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# Durational cues which mark clause boundaries in mother–child speech*

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*Received November 1985, and in revised form April, 1986*

Research has shown that infants prefer maternal speech artificially segmented at major syntactic boundaries to speech segmented at other loci. Potential causes for this preference are examined. Phrase and clause boundaries are usually marked by distinctive $F_0$ contour, pre-boundary vowel lengthening and pausing. This study examined patterns of pre-boundary lengthening in mother-child speech. It was found that maternal speech to children on the verge of expressive language ability was characterized by a statistically significant increase in the degree of pre-boundary lengthening normally to be expected in conversational speech. Observable but non-significant pre-boundary lengthening was observed in maternal speech to children using one-word utterances and to children using combinatorial language. It is suggested that maternal speech exaggerates a salient cue to the identification of major syntactic units in conversational speech.

## 1. Introduction

The complex nature of the conversational speech signal and the rapidity with which children acquire language suggest that infants may be equipped with strong innate abilities to process auditory input (see Jusczyk, 1981, for review); additionally, these facts suggest that adults may need to modify their typical conversational speech styles when speaking to young children in order to better allow them to process input (Bernstein Ratner, 1984a,b). It is probable that both tendencies operate cooperatively to allow language learning.

Recently, Hirsh-Pasek, Kemler Nelson, Jusczyk, Wright & Druss (1985) evaluated the hypothesis that the clause boundary serves an important function in infant speech processing by allowing the child to delineate large units within which grammatical hypotheses can be tested. They manipulated a speech sample made of a mother reading to her 19-month-old infant by inserting silences at "natural" boundaries (clause boundaries) and at "unnatural" boundaries (within clauses). They then appraised 7- to 10-month-old infants' preferences for each of these types of speech by means of a visual

*Paper presented at 1985 American Speech-Language Hearing Association Annual convention, Washington, D.C., U.S.A.

0095–4470/86/020303 + 07 $03.00/0

preference task. Hirsh-Pasek *et al.* (1985) found that infants were significantly more likely to prefer speech segmented at clause boundaries.

While interesting, it is unclear what cues in the preferred stimulus speech sample allowed the infants to activate their presumably innate ability to locate clause boundaries. Research has shown that a number of cues reliably cue the presence of phrase and constituent boundaries. These include pausal phenomena (Hayes & Clark, 1970), pre-boundary vowel lengthening (Klatt, 1975), specific pitch contours (t'Hart & Cohen, 1973) and fundamental frequency declination (Cooper & Sorenson, 1981). It would appear that pausing alone is not a sufficient indicator of a syntactic boundary, both from the infants' preference for pauses in particular loci, and from experimental evidence suggesting that adults may add pausal phenomena to other considerations in the determination of clause boundaries (Streeter, 1978). Gleitman & Wanner (1982) have suggested that infants may be "innately biased to treat intonationally circumscribed utterance segments as potential syntactic constituents" (p. 26), and it may well be such an awareness of the usual co-occurence of falling $F_0$ and pausing which led the infants of the study by Hirsh-Pasek *et al.* to prefer speech segmented at natural clause boundaries. However, it is far from clear that $F_0$ declination reliability cues syntactic boundaries in all languages; the data on fundamental frequency patterns of the world's languages is at present quite scanty (Cooper & Sorenson, 1981). Additionally, even for English, rise-fall patterns at syntactic boundaries can be somewhat ideosyncratic (Streeter, 1978).

Because there is some evidence that pre-boundary lengthening occurs cross-linguistically (Cooper & Paccia-Cooper, 1980), this cue is also potentially available to infants attempting to parse speech input. Accordingly, the present study sought to investigate the durational cues which characterize syntactic boundaries in child-addressed speech, and to compare the strength of such cues with those normally observed in adult–adult conversation.

## 2. Method

The present study analysed the speech of nine women, who were followed while engaging in recorded play sessions with their infant daughters over a period of 6 months. Some of the infants were essentially pre-linguistic (ages 9-13 months), some were utilizing expressive one-word utterances and some were combining speech into two- and three-word utterances. As the study progressed, and as the infants matured, it was possible to have more mothers' speech represented in analyses of the two older age groups. Thus, while three mothers' conversations with children were available for the youngest group, seven mothers eventually were recorded conversing with children at the one-word stage, and six mothers were eventually available for an analysis of maternal speech to children at the multi-word stage of child language development.

