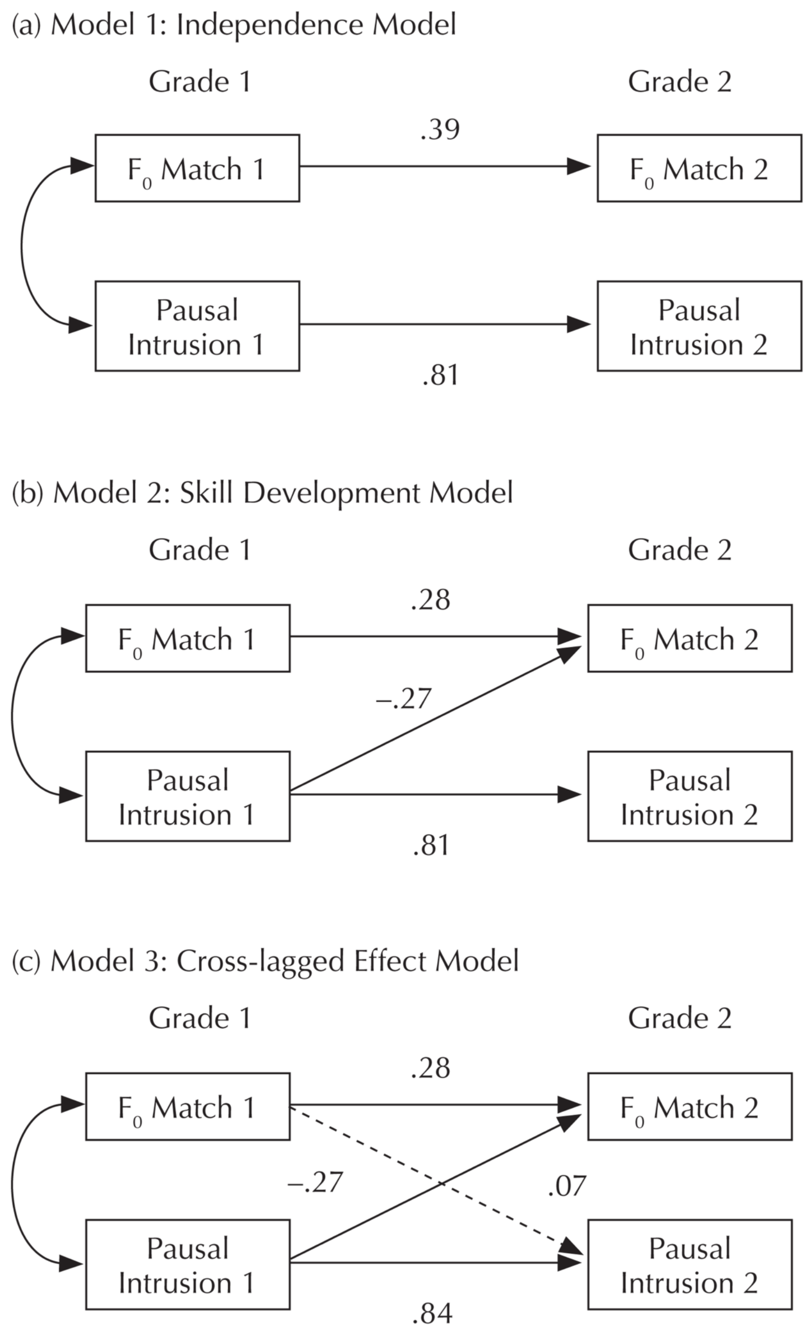

Figure 1. Path Models Tested to Examine the Relationship Between Intrasentential Pause and Child–Adult F_0 Contour Match (F_0 match; N = 92)

Note. The number after the variable name corresponds to the time point at which the measurement was taken (1 = spring of first grade, 2 = spring of second grade). Pausal intrusion = total number of intrasentential pauses recorded during oral reading.

