INTERACTIONS BETWEEN LEXICAL AND PHRASAL PROSODY IN SCHOOL-AGED CHILDREN'S SPEECH

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ABSTRACT

This longitudinal study investigated how children deploy cues to prominence in a speech task designed to encourage lexical stress shift. The duration, amplitude and F0 of the rhymes in stress-shiftable words were compared in stress clash and non-clash contexts. In adults' speech, lexical and phrasal prominence patterns reinforced each other and were not sensitive to context. In children's speech, the prominence patterns were independent of one another, and the lexical patterns were sensitive to context. A year later, the same children showed more adult-like prominence patterns. The results are interpreted to suggest a developmental progression from more sequentially organized units towards hierarchically structured prosodic phrases.

Keywords: prosody acquisition, lexical stress, accent clash, prominence shift, English.

1. INTRODUCTION

This study focuses on the integration of lexical and phrasal prominences in two-word phrases produced by elementary school children and adults. Prominence patterns in English are shaped by lexical stress and phrasal pitch accents, which may signal focus or phrase boundaries [2, 3, 6, 11, 12]. Stress or accent clash contexts are thought to cause the reorganization of prosodic structure in English phrases.

In adult speech, a leftward shift in prominence can be observed in the context of adjacent stressed syllables, which creates a clash context, e.g., *Eugéne híppie* → *Éugene híppie* [7, 10]. Acoustic studies investigating this kind of clash in adult productions find that prominence shifting does not occur literally, but rather stressed syllables become more like unstressed ones in words where the vowel quality allows for prominence shifting [5, 13]. Stress pattern neutralization in words like *Eugéne* nonetheless corresponds to the perception of a prominence shift from its lexically specified location to the phrase-initial syllable [5, 12, 13]. The motivation for prominence shifting may be to create metrically coherent units [7], or to mark the unit boundary [3, 12], or a combination of these factors. Whether the motivating factor is metrical or intonational, the key idea is that lexical patterns are reorganized to fit within the larger prosodic unit. Since lexical and phrasal prominence patterns are likely to have different courses of development in first-language acquisition, it is possible that children and adults will implement temporal and accentual cues to prominence differently in clash versus non-clash contexts. This paper addresses two questions:

(1) Do children's prosodic patterns differ from adults in clash versus non-clash environments?

(2) What is the developmental trajectory of the prosodic organization of phrases?

To answer the first question, acoustic correlates of lexical and phrasal prominence were analyzed in child and adult productions of two-word phrases that were designed to induce prominence shifting or to preserve the prominence pattern. To answer the second question, acoustic correlates of prominence were measured for a subset of children who repeated the same task a year later.

2. METHODS

2.1. Participants

Year 1 data were collected from 25 first graders, ranging in age from 6;2 to 7;3, and 25 adults (age 18-21). Participants were functionally monolingual native speakers of American English. Children passed a pure-tone hearing screen. Their parents reported no delays in children's speech development, and their vocabulary was typical for their age group.

Year 2 data were collected from a subset of 15 Year 1 children who returned to the lab for follow up study. In Year 2 the children ranged in age from 7;3 to 8;4.

2.2. Task

A counting task was used to elicit maximally rhythmic speech, while still retaining some ecological validity. Participants were asked to

count from 1 to 20 with an intervening noun word. The noun *banána* provided a control non-clash context (e.g., *thirtéen banána*, *fourtéen banána*…). The noun *bárbeque* created a lexical stress-clash context (e.g., *thirtéen bárbeque*), which was meant to encourage stress shift from the *-teen* to the phrase-initial syllable.

2.3. Acoustic measurements

Only the phrases with disyllabic stress-shiftable number words (i.e., 13-16, 18-19) were analyzed. The sonorant rhymes of all syllables (R) were manually segmented [1]. To investigate age and context effects on lexical prominence (i.e., stress), rhyme duration and rms amplitude were measured number words and for the first 2 syllables of the nouns [4]. F0 was also measured, although this measure is arguably more related to phrase-level pitch accents in English than to lexical stress per se [8, 9].