All mothers were additionally recorded while in conversational interaction with an adult (the researcher). Following procedures discussed in the next section, three paired comparison conditions were constructed to analyse the characteristics of clause-medial and clause-final vowels in adult-adult and adult-child speech:

(1) Mothers of pre-verbal children speaking to their child, and to an adult;
(2) Mothers of children at the l-word stage speaking to their child and to an adult;
(3) Mothers of children with combinatorial language speaking to their child and to an adult.

From transcripts of the conversational interactions, a variety of monosyllabic words were chosen for analysis. A total of 2446 words, representing clause-medial and clause-final loci of occurrence, were excised from audio-tapes by use of a computer waveform segmentation program, and the durations of their embedded vowels were measured and analysed. The program allowed segmentation and measurement of the digitized waveform to the nearest millisecond (FBMain; Klatt, 1975). Criteria for vowel segmentation and measurement were similar to those used by Naeser (1970) and included determination of vowel onset from the point of first patterned amplitude display which followed stop release or frication. Cessation of patterned amplitude display and/or leveling of the display to the zero line were used as cues to vowel termination, in addition to information which signalled the onset of the following consonant. Remeasurement reliability was calculated for 50 data-set tokens; absolute mean error of measurement was found to be approximately 6 ms. Because of inherent problems in segmenting vowels from sonorant consonants, words with such CV or VC sequences were rarely chosen for analysis. For comparisons between adult–adult and mother–prelinguistic child speech, 460 words were available for analysis; for comparisons between adult–adult and maternal speech to children at the one-word stage, 1195 words were available; and for comparisons between adult–adult and maternal speech to the more advanced children, 791 words were selected. Unfortunately, it was not possible to balance the relative proportions of syllable-final voiced and voiceless consonants in each clause position category, though post-vocalic voicing is known to exert an influence on vowel duration (Peterson & Lehiste, 1960; Klatt, 1973). However, *within* each mother–adult and mother–child comparison condition, identical words (hence, identical post-vocalic consonants) were compared in identical clause positions. In each of the three comparison sets, clause-final tokens comprised 28–33% of the words selected for analysis. As vowels are characterized by inherent durational properties, all analyses compared the mean durations of nine specific vowels in medial and final position. For each listener condition, differentials were computed for the relative degree to which each of nine vowel vowel phonemes was lengthened in clause-final position. That is, the average clause-medial duration value for a vowel was subtracted from the average clause-final duration of that vowel to determine the relative clause-final lengthening of that vowel in each addressee condition.

## 3. Results

The results of our vowel duration analyses indicate that mothers significantly increase pre-boundary vowel lengthening when speaking to pre-verbal children (children similar in ability to those of the study by Hirsh-Pasek *et al.*). (See Table 1 and Figure 1). While in adult–adult speech, vowels in clause-final position are expected to be longer in duration than those in clause-medial position, this expected degree of lengthening was almost doubled in speech to preverbal children (almost 50 ms. longer than that observed in the mothers' speech to an adult listener). The mean difference between vowel length in final as opposed to medial position was 52.16 ms for adult–adult speech; this differential increased to 100.74 ms for the adult–child sample. Such pre-pausal lengthening was significantly greater than that seen in the adult–adult condition ($t = 2.3100$, $df = 8$, $p < 0.05$, two-tailed analysis). This exaggeration of a normal speech function became less pronounced in speech to children using single words, when clause-final vowels were only 15 ms longer than those observed in adult–adult speech (mean difference 74.43 ms vs 59.47 ms, $t = 1.4011$, $df = 8$, ns), and became negligible in speech to older children,

