Pre-Boundary Lengthening: Universal or Language-Specific? The Case of Hungarian

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1. Introduction

Right edges of prosodic boundaries can be marked by a variety of acoustic cues. Among these features, increased segmental duration, referred to as pre-boundary lengthening (PBL), is of particular interest, because it raises the question of how this phonetic lengthening interacts with segmental length distinctions. While the general consensus is that PBL is widely used among the world’s languages to mark phonological phrasing (Hayes, 1997), and therefore it might be universal (Vaissière, 1983), some languages are considered exceptions. It has been argued, for instance, that languages with phonemic length distinctions, such as Finnish (Lehiste, 1965), Estonian (opt.c.) and Skolt-Sami (McRobbi, 1996) do not have PBL, because they would not utilize duration for additional functions.

In this paper we report the results of an investigation on PBL in Hungarian, a Finno-Ugric language known to have phonemic length distinctions. We begin by showing that there is no convincing evidence against PBL in Finno-Ugric languages, especially not in Hungarian. We will argue based on our data that Hungarian shows a consistent tendency for pre-boundary lengthening, and that the amount of lengthening we observe should be well within the range of perceptibility for native speakers of Hungarian.

2. PBL According to the Literature

2.1. What is PBL?

PBL is one of the acoustic cues used to segment speech into linguistically meaningful units. There is, however, some discrepancies between its use in production and the perception. While adults systematically lengthen boundaries when disambiguating between different syntactic bracketings, 5 and 7-year old children do not use such durational cues (Katz et al. 1996), which indicates that PBL may be a learned behavior (Oller and Smith, 1977). On the other hand, adults and 7-year old children massively rely on durational cues in perceiving the same syntactic groupings (Beach et al., 1996). This is consistent with the “phonological bootstrapping” hypothesis (Gleitman et al,
1988), stating that the phonological phrase structure facilitates the processing of syntactic information by children. It remains, however, an open question exactly what constituents are marked by PBL, and to what extent this marking reflects a hierarchical phrase structure.

### 2.2. What is Lengthened?

Following SPE phonology\(^1\), early studies on PBL assumed a complete overlap between prosodic and syntactic constituents. Therefore, they used a limited set of read-aloud sentences in which syntactic boundaries were selected first, then duration measured. Findings invariably indicated that: 1) PBL reflects the syntactic hierarchy, and 2) it exists in a great variety of languages, such as English (Klatt, 1975; Lehiste et al. 1976), Swedish (Lindblom, 1968), French, Spanish and German (Delattre, 1968), to name the most well-known examples.

In these studies, the domain of PBL could be any size constituent: final vowels and consonants (Lindblom, 1968), final syllables (Delattre, 1968); words (Umeda and Quinn, 1981), syntactic clauses (Streeter, 1978), sentences (Klatt, 1975) and paragraphs (Lehiste, 1979). Based on the type of boundary under investigation, lengthening was called ‘pre-pausal’, ‘phrase-final’ or just ‘final’. This led to the conclusion that “there might be three kinds of lengthening phenomena” (Vaissière, 1983, p.61): the last syllable in a phrase, the last word in a phrase, and the last sentence of a paragraph.

Linguistic theories of the eighties and nineties shed new light on PBL. It is generally accepted that there is a phonological hierarchy of prosodic constituents separate from the surface syntactic structure. The levels of this hierarchy were shown to be recursive, and cued by several acoustic correlates. PBL, for instance, can signal at least four levels of constituency above the word level in English (Ladd and Campbell, 1991), and reflects a three-level prosodic hierarchy—accentual phrase, intermediate phrase and intonational phrase—in French (Jun and Fougeron, 1997). At each level of constituency, the domain of PBL is restricted to the rhyme of the final syllable in English and in Dutch (Wightman and al., 1992). If the rhyme is a schwa, the lengthening spreads over the penultimate rhyme in Dutch (Cambier-Langeveld, 1997). Although the exact number of prosodic constituents varies widely from one study to the other, the “prosodic word” and the “intonational

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phrase” seem to be uniformly accepted as the lowest and highest units above the syllable.

Our study follows recent work on PBL in assuming prosodic constituents separate from syntactic constituents. Since prosodic constituents have not previously been studied independently from the syntactic structure in Hungarian, we used acoustic correlates typical of prosodic constituent boundaries in other language to identify such boundaries in our corpus (see section 3).

2.3. PBL in Finno-Ugric Languages?

As illustrated in the previous section, increased segmental duration is used for boundary signaling in many languages. PBL is, therefore, often considered universal (Vaissière, 1983). This is contradicted, however, by some studies that argue that PBL is nonexistent or perceptually irrelevant in languages where length is phonemic. As for Finno-Ugric languages, a number of sources were repeatedly cited in support of this interpretation (see Oller et al., 1977; Vaissière, 1983). However, by returning to these studies, we found that they either do not mention phonetic lengthening at all, or they dismiss its existence based evidence we find questionable.