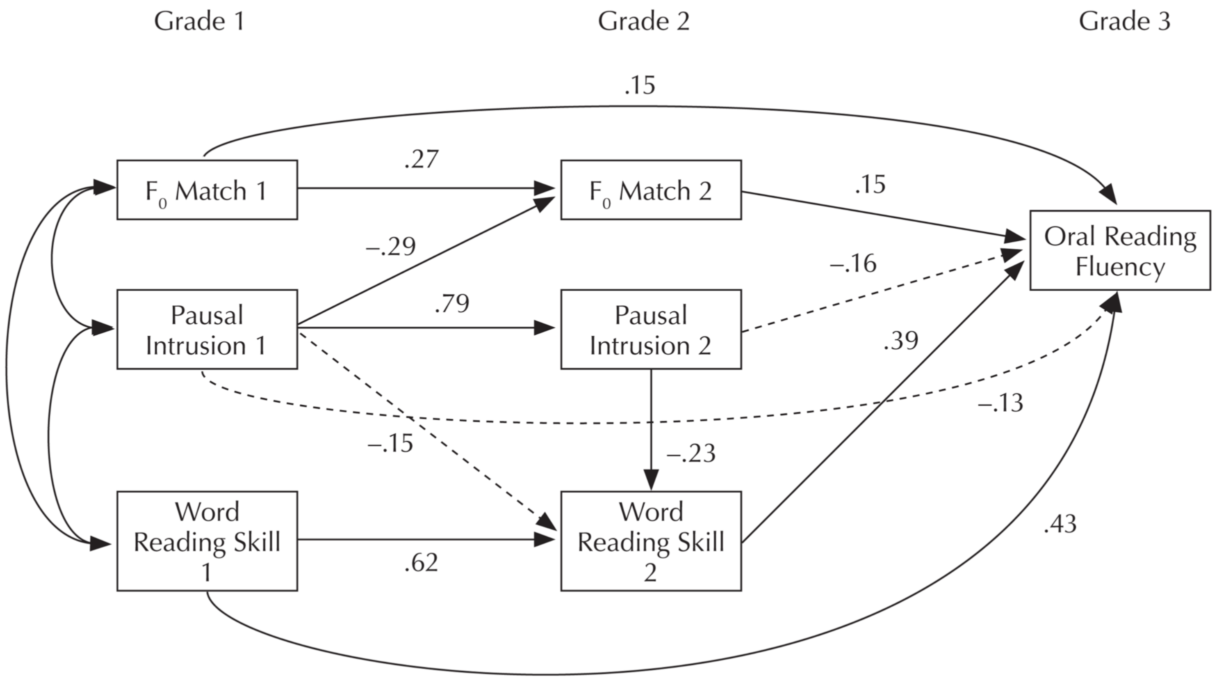

Figure 2. Path Model Tested for Fluency as Outcome Model (N = 92)

Note. The number after the variable name corresponds to the time point at which the measurement was taken (1 = spring of first grade, 2 = spring of second grade). Dashed lines = nonsignificant path; solid lines = statistically significant path. F_0 Match = Child-adult pitch (F_0) contour match; Pausal intrusion = total number of intrasentential pauses recorded during oral reading; Word reading skill = raw score on the Sight Word Efficiency subtest of the Test of Word Reading Efficiency, Form A; Fluency = sum of the individual passage scores on the Gray Oral Reading Test, fourth edition, Form B, administered during the spring of the third grade school year.