TABLE I. Mean vowel durations (in ms) for vowels in clause-medial and clause-final positions in the speech of women addressing adults and children at three stages of language acquisition

| | Adult–Adult | Adult–child |
|---|---|---|
| | Final – Medial = Difference | Final – Medial = Difference |
| Vowels to adults and to prelinguistic children | | |
| /æ/ | 171.9 – 129.8 = 42.1 | 240.6 – 114.6 = 126.0 |
| /ɛ/ | 165.8 – 115.1 = 50.7 | 157.8 – 95.0 = 62.8 |
| /I/ | 129.0 – 98.0 = 31.0 | 152.0 – 95.6 = 56.4 |
| /U/ | 155.6 – 68.0 = 87.6 | 149.1 – 81.4 = 67.7 |
| /a/ | 203.0 – 135.4 = 67.6 | 244.0 – 137.9 = 106.1 |
| /e/ | 180.7 – 146.2 = 34.5 | 174.4 – 133.6 = 40.8 |
| /i/ | 173.8 – 129.1 = 44.7 | 182.5 – 131.0 = 51.5 |
| /o/ | 188.0 – 128.0 = 60.0 | 278.8 – 122.3 = 156.5 |
| /u/ | 177.0 – 124.8 = 52.2 | 360.2 – 124.3 = 235.9 |
| Vowels to adults and to children at 1-word stage | | |
| /æ/ | 184.9 – 112.7 = 72.2 | 209.1 – 101.9 = 107.2 |
| /ɛ/ | 156.3 – 109.1 = 47.2 | 167.5 – 81.4 = 86.1 |
| /I/ | 138.2 – 92.6 = 45.6 | 138.6 – 84.9 = 53.7 |
| /U/ | 150.2 – 72.7 = 77.5 | 101.8 – 71.8 = 30.0 |
| /a/ | 212.4 – 132.3 = 80.1 | 202.0 – 128.4 = 73.6 |
| /e/ | 185.0 – 131.7 = 53.3 | 209.4 – 131.0 = 78.4 |
| /i/ | 175.4 – 135.9 = 39.5 | 158.9 – 129.4 = 29.5 |
| /o/ | 177.8 – 132.2 = 45.6 | 229.0 – 144.8 = 84.2 |
| /u/ | 187.3 – 112.9 = 74.4 | 253.5 – 126.4 = 127.1 |
| Vowels to adults and to children at multi-word stage | | |
| /æ/ | 196.0 – 105.1 = 90.9 | 188.6 – 100.5 = 88.1 |
| /ɛ/ | 129.9 – 76.3 = 53.6 | 195.0 – 83.6 = 111.4 |
| /I/ | 123.9 – 85.4 = 38.5 | 120.2 – 86.4 = 33.8 |
| /U/ | 128.2 – 65.9 = 62.3 | 112.7 – 73.8 = 38.9 |
| /a/ | 192.8 – 125.6 = 67.2 | 215.7 – 108.0 = 107.7 |
| /e/ | 176.9 – 113.3 = 63.6 | 186.4 – 104.9 = 81.5 |
| /i/ | 146.9 – 131.1 = 15.8 | 138.9 – 116.3 = 22.6 |
| /o/ | 179.0 – 127.0 = 52.0 | 210.0 – 115.6 = 95.3 |
| /u/ | 196.7 – 104.6 = 92.1 | 152.8 – 127.1 = 25.7 |

where less than 10 ms increases in clause-final lengthening could be observed (the mean difference for the adult–adult condition was 59.57, that for the adult–child condition was 67.22, $t = 0.604$, df = 8, ns). Klatt (1975) reported that phrase-final vowels were lengthened an average of 30% when compared with vowels within phrases uttered by his subject speaker. The subjects in the present study showed slightly stronger lengthening effects. For the adult-prelinguistic child group, phrase-final lengthening was 44% in speech to the adult, and 87.5% in speech to the infant. For the sample of mothers addressing children at the one-word stage, boundary lengthening was 52% in speech to the adult, and 67% in speech to the child. Mothers of the more advanced children lengthened phrase-final vowels an average of 57% to an adult and 66% to their children. It should be noted that the JND for vowel duration has been noted to vary between 2–33 ms (or 2.5–14%) for vowels having reference durations of 100–200 ms (Lehiste, 1970; Klatt & Cooper, 1975). This would seem to make the small degree of additional pre-pausal lengthening seen in speech to children at the one- and multi-word stages not only statistically insignificant, but also of dubious perceptual salience.