One of the studies systematically cited against the existence of PBL in languages with phonemic length distinctions is Lehiste’s 1965 paper about the function of quality and quantity in Finnish and Estonian. In this paper PBL is not even mentionned. Lehiste’s demonstration of different prosodic hierarchies in Estonian (four levels) and in Finnish (three levels) is crucial in showing how quantity and syllabic weight determine word structure in both languages, but it does not concern phonetic lengthening phenomena. PBL, or synonymous expressions, are not evoked as a phonetic cue of the phonological hierarchy Lehiste is concerned with. The reason that this paper is quoted as evidence against PBL remains unclear for us. We can only guess that Lehiste’s statement about vowel quantity not being contrastive at the end of words in these languages might have motivated erroneous references to this paper. As a matter of fact, Lehiste is among the authors who showed that PBL is used to signal prosodic constituency above the level of the intonational phrase (see Lehiste et al., 1976 on ‘paragraphs’).

McRobbi (1994, 1996) also argues that PBL is nonexistent in Skolt-Sami. However, based on references to Lehiste’s papers on paragraphs in speech, she first dismisses the existence of PBL in general:
“It can be stated that durational increase does not play a role in signalling the presence of boundaries...” (McRobbi, 1994, p.383)

This statement is surprising, given the considerable amount of evidence supporting the opposite in both perception and production (see section 2). Despite her previous conclusion on PBL, McRobbi (1996) carries out the study of duration in boundary signalling in Skolt-Sami. By studying disyllabic words embedded in a sentence frame, she reaches the conclusion that that there is a significant decrease in absolute durational values in disyllabics occurring in a paragraph-final sentence. Although her data indicates some durational decrease, we found that the lack of perceptual experiments or statistical significance levels in her paper, makes the significance of this decrease difficult to estimate. Another result of her study, used as an argument against PBL, is that in paragraph-final position disyllabics undergo vowel reduction or drop. According to her table 5 (p.1191), this is true in the controlled experiment where the majority (89%) of disyllabics in sentence-final position are reduced or dropped, as compared to their sentence-initial position (14%). However, this ratio is not confirmed when more than twice as much data are analyzed from spontaneous conversations. In spontaneous contexts, the amount of reduction and drop is the same in both positions: 98% paragraph-initially and 100% paragraph-finally. Based on these studies, the evidence seems insufficient to reject the possibility of PBL in this language.

In Hungarian, the Finno-Ugric language our study is concerned with, no studies argued that PBL is nonexistent. On the contrary, present-day and historical data indicate some amount of lengthening at the boundaries of syntactic constituents in the language (Kassai, 1979; 1982). However, this lengthening was systematically dismissed, because the authors concluded that it is not perceptually relevant. Kassai (1979; 1982), for instance, shows that vowels and consonants are longer at the end of words and sentences. She even states that durational differences between segments in sentence-initial and sentence-final positions are the only non-negligible difference in her corpus. However, she also seems to conclude that this amount of lengthening is not perceptually relevant, because the listener tends to compare sentence-final durational cues to their sentence-medial (and not sentence-initial) counterparts (Kassai, 1982, p. 136). We do not think this assumption about the mechanism of perceptual processes is correct. In the following sections, we argue that the amount of lengthening we observe in our data must be perceptible.
3. Corpus and Data

The data for this study comes from a corpus of approximately 3 hours of restricted spontaneous speech transcribed, digitized and analyzed by the authors, using Entropics’ acoustic analysis software. Two native Hungarian speakers (one male and one female) from Budapest were taped in a quiet room, using head mounted directional microphones, while exchanging information about the actions and characters in simple computer animations. The speakers were recorded in three dialog situations, representing decreasing control of the investigator over the speech material: question-answer, directed description and undirected description (see Hockey, 1998 for more detail). There were two sequences of 24 animations used as stimuli in recording the participants. Data for this study came from each participants’ directed and undirected descriptions, as well as from their answers in the question-answer task.