To investigate age and context effects on phrasal prominence, the F0 contour across the phrase was reconstructed by taking the midpoint F0 for all syllables in the phrase.

2.4. Analysis

The data from Year 1 consisted of 600 phrases (12 phrases x 2 groups x 25 speakers). To examine whether children and adults differed in their lexical stress patterns, R1/R2 ratios were computed for duration, amplitude and F0 and submitted to a Repeated Measures Analysis of Variances with the within-subjects factors of Context (N-*teen banána* v. N-*teen bárbeque*) and Word (number v. noun), and the between-subject factor of Group (children v. adults). Four planned comparisons on each measure were conducted to better understand the effect of context on the N-*teen* words within each age group.

Similar analyses were conducted for the 15 children who returned in Year 2 of the study, except that the analyses included three within-subject factors: Time, Context, and Word.

To examine whether children and adults differed in their phrasal stress patterns, normalized F0 contours were reconstructed from the F0 measures for each syllable. Speaker normalization was achieved by subtracting from each measurement the grand mean F0 value for that speaker. Next, the contours were averaged across groups for each context and global patterns were visually inspected. F0 peaks were assumed to signal a pitch accent.

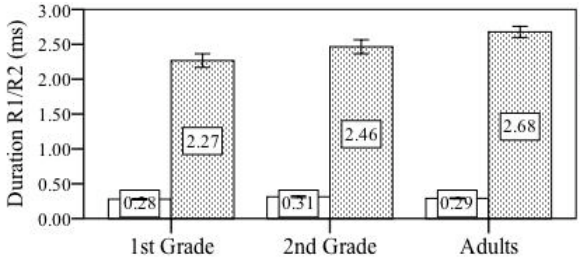
3. RESULTS

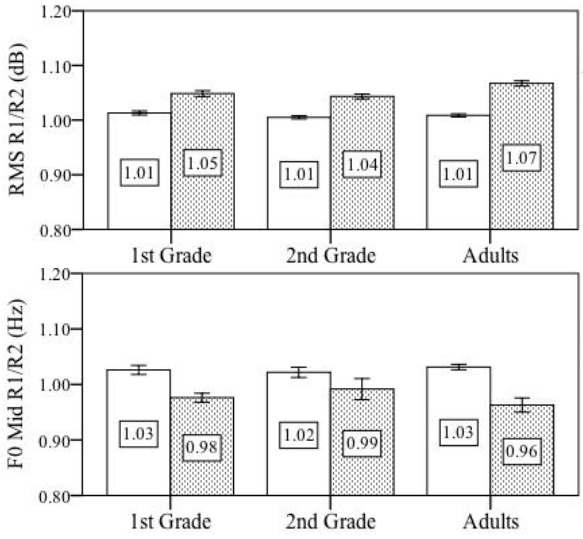
3.1. Lexical Stress

The analyses on Year 1 data indicated significant simple effects of Group, Context, and Word on duration ratios [Group, $F(1,48) = 17.81$, $p < .001$; Context, $F(1,48) = 671.27$, $p < .001$; Word, $F(1,48) = 190.79$, $p < .001$] and on amplitude ratios [Group, $F(1,48) = 14.73$, $p < .001$; Context, $F(1,48) = 21.35$, $p < .001$; Word, $F(1,48) = 6.68$, $p = .013$], but not on F0 ratios. The 2-way interaction between Group and Context almost reached significance for the duration ratios, but not for the other 2 measures. The 2-way interaction between Group and Word was only significant for amplitude ratios [$F(1,48) = 11.56$, $p < .001$]. The 2-way interaction between Context and Word was significant for all of the measures [duration, $F(1,48) = 618.50$, $p < .001$; amplitude, $F(1,48) = 22.99$, $p < .001$; F0, $F(1,47) = 9.33$, $p = .004$]. Finally, the 3-way interaction between Group, Context, and Word was significant for duration ratios [$F(1,48) = 8.21$, $p = .006$] and for F0 ratios [$F(1,47) = 7.80$, $p = .008$].