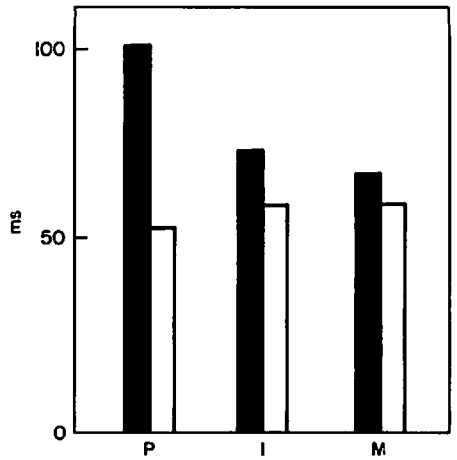


**Figure 1.** Relative clause-final vowel lengthening values for adult and child addressees: □, adult–adult vowel differences; ■, adult–child vowel differences. P = prelinguistic children, I = children at one-word stage, M = children at multi-word stage.

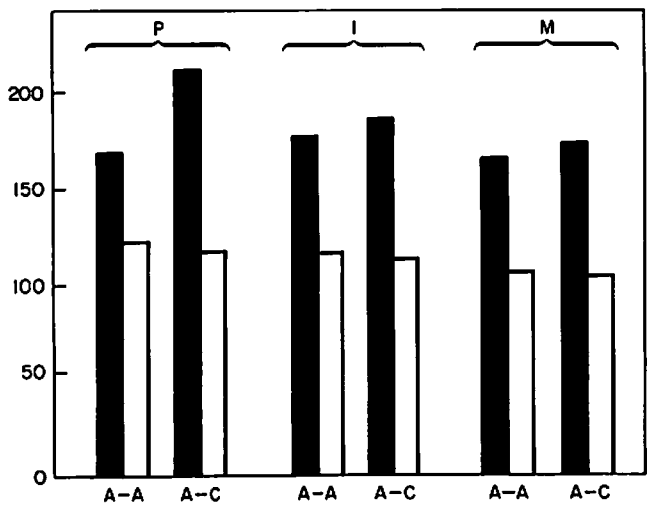


**Figure 2.** Mean vowel durations in final and medial positions: ■, clause-final vowel durations; □, clause-medial vowel durations. A–A = adult–adult, A–C = adult–child. P = prelinguistic children, I = children at 1-word stage, M = children at multi-word stage.

It is interesting to note that the more pronounced cues to clause termination in child-addressed speech are not simply artifactual of a greater duration in all words used to the child listeners. Rather, clause-medial vowels remained almost constant in durational properties across all groups of child and adult listeners (ranging from approximately 102 to 119 ms), while the durations of clause-final vowels varied from 163 to almost 216 ms. Such clause-final vowel lengthening appears to be a linear function inversely determined by the conversational addressee's age and linguistic ability (see Fig. 2).

## 4. Discussion

While it is likely that other cues also enter into the child's ability to locate clause boundaries (such as falling intonation contour), data which indicate that English speakers can identify clause boundaries in unfamiliar languages (Pilon, 1981; Wakefield, Doughtie & Yom, 1974) may suggest that intonation alone is probably not an innate single identifier of clause boundaries, as intonation contours vary across language systems. Given the relatively sophisticated algorithms which have been developed to predict $F_0$ patterns at clause boundaries in English (Cooper & Paccia-Cooper, 1980), it would, however, be of interest to determine whether rise–fall and declination patterns of mother–child speech cue syntactic boundaries more strongly than they appear to do in normal adult conversational speech.

Cooper & Paccia-Cooper assert that "elongation of phrase-final words is observed . . . within the structure of natural languages" (1980, pp. 237). If this is indeed the case on a universal basis, then innate infant preference for units bounded by lengthened final segments could serve a useful function in the language acquisition process. It would certainly appear from the data presented here that maternal speech grossly exaggerates this function, and presumably makes syntactic boundaries even more salient than they might otherwise be, at least for children who are on the verge of developing expressive language ability.

The author wishes to thank Victor Zue, Keith North and other members of the Research Laboratory of Electronics at the Massachusetts Institute of Technology for lending material and technical support during the acoustical analysis phase of this project.

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