As opposed to previous studies using read-aloud speech produced in laboratory conditions (see 2.), our corpus has the advantage of a controlled situation and of spontaneous speech production: the speakers were engaged in a constrained task, but they spoke spontaneously within the context of performing the task. On the other hand, the restricted context and limited vocabulary provided many occurrences of identical words uttered in different prosodic positions by both speakers. 130 pairs of words were selected from this corpus. These target words were paired according to their occurrences in each of two prosodic positions: (i) Intonational Phrase-final (IPF) and (ii) Intonational Phrase-medial (IPM). To insure clear cases of IPF words, we only considered the last word of turn-final utterances followed by major pitch movements, pauses or hesitations, i.e. any one or more of prosodic features typically associated with major prosodic boundaries. For IPM words, we excluded all items preceded or followed by any such boundary cues. The following utterances show the target word esernyő ‘umbrella’ in the two prosodic positions:

Intonational Phrase Medial (IPM):
A zöld esernyő nekiütközik a fekete lakatnak.
‘The green umbrella (with)hits the black padlock(with)’
(h-aja-t2s1, anim. 20, Line 169)

2 The carat sign (^) stands for double-bar accent used in the spelling of long labial vowels.
Intonational Phrase Final (IMF):

*Fekete lakatnak ütközik a fehér esernyő.*
“The black padlock(with) hits the white umbrella’
(h-aja-t2s1, anim. 20, Line 174)

The animation corpus provided multiple instances of various nouns, adjectives, adverbs, verbs and particles in both IPM and IPF positions. Out of the 130 matched pairs of words, 58 pairs were produced by the female speaker, and 72 pairs by the male speaker.

Durations of IPM and IPF words were measured. Since the corpus of IPM and IPF items did not contain utterance-initial words, silent periods of stop consonants in both positions could be measured accurately. We also measured individual vowels in order to compare the long to short vowel ratios in our corpus to previous reports of these ratios for Hungarian. Vowels were measured from the onset to the offset of voicing, bursts of stop consonants were excluded from vowel durations. If two adjacent vowels or vowels and glides occurred, the segmentation was decided on the basis of formant transitions and perceptual judgements.

4. **Results and Discussion**

The result of our matched pair analysis, shown graphically in figure 1, is the finding that intonational phrase-final tokens of words are systematically longer than their intonational phrase-medial partners. This result is significant at *p*<.0001, using the Wilcoxon signed rank test. It is clear from the scatterplot in figure 1 that the significance of the result comes more from consistency of the phenomenon rather than from huge differences in duration between intonational phrase-final and intonational phrase-medial items. In other words, while the difference in duration between IPM and IPF items may not always be large, the IPF words are almost always longer. Contrary to what might have been expected, it appears that Hungarian speakers are consistently using increased duration to mark phrase boundaries in the same way that speakers do in other languages, such as English. This result clearly contradicts previous assumptions about the absence of PBL in languages with phonemic length, and it supports the hypothesis that PBL is likely to be universally used by languages to cue major prosodic boundaries.
This result is not completely new, since earlier studies on Hungarian clearly showed effects similar to figure 1. As discussed in Section 2, systematic lengthening of vowels and consonants in final position is a well-documented phenomenon in the Hungarian phonetic literature. However, PBL was rejected as a legitimate boundary cue, because people thought it is not perceptually relevant. The lack of perceptual experiments in the literature led us to wonder if this is simply speculative, and to ask what type of data could address the question of perceptual relevance. We decided to compare the difference in duration between IPF and IPM items with a durational difference known to be crucial in the language. Hence we compared the differences in IPF and IPM durations to those of long and short vowels. We measured the duration of individual vowels within the target words, and then calculated: 1) the ratios of long to short vowels, and 2) the ratios of IPF to IPM vowels. We did not distinguish between vowels in different positions within the word or between syllable-types. Our hypothesis was that if we found that the IPF/IPM ratio was as large or larger than the long/short ratio, we could conclude that the IPF/IPM distinction must be perceptually relevant. If this is
the case, then it seems likely that speakers and hearers of Hungarian can use PBL as a distinction since it is as noticeable as the phonemic length. Table 1 shows that in fact our hypothesis seems to be correct. There are IPF/IPM ratios that are bigger than long/short ratios.

**Table 1**: Duration ratios for long/short and IPF/IPM distinctions.

<table>
<thead>
<tr>
<th>Vowel</th>
<th>long/short</th>
<th>IPF/IPM</th>
<th>N (IPM/IPM pairs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>1.52:1</td>
<td>1.13:1</td>
<td>46</td>
</tr>
<tr>
<td>i:</td>
<td>1.04:1</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>1.47:1</td>
<td>1.18:1</td>
<td>131</td>
</tr>
<tr>
<td>e:</td>
<td>1.25:1</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td><em>no data</em></td>
<td>0.99:1</td>
<td>13</td>
</tr>
<tr>
<td>y:</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>u</td>
<td><em>no data</em></td>
<td>0.99:1</td>
<td>14</td>
</tr>
<tr>
<td>u:</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ø</td>
<td>1.81:1</td>
<td>1.37:1</td>
<td>31</td>
</tr>
<tr>
<td>ø:</td>
<td>1.52:1</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>o</td>
<td>1.66:1</td>
<td>1.10:1</td>
<td>64</td>
</tr>
<tr>
<td>o:</td>
<td>2.27:1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>1.78:1</td>
<td>1.21:1</td>
<td>37</td>
</tr>
<tr>
<td>a:</td>
<td>1.36:1</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