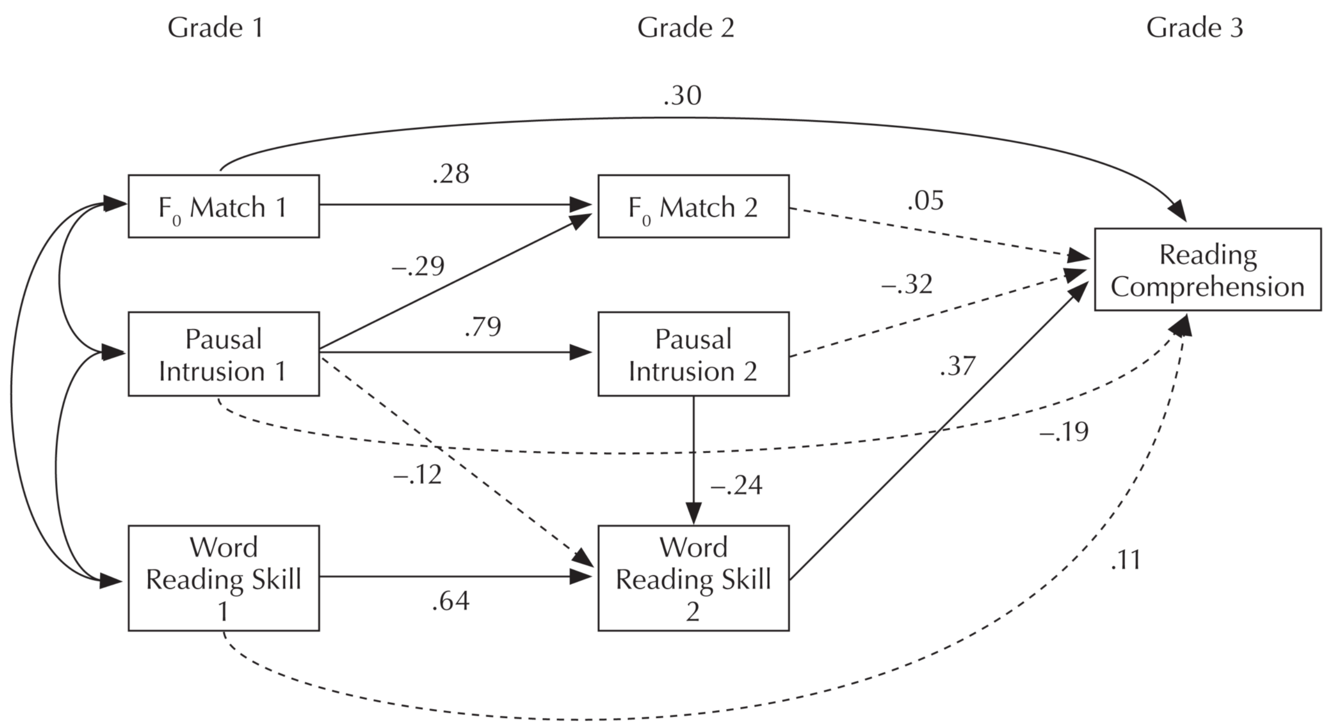

Figure 3. Path Model Tested for Comprehension as Outcome Model (N = 92)

Note. The number after the variable name corresponds to the time point at which the measurement was taken (1 = spring of first grade, 2 = spring of second grade). Dashed lines = nonsignificant path; solid lines = statistically significant path. F_0 Match = Child-adult pitch (F_0) contour match; Pausal intrusion = total number of intrasentential pauses recorded during oral reading; Word reading skill = raw score on the Sight Word Efficiency subtest of the Test of Word Reading Efficiency; Reading comprehension = raw number of points earned on the Reading Comprehension subtest of the Wechsler Individual Achievement Test administered during the spring of the third grade school year.

Table 1

Descriptive Statistics for Preliminary Analysis of Prosodic Features (N = 30)

Prosody feature	**Minimum**	**Maximum**	***M***	***SD***
Intrasentential pause duration (ms)				
Grade 1	0	1,419	403	267
Grade 2	0	1,110	326	274
Number of pausal intrusions				
Grade 1	0	21	5.27	4.85
Grade 2	0	9	2.07	2.41
Intersentential pause duration (ms)				
Grade 1	352	1,765	623	319
Grade 2	78	1,979	496	368
Phrase-final comma pause duration (ms)				
Grade 1	0	1,109	314	296
Grade 2	0	684	140	154
Basic declarative F_0 change (Hz)				
Grade 1	−102	12	−25	22
Grade 2	−116	−10	−36	21
Child–adult F_0 contour match				
Grade 1	0.041	0.757	0.527	0.203
Grade 2	0.000	0.836	0.688	0.094

Note. Grade 1 = spring of first grade; Grade 2 = spring of second grade; F_0 = pitch.