The analyses on Year 2 data indicated no significant effect of Time on any of the measures, but a significant interaction between Time and Context on F0 ratios [$F(1,13) = 5.18$, $p = .040$]. There were also significant simple effects of Word and Context and the interaction between these two variables on duration [Word, $F(1,14) = 94.07$, $p < .001$; Context, $F(1,14) = 282.92$, $p < .001$; Word × Context, $F(1,14) = 223.27$, $p < .001$] and amplitude ratios [Word, $F(1,14) = 10.30$, $p = .006$; Context, $F(1,14) = 14.54$, $p = .002$; Word × Context, $F(1,14) = 6.17$, $p = .026$]. Figure 1 and 2 below summarize all of the Year 1 and Year 2 results for nouns and N-*teen* words, respectively.

Figure 1: Acoustic correlates of lexical stress in nouns *banána* (white bars) and *bárbeque* (gray bars) for all Year 1 (1st grade and adults) and Year 2 (2nd grade) data. Duration ratios are shown in the top panel (this page), amplitude ratios in the middle panel and F0 ratios in the bottom panel (next page).





The top and middle panels of Figure 1 show that that duration and amplitude correlated with lexical stress in child and adult production of *banána* and *bárbeque*. Specifically, the duration and amplitude ratios are lower for *banána* than for *bárbeque*. The pattern is reversed, however, for F0 ratios, a point to which we will return later.

Figure 2: Acoustic correlates of lexical stress in N-*teen* words as a function of non-clash (white bars) and clash (gray bars) contexts for all Year 1 (1st grade and adults) and Year 2 (2nd grade) data. Duration ratios are shown in the top panel, amplitude ratios in the middle panel, and F0 ratios in the bottom panel.

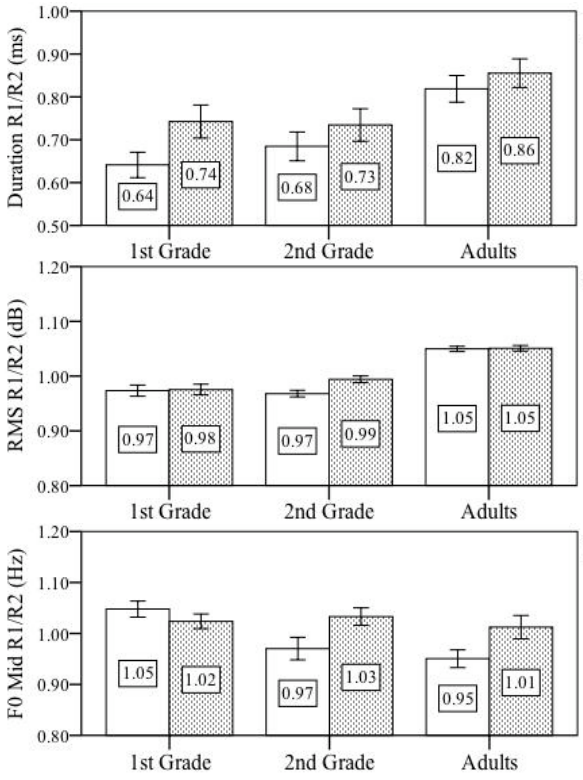


Figure 2 indicates that the stress pattern in the N-*teen* words varied as a function of the context, but not across all measures or all age groups represented in the Year 1 and Year 2 data. Specifically, planned comparisons indicated that the youngest children's duration ratios were significantly different depending on whether the subsequent word was *banána* or *bárbeque* [p = .045] as were F0 ratios for adults [p = .011].

3.2. Phrasal F0 Contours

The analysis of F0 contours indicated that, in Year 1, children and adults differed in where they placed pitch accents. In children's productions, F0 fell from the 1st to the 2nd syllable of the N-*teen* words in the non-clash context [$t(24) = 2.38$, p = .026]. By contrast, in adult productions, F0 fell from the 2nd to the 3rd syllable in non-clash contexts [$t(24) = 2.57$, p = .017] and clash contexts [$t(24) = 2.40$, p = .024]. Thus, children tended to place an accent on the first syllable of N-*teen* words regardless of context; whereas adults made the second syllable in the N-*teen* words relatively more prominent regardless of context. These results are shown in Figure 3.

Figure 3: The average F0 contour for each group in the *N-teen banána* phrases (top panel) and the *N-teen bárbeque* phrases (bottom panel).

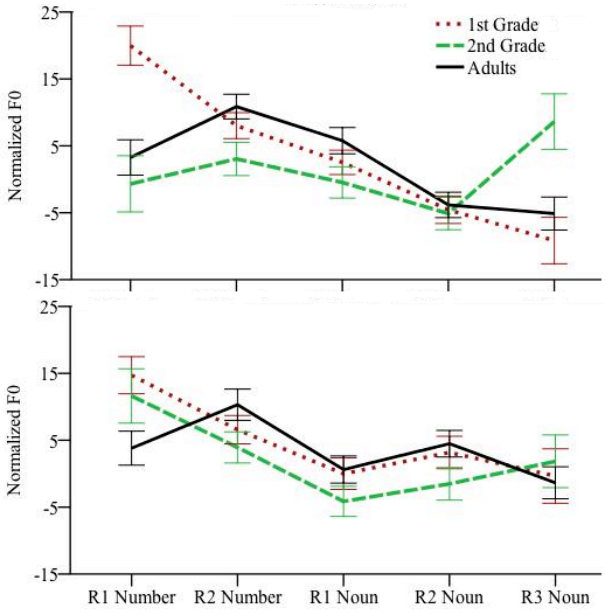


Figure 3 also shows F0 contours for the 15 children who returned a year later to complete the same task again. Similar to adults, the now older

children tended to place a pitch accent on the second syllable of the N-*teen* word in a non-clash context, but like their younger selves, they tended to place a pitch accent on the first syllable in a clash context. Thus, the older children's patterns appeared to be intermediate to their previous productions and adult productions.

4. DISCUSSION

The findings of this study suggest that children and adults integrate lexical and phrasal prominences differently in two-word phrases when prosodic organization is probed by accent clash. Young children appear sensitive to accent clash in that they neutralized the unstressed-stressed pattern of N-*teen* words before the dactylically stressed *bárbeque*. However, phrasal prominences followed a different pattern in that children consistently placed a pitch accent on the first syllable of the N-teen word regardless of the context, perhaps in order to signal the phrase-initial boundary [3, 11]. In this way, the lexical and phrasal patterns appeared to be independent of one another.

In contrast to young children, adult lexical and phrasal prominences were centered on -*teen* regardless of context. The fact that the phrasal pitch accent consistently landed on the second syllable of the N-*teen* word, and the primary acoustic correlates of stress followed this placement, gives the impression that the phrasal prominence subsumed lexical prominence. This organization may indicate that adults grouped the N-*teen* plus noun phrases into a single prosodic unit [7].

When tested again a year later, the children appeared to produce prominence patterns that were intermediate between their earlier patterns and the adult patterns, suggesting a developmental trajectory. Specifically, the primary acoustic correlates of lexical stress were no longer affected by context, but phrasal accents were.

Future work will explore whether the developmental trajectory outlined in this paper is affected by word frequency and/or syllabic structure. In particular, the word *bárbeque* is a lower frequency word than the word *banána* and has a more complicated syllable structure as well (CVCCVCV vs. CVCVCV). Thus the word *bárbeque* may have unduly disrupted children's ability to form larger prosodic units. It is an open question whether children would have exhibited more adult-like patterns had we used a monosyllabic or trochaically-stressed disyllabic noun.

5. ACKNOWLEDGMENTS

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