For example, the IPF/IPM ratio for /ø:/ is as big as the long/short ratio for /i/ and larger than the long/short ratio for /e/. The IPF/IPM ratio for /ø:/ is larger than any of the long/short ratios including the long/short ratio between /ø:/ and /ø/. It seems unreasonable to assume that speakers would be able to perceive a 1.66:1 difference between /ø:/ and /ø/ but not a 2.27:1 difference between /ø:/ in IPF and IPM positions. This is particularly significant in light of the fact that we did not control for position of the vowel within the word, and controlling for position in the word is likely to make the ratios even larger in the same direction.

Table 2 shows vowel length ratios in our corpus compared to two previous studies. Meyer and Gombócz’s historical data were taken from Kassai (1979). The ratios shown for Kassai (1979) were recalculated for those type of items by the second author, based on the tables Kassai provides. We have sufficient data for comparison of 5 of the 7 long/short vowel pairs. As might be expected for a corpus of spontaneous speech as opposed to read
minimal pairs, the ratios in our corpus show less variation. It has been
claimed that high vowel ratios should be bigger than the ratios for lower
vowels, but this is not supported by either our ratios or the ratios we cal-
culated from Kassai’s data. For example the ratio of /i:/ to /i/ is 1.52:1 for us
and 1.28:1 for Kassai. This is smaller than the ratios for /a:/ to /a/ in both
studies: 1.78:1 in our corpus, and 1.82:1 in Kassai’s corpus. The claim that
vowel ratios should be larger for vowels distinguished only by length is also
not supported (see appendix for vowel chart). The same comparison be-
tween /i:/ and /a:/ just discussed also demonstrates this point. The most
important point is that in spite of the difference in speech style (spontaneous
vs. read) our vowel ratios are sufficiently similar to previously reported
vowel ratios that our results on PBL cannot be discounted as a peculiarity of
our corpus.

Table 2: Ratios of long to short vowels in three studies.

<table>
<thead>
<tr>
<th>Vowel</th>
<th>H &amp; F (1998)*</th>
<th>Kassai (1979)**</th>
<th>Meyer &amp; Gombócz (1925)***</th>
</tr>
</thead>
<tbody>
<tr>
<td>/i:/</td>
<td>1.52:1</td>
<td>1.28:1</td>
<td>2.11:1</td>
</tr>
<tr>
<td>/e:/e</td>
<td>1.47:1</td>
<td>1.25:1</td>
<td>1.69:1</td>
</tr>
<tr>
<td>/y:/y</td>
<td>no data</td>
<td>1.79:1</td>
<td>1.97:1</td>
</tr>
<tr>
<td>/u:/u</td>
<td>no data</td>
<td>2.00:1</td>
<td>2.02:1</td>
</tr>
<tr>
<td>/ø:/ø</td>
<td>1.81:1</td>
<td>1.60:1</td>
<td>1.86:1</td>
</tr>
<tr>
<td>/o:/o</td>
<td>1.66:1</td>
<td>1.89:1</td>
<td>2.11:1</td>
</tr>
<tr>
<td>/a:/a</td>
<td>1.78:1</td>
<td>1.82:1</td>
<td>1.78:1</td>
</tr>
</tbody>
</table>

* spontaneous speech, all types of syllables, 1-6 syllable words
** minimal pairs, open syllables, 1-4 syllable words
*** minimal pairs, all syllables, one-syllable words

5. Conclusion

In this paper we have shown that Hungarian, a language with phonemic
length also has consistent preboundary lengthening. Contra previous work
which also noted this lengthening but claimed that it was not perceptually
relevant, we presented evidence that PBL is as great or greater than differences
in length between short and long vowels. Since it is clear that native speak-
ers of Hungarian are able to perceive the difference between long and short
vowels, we conclude that it is highly likely that they are also able to perceive
PBL. This suggests that the use of phonemic length in a language does not
preclude the use of PBL and that Hungarian does not seem to be an exception to the universality of PBL.

6. Appendix

Vowels of Hungarian: 5 pairs of vowels are distinguished by length only, 2 pairs of vowels differ both in length and in quality.

\[ \begin{array}{c}
\varepsilon \\
\varnothing \\
e: \\
i: \\
y: \\
\varnothing: \\
o: \\
a: \\
\end{array} \]

\[ \begin{array}{c}
u: \\
o: \\
\end{array} \]

References


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