Table 2

Means, Standard Deviations, Skewness, and Kurtosis Values for Variables Used in Model Tests (N = 92)

Variable	*M*	*SD*	*Skewness*	*Kurtosis*
Number of pausal intrusions				
Grade 1	7.457	5.894	0.824	−0.291
Grade 2	2.837	3.100	1.129	0.397
Child–adult F_0 match				
Grade 1	0.510	0.175	−0.462	−0.296
Grade 2	0.660	0.099	−0.590	0.472
TOWRE-Sight Word Efficiency (raw score)				
Grade 1	43.696	15.221	0.259	−0.148
Grade 2	57.859	13.623	−0.288	−0.342
GORT-Fluency (sum score)				
Grade 3	52.761	18.317	0.508	0.558
WIAT-Reading Comprehension (raw score)				
Grade 3	21.967	4.819	−0.532	−0.532

Note. Grade 1 = spring of first grade; Grade 2 = spring of second grade; Grade 3 = spring of third grade, as outlined in the adjusted layout and assessment design for the full developmental study of prosodic text reading. F_0 = pitch; TOWRE = Test of Word Reading Efficiency; GORT = Gray Oral Reading Test; WIAT = Wechsler Individual Achievement Test.

Table 3

Correlations Between Variables Used in Model Tests (N = 92)

Variable	1	2	3	4	5	6	7	8
1. Pausal intrusions 1	—							
2. Pausal intrusions 2	0.773**	—						
3. F_0 match 1	−0.384**	−0.215	—					
4. F_0 match 2	−0.359**	−0.313*	0.363**	—				
5. TOWRE 1	−0.774**	−0.721**	0.294*	0.396**	—			
6. TOWRE 2	−0.798**	−0.745**	0.379**	0.383**	0.864**	—		
7. GORT-Fluency	−0.593**	−0.627**	0.270	0.182	0.770**	0.770**	—	
8. WIAT-RC	−0.365**	−0.556**	0.400**	0.240*	0.538**	0.627**	0.518**	—

Note. The number after the variable name corresponds to the time point at which the measurement was taken (1 = Spring of first grade, 2 = Spring of second grade). Pausal intrusion = Total number of intrasentential pauses recorded during oral reading; F_0 match = Child–adult pitch (F_0) contour match; TOWRE = Raw score on the Sight Word Efficiency subtest of the Test of Word Reading Efficiency; GORT-Fluency = Sum score on the Gray Oral Reading Tests, fourth edition, in Grade 3; WIAT-RC = Raw score on the Reading Comprehension subtest of the Wechsler Individual Achievement Test in Grade 3.

* $p < .05$.

** $p < .01$.

Table 4

Path Weights, Standard Errors, and t Values for Path Models Examining the Relationship Between Prosody Variables (N = 92)

Model/Path	**Weight**	***SE***	***t***
Independence			
F_0 match 1 → F_0 match 2	0.39	0.098	3.98**
Pausal intrusion 1 → Pausal intrusion 2	0.81	0.062	13.06**
Skill development			
F_0 match 1 → F_0 match 2	0.28	0.101	2.76**
Pausal intrusion 1 → Pausal intrusion 2	0.81	0.062	13.06**
Pausal intrusion 1 → F_0 match 2	−0.27	0.101	−2.66**
Cross-lagged effect			
F_0 match 1 → F_0 match 2	0.28	0.101	2.76**
Pausal intrusion 1 → Pausal intrusion 2	0.84	0.067	12.49**
Pausal intrusion 1 → F_0 match 2	−0.27	0.101	−2.66**
F_0 match 1 → Pausal intrusion 2	0.07	0.067	1.04

Note. The number after the variable name corresponds to the time point at which the measurement was taken (1 = spring of first grade, 2 = spring of second grade). F_0 match = Child–adult pitch (F_0) contour match; Pausal intrusion = total number of intrasentential pauses recorded during oral reading.

* *p* < .05, critical value = 1.96.

** *p* < .01, critical value = 2.58.

Table 5

Path Weights, Standard Errors, and t Values for the Fluency-Outcome Model (N = 92)

Model/Path	Weight	*SE*	*t*
Skill-development component			
F_0 match 1 → F_0 match 2	0.27	0.104	2.59**
Pausal intrusion 1 → Pausal intrusion 2	0.79	0.065	12.12**
Pausal intrusion 1 → F_0 match 2	−0.29	0.104	−2.79**
Word reading skill 1→ Word reading skill 2	0.62	0.075	8.26**
Pausal intrusion 1 → Word reading skill 2	−0.15	0.096	−1.56
Pausal intrusion 2 → Word reading skill 2	−0.23	0.073	−3.13**
Fluency as predicted outcome			
F_0 match 1 → Fluency	0.15	0.067	2.24*
Pausal intrusion 1 → Fluency	−0.13	0.083	−0.96
Word reading skill 1 → Fluency	0.43	0.132	3.26**
F_0 match 2 → Fluency	0.15	0.068	2.20*
Pausal intrusion 2 → Fluency	−0.16	0.104	−1.53
Word reading skill 2 → Fluency	0.39	0.142	2.74**

Note. The number after the variable name corresponds to the time point at which the measurement was taken (1 = spring of first grade, 2 = spring of second grade). F_0 Match = Child–adult pitch (F_0) contour match; Pausal intrusion = total number of intrasentential pauses recorded during oral reading; Word reading skill = raw score on the Sight Word Efficiency Subtest of the Test of Word Reading Efficiency; Fluency = the sum of the individual passage scores on the Gray Oral Reading Test, fourth edition, Form B, administered during the spring of the third grade school year.

* $p < .05$, critical value = 1.96,

** $p < .01$, critical value = 2.58.

Table 6

Path Weights, Standard Errors, and t Values for the Comprehension-Outcome Model (N = 92)

Model/Path	Weight	*SE*	*t*
Skill-development component			
F_0 match 1 → F_0 match 2	0.28	0.104	2.68**
Pausal intrusion 1 → Pausal intrusion 2	0.79	0.065	12.11**
Pausal intrusion 1 → F_0 match 2	−0.29	0.103	−2.62**
Word reading skill 1 → Word reading skill 2	0.64	0.073	8.82**
Pausal intrusion 1 → Word reading skill 2	−0.12	0.092	−1.30
Pausal intrusion 2 → Word reading skill 2	−0.24	0.068	−3.50**
Comprehension as predicted outcome			
F_0 match 1 → Reading comprehension	0.30	0.084	3.57**
Pausal intrusion 1 → Reading comprehension	−0.19	0.159	−1.19
Word reading skill 1 → Reading comprehension	0.11	0.154	0.65
F_0 match 2 → Reading comprehension	0.05	0.093	0.54
Pausal intrusion 2 → Reading comprehension	−0.32	0.128	−2.50*
Word reading skill 2 → Reading comprehension	0.37	0.184	2.01*

Note. The number after the variable name corresponds to the time point at which the measurement was taken (1 = spring of first grade, 2 = spring of second grade). F_0 match = Child–adult pitch (F_0) contour match; Pausal intrusion = total number of intrasentential pauses recorded during oral reading; Word reading skill = raw score on the Sight Word Efficiency subtest of the Test of Word Reading Efficiency; Reading comprehension = raw number of points earned on the Reading Comprehension subtest of the Wechsler Individual Achievement Test administered during the spring of the third grade school year.

* $p < .05$, critical value = 1.96.

** $p < .01$, critical value = 2